ASSOCIATION BETWEEN STROKE RISK FACTORS

AND ACCESS TO CARE

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ABSTRACT

A number of medically diagnosed risk factors are associated with an increased risk of having a stroke. Individuals recognized with hypertension, diabetes, and dyslipidemia all show greater probability of experiencing a stroke. Rural inhabitants are often considered to have limited access to health care, thus frequently decreasing the likelihood of their being aware of, treated, or controlled for these and other stroke-risk factors. This investigation provides an avenue for exploration into the association nontraditional risk factors for stroke, rural/urban designation, and travel time to a usual source of health care have on awareness, treatment, and control of hypertension, diabetes, and dyslipidemia.

The association between awareness, treatment, and control of stroke-risk factors and an individual's rural/urban status was investigated to identify geographic disparities. Furthermore, travel time to a participant's usual source of medical care was explored for its relationship to these stages of stroke-risk factors and to investigate how travel time might influence the association between these factors and rural/urban status.

No associations were identified for the main effects between the likelihood of being aware of, treated, or controlled for stroke-risk factors, and living in rural and urban settings. Drive time showed no relationship with these stages of stroke-risk factors, nor did it modify the effect rural or urban status had on the dependent variables. Disparities were noted for demographic, socioeconomic, and health behavioral traits for all three risk factors.

This project made use of REGARDS study data sources to provide an understanding of stroke disparities for a certain geographic dimension. However, these data alone are unable to specifically identify rural and urban differences in stroke-risk factors and assess what effects access to health care has on the management of stroke-risk factors. The results from this investigation specify limited variability for management of these conditions by this study's measures of access to care.

LIST OF ABBREVIATIONS AND SYMBOLS

α	A measure of reliability of a statistical test based on the scores obtained by a sample of individuals
A-T-C	Awareness, Treatment, and Control of stroke risk factors
B	Sign of the original logistic regression coefficient
CATI	Computer-Assisted Telephone Interviewing
χ^2	A test of goodness-of-fit of a set of observations to a theoretical discrete distribution
CI	Confidence interval is an interval derived from a sample that has some stated probability of containing the value of some unknown population parameter
CVD	Cardiovascular Disease
df	Degrees of freedom is the number of values that can be assigned freely, without restriction
dL	deciliter
ECG	Ecocardiogram
EMSI	Examination Management Services Inc.
Hg	Mercury
mg	milligram
mm	millimeter
n	A finite subset of a population or other set of items

NA Not applicable

OR Odds ratio is the ratio of the probability of an event occurring to the probability of the event not happening, which is used as a measure of the dependent variable in logistic regression

p Probability, under the null hypothesis, of the statistic taking a value as extreme as or more extreme than the one calculated

R^2 The ratio of the sum of squares regression to the total sum of squares

REGARDS Reasons for Geographic and Racial Differences in Stroke Study

RUCA Rural-Urban Commuting Area Codes

SD Standard deviation is the positive square root of the average of the squares of the deviations from the mean and is a dispersion of the numbers

$\overline{x}$ The arithmetic mean or average of a set of observations in their sum divided by the number of observations

† Denotes a p-value based on Pearson's chi-squared test

‡ Denotes a p-value based on a Wald chi-squared test or insufficient number of observations per category for comparison

< Less than

= Equal to

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Abstract

Background and Purpose **–** Hypertension is one of three major risk factors for cardiovascular disease and affects approximately 65 million people in the United States. This study focuses its efforts on the role access to primary care has on REGARDS study participants as it pertains to awareness, treatment, and control of hypertension.

Methods **–** The association between awareness, treatment, and control of hypertension and an individual's rural/urban status was investigated to identify geographic disparities. Furthermore, travel time to a participant's usual source of medical care was explored for its relationship to these stages of hypertension and for its influence on the association between hypertension and rural/urban status.

Results **–** No associations were identified for the main effects between the likelihood of being aware of, treated, or controlled for hypertension and living in rural and urban settings. Drive time showed no relationship with these stages of hypertension nor did it modify the effect rural or urban status had on the dependent variables. Disparities were noted for demographic, socioeconomic, and health behavioral traits.

Conclusion **–** Results from this study suggest that living in rural and urban settings has little to no implication on an individual's awareness, treatment, or control of hypertension, even when examined with travel time to a usual source of health care. Rural/urban status is, however, a dynamic variable and could be scrutinized from a more specific perspective to uncover why such an anomaly is present.

Introduction

Cardiovascular disease is one of the foremost health concerns in the United States and is particularly disproportionate in certain races and geographic locations. Geographic variations in heart disease and stroke have been widely documented.[1-6] The cardiovascular risk profile of Southern states compares poorly to that of other states, with self-reported prevalence of hypertension, diabetes, and dyslipidemia higher than most of the nation.[2] Moreover, these conditions are risk factors for stroke and are frequently heightened in the African-American community.[4,7] Hypertension is one of three major risk factors for stroke and many other cardiovascular diseases and affects approximately 65 million people in the United States.[3,8] Prevalence of hypertension is considerably higher in African-American populations and in the South, and inadequate control of hypertension has been suggested as one of the most likely causes of stroke.[5,9-11] Previous findings from the National Health and Nutrition Examination Survey (NHANES) and the Reasons for Geographic and Racial Differences in Stroke (REGARDS) study indicate higher awareness and treatment, but poorer control, of hypertension among blacks than among whites.[4,5] These geographic and demographic disparities may, however, not only be inherent between regions but also exist in regard to the rural or urban make-up of the United States. Residents in rural areas often experience an increased risk for stroke due to an elderly population, increased prevalence of hypertension and diabetes, and higher rates of cardiovascular disease, and smoking.[12,13] Furthermore, in many parts of the United States, rural populations reside significant distances from large health and medical centers and often have limited access to these facilities because the majority of rural areas are designated as Health Professional Shortage Areas (HPSAs) and have less than the recommended numbers of primary medical care providers per population.[14] This investigation focuses its efforts on a geographic examination of the association between the awareness, treatment, and control (A-T-C) of hypertension and an individual's rural/urban designation. An additional dimension of access to care is inspected through the drive time to primary care (as indexed by travel time to the physician) so as to observe effect modification to the rural/urban relationship.

Minority and rural populations are at an increased risk for developing hypertension and are particularly susceptible to the effects limited access to care can have on high blood pressure and other health conditions.[15-18] The limited access people in rural areas encounter can result in a lack of diagnosis, an inability to obtain prescription medication, and difficulty in monitoring blood pressure. The REGARDS project is a study sponsored by the National Institutes of Health (NIH) that focuses on learning the root causes of racial and geographic disparities in stroke mortality. Investigations from REGARDS and other studies have shown geographic and racial disproportions in the prevalence, as well as in the awareness, treatment, and control of hypertension.[4,5,19-21]

This study utilizes the REGARDS study data set to identify and locate participants with hypertension in order to investigate differences and associations of awareness, treatment, and control of hypertension relative to participants' rural/urban status and the time it takes them to access their usual source of medical care as characterized by travel time to the facility. Although several studies have examined geographic and racial disparities of stroke risk factors such as hypertension, to our knowledge there have been few, if any, reports investigating the relationship between A-T-C of hypertension and a person's rural/urban profile. Rural inhabitants are often considered to have limited access to health care, thus decreasing their likelihood of being aware of, treated, or controlled for hypertension. Although access to care is a dynamic point of interest and involves many factors, this study considers travel time as a surrogate measure of the access to care. However, we acknowledge that access may also be confounded with factors such as socio-economic status (SES). For example, even with the same travel time, a low-SES individual who does not own a car may have poor access compared to a higher-SES individual who does own a car. The REGARDS study provides an avenue to explore the association that access-to-care risk factors for cardiovascular disease (rural/urban status and drive time to usual source of medical care) have on A-T-C of hypertension. These possible barriers to accessing primary medical care could potentially cause people to postpone preventive medical services until significant advancement of a disease has occurred. This study seeks to investigate the possible differences and associations rural/urban designation and travel time to a usual source of medical care has on a person's adeptness in their awareness, treatment, and control of hypertension. Specifically,

- Is there an association between A-T-C of hypertension among REGARDS study participants when considering rural or urban residency?
- Is there an association between driving time to a usual source of medical care and A-T-C of hypertension?
- Is the association between rural or urban residency and A-T-C of hypertension different when considering drive time to a usual source of medical care? In other words, does travel time act as an effect modifier to the impact of rural/urban designation?

Methods

This study seeks to identify and measure geographic and racial variations pertaining to the awareness, treatment, and control (A-T-C) of hypertension. Recognition of these differences provides insight into varying geographic degrees in which hypertension A-T-C disparities occur. Furthermore, this project aims to investigate the association between hypertension and access to an individual's usual source of medical care. These objectives will be pursued through secondary data analysis of the REGARDS study data combined with efforts to geographically match participants with rural and urban designations.

REGARDS Study

The REGARDS study is based on a nationally distributed longitudinal cohort consisting of 50% black and 50% white participants whose baseline and first round of data were collected from January 2003 to October 2007. This observational study is comprised of more than 30,000 adults 45 years of age and older with a focus of learning more about factors that increase the risk of stroke. Participants were selected from a commercially available nationwide list purchased from Genesys Inc. The recruitment goal for REGARDS was 30,000 participants, including 30 percent from "Stroke Belt" states (North Carolina, South Carolina, Georgia, Alabama, Arkansas, Louisiana, Tennessee, and Mississippi), 20 percent from the region known as the "Stroke Buckle" (coastal region of North Carolina, South Carolina, and Georgia), and the remainder proportionately selected from throughout the continental United States. The racial and gender demographics for each region were equivalent numbers of black and white participants, and equal numbers of male and female participants.[1,22]

A letter and brochure about the REGARDS study were sent to potential participants two weeks prior to attempting contact by telephone. Random household members were selected for accurate representation. Interviewers called throughout the day and evening, both weekdays and weekends. Once contact was made, participants 45 years of age and older were screened for eligibility. Exclusions included race other than black or white, active treatment for cancer, medical conditions preventing long-term participation, cognitive impairment as judged by the interviewer, residence in or waiting for admittance to a nursing facility, or an inability to communicate in English. Verbal informed consent was requested upon establishment of eligibility. After consent was obtained, a medical history, including risk-factor evaluation, was collected by computer-assisted telephone interviewing (CATI).[23,24] CATI was used for quality control. Following the telephone interview, an in-home exam was scheduled at the participant's convenience. Participants were asked to fast for 10 to 12 hours before the visit and to have medications present for recording. Examination Management Services Inc. (EMSI) technicians trained for the REGARDS study conducted the in-home exams and shipped blood and urine samples to a central laboratory. Written informed consent was obtained by EMSI personnel. Standardized methods were used to collect physical measurements, resting ECG, medication inventory, phlebotomy, and a urine sample. Participants wishing not go forth with the exam were classified as partial participants. Questionnaires were left with participants to collect additional demographic and risk-factor information. These forms were completed by participants after the visit and returned to the Operation Center via a self-addressed, prepaid envelope. One of the forms requested information about participants' primary medical care. This form contained questions about participants' travel time to their usual source of medical care, their perception of the medical care, and their confidence in their doctor. Six to eight weeks after the in-home visit, participants were mailed a thank you letter and a check for $30.[22]

Table 1.

REGARDS Study components and method of collection.			
Component	**Telephone interview**	**In-home interview**	**Self-administered**
Medical history	X		
Personal history, demographics, SES	X		
Stroke-free status	X		
Physical activity	X		
Depression	X		
Cognitive screening	X		
Perceived health/quality of life	X		
Social support	X		
Social network	X		
Potential caregivers	X		
Laboratory assays		X	
Urine		X	
Height, weight, waist circumference		X	
Blood pressure, pulse		X	
Electrocardiography		X	
Medication in past two weeks		X	
Residential history			X
Dietary intake			X
Family history			X

Components of the REGARDS study data are found in Table 1. The components are made up of variables including age, race, and gender of the participant, history of heart disease, kidney disease, reproductive history, aspirin use, cigarette smoking (including smoking status, pack-years exposure, and exposure to passive cigarette smoke), alcohol intake, physical activity level, general health (MOS short form-12),[25] access to health care, insurance status, marital status, measures of socioeconomic status (education and income), indicators of existing social networks,[25] psychosocial factors (social network, depressive symptoms, and stress), history of cardiovascular procedures (endarterectomy, coronary artery bypass surgery, peripheral vascular surgery, and percutaneous transluminal coronary angioplasty), and history of myocardial infarction and/or stroke. Data pertaining to previous stroke symptoms were determined using the Questionnaire for Verifying Stroke-Free Status.[26] Depressive symptoms were determined by use of the Center for Epidemiologic Studies Depression Scale[27] and Cohen's Perceived Stress Scale.[28] Cognitive function was measured by the Six-Item Cognitive Screener.[29] Information about participants' residence included city and state of birth and all other cities and states lived in up to and including the present residence.

RUCA Codes and Rural Health Research Center

Rural-Urban Commuting Area (RUCA) codes are a U.S. Census tract-based classification scheme developed by the U.S. Department of Agriculture to characterize census tracts based on their rural and urban status and relationship.[30] RUCA version 2.0 was created from 2000 census commuting and census tract information. The purpose of the codes is to identify urban cores and adjacent territory that are economically integrated to the core. RUCA designations have been used previously in health-related research to classify rural and urban status and to offer geographic guidance about access-to-care concerns.[31-34] The designations provide an appropriate and innovative classification scheme for this study because they recognize how limited access to care might affect A-T-C of hypertension. The RUCA classification scheme is made up of 10 primary codes and 30 secondary codes (Table 2). The codes offer a delineation of metropolitan and non-metropolitan settlements based on size and direction of commuting flows. The RUCA codes for this project are reduced to a two-category classification by collapsing the 10 primary codes, as suggested by information provided by the Rural Health Research Center.[35]

The Rural Health Research Center is one of six research centers funded by the Health Resources and Services Administration's Federal Office of Rural Health Policy and is tasked to perform policy-oriented research on matters related to rural health care. Methods developed by the center combine RUCA code designations to highlight distinctions between rural and urban sections of a state.[35] Previous studies have made use of this code aggregation to compare geographic access to health care and quality of care for myocardial infarction in rural and urban hospitals.[36,37] The two categories for rural or urban designation examine the urban category against a collapsed category that combines large rural, small rural, and isolated codes[30,35] (Table 3). Although the analysis performed in this study only specifies whether or not an area is rural or urban, this binary grouping is based on RUCA categorized census tracts and is, therefore, derived from a more specific stratification than rural/urban designations resulting from a simple, county-level classification of rural and urban.

Table 2.

Rural-Urban Commuting Areas (RUCAs), 2000
1 Metropolitan area core: primary flow within an urbanized area (UA)
1.0 No additional code
1.1 Secondary flow 30% to 50% to a larger UA
2 Metropolitan area high commuting: primary flow 30% or more to a UA
2.0 No additional code
2.1 Secondary flow 30% to 50% to a larger UA
3 Metropolitan area low commuting: primary flow 5% to 30% to a UA
3.0 No additional code
4 Micropolitan area core: primary flow within an Urban Cluster of 10,000 to 49,999 (large UC)
4.0 No additional code
4.1 Secondary flow 30% to 50% to a UA
4.2 Secondary flow 10% to 30% to a UA
5 Micropolitan high commuting: primary flow 30% or more to a large UC
5.0 No additional code
5.1 Secondary flow 30% to 50% to a UA
5.2 Secondary flow 10% to 30% to a UA
6 Micropolitan low commuting: primary flow 10% to 30% to a large UC
6.0 No additional code
6.1 Secondary flow 10% to 30% to a UA
7 Small town core: primary flow within an Urban Cluster of 2,500 to 9,999 (small UC)
7.0 No additional code
7.1 Secondary flow 30% to 50% to a UA
7.2 Secondary flow 30% to 50% to a large UC
7.3 Secondary flow 10% to 30% to a UA
7.4 Secondary flow 10% to 30% to a large UC
8 Small town high commuting: primary flow 30% or more to a small UC
8.0 No additional code
8.1 Secondary flow 30% to 50% to a UA
8.2 Secondary flow 30% to 50% to a large UC
8.3 Secondary flow 10% to 30% to a UA
8.4 Secondary flow 10% to 30% to a large UC
9 Small town low commuting: primary flow 10% to 30% to a small UC
9.0 No additional code
9.1 Secondary flow 10% to 30% to a UA
9.2 Secondary flow 10% to 30% to a large UC

10	Rural areas: primary flow to a tract outside a UA or UC
10.0	No additional code
10.1	Secondary flow 30% to 50% to a UA
10.2	Secondary flow 30% to 50% to a large UC
10.3	Secondary flow 30% to 50% to a small UC
10.4	Secondary flow 10% to 30% to a UA
10.5	Secondary flow 10% to 30% to a large UC
10.6	Secondary flow 10% to 30% to a small UC

Table 3.

Two and Four Category Rural/Urban Classification.

2 Category	4 Category	RUCA Code
Rural	Isolated	10.0
		10.2
		10.3
		10.4
		10.5
		10.6
	Small Rural	7.0
		7.2
		7.3
		7.4
		8.0
		8.2
		8.3
		8.4
		9.0
		9.1
		9.2
	Large Rural	4.0
		4.2
		5.0
		5.2
		6.0
		6.1
Urban	Urban	1.0
		1.1
		2.0
		2.1
		3.0
		4.1
		5.1
		7.1
		8.1
		10.1

Analysis

Awareness, treatment, and control (A-T-C) of hypertension is defined using the approach of Howard et al.[4] Their measurements for blood pressure were obtained from the average of two blood pressure readings acquired as part of the REGARDS in-home examination survey. Hypertension was defined as a systolic blood pressure reading of ≥ to 140 mm Hg and diastolic blood pressure reading of ≥ 90 mm Hg, or by the participant's self-report of high blood pressure. Female participants who were told they were hypertensive only while pregnant were coded as normotensive. Data from the REGARDS baseline survey and the in-home exam were used to define hypertension "awareness," "treatment," and "control." Participants considered "aware" of hypertension answered "yes" to "Has a doctor or other health professional ever told you that you have high blood pressure?" Participants considered "treated" for hypertension were the proportion of the "aware" population that answered "yes" to the question "Are you now taking any medicine for high blood pressure?" Participants considered "under control" for hypertension were the proportion of the "treated" population that had an average blood pressure measurement of a systolic reading < 140 mm Hg and a diastolic reading < 90 mm Hg as collected from the in-home exam. Additional variables from the REGARDS baseline survey were used to examine and control for other areas of interest, including demographics, smoking and alcohol use, physical activity, and general health.

Participants from the REGARDS study were geographically matched based on rural/urban designation as per address information collected from the REGARDS baseline survey, which has already been geo-coded to the census track level (the level required for RUCA code assignment). A total of 30,239 individuals completed the telephone interview followed by an in-home physical exam, which constitutes the sample for the baseline survey. The "You and

Your Doctor" form, where drive time to participants' usual source of medical care was collected, was part of the mail-in questionnaires received six to eight weeks after the in-home exam. The resulting sample after participants from the baseline survey were assigned a RUCA code and matched to those who completed and returned the "You and Your Doctor" questionnaire was 14,374. In order to identify participants with hypertension, subjects must have had a systolic blood pressure of ≥ 140 mm Hg or a diastolic blood pressure ≥ 90 mm Hg, or have self-reported that they were taking medications for high blood pressure. After controlling for these measures, the sample resulted in 8,336 hypertensive participants.

Statistical analysis was done using Statistical Analysis Software (SAS) version 9.2. A descriptive breakdown provided the sample characteristics. Information about sample size, as well as strata on basic demographic and geographic values such as gender, race, and rural/urban designation, is provided. Pearson's chi-square and an independent sample t-test were used for comparison of the sample characteristics table between the "hypertension A-T-C" variables and the independent variables (Tables 4,7,10). The association between A-T-C of hypertension and rural/urban status was investigated through a series of logistic regression models. The first model examined the unadjusted relationship between A-T-C of hypertension and the participant's rural or urban designation. Second, a model making an adjustment for drive time to a usual source of medical care in order to expose any effect modification this variable may render on the relationship between A-T-C of hypertension and the participant's rural/urban status was used. The final two logistic regression models were enhanced to include demographic and behavioral descriptions, as well as interactions between race, gender, and socio-economic variables, to expose underlying relationships of known inconsistencies.

Results

Awareness of Hypertension

Of the 8,336 hypertensive participants, 7,725 (92.7%) were aware of their condition (Table 4). No differences were observed between the proportion of rural participants and urban participants who were aware of their condition or in the mean drive times for those who were aware versus those who were not aware. Blacks (93.9%) were significantly ($p<.001$) more aware of their hypertension than whites (91.4%), while females (93.9%) were significantly ($p<.001$) more aware than males (90.4%). Socioeconomic factors were also significant, with both lower income ($p=.006$) and lower education ($p=.002$) participants trending toward being more aware. All health behaviors and perception of health showed significant differences. Individuals who reported never smoking (93.4%, $p<.001$) as well as not using of alcohol (93.7%, $p<.001$) displayed the highest proportion of those aware of being hypertensive, while individuals who were the most active with regular exercise (91.8%, $p=.048$) consisted of the lowest proportion of those aware. Participants' perception of health also exhibited significant differences ($p<.001$), with movement from reporting excellent (84.5%) to poor (98.6%) for those who were aware.

The hierarchal multivariable model presents the varying stages of adjustment for predicting awareness of hypertension (Table 5). The unadjusted model, with only rural/urban status as a predictor, indicates no significant increase ($p=.427$) in the model's ability to predict awareness of hypertension over the base model. Despite an adjustment for drive time, the model still lacks statistical evidence ($p=.435$) to support these variables predicting hypertensive awareness. The adjustments for additional independent variables for demographics and health indicators offered significantly ($p<.001$) better predictability over the base model.

Race (p=.024), gender (p=.003), smoking status (p<.001), and perception of general health (p<.001) were all significant indicators of hypertensive awareness. The final model presented no significant association between the interactions of rural/urban status and demographic variables for being aware of hypertension.

There was no association between being aware of hypertension and rural/urban status (OR, 1.09; 95% CI, .87 to 1.37) or drive time (OR, 1.00; 95% CI, 1.00 to 1.01) (Table 6). Whites were 21% less likely to be aware of hypertension than blacks (OR, .79; 95% CI, .64 to .97), and females were 37% more likely to be aware than males (OR, 1.37; 95% CI, 1.12 to 1.68). Although differences were shown between awareness of hypertension and socioeconomic status (SES) categories in the sample characteristics table, no significant relationships were revealed in the multivariable model. Smoking status remained the only heath behavior to show a significant relationship, with past smokers 80% more likely (OR, 1.80; 95% CI, 1.36 to 2.39) and people who have never smoked 66% more likely (OR, 1.66; 95% CI, 1.26 to 2.19) to be aware of their hypertension than current smokers. Participants' perception of general health pointed to a tendency of the better the perception of health, the less probable one is to be aware of hypertension, with individuals in the "excellent" category being the least likely to be aware (OR, .06; 95% CI, .02 to .20) of their hypertension.

Table 4.

Sample characteristics, according to awareness of hypertension.

Characteristic	**Awareness**		**p value†**
	Not Aware	Aware	
Total [No. (%)]	611 (7.3)	7,725 (92.7)	
Rural/Urban			.427
Rural	127 (7.9)	1,490 (92.2)	
Urban	427 (7.3)	5,446 (92.7)	
Race			<.001
Black	264 (6.1)	4,051 (93.9)	
White	347 (8.6)	3,674 (91.4)	
Gender			<.001
Male	281 (9.6)	2,658 (90.4)	
Female	330 (6.1)	5,067 (93.9)	
Income			.006
Less than $20k	95 (5.7)	1,569 (94.3)	
$20k - $34k	163 (7.8)	1,937 (92.2)	
$35k - $74k	174 (7.3)	2,219 (92.7)	
$75k and above	103 (9.5)	985 (90.5)	
Refused	76 (7.0)	1,015 (93.0)	
Education			.002
Less than high school	72 (6.2)	1,099 (93.6)	
High school graduate	142 (6.3)	2,107 (93.7)	
Some college	166 (7.2)	2,129 (92.8)	
College graduate and above	231 (8.8)	2,381 (91.2)	
Smoking Status			<.001
Current	119 (9.6)	1,089 (90.2)	
Past	227 (7.3)	2,897 (92.7)	
Never	264 (6.7)	3,708 (93.4)	
Alcohol Use			<.001
Heavy	36 (13.1)	238 (86.9)	
Moderate	210 (9.0)	2,129 (91.0)	
None	350 (6.3)	5,213 (93.7)	
Exercise			.048
None	208 (6.5)	3,014 (93.5)	
1 to 3 times per week	219 (7.5)	2,694 (92.5)	
4 or more times per week	171 (8.2)	1,915 (91.8)	
General Health			<.001
Poor	5 (1.4)	363 (98.6)	
Fair	64 (3.9)	1,581 (96.1)	
Good	202 (6.0)	3,169 (94.0)	
Very good	223 (10.2)	1,963 (89.8)	
Excellent	116 (15.5)	633 (84.5)	
Drive time (Mean ± SD)	21.68 ± 15.20	22.28 ± 14.95	.369
Age (Mean ± SD)	64.94 ± 10.39	65.22 ± 9.39	.485

Table 5.

Model statistics of incremental logistic regression models for the association between the likelihood of being aware of hypertension and other factors.

	Unadjusted (n = 7,490)		**Adjusted for Drive Time (n = 7,074)**		**Adjusted for Other Independent Variables (n = 6,755)**		**Adjusted for Interactions with Other Independent Variables (n = 6,755)**	
Max-Rescaled R^2	<.001		.001		.057		.059	
Parameter	**χ^2 (*df*)**	**p value**	**χ^2 (*df*)**	**p value**	**χ^2 (*df*)**	**p value**	**χ^2 (*df*)**	**p value**
Global $H_0: \beta = 0$	.630 (1)	.427†	1.665 (2)	.435†	137.909 (22)	<.001†	145.035 (31)	<.001†
Type 3 Analysis								
Rural/Urban	.630 (1)	.427†	.721 (1)	.396†	.581 (1)	.446†	1.281 (1)	.258†
Drive Time	-	-	.908 (1)	.341†	.133 (1)	.716†	.105 (1)	.747†
Age	-	-	-	-	1.140 (1)	.286†	1.219 (1)	.270†
Race	-	-	-	-	5.092 (1)	.024†	2.111 (1)	.146†
Gender	-	-	-	-	9.153 (1)	.003†	2.583 (1)	.108†
Income	-	-	-	-	2.835 (4)	.586†	1.460 (4)	.834†
Education	-	-	-	-	1.777 (3)	.620†	7.338 (3)	.062†
Smoking	-	-	-	-	17.844 (2)	<.001†	17.377 (2)	<.001†
Alcohol	-	-	-	-	2.150 (2)	.341†	2.142 (2)	.343†
Exercise	-	-	-	-	.277 (2)	.871†	.248 (2)	.883†
Gen. Health	-	-	-	-	78.873 (4)	<.001†	78.523 (4)	<.001†
Rural/Urban* Race	-	-	-	-	-	-	.196 (1)	.658†
Rural/Urban* Gender	-	-	-	-	-	-	.014 (1)	.905†
Rural/Urban* Income	-	-	-	-	-	-	1.010 (4)	.908†
Rural/Urban* Education	-	-	-	-	-	-	6.310 (3)	.098†
Hosmer & Lemeshow	NA	NA	15.620 (8)	.048‡	3.944 (8)	.862‡	4.817 (8)	.777‡

df degrees of freedom
† p value based on Wald χ^2 statistic.
‡ p value based on χ^2 Goodness-of-Fit statistic.

Table 6.

Association between likelihood of being aware of hypertension and other factors with incremental logistic regression models.

Predictor Variable	Unadjusted (n = 7,490) Odds Ratio [e^{β} (95% CI)]	Unadjusted p value†	Adjusted for Drive Time (n = 7,074) Odds Ratio [e^{β} (95% CI)]	Adjusted for Drive Time p value†	Adjusted for Other Independent Variables (n = 6,755) Odds Ratio [e^{β} (95% CI)]	Adjusted for Other Independent Variables p value†	Adjusted for Interactions with Other Independent Variables (n = 6,755) Odds Ratio [e^{β} (95% CI)]	Adjusted for Interactions with Other Independent Variables p value†
Rural/Urban								
Rural	Reference		Reference		Reference		Reference	
Urban	1.09 (.89, 1.34)	.427	1.09 (.88, 1.36)	.438	1.09 (.87, 1.37)	.446	1.60	.258
Drive Time	NA	NA	1.01 (1.00, 1.01)	.053	1.00 (1.00, 1.01)	.716	1.00 (.99, 1.01)	.747
Age	NA	NA	NA	NA	1.01 (1.00, 1.02)	.286	1.01 (1.00, 1.02)	.270
Race	NA	NA	NA	NA				
Black	-	-	-	-	Reference		Reference	
White	-	-	-	-	.79 (.64, .97)	.024	.71	.146
Gender	NA	NA	NA	NA				
Male	-	-	-	-	Reference		Reference	
Female	-	-	-	-	1.37 (1.12, 1.68)	.003	1.40	.108
Income	NA	NA	NA	NA				
Less than $20k	-	-	-	-	Reference		Reference	
$20k - $34k	-	-	-	-	.83 (.61, 1.15)	.266	.86	.644
$35k - $74k	-	-	-	-	1.03 (.74, 1.43)	.871	1.10	.777
$75k and above	-	-	-	-	.98 (.67, 1.45)	.930	1.24	.597
Refused	-	-	-	-	.91 (.62, 1.33)	.627	1.20	.661
Education	NA	NA	NA	NA				
Less than H.S.	-	-	-	-	Reference		Reference	
H.S. graduate	-	-	-	-	1.03 (.72, 1.47)	.874	1.57	.172
Some college	-	-	-	-	1.14 (.80, 1.64)	.467	1.95	.072
College grad and above	-	-	-	-	.97 (.67, 1.39)	.861	.99	.970
Smoking Status	NA	NA	NA	NA				
Current	-	-	-	-	Reference		Reference	
Past	-	-	-	-	1.80 (1.36, 2.39)	<.001	1.79 (1.35, 2.38)	<.001
Never	-	-	-	-	1.66 (1.26, 2.19)	<.001	1.65 (1.25, 2.17)	<.001

† All p values were based on the Wald χ^2 statistic.

Table 6 (continued).

Association between likelihood of being aware of hypertension and other factors with incremental logistic regression models.

	Unadjusted (n = 7,490)		Adjusted for Drive Time (n = 7,074)		Adjusted for Other Independent Variables (n = 6,755)		Adjusted for Interactions with Other Independent Variables (n = 6,755)	
Predictor Variable	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**
Rural/Urban								
Rural	Reference		Reference		Reference		Reference	
Urban	1.09 (.89, 1.34)	.427	1.09 (.88, 1.36)	.438	1.09 (.87, 1.37)	.446	1.60	.258
Drive Time	NA		1.01 (1.00, 1.01)	.053	1.00 (1.00, 1.01)	.716	1.00 (.99, 1.01)	.747
Alcohol Use	NA		NA	NA				
Heavy	-		-	-	Reference		Reference	
Moderate	-		-	-	1.20 (.76, 1.90)	.429	1.22 (.77, 1.93)	.390
None	-		-	-	1.34 (.85, 2.11)	.203	1.35 (.86, 2.13)	.190
Exercise	NA		NA	NA				
None	-		-	-	Reference		Reference	
1 to 3 times per week	-		-	-	1.01 (.81, 1.27)	.907	1.01 (.81, 1.27)	.905
≥ 4 times per week	-		-	-	1.07 (.83, 1.37)	.615	1.06 (.83, 1.36)	.632
General Health	NA		NA	NA				
Poor	-		-	-	Reference		Reference	
Fair	-		-	-	.25 (.08, .82)	.022	.25 (.08, .82)	.022
Good	-		-	-	.16 (.05, .49)	.002	.16 (.05, .49)	.002
Very good	-		-	-	.10 (.03, .31)	<.001	.10 (.03, .31)	<.001
Excellent	-		-	-	.06 (.02, .20)	<.001	.06 (.02, .20)	<.001

† All p values were based on the Wald χ^2 statistic.

Table 6 (continued).

Association between likelihood of being aware of hypertension and other factors with incremental logistic regression models.

	Unadjusted (n = 7,490)		**Adjusted for Drive Time (n = 7,074)**		**Adjusted for Other Independent Variables (n = 6,755)**		**Adjusted for Interactions with Other Independent Variables (n = 6,755)**	
Predictor Variable	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**
Rural/Urban								
Rural	Reference		Reference		Reference		Reference	
Urban	1.09 (.89, 1.34)	.427	1.09 (.88, 1.36)	.438	1.09 (.87, 1.37)	.446	1.60	.258
Drive Time	NA		1.01 (1.00, 1.01)	.053	1.00 (1.00, 1.01)	.716	1.00 (.99, 1.01)	.747
Rural/Urban* Race	NA	NA	NA	NA	NA	NA		
Rural, Black	-	-	-	-	-	-	Reference	
Urban, White	-	-	-	-	-	-	1.12	.658
Rural/Urban* Gender	NA	NA	NA	NA	NA	NA		
Rural, Male	-	-	-	-	-	-	Reference	
Urban, Female	-	-	-	-	-	-	.97	.905
Rural/Urban* Income	NA	NA	NA	NA	NA	NA		
Rural, Less than 20k	-	-	-	-	-	-	Reference	
Urban, $20k - $34k	-	-	-	-	-	-	.96	.909
Urban, $35k - $74k	-	-	-	-	-	-	.93	.841
Urban, $75k and above	-	-	-	-	-	-	.74	.518
Urban, Refused	-	-	-	-	-	-	.71	.458
Rural/Urban* Education	NA	NA	NA	NA	NA	NA		
Rural, Less than H.S.	-	-	-	-	-	-	Reference	
Urban, H.S. graduate	-	-	-	-	-	-	.56	.139
Urban, Some college	-	-	-	-	-	-	.50	.103
Urban, ≥ college grad.	-	-	-	-	-	-	.95	.894

† All p values were based on the Wald χ^2 statistic.

Treatment of Hypertension

The 7,442 (98.2%) participants who were aware of hypertension were also treated (Table 7). There was no significant difference (p=.696) in the proportion of rural and urban individuals who were treated for hypertension, nor was there a mean difference in drive time by treated or not treated. Even though demographic factors of age (p=.019), race (p=.048), and gender (p=.036) all showed statistically significant differences, the differences were marginal and hold little practical significance. No statistical differences were observed for variables representing health behaviors or self-perception of health.

The initial unadjusted model presents no indication that the addition of the rural/urban variable contributes to greater predictability of being treated for hypertension than does the base model (p=.696) (Table 8). The adjustment for drive time to the participant's usual source of medical care provides no change in regard to these variables, thus causing this model to be improved over the base (p=.454). After the adjusting for the additional independent variables, the model showed improvement for predicting treatment for hypertension from the base model (p=.006). Type III analysis showed both age (p=.004) and income (p=.007) to be significant predictors of treatment for hypertension. No interactions between rural/urban status and demographic variables were detected.

A participant's rural/urban designation had no influence on being treated for hypertension (OR, 1.17; 95% CI, .74 to 1.86) (Table 9). Drive time did not affect either the relationship between being treated for hypertension and rural/urban status, nor was it relevant by itself for participants who were treated for hypertension (OR, 1.01; 95% CI, 1.00 to 1.03). Age showed a statistically significant association with being treated for hypertension (OR, 1.03; 95% CI, 1.01 to 1.06); however the magnitude of this relationship holds little practical relevance.

Conversely, even though only one income category has a statistically significant value (p=.003), participants at or above $75,000 in annual income are approximately 10 times as likely to be treated for hypertension than those earning less than $20,000 a year (OR. 9.86; 95% CI, 2.18 to 44.53)

Table 7.

Sample characteristics, according to treatment of hypertension.

Characteristic	**Treatment**		**p value†**
	Not Treated	Treated	
Total [No. (%)]	133 (1.8)	7,442 (98.2)	
Rural/Urban			.696
Rural	29 (2.0)	1,440 (98.0)	
Urban	97 (1.8)	5,236 (98.2)	
Race			.048
Black	81 (2.0)	3,890 (98.0)	
White	52 (1.4)	3,552 (98.6)	
Gender			.036
Male	57 (2.2)	2,541 (97.8)	
Female	76 (1.5)	4,901 (98.5)	
Income			.003
Less than $20k	31 (2.0)	1,500 (98.0)	
$20k - $34k	35 (1.8)	1,870 (98.2)	
$35k - $74k	36 (1.7)	2,141 (98.4)	
$75k and above	4 (0.4)	961 (99.6)	
Refused	27 (2.7)	970 (97.3)	
Education			.034
Less than high school	27 (2.5)	1,047 (97.5)	
High school graduate	43 (2.1)	2,024 (97.9)	
Some college	34 (1.6)	2,045 (98.4)	
College graduate and above	29 (1.2)	2,318 (98.8)	
Smoking Status			.090
Current	27 (2.6)	1,024 (97.4)	
Past	45 (1.6)	2,812 (98.4)	
Never	60 (1.6)	3,577 (98.6)	
Alcohol Use			.187
Heavy	5 (2.2)	226 (97.8)	
Moderate	44 (2.1)	2,039 (97.9)	
None	78 (1.5)	5,042 (98.5)	
Exercise			.441
None	50 (1.7)	2,904 (98.3)	
1 to 3 times per week	42 (1.6)	2,603 (98.4)	
4 or more times per week	39 (2.1)	1,837 (97.9)	
General Health			.787
Poor	8 (2.2)	350 (97.8)	
Fair	26 (1.7)	1,529 (98.3)	
Good	54 (1.7)	3,065 (98.3)	
Very good	31 (1.6)	1,883 (98.4)	
Excellent	14 (2.3)	601 (97.7)	
Drive time (Mean ± SD)	21.27 ± 15.87	23.34 ± 18.85	.230
Age (Mean ± SD)	63.38 ± 11.03	65.31 ± 9.34	.019

† All p values were based on a Pearson's χ^2 and an independent samples t-test (for the last two variables with mean ± standard deviation).

Table 8.

Model statistics of incremental logistic regression models for the association between the likelihood of being treated for hypertension and other factors.

	Unadjusted (n = 6,802)		**Adjusted for Drive Time (n = 6,465)**		**Adjusted for Other Independent Variables (n = 6,176)**		**Adjusted for Interactions with Other Independent Variables (n = 6,176)**	
Max-Rescaled R^2	<.001		.002		.052		.059	
Parameter	**χ^2 (*df*)**	**p value**	**χ^2 (*df*)**	**p value**	**χ^2 (*df*)**	**p value**	**χ^2 (*df*)**	**p value**
Global $H_0: \beta = 0$	.153 (1)	.696†	1.579 (2)	.454†	42.130 (22)	.006†	45.978 (31)	.041†
Type 3 Analysis								
Rural/Urban	.153 (1)	.696†	.718 (1)	.397†	.436 (1)	.509†	.113 (1)	.737†
Drive Time	-	-	.824 (1)	.364†	1.818 (1)	.178†	1.733 (1)	.188†
Age	-	-	-	-	8.314 (1)	.004†	8.495 (1)	.004†
Race	-	-	-	-	.012 (1)	.912†	.527 (1)	.468†
Gender	-	-	-	-	3.792 (1)	.052†	.156 (1)	.693†
Income	-	-	-	-	14.194 (4)	.007†	2.516 (4)	.642†
Education	-	-	-	-	3.660 (3)	.301†	3.044 (3)	.385†
Smoking	-	-	-	-	1.904 (2)	.386†	1.954 (2)	.377†
Alcohol	-	-	-	-	4.115 (2)	.128†	4.374 (2)	.112†
Exercise	-	-	-	-	.265 (2)	.876†	.251 (2)	.882†
Gen. Health	-	-	-	-	3.001 (4)	.558†	3.331 (4)	.504†
Rural/Urban* Race	-	-	-	-	-	-	.960 (1)	.327†
Rural/Urban* Gender	-	-	-	-	-	-	.464 (1)	.496†
Rural/Urban* Income	-	-	-	-	-	-	2.426 (4)	.658†
Rural/Urban* Education	-	-	-	-	-	-	1.615 (3)	.656†
Hosmer & Lemeshow	NA	NA	7.504 (7)	.378‡	3.901 (8)	.866‡	9.296 (8)	.318‡

df degrees of freedom
† p value based on Wald χ^2 statistic.
‡ p value based on χ^2 Goodness-of-Fit statistic.

Table 9.

Association between likelihood of being treated for hypertension and other factors with incremental logistic regression models.

	Unadjusted (n = 6,802)		Adjusted for Drive Time (n = 6,465)		Adjusted for Other Independent Variables (n = 6,176)		Adjusted for Interactions with Other Independent Variables (n = 6,176)	
Predictor Variable	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**
Rural/Urban								
Rural	Reference		Reference		Reference		Reference	
Urban	1.09 (.72, 1.65)	.696	1.24 (.81, 1.90)	.319	1.17 (.74, 1.86)	.509	1.26	.737
Drive Time	NA	NA	1.01 (.99, 1.02)	.423	1.01 (1.00, 1.03)	.178	1.01 (1.00, 1.03)	.188
Age	NA	NA	NA	NA	1.03 (1.01, 1.06)	.004	1.04 (1.01, 1.06)	.004
Race	NA	NA	NA	NA				
Black	-	-	-	-	Reference		Reference	
White	-	-	-	-	1.02 (.67, 1.57)	.912	.73	.468
Gender	NA	NA	NA	NA				
Male	-	-	-	-	Reference		Reference	
Female	-	-	-	-	1.52 (1.00, 2.32)	.052	1.19	.693
Income	NA	NA	NA	NA				
Less than $20k	-	-	-	-	Reference		Reference	
$20k - $34k	-	-	-	-	1.07 (.59, 1.93)	.831	2.26	.195
$35k - $74k	-	-	-	-	1.07 (.58, 1.95)	.832	1.10	.869
$75k and above	-	-	-	-	9.86 (2.18, 44.53)	.003	‡	‡
Refused	-	-	-	-	.63 (.34, 1.18)	.149	.81	.721
Education	NA	NA	NA	NA				
Less than H.S.	-	-	-	-	Reference		Reference	
H.S. graduate	-	-	-	-	1.20 (.66, 2.18)	.541	1.44	.502
Some college	-	-	-	-	1.49 (.80, 2.80)	.215	1.42	.564
College grad and above	-	-	-	-	1.85 (.93, 3.67)	.080	3.71	.086
Smoking Status	NA	NA	NA	NA				
Current	-	-	-	-	Reference		Reference	
Past	-	-	-	-	1.47 (.84, 2.58)	.181	1.47 (.84, 2.59)	.180
Never	-	-	-	-	1.19 (.69, 2.05)	.529	1.18 (.68, 2.03)	.555

† All p values were based on the Wald χ^2 statistic.

‡ Insufficient number of observations for category

Table 9 (continued).

Association between likelihood of being treated for hypertension and other factors with incremental logistic regression models.

	Unadjusted (n = 6,802)		**Adjusted for Drive Time (n = 6,465)**		**Adjusted for Other Independent Variables (n = 6,176)**		**Adjusted for Interactions with Other Independent Variables (n = 6,176)**	
Predictor Variable	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**
Rural/Urban								
Rural	Reference		Reference		Reference		Reference	
Urban	1.09 (.72, 1.65)	.696	1.24 (.81, 1.90)	.319	1.17 (.74, 1.86)	.509	1.26	.737
Drive Time	NA	NA	1.01 (.99, 1.02)	.423	1.01 (1.00, 1.03)	.178	1.01 (1.00, 1.03)	.188
Alcohol Use	NA		NA	NA				
Heavy	-		-	-	Reference		Reference	
Moderate	-		-	-	1.24 (.47, 3.25)	.661	1.23 (.47, 3.25)	.671
None	-		-	-	1.87 (.72, 4.85)	.203	1.89 (.72, 4.92)	.195
Exercise	NA		NA	NA				
None	-		-	-	Reference		Reference	
1 to 3 times per week	-		-	-	1.00 (.62, 1.59)	.989	1.00 (.63, 1.60)	.992
≥ 4 times per week	-		-	-	.89 (.54, 1.47)	.646	.90 (.54, 1.48)	.662
General Health	NA		NA	NA				
Poor	-		-	-	Reference		Reference	
Fair	-		-	-	1.27 (.50, 3.25)	.619	1.24 (.48, 3.18)	.657
Good	-		-	-	.98 (.40, 2.38)	.960	.96 (.39, 2.33)	.919
Very good	-		-	-	.90 (.35, 2.29)	.818	.88 (.34, 2.26)	.791
Excellent	-		-	-	.64 (.22, 1.84)	.408	.60 (.21, 1.72)	.343

† All p values were based on the Wald χ^2 statistic.

Table 9 (continued).

Association between likelihood of being treated for hypertension and other factors with incremental logistic regression models.

	Unadjusted (n = 6,802)		**Adjusted for Drive Time (n = 6,465)**		**Adjusted for Other Independent Variables (n = 6,176)**		**Adjusted for Interactions with Other Independent Variables (n = 6,176)**	
Predictor Variable	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**
Rural/Urban								
Rural	Reference		Reference		Reference		Reference	
Urban	1.09 (.72, 1.65)	.696	1.24 (.81, 1.90)	.319	1.17 (.74, 1.86)	.509	1.26	.737
Drive Time	NA	NA	1.01 (.99, 1.02)	.423	1.01 (1.00, 1.03)	.178	1.01 (1.00, 1.03)	.188
Rural/Urban* Race	NA	NA	NA	NA	NA	NA		
Rural, Black	-	-	-	-	-	-	Reference	
Urban, White	-	-	-	-	-	-	1.64	.327
Rural/Urban* Gender	NA	NA	NA	NA	NA	NA		
Rural, Male	-	-	-	-	-	-	Reference	
Urban, Female	-	-	-	-	-	-	1.40	.496
Rural/Urban* Income	NA	NA	NA	NA	NA	NA		
Rural, Less than 20k	-	-	-	-	-	-	Reference	
Urban, $20k - $34k	-	-	-	-	-	-	.37	.164
Urban, $35k - $74k	-	-	-	-	-	-	.94	.920
Urban, $75k and above	-	-	-	-	-	-	‡	‡
Urban, Refused	-	-	-	-	-	-	.70	.611
Rural/Urban* Education	NA	NA	NA	NA	NA	NA		
Rural, Less than H.S.	-	-	-	-	-	-	Reference	
Urban, H.S. graduate	-	-	-	-	-	-	.79	.719
Urban, Some college	-	-	-	-	-	-	1.08	.916
Urban, ≥ college grad.	-	-	-	-	-	-	.42	.313

† All p values were based on the Wald χ^2 statistic.
‡ Insufficient number of observations for category

Control of Hypertension

The proportion of the treated population that had its hypertension controlled was 5,496 (73.6%) (Table 10). No differences were noted for control between the proportion of rural and urban participants (p=.949). Furthermore, there was no mean difference between controlled and un-controlled hypertension with respect to drive time (p=.774). Even though blacks were significantly more aware of their hypertension, whites (78.6%) displayed significantly (p<.001) better control of their hypertension than blacks (69.5%). Females being aware (75.0%) were significantly (p=.001) better at controlling their hypertension than males (71.6%). There was a statistically significant difference (p=.007) between the mean ages of controlled ($\bar{x}$ = 65.79 years; SD ± 9.28) versus uncontrolled ($\bar{x}$ = 65.13 years; SD ± 9.36) hypertensive participants; however, the difference was minimal and serves little purpose for making inferences. Also, contrary to the trend shown for being aware of hypertension for the SES variables, the inclination for income (p<.001) and education (p<.001) both point toward participants with higher salaries and greater levels of education as being more controlled. Current smokers (69.6%) represented the lowest proportion of controlled hypertensive individuals, while past smokers (75.1%) represented the highest proportion. Moderate alcohol use (76.2%) was the most frequent category for control followed by people who did not drink (73.0%). General self perception of health displayed no pattern from "poor" to "excellent" health, but was there was a statistical difference between the categories, with participants specifying "fair" health (67.6%) to be the least frequent group of controlled hypertensive individuals and participants specifying "very good" health (76.9%) representing the most frequent group.

Table 10 shows the incremental adjustments for each logistic regression model. Neither the unadjusted model with only rural/urban status as the predictor (p=.949) nor the model after adjusting for drive time (p=.689) represented any greater predictive accuracy over the base model. The logistic model after adjusting for the additional independent variables indicated that certain factors contributed to an increased ability to predict being controlled for hypertension over the base model (p<.001). The Type III analysis reveals these variables to be race (p=.025), gender (p=.003), smoking status (p<.001), and general perception of health (p<.001). Interactions were present at alpha $\leq$ .05; therefore interpretations are made from the model and adjusted for interactions between rural/urban and the demographic variables.

The main effect for rural/urban status showed no association with the probability of being controlled for hypertension (OR, .94; p=.779). However, when examining the interaction between rural/urban status and income, participants in urban areas with an annual income between $35,000 and $74,000 were only half as likely to be controlled for hypertension (OR, .53; p=.005) as those from rural areas and earning less than $20,000 (Table 12). No other interactions with rural/urban status existed. Age showed a statistically significant relationship with the probability of being controlled for hypertension (OR, .99; 95% CI, .98 to 1.00), signifying that with every year increase in age, participants' odds of being controlled for hypertension decreases by 1 percent. Whites (OR, 1.33; p=.040) and females (OR, 1.37; p=.025) were both more likely to be controlled for hypertension than blacks and males, respectively. Participants earning between $35,000 and $74,000 (OR, 2.10; p<.001) and those earning $75,000 or more (OR, 2.15; p=.005) were twice as likely to be controlled for hypertension as participants earning less than $20,000. Past smokers (OR, 1.23; 95% CI, 1.02 to 1.48) were 23% more likely to be controlled for hypertension than current smokers, and participants who never drink alcohol (OR, 1.54; 95% CI, 1.10 to 2.16) or who drink moderately (OR, 1.49; 95% CI, 1.07 to 2.08) were 1.5 times more likely to be controlled for hypertension than heavy drinkers.

Only participants in the “fair” category of general self perception of health (OR, .70; 95% CI, .53 to .96) had lower odds of being controlled for hypertension when compared to participants in the “poor” category.

Table 10.

Sample characteristics, according to control of hypertension.

Characteristic	**Control**		**p value†**
	Not Controlled	Controlled	
Total [No. (%)]	1,946 (26.15)	5,496 (73.85)	
Rural/Urban			.949
Rural	381 (26.5)	1,059 (73.5)	
Urban	1,381 (26.4)	3,855 (73.6)	
Race			<.001
Black	1,185 (30.5)	2,705 (69.5)	
White	761 (21.4)	2,791 (78.6)	
Gender			.001
Male	722 (28.4)	1,819 (71.6)	
Female	1,224 (25.0)	3,677 (75.0)	
Income			<.001
Less than $20k	469 (31.3)	1,031 (68.7)	
$20k - $34k	538 (28.8)	1,332 (71.2)	
$35k - $74k	506 (23.6)	1,635 (76.4)	
$75k and above	194 (20.2)	767 (79.8)	
Refused	239 (24.6)	731 (75.4)	
Education			<.001
Less than high school	326 (31.1)	721 (68.9)	
High school graduate	553 (27.3)	1,471 (72.7)	
Some college	511 (25.0)	1,534 (75.0)	
College graduate and above	553 (23.9)	1,765 (91.2)	
Smoking Status			.003
Current	311 (30.4)	713 (69.6)	
Past	701 (24.9)	2,111 (75.1)	
Never	930 (26.0)	2,647 (74.0)	
Alcohol Use			.011
Heavy	67 (29.7)	159 (70.4)	
Moderate	486 (23.8)	1,553 (76.2)	
None	1,362 (27.0)	3,680 (73.0)	
Exercise			.090
None	797 (27.4)	2,107 (72.6)	
1 to 3 times per week	663 (25.5)	1,940 (74.5)	
4 or more times per week	456 (24.8)	1,381 (75.2)	
General Health			<.001
Poor	94 (26.9)	256 (73.1)	
Fair	495 (32.4)	1,034 (67.6)	
Good	778 (25.4)	2,287 (74.6)	
Very good	435 (23.1)	1,448 (76.9)	
Excellent	142 (23.6)	459 (76.4)	
Drive time (Mean ± SD)	23.45 ± 20.06	23.31 ± 18.41	.774
Age (Mean ± SD)	65.79 ± 9.28	65.13 ± 9.36	.007

† All p values were based on a Pearson's χ^2 and an independent samples t-test (for the last two variables with mean ± standard deviation)

Table 11.

Model statistics of incremental logistic regression models for the association between the likelihood of being controlled for hypertension and other factors.

	Unadjusted (n = 6,676)		**Adjusted for Drive Time (n = 6,351)**		**Adjusted for Other Independent Variables (n = 6,071)**		**Adjusted for Interactions with Other Independent Variables (n = 6,071)**	
Max-Rescaled R^2	<.001		<.001		.038		.041	
Parameter	**χ^2 (*df*)**	**p value**	**χ^2 (*df*)**	**p value**	**χ^2 (*df*)**	**p value**	**χ^2 (*df*)**	**p value**
Global $H_0: \beta = 0$	.004 (1)	.949†	.747 (2)	.689†	137.909 (22)	<.001†	166.065 (31)	<.001†
Type 3 Analysis								
Rural/Urban	.004 (1)	.949†	.073 (1)	.786†	.581 (1)	.446†	.079 (1)	.779†
Drive Time	-	-	.670 (1)	.413†	.133 (1)	.716†	1.935 (1)	.164†
Age	-	-	-	-	1.14 (1)	.286†	9.237 (1)	.002†
Race	-	-	-	-	5.092 (1)	.024†	4.221 (1)	.040†
Gender	-	-	-	-	9.153 (1)	.003†	5.009 (1)	.025†
Income	-	-	-	-	2.835 (4)	.586†	17.315 (4)	.002†
Education	-	-	-	-	1.777 (3)	.620†	3.185 (3)	.364†
Smoking	-	-	-	-	17.844 (2)	<.001†	4.804 (2)	.091†
Alcohol	-	-	-	-	2.150 (2)	.341†	6.417 (2)	.040†
Exercise	-	-	-	-	.277 (2)	.871†	1.634 (2)	.442†
Gen. Health	-	-	-	-	78.873 (4)	<.001†	19.092 (4)	.001†
Rural/Urban* Race	-	-	-	-	-	-	1.742 (1)	.187†
Rural/Urban* Gender	-	-	-	-	-	-	.037 (1)	.847†
Rural/Urban* Income	-	-	-	-	-	-	9.440 (4)	.051†
Rural/Urban* Education	-	-	-	-	-	-	4.313 (3)	.230†
Hosmer & Lemeshow	NA	NA	12.597 (8)	.127‡	6.629 (8)	.577‡	8.156 (8)	.418‡

df degrees of freedom
† p value based on Wald χ^2 statistic.
‡ p value based on χ^2 Goodness-of-Fit statistic.

Table 12.

Association between likelihood of being controlled for hypertension and other factors with incremental logistic regression models.

	Unadjusted (n = 6,676)		Adjusted for Drive Time (n = 6,351)		Adjusted for Other Independent Variables (n = 6,071)		Adjusted for Interactions with Other Independent Variables (n = 6,071)	
Predictor Variable	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**
Rural/Urban								
Rural	Reference		Reference		Reference		Reference	
Urban	1.00 (.88, 1.15)	.949	1.02 (.89, 1.17)	.801	1.08 (.94, 1.25)	.274	.94	.779
Drive Time	NA	NA	1.00 (1.00, 1.00)	.898	1.00 (1.00, 1.01)	.167	1.00 (1.00, 1.01)	.188
Age	NA	NA	NA	NA	.99 (.98, 1.00)	.003	.99 (.98, 1.00)	.002
Race	NA	NA	NA	NA				
Black	-	-	-	-	Reference		Reference	
White	-	-	-	-	1.56 1.37, 1.77)	<.001	1.33	.040
Gender	NA	NA	NA	NA				
Male	-	-	-	-	Reference		Reference	
Female	-	-	-	-	1.40 (1.23, 1.60)	<.001	1.37	.025
Income	NA	NA	NA	NA				
Less than $20k	-	-	-	-	Reference		Reference	
$20k - $34k	-	-	-	-	1.03 (.86, 1.22)	.774	1.17	.374
$35k - $74k	-	-	-	-	1.28 (1.06, 1.54)	.009	2.10	<.001
$75k and above	-	-	-	-	1.45 (1.14, 1.85)	.003	2.15	.005
Refused	-	-	-	-	1.24 (1.00, 1.53)	.050	1.31	.227
Education	NA	NA	NA	NA				
Less than H.S.	-	-	-	-	Reference		Reference	
H.S. graduate	-	-	-	-	1.07 (.88, 1.30)	.497	.81	.290
Some college	-	-	-	-	1.15 (.95, 1.41)	.158	1.01	.980
College grad and above	-	-	-	-	1.08 (.88, 1.33)	.473	.76	.223
Smoking Status	NA	NA	NA	NA				
Current	-	-	-	-	Reference		Reference	
Past	-	-	-	-	1.24 (1.03, 1.49)	.025	1.23 (1.02, 1.48)	.029
Never	-	-	-	-	1.16 (.96, 1.39)	.118	1.15 (.96, 1.38)	.131

† All p values were based on the Wald χ^2 statistic.

Table 12 (continued).

Association between likelihood of being controlled for hypertension and other factors with incremental logistic regression models.

	Unadjusted (n = 6,676)		**Adjusted for Drive Time (n = 6,351)**		**Adjusted for Other Independent Variables (n = 6,071)**		**Adjusted for Interactions with Other Independent Variables (n = 6,071)**	
Predictor Variable	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**
Rural/Urban								
Rural	Reference		Reference		Reference		Reference	
Urban	1.00 (.88, 1.15)	.949	1.02 (.89, 1.17)	.801	1.08 (.94, 1.25)	.274	.94	.779
Drive Time	NA	NA	1.00 (1.00, 1.00)	.898	1.00 (1.00, 1.01)	.167	1.00 (1.00, 1.01)	.188
Alcohol Use	NA		NA	NA				
Heavy	-		-	-	Reference		Reference	
Moderate	-		-	-	1.55 (1.11, 2.17)	.011	1.54 (1.10, 2.16)	.012
None	-		-	-	1.49 (1.07, 2.07)	.018	1.49 (1.07, 2.08)	.018
Exercise	NA		NA	NA				
None	-		-	-	Reference		Reference	
1 to 3 times per week	-		-	-	1.09 (.95, 1.25)	.234	1.09 (.95, 1.38)	.215
≥ 4 times per week	-		-	-	1.06 (.91, 1.24)	.427	1.07 (.91, 1.24)	.412
General Health	NA		NA	NA				
Poor	-		-	-	Reference		Reference	
Fair	-		-	-	.72 (.53, .97)	.033	.71 (.53, .96)	.027
Good	-		-	-	.98 (.73, 1.31)	.892	.97 (.72, 1.30)	.844
Very good	-		-	-	1.00 (.74, 1.36)	1.00	.99 (.73, 1.35)	.952
Excellent	-		-	-	.92 (.64, 1.30)	.622	.90 (.63, 1.29)	.579

† All p values were based on the Wald χ^2 statistic.

Table 12 (continued).

Association between likelihood of being controlled for hypertension and other factors with incremental logistic regression models.

Predictor Variable	Unadjusted (n = 6,676) Odds Ratio [e^{β}(95% CI)]	Unadjusted p value†	Adjusted for Drive Time (n = 6,351) Odds Ratio [e^{β}(95% CI)]	Adjusted for Drive Time p value†	Adjusted for Other Independent Variables (n = 6,071) Odds Ratio [e^{β}(95% CI)]	Adjusted for Other Independent Variables p value†	Adjusted for Interactions with Other Independent Variables (n = 6,071) Odds Ratio [e^{β}(95% CI)]	Adjusted for Interactions p value†
Rural/Urban								
Rural	Reference		Reference		Reference		Reference	
Urban	1.00 (.88, 1.15)	.949	1.02 (.89, 1.17)	.801	1.08 (.94, 1.25)	.274	.94	.779
Drive Time	NA	NA	1.00 (1.00, 1.00)	.898	1.00 (1.00, 1.01)	.167	1.00 (1.00, 1.01)	.188
Rural/Urban* Race	NA	NA	NA	NA	NA	NA		
Rural, Black	-	-	-	-	-	-	Reference	
Urban, White	-	-	-	-	-	-	1.23	.187
Rural/Urban* Gender	NA	NA	NA	NA	NA	NA		
Rural, Male	-	-	-	-	-	-	Reference	
Urban, Female	-	-	-	-	-	-	1.03	.847
Rural/Urban* Income	NA	NA	NA	NA	NA	NA		
Rural, Less than 20k	-	-	-	-	-	-	Reference	
Urban, $20k - $34k	-	-	-	-	-	-	.83	.367
Urban, $35k - $74k	-	-	-	-	-	-	.53	.005
Urban, $75k and above	-	-	-	-	-	-	.60	.095
Urban, Refused	-	-	-	-	-	-	.92	.742
Rural/Urban* Education	NA	NA	NA	NA	NA	NA		
Rural, Less than H.S.	-	-	-	-	-	-	Reference	
Urban, H.S. graduate	-	-	-	-	-	-	1.46	.095
Urban, Some college	-	-	-	-	-	-	1.22	.418
Urban, ≥ college grad.	-	-	-	-	-	-	1.58	.070

† All p values were based on the Wald χ^2 statistic.

Discussion

This study's efforts were focused on identifying potential disparities of awareness, treatment, and control (A-T-C) of hypertension with regard to living in rural or urban settings, and to determine if those findings were modified by drive time to a person's usual source of medical care. Results from the sample characteristics tables show no significant differences between rural and urban categories for REGARDS study participants who were aware of, treated, or controlled for hypertension. The proportions in the rural and urban categories were remarkably similar for all three of the defined stages of hypertension. Throughout the investigation, the greatest separation between the groups occurred when examining participants who were aware of their high blood pressure. Even then, only ½ percent separated rural from urban, which was not statistically significant. Furthermore, travel time to the participant's usual source of medical care also demonstrated no significant difference between the means of drive time when comparing A-T-C of hypertension. The most substantial separation was for treatment of hypertension, where the mean of drive time for the treated group was two minutes greater than the mean of drive time for the untreated group. The study did, however, find a significant difference between demographics and the health profiles of the participants. The number of participants aware of their hypertension was significantly higher for blacks (93.9%) than whites (91.4%), but less for being treated (blacks 98.0%, whites 98.6%) and controlled (blacks 69.5%, whites 78.6%). Males were consistently less aware of, treated, and controlled for hypertension. Participants with lower levels of income and education were more aware of their high blood pressure but less treated and controlled. Behavioral aspects also demonstrated that individuals who smoke or drink make up the lowest percent of the three defined level of hypertension.

Generally, participants who perceived their health as less favorable were the most aware of their hypertension, while those viewing their health as very good or excellent were more frequently controlled for their high blood pressure.

Analysis for examining the probability of being aware of, treated, or controlled for hypertension found no association between these outcomes and the RUCA designated rural and urban areas for REGARDS study participants. However, upon inspection of an interaction between rural/urban status and income, it was discovered that participants living in urban areas and earning between $35,000 and $74,000 annually were only half as likely to be controlled for hypertension as those in rural areas and earning less than $20,000 annually. Although this was the only interaction that displayed a statistically significant association with being controlled for high blood pressure, all categories of this interaction indicated an odds ratio less than one when compared to the reference category of residing in a rural setting with annual income of less than $20,000. This result is counter-intuitive to what many would expect, as well as to the analysis from the sample characteristics table, which showed a higher percentage of controlled participants with a greater income. Findings from the demographic variables showed that whites were less likely to be aware of hypertension but more likely to be controlled than were blacks, and females were 37% more likely to be aware of and controlled for hypertension. Age revealed a statistically significant relationship with treatment and control of hypertension, although this association was diminutive in nature and holds little if any relevance. Evidence showed income as a substantial predictor for being treated and controlled for high blood pressure. Participants earning $75,000 or more were nearly 10 times as likely to be treated as those earning less than $20,000 annually, and participants in the $35,000 to $74,000 and $75,000 and above groups were twice as likely to be controlled for hypertension. Past smokers and those who have never smoked both showed they were more likely to be aware of hypertension than current smokers, while past smokers were more likely to be controlled than current smokers. Moderate alcohol users and non-drinkers were more likely to be controlled than heavy alcohol users, and perception of general health demonstrated a trend that a better perception of health was more conducive to being less aware of hypertension.

Results for prevalence and awareness in this study showed consistencies with previous national studies.[4,38,39] Wyatt et al, in an investigation examining the prevalence, awareness, treatment, and control of hypertension in the Jackson Heart Study, found a higher overall prevalence of hypertension but lower percentages for A-T-C of hypertension.[40] Our study showed considerably higher awareness percentages for blacks than whites (98.0% vs. 83.1%). However, our study showed whites exhibited higher levels of treatment and control than blacks.

Contradictory results were found between our study and Mainous et al, which examined data from the National Health and Nutrition Examination Survey (NHANES) III, 1988 to 1994. [15,41] Their conclusions showed that rural blacks exhibited poor diastolic blood pressure control compared to urban blacks or urban whites, while this investigation demonstrated several key differences. Their study utilized data from NHANES III, which was collected several years prior to the REGARDS data. Rural/urban disparities may be less prominent than in previous years. Also, their measure of control consisted of only the proportion of the aware population followed by a clinical measurement of systolic and diastolic blood pressure. Since our study investigated the probability of individuals being aware of, treated, and controlled for hypertension, our control population was a subset of those who were being treated for high blood pressure. The definitions for rural and urban also took a different approach. Mainous et al characterized urban subjects as living in a metropolitan statistical area; otherwise subjects were considered rural. No doubt there would be a large degree of overlap between the two methods of rural/urban classification, but this study matched RUCA codes to census tracts in order to create a grouping that encompassed a component of access to care. Leira et al noted disparities for stroke management in rural areas.[42] They showed care for stroke patients in rural areas to be suboptimal compared to care for residents in urban locations (rural and urban whites were less likely to have elevated blood pressure readings than rural blacks). However, this disparity seems more likely due to race than place of residence. This allows for reasonable comparisons of race between the two studies and in view of the fact that hypertension is a major risk factor for cardiovascular disease and stroke. Although the focus of our study was different from the Howard et al study, the sample population and methods of defining the dependent variables were derived from their study approach.[4] Overall, the aware populations in the two studies (Parton et al, 92.7%; Howard et al, 90.9%) were similar, but our investigation's treated (Parton et al, 98.2%; Howard et al, 88.8%) and controlled populations (Parton et al, 73.9%; Howard et al, 65.8%) were considerably higher. Like their study, our study did not find great inequalities between geographic settings and the probability that an individual is aware of, treated, or controlled for hypertension. Findings for demographic variables were similar for the two studies, with blacks being more aware and less controlled for hypertension than whites. However, our study noticed only marginal differences between the races for treatment.

The strengths and weaknesses of this study are worthy of mention. The study sample encompassed data collected from the REGARDS study that examined underlying causes for stroke. The use of this data allowed for a substantial sample size and for this investigation to be national in scope. The considerable sample size, along with self-reports and in-home exam measurements collected from the baseline survey, afforded us the opportunity to comprehensively investigate the association between awareness, treatment, and control of hypertensive individuals and if they live in a rural or urban setting. To our knowledge, the association between awareness, treatment, and control of hypertension and rural or urban status has yet to be thoroughly explored, thus making this study unique in its efforts. The study is also innovative because of the assessment of any consequence travel time to a usual source of medical care has on the awareness, treatment, and control of hypertension, or if it travel time modifies the effect of the rural and urban designation. Although rural and urban representation in this study originated from a census tract classification scheme, the independent variable of interest included only one category for rural and one for urban; therefore the different natures of rural and urban locales are not fully represented. For example, individuals residing in isolated, rural areas are possibly exposed to different barriers to care than those in small or large townships. Also, race disparities were examined only between black and white participants. Inspection of differences and associations within race by rural or urban designation has yet to be explored. In other words, do differences exist between rural blacks and urban blacks with regard to awareness, treatment, and control of hypertension?

Not only are there varying degrees within which rural and urban locales differ, but rural and urban areas are also different in separate regions of the United States. Assessments of various cardiovascular disease risk factors such as hypertension should be scrutinized because these risk factors may exhibit different outcomes when examined from a perspective that separates rural and urban by region. Follow-up studies should meticulously inspect any discrepancies that may exist between rural and urban locations by separate regions of the United States. For example, do Southern rural blacks have different awareness, treatment, and control of hypertension than rural blacks from the Midwest? There are several components of this study that have been designed to provide an awareness that will have an impact beyond this investigation. Hypertension disparities have yet to be explored from many perspectives. A continued comprehensive approach to investigating major risk factors for cardiovascular disease affords a better understanding of the degree to which geographic inequalities exist.

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Association between Awareness, Treatment, and Control of Diabetes and Rural/Urban Access to Care

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Abstract

Background and Purpose – Diabetes is a national concern and a major risk factor for cardiovascular disease and stroke. Much of the morbidity and mortality commencing from illnesses such as cardiovascular disease (CVD) and stroke may be lessened with adequate control of diabetes and other risk factors. This investigation explores differences and associations of awareness, treatment, and control (A-T-C) of diabetes relative to individuals' access to health care as characterized by rural/urban designation and travel time to their usual source of health care.

Methods – The association between A-T-C for diabetes and an individual's rural/urban status was investigated using data from the REGARDS study to identify geographic disparities. Furthermore, travel time to a participant's usual source of medical care was explored for its relationship to these stages of diabetes and to determine how travel time might influence the association between diabetes and rural/urban status.

Results – No associations were identified between the likelihood of an individual being aware of, treated, or controlled for diabetes and living in rural and urban settings. Drive time showed no relationship with these stages of diabetes, nor did it modify the effect rural or urban status had on the dependent variables. Disparities were noted for demographic, socioeconomic, and health behavioral traits.

Conclusion – Results from this study suggest that living in rural and urban settings has no implication on an individual's awareness of, treatment, or control for diabetes, even when examined with travel time to a usual source of medical care.

Introduction

Diabetes is one of the top 10 causes of death in the United States and a leading risk factor for cardiovascular disease and stroke.[1] The 2009 Behavioral Risk Factor Surveillance Survey (BRFSS) estimated that more than 8% of the U.S. population has been diagnosed with diabetes. While concern about diabetes is national in scope, as with many health conditions, diabetes is most prevalent in Southern states and rural areas.[2,3] Average estimates show a diabetes prevalence of approximately 11% in the Southern region of the country and as much as 13% in some rural areas.[2,4] In addition to the geographic disparity, several studies have identified inequalities of race and socioeconomic (SES) that further distinguish the South and rural locations with regard to diabetes and other health conditions.[5-8] Much of the morbidity and mortality commencing from illnesses such as cardiovascular disease (CVD) and stroke may be lessened with adequate control of diabetes and other risk factors.[9] People often manage such diseases through the care provided by Family Medicine and Internal Medicine facilities. However, many diabetic patients lack awareness, treatment, and control (A-T-C) of their disease.[8-10] This failure is plausibly the result of a number of circumstances concerning patients and their environment. One such consideration in diabetes control may be the access patients have to a health care facility because they reside in a rural area with no readily available source of health care. Describing an association with this dynamic will lead to a more comprehensive understanding of diabetes management and afford awareness for patients and health care providers. This study focuses its efforts on the role access to health care has on the Reasons for Geographic and Racial Differences in Stroke (REGARDS) study participants in management of diabetes.

Rural inhabitants are often considered to have limited access to health care, thus frequently decreasing the likelihood of their being aware of, treated, or controlled for diabetes. Although, access to care is a dynamic point of interest and involves many factors, this study considers rural or urban place of residence and travel time to a usual source of health care as surrogate measures of access to care, but we acknowledge that access may also be confounded with factors such as socioeconomic status. For example, even with the same travel time, a low-SES individual who does not own a car may have poor access to care compared to a higher-SES individual who does own a car. The data will provide an avenue for exploration into the association that nontraditional risk factors for cardiovascular disease, rural/urban designation, and travel time to a usual source of health care has on A-T-C of diabetes. These possible barriers to accessing primary health care could potentially cause people to postpone preventive medical services until significant advancement of a disease has occurred. This study seeks to investigate the possible differences and associations between access to health care (rural/urban status and travel time to medical care) and a person's adeptness at managing their diabetes.

The study will utilize the REGARDS study data set to identify participants with diabetes. The data, combined with the U.S. Department of Agriculture's rural-urban commuting area (RUCA) codes, will provide an avenue for exploration into the associations these nontraditional risk factors have on diabetes control. This investigation will explore differences and associations of A-T-C of diabetes relative to individuals' access to health care as characterized by rural/urban designation and travel time to their usual source of health care. Specifically,

- Is there an association between A-T-C of diabetes for REGARDS study participants when considering the rural or urban designation of their residency?

- Is there an association between driving time to a usual source of health care and A-T-C of diabetes?
- Is the association between rural or urban designation and A-T-C of diabetes different when considering drive time to a usual source of health care? That is, does travel time act as an effect modifier to the impact of rural/urban designation?

Methods

This study seeks to identify and measure geographic, particularly rural and urban, and racial variations pertaining to the awareness, treatment, and control (A-T-C) of diabetes. Recognition of these differences provides insight into the varying geographic degrees at which disparities in A-T-C of diabetes occur. Furthermore, the project aims to investigate the association between diabetes and access to an individual's usual source of health care. These objectives will be pursued through secondary data analysis of the REGARDS study data combined with rural-urban commuting area codes (RUCA).

REGARDS Study

The REGARDS study is a national, longitudinal cohort collected from January 2003 to October 2007 consisting of 50% African-American and 50% Caucasian participants. The observational study is comprised of more than 30,000 adults 45 years of age and older and is focused on learning more about factors that increase the risk of stroke. Participants were selected from a commercially available nationwide list purchased from Genesys Inc. The recruitment goal for REGARDS was 30,000 participants, including 30% from "Stroke Belt" states (North Carolina, South Carolina, Georgia, Alabama, Arkansas, Louisiana, Tennessee, and Mississippi), 20% percent from the region known as the "Stroke Buckle" (coastal region of North Carolina, South Carolina, and Georgia), and the remainder from throughout the continental United States. The racial and gender demographics for each region are approximately 50% percent black and 50% white, as well as 50% male and 50% female. While the methods for the REGARDS study are presented here, a more detailed description is available in a report by Howard et al.[11]

A letter and brochure about the REGARDS study was sent to potential participants two weeks prior to attempting contact by telephone. Random household members were selected for accurate representation. Interviewers called throughout the day and evening, both weekdays and weekends. Once contact was made, participants 45 years of age and older were screened for eligibility. Exclusions included race other than black or white, active treatment for cancer, medical conditions preventing long-term participation, cognitive impairment as judged by the interviewer, residence in or waiting for admittance to a nursing facility, or an inability to communicate in English. Verbal informed consent was requested upon establishment of eligibility. After consent was obtained, a medical history, including risk factor evaluation, was collected by computer assisted telephone interviewing (CATI).[12,13] CATI was used for quality control. Following the telephone interview, an in-home exam was scheduled at the participant's convenience. Participants were asked to fast for 10 to 12 hours before the visit and to have medications present for recording. Examination Management Services Inc. (EMSI) technicians trained for the REGARDS study conducted the in-home exams and shipped samples to a central laboratory. Participants not wishing to go forth with the exam were classified as partial participants. Written informed consent was obtained by EMSI personnel. Standardized methods were used to collect physical measurements, resting ECG, medication inventory, blood, and urine. Questionnaires were left with participants to collect additional demographics and risk-factor information. These forms were completed by participants after the visit and returned to the Operation Center via self-addressed prepaid envelopes. One of the forms requested information about participants' primary medical care. This form contained questions about participants' travel time to their usual source of medical care, their perception of the medical care, and their confidence in their doctor. Six to eight weeks after the in-home visit, participants were mailed a thank you letter and check for $30.[11]

Table 1.

REGARDS Study components and method of collection.

Component	**Telephone interview**	**In-home interview**	**Self-administered**
Medical history	X		
Personal history, demographics, SES	X		
Stroke-free status	X		
Physical activity	X		
Depression	X		
Cognitive screening	X		
Perceived health/quality of life	X		
Social support	X		
Social network	X		
Potential caregivers	X		
Laboratory assays		X	
Urine		X	
Height, weight, waist circumference		X	
Blood pressure, pulse		X	
Electrocardiography		X	
Medication in past two weeks		X	
Residential history			X
Dietary intake			X
Family history			X

Components of the REGARDS study data are found in Table 1. The components are made up of variables including age, race, and gender of the participant, history of heart disease, kidney disease, reproductive history, aspirin use, cigarette smoking (including smoking status, pack-years exposure, and exposure to passive cigarette smoke), alcohol intake, physical activity level, general health (MOS short form-12),[14] access to health care, insurance status, marital status, measures of socioeconomic status (education and income), indicators of existing social networks, psychosocial factors (social network, depressive symptoms, and stress), and history of cardiovascular procedures (endarterectomy, coronary artery bypass surgery, peripheral vascular surgery, and percutaneous transluminal coronary angioplasty), and history of myocardial infarction and/or stroke. Data pertaining to previous stroke symptoms were determined using the Questionnaire for Verifying Stroke-Free Status.[15] Depressive symptoms were determined by use of the Center for Epidemiologic Studies Depression Scale[16] and Cohen's Perceived Stress Scale.[17] Cognitive function was measured by the Six-Item Cognitive Screener.[18] Information about participant's residence included city and state of birth and all other cities and states lived in up to and including the present residence.

RUCA Codes and Rural Health Research Center

Rural-Urban Commuting Area (RUCA) codes are a U.S. census tract-based classification scheme developed by the U.S. Department of Agriculture to characterize census tracts based on their rural and urban status and relationship.[19] RUCA version 2.0 was created from 2000 census commuting and census tract information. The purpose of the codes is to identify urban cores and adjacent territory that are economically integrated to the core. RUCA designations have been used previously in health-related research to classify rural and urban status and to offer geographic guidance about access-to-care concerns.[20-23] The designations provide an appropriate and innovative classification scheme for this investigation because they recognize how limited access to care may affect A-T-C of diabetes. The classification scheme is made up of 10 primary codes and 30 secondary codes (Table 2). The codes offer a delineation of metropolitan and non-metropolitan settlements based on size and direction of commuting flows. The RUCA codes for this project are reduced to a two-category classification collapsed from established information provided by the Rural Health Research Center.[24]

The Rural Health Research Center is one of six research centers funded by the Health Resources and Services Administration's Federal Office of Rural Health Policy and is tasked to perform policy-oriented research on matters related to rural health care. Methods developed by the center combine RUCA code designations to highlight distinctions between rural and urban sections of a state.[24] Previous studies have made use of this data aggregation to compare geographic access to health care and quality of care for myocardial infarction in rural and urban hospitals.[25,26] The two categories for rural or urban designation examine the urban category against a collapsed category that combines large rural, small rural, and isolated codes[19,24] (Table 3). Although the analysis performed in this study only specifies whether or not an area is rural or urban, this binary grouping is based on RUCA categorized census tracts and is, therefore, derived from a more specific stratification than rural/urban designations resulting from a county-level classification.

Table 2.

Rural-Urban Commuting Areas (RUCAs), 2000

1 Metropolitan area core: primary flow within an urbanized area (UA)
- 1.0 No additional code
- 1.1 Secondary flow 30% to 50% to a larger UA

2 Metropolitan area high commuting: primary flow 30% or more to a UA
- 2.0 No additional code
- 2.1 Secondary flow 30% to 50% to a larger UA

3 Metropolitan area low commuting: primary flow 5% to 30% to a UA
- 3.0 No additional code

4 Micropolitan area core: primary flow within an Urban Cluster of 10,000 to 49,999 (large UC)
- 4.0 No additional code
- 4.1 Secondary flow 30% to 50% to a UA
- 4.2 Secondary flow 10% to 30% to a UA

5 Micropolitan high commuting: primary flow 30% or more to a large UC
- 5.0 No additional code
- 5.1 Secondary flow 30% to 50% to a UA
- 5.2 Secondary flow 10% to 30% to a UA

6 Micropolitan low commuting: primary flow 10% to 30% to a large UC
- 6.0 No additional code
- 6.1 Secondary flow 10% to 30% to a UA

7 Small town core: primary flow within an Urban Cluster of 2,500 to 9,999 (small UC)
- 7.0 No additional code
- 7.1 Secondary flow 30% to 50% to a UA
- 7.2 Secondary flow 30% to 50% to a large UC
- 7.3 Secondary flow 10% to 30% to a UA
- 7.4 Secondary flow 10% to 30% to a large UC

8 Small town high commuting: primary flow 30% or more to a small UC
- 8.0 No additional code
- 8.1 Secondary flow 30% to 50% to a UA
- 8.2 Secondary flow 30% to 50% to a large UC
- 8.3 Secondary flow 10% to 30% to a UA
- 8.4 Secondary flow 10% to 30% to a large UC

9 Small town low commuting: primary flow 10% to 30% to a small UC
- 9.0 No additional code
- 9.1 Secondary flow 10% to 30% to a UA
- 9.2 Secondary flow 10% to 30% to a large UC

10 Rural areas: primary flow to a tract outside a UA or UC
10.0 No additional code
10.1 Secondary flow 30% to 50% to a UA
10.2 Secondary flow 30% to 50% to a large UC
10.3 Secondary flow 30% to 50% to a small UC
10.4 Secondary flow 10% to 30% to a UA
10.5 Secondary flow 10% to 30% to a large UC
10.6 Secondary flow 10% to 30% to a small UC

Table 3.

Two and Four Category Rural/Urban Classification.

2 Category	4 Category	RUCA Code
Rural	Isolated	10.0
		10.2
		10.3
		10.4
		10.5
		10.6
	Small Rural	7.0
		7.2
		7.3
		7.4
		8.0
		8.2
		8.3
		8.4
		9.0
		9.1
		9.2
	Large Rural	4.0
		4.2
		5.0
		5.2
		6.0
		6.1
Urban	Urban	1.0
		1.1
		2.0
		2.1
		3.0
		4.1
		5.1
		7.1
		8.1
		10.1

Analysis

Awareness, treatment, and control (A-T-C) of diabetes is defined using the approach of Voeks et al.[27] Measurements for glucose were obtained as part of the REGARDS in-home examination. Diabetes was defined as a fasting blood glucose measurement of > 126 mg/dL, a non-fasting blood glucose measurement of > 200 mg/dL, or if the participant was medicated for diabetes by pills or insulin. Female participants who were told they were diabetic only while pregnant were coded as non-diabetic. Data from the REGARDS baseline survey and the in-home exam were used to define diabetes "awareness," "treatment," and "control." Participants considered "aware" of diabetes answered "yes" to "Have you ever been told by a doctor that you have diabetes or high blood sugar?" Participants considered as "treated" for diabetes were the proportion of the "aware" population that answered "yes" to having self-reported taking pills or insulin. Participants considered as "under control" for diabetes were the proportion of the "treated" population that had a fasting blood glucose measurement of ≤ 126 mg/dL or a non-fasting blood glucose measurement of ≤ 200 mg/dL. Additional variables from the REGARDS baseline survey were used to examine and control for other areas of interest, including demographics, smoking and alcohol use, physical activity, and general health.

Participants from the REGARDS study were geographically matched based on rural/urban designation as per address information collected from the REGARDS baseline survey, which has already been geo-coded to the census track level (the level required for RUCA code assignment). A total of 30,239 individuals completed the telephone interview followed by an in-home physical exam, which constitutes the sample for the baseline survey. The "You and Your Doctor" form, where drive time to participants' usual source of medical care was collected, was part of the mail-in questionnaires received six to eight weeks after the in-home exam. The resulting sample after participants from the baseline survey were assigned a RUCA code and matched to those who completed and returned the "You and Your Doctor" questionnaire was 14,374. In order to identify participants with diabetes, subjects must have had a fasting blood glucose reading of > 126 mg/dL or a non-fasting blood glucose reading of > 200 mg/dL, or must have been medicated with pills or insulin. After controlling for these measures, the sample resulted in 2,597 diabetic participants.

Statistical analysis was done using Statistical Analysis Software (SAS) version 9.2. Descriptive analysis provided the sample characteristics. Information about sample size, as well as strata on basic demographic and geographic values such as gender, race, and rural/urban designation, is provided. Pearson's chi-square and independent sample t-test were used for comparison of the sample characteristics table between the "diabetes A-T-C" variables and the independent variables (Tables 4,7,10). The association between A-T-C of diabetes and rural/urban status was investigated in a series of logistic models. The first model examined the unadjusted relationship between A-T-C of diabetes and the participant's rural or urban designation. Second, a model making an adjustment for drive time to a usual source of health care was implemented to expose any effect modification this variable might render on the relationship between A-T-C of diabetes and the participant's rural/urban status. The final two logistic regression models were enhanced to include demographic and behavioral descriptions, as well as interactions between race, gender, and socio-economic variables, to expose underlying relationships of known inconsistencies.

Results

Awareness of Diabetes

Of the 14,374 REGARDS study participants, 2,597 were considered diabetic. Blacks (90.3%) were significantly ($p<.001$) more aware they had diabetes than were whites (85.7%) (Table 4). Age also displayed a statistically significant ($p=.003$) result with individuals who were aware of having diabetes being, on average, approximately a year and a half older than those who were not aware of having diabetes (aware: $\bar{x} =$ 64.63 years, SD ± 8.83; not aware: $\bar{x} =$ 63.01 years, SD ± 9.30). Both indicators of socioeconomic status exhibited statistically significant differences ($p<.05$) and showed trends for participants who were the most educated and had the highest levels of income being the least aware of having diabetes. Participants who were classified as college graduates and higher (86.7%) were the least aware, while those with less than a high school education (90.9%) were the most aware. Likewise, participants with annual earnings at or above $75,000 (83.2%) were the least aware, while those whose annual earnings were less than $20,000 (89.8%) were the most aware. Alcohol use was the only lifestyle factor that displayed a significant result ($p<.001$). Participants with no alcohol use (90.8%) leaned toward being more aware of their diabetes. Additionally, perceiving one's health as less favorable contributed more to being aware of diabetes.

The overall model statistics for the series of logistic regression models used to model the probability of being aware of diabetes did not indicate rural/urban status (p.=356) or drive time ($p=.768$) to be significantly improved from the base model (Table 5). The addition of demographic, socioeconomic, health behaviors, and perception of general health factors improved the model's ability to predict participants' awareness of diabetes ($p<.001$). Among these variables, the Type III analysis showed age (p.=014), alcohol use ($p<.001$), and perception of general health (p<.001) to be the main contributors to this result. No interactions between rural/urban status and the other variables were found.

Age was the only demographic variable to show a relationship with awareness of diabetes (Table 6). However, this relationship, while statistically significant (p=.014), shows that the odds of being aware of diabetes increases by only 2% (OR, 1.02; 95% CI, 1.00 to 1.04) for every year increase in age. Only the "refused" category for income showed a significant association with being aware of diabetes (OR, 1.95; 95% CI, 1.03 to 3.69). Participants' use of alcohol demonstrated a strong relationship with being aware of diabetes. Moderate drinkers were more than twice as likely (OR, 2.12; 95% CI, 1.01 to 4.44) to be aware of their diabetes as were heavy drinkers, and individuals who used no alcohol were four times as likely to be aware of their diabetes (OR, 4.05; 95% CI, 1.96 to 8.39). Perceived general health also had categories with strong associations of diabetes awareness. Participants with a perception of "very good" health were 31% as likely (OR, .31; 95% CI .15 to .64) to be aware of their diabetes, while those whose perception was "excellent" were only 17% as likely (OR, .17; 95% CI, .07 to .38) to be aware of their diabetes.

Table 4.
Sample characteristics, according to awareness of diabetes.

Characteristic	Awareness		p value†
	Not Aware	Aware	
Total [No. (%)]	301 (11.6)	2,296 (88.4)	
Rural/Urban			.356
Rural	58 (10.6)	490 (89.4)	
Urban	218 (12.0)	1,594 (88.0)	
Race			<.001
Black	148 (9.7)	1,381 (90.3)	
White	153 (14.3)	915 (85.7)	
Gender			.228
Male	123 (12.6)	856 (87.4)	
Female	178 (11.0)	1,440 (89.0)	
Income			<.001
Less than $20k	62 (10.2)	545 (89.8)	
$20k - $34k	74 (10.8)	614 (89.2)	
$35k - $74k	100 (14.3)	600 (85.7)	
$75k and above	43 (16.8)	213 (83.2)	
Refused	22 (6.4)	324 (93.6)	
Education			.042
Less than high school	42 (9.1)	419 (90.9)	
High school graduate	70 (10.0)	631 (90.0)	
Some college	93 (13.1)	617 (86.9)	
College graduate and above	96 (13.3)	624 (86.7)	
Smoking Status			.129
Current	53 (14.7)	307 (85.3)	
Past	107 (10.9)	878 (89.1)	
Never	140 (11.3)	1,104 (88.8)	
Alcohol Use			<.001
Heavy	16 (33.3)	32 (66.7)	
Moderate	99 (17.8)	458 (82.2)	
None	178 (9.2)	1,755 (90.8)	
Exercise			.236
None	113 (10.4)	973 (89.6)	
1 to 3 times per week	114 (12.8)	777 (87.2)	
4 or more times per week	71 (12.1)	516 (89.9)	
General Health			<.001
Poor	13 (6.9)	176 (93.1)	
Fair	40 (5.6)	669 (94.4)	
Good	115 (10.9)	936 (89.1)	
Very good	91 (18.4)	404 (81.6)	
Excellent	41 (28.5)	103 (71.5)	
Drive time (Mean ± SD)	24.01 ± 25.00	23.88 ± 21.55	.926
Age (Mean ± SD)	63.01 ± 9.30	64.63 ± 8.83	.003

† All p values were based on a Pearson's χ^2 and an independent samples t-test (for the last two variables with mean ± standard deviation).

Table 5.

Model statistics of incremental logistic regression models for the association between the likelihood of being aware of diabetes and other factors.

	Unadjusted (n = 2,360)		**Adjusted for Drive Time (n = 2,234)**		**Adjusted for Other Independent Variables (n = 2,120)**		**Adjusted for Interactions with Other Independent Variables (n = 2,120)**	
Max-Rescaled R^2	<.001		<.001		.110		.119	
Parameter	**χ^2 (*df*)**	**p value**	**χ^2 (*df*)**	**p value**	**χ^2 (*df*)**	**p value**	**χ^2 (*df*)**	**p value**
Global $H_0: \beta = 0$	.852 (1)	.356†	.527 (2)	.768†	110.605 (22)	<.001†	109.165 (31)	<.001†
Type 3 Analysis								
Rural/Urban	.852 (1)	.356†	.524 (1)	.469†	.628 (1)	.428†	.706 (1)	.401†
Drive Time	-	-	.004 (1)	.949†	.033 (1)	.856†	.010 (1)	.921†
Age	-	-	-	-	6.080 (1)	.014†	5.903 (1)	.015†
Race	-	-	-	-	3.241 (1)	.072†	1.309 (1)	.253†
Gender	-	-	-	-	.570 (1)	.450†	2.268 (1)	.132†
Income	-	-	-	-	7.918 (4)	.095†	.925 (4)	.921†
Education	-	-	-	-	.377 (3)	.945†	.564 (3)	.905†
Smoking	-	-	-	-	2.196 (2)	.334†	1.970 (2)	.373†
Alcohol	-	-	-	-	24.687 (2)	<.001†	24.83 (2)	<.001†
Exercise	-	-	-	-	.653 (2)	.722†	.564 (2)	.754†
Gen. Health	-	-	-	-	49.280 (4)	<.001†	47.531 (4)	<.001†
Rural/Urban* Race	-	-	-	-	-	-	.171 (1)	.679†
Rural/Urban* Gender	-	-	-	-	-	-	1.792 (1)	.181†
Rural/Urban* Income	-	-	-	-	-	-	1.312 (4)	.859†
Rural/Urban* Education	-	-	-	-	-	-	1.241 (3)	.743†
Hosmer & Lemeshow	NA	NA	13.915 (7)	.127‡	7.514 (8)	.482‡	13.099 (8)	.109‡

df degrees of freedom

† p value based on Wald χ^2 statistic.

‡ p value based on χ^2 Goodness-of-Fit statistic.

Table 6.

Association between likelihood of being aware of diabetes and other factors with incremental logistic regression models.

	Unadjusted (n = 2,360)		Adjusted for Drive Time (n = 2,234)		Adjusted for Other Independent Variables (n = 2,120)		Adjusted for Interactions with Other Independent Variables (n = 2,120)	
Predictor Variable	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**
Rural/Urban								
Rural	Reference		Reference		Reference		Reference	
Urban	.87 (.64, 1.18)	.356	.91 (.66, 1.25)	.545	.87 (.61, 1.24)	.428	.60	.401
Drive Time	NA	NA	1.00 (.99, 1.00)	.523	1.00 (.99, 1.01)	.856	1.00 (.99, 1.01)	.921
Age	NA	NA	NA	NA	1.02 (1.00, 1.04)	.014	1.02 (1.00, 1.04)	.015
Race	NA	NA	NA	NA				
Black	-	-	-	-	Reference		Reference	
White	-	-	-	-	.76 (.56, 1.03)	.072	.67	.253
Gender	NA	NA	NA	NA				
Male	-	-	-	-	Reference		Reference	
Female	-	-	-	-	.89 (.65, 1.21)	.450	.60	.132
Income	NA	NA	NA	NA				
Less than $20k	-	-	-	-	Reference		Reference	
$20k - $34k	-	-	-	-	.90 (.58, 1.38)	.616	1.41	.473
$35k - $74k	-	-	-	-	.82 (.53, 1.29)	.97	.97	.954
$75k and above	-	-	-	-	.84 (.48, 1.45)	.529	.89	.841
Refused	-	-	-	-	1.95 (1.03, 3.69)	.041	‡	‡
Education	NA	NA	NA	NA				
Less than H.S.	-	-	-	-	Reference		Reference	
H.S. graduate	-	-	-	-	1.07 (.66, 1.74)	.790	.96	.940
Some college	-	-	-	-	1.10 (.67, 1.80)	.714	.94	.918
College grad and above	-	-	-	-	1.17 (.70, 1.96)	.557	.72	.585
Smoking Status	NA	NA	NA	NA				
Current	-	-	-	-	Reference		Reference	
Past	-	-	-	-	1.39 (9.0, 2.14)	.139	1.36 (.88, 2.10)	.161
Never	-	-	-	-	1.25 (.82, 1.91)	.300	1.24 (.81, 1.90)	.323

† All p values were based on the Wald χ^2 statistic.

‡ Insufficient number of observations for category

Table 6 (continued).

Association between likelihood of being aware of diabetes and other factors with incremental logistic regression models.

	Unadjusted (n = 2,360)		**Adjusted for Drive Time (n = 2,234)**		**Adjusted for Other Independent Variables (n = 2,120)**		**Adjusted for Interactions with Other Independent Variables (n = 2,120)**	
Predictor Variable	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**
Rural/Urban								
Rural	Reference		Reference		Reference		Reference	
Urban	.87 (.64, 1.18)	.356	.91 (.66, 1.25)	.545	.87 (.61, 1.24)	.428	.60	.401
Drive Time	NA	NA	1.00 (.99, 1.00)	.523	1.00 (.99, 1.01)	.856	1.00 (.99, 1.01)	.921
Alcohol Use	NA		NA	NA				
Heavy	-		-	-	Reference		Reference	
Moderate	-		-	-	2.12 (1.01, 4.44)	.048	2.20 1.03, 4.66)	.041
None	-		-	-	4.05 (1.96, 8.39)	<.001	4.20 (2.00, 8.81)	<.001
Exercise	NA		NA	NA				
None	-		-	-	Reference		Reference	
1 to 3 times per week	-		-	-	1.02 (.73, 1.42)	.900	1.00 (.72, 1.39)	.989
≥ 4 times per week	-		-	-	1.16 (.80, 1.69)	.443	1.14 (.78, 1.66)	.507
General Health	NA		NA	NA				
Poor	-		-	-	Reference		Reference	
Fair	-		-	-	1.04 (.48, 2.27)	.913	1.04 (.48, 2.27)	.913
Good	-		-	-	.50 (.24, 1.03)	.058	.50 (.24, 1.03)	.060
Very good	-		-	-	.31 (.15, .64)	.002	.31 (.15, 66)	.002
Excellent	-		-	-	.17 (.07, .38)	<.001	.17 (.08, .40)	<.001

† All p values were based on the Wald χ^2 statistic.

Table 6 (continued).

Association between likelihood of being aware of diabetes and other factors with incremental logistic regression models.

	Unadjusted (n = 2,360)		**Adjusted for Drive Time (n = 2,234)**		**Adjusted for Other Independent Variables (n = 2,120)**		**Adjusted for Interactions with Other Independent Variables (n = 2,120)**	
Predictor Variable	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**
Rural/Urban								
Rural	Reference		Reference		Reference		Reference	
Urban	.87 (.64, 1.18)	.356	.91 (.66, 1.25)	.545	.87 (.61, 1.24)	.428	.60	.401
Drive Time	NA	NA	1.00 (.99, 1.00)	.523	1.00 (.99, 1.01)	.856	1.00 (.99, 1.01)	.921
Rural/Urban* Race	NA	NA	NA	NA	NA	NA		
Rural, Black	-	-	-	-	-	-	Reference	
Urban, White	-	-	-	-	-	-	1.18	.679
Rural/Urban* Gender	NA	NA	NA	NA	NA	NA		
Rural, Male	-	-	-	-	-	-	Reference	
Urban, Female	-	-	-	-	-	-	.57	.293
Rural/Urban* Income	NA	NA	NA	NA	NA	NA		
Rural, Less than 20k	-	-	-	-	-	-	Reference	
Urban, $20k - $34k	-	-	-	-	-	-	.57	.293
Urban, $35k - $74k	-	-	-	-	-	-	.81	.692
Urban, $75k and above	-	-	-	-	-	-	.94	.924
Urban, Refused	-	-	-	-	-	-	‡	‡
Rural/Urban* Education	NA	NA	NA	NA	NA	NA		
Rural, Less than H.S.	-	-	-	-	-	-	Reference	
Urban, H.S. graduate	-	-	-	-	-	-	1.11	.863
Urban, Some college	-	-	-	-	-	-	1.21	.774
Urban, ≥ college grad.	-	-	-	-	-	-	1.79	.378

† All p values were based on the Wald χ^2 statistic.

‡ Insufficient number of observations for category

Treated for Diabetes

There were no statistically significant findings for the analysis of diabetes treatment. Table 7 provides the characteristics of the sample and indicates that only four participants from the aware population were not treated for their diabetes. This minimal frequency for those not being treated for diabetes does not allow for accurate statistical inferences to be made from the results.

Table 7.

Sample characteristics, according to treatment of diabetes.

Characteristic	**Treatment**		**p value†**
	Not Treated	Treated	
Total [No. (%)]	4 (.18)	2,177 (99.8)	
Rural/Urban			.938‡
Rural	1 (.2)	461 (99.8)	
Urban	3 (.2)	1,513 (99.8)	
Race			.556‡
Black	3 (.2)	1,319 (99.8)	
White	1 (.1)	858 (99.9)	
Gender			.613‡
Male	1 (.1)	811 (99.9)	
Female	3 (.2)	1,366 (99.8)	
Income			.950‡
Less than $20k	1 (.2)	521 (99.8)	
$20k - $34k	1 (.2)	584 (99.8)	
$35k - $74k	1 (.2)	567 (99.8)	
$75k and above	0 (.0)	199 (100.0)	
Refused	1 (.3)	306 (99.7)	
Education			.678‡
Less than high school	0 (.0)	401 (100.0)	
High school graduate	1 (.2)	596 (99.8)	
Some college	1 (.2)	585 (99.8)	
College graduate and above	2 (.3)	590 (99.7)	
Smoking Status			.522‡
Current	0 (.0)	294 (100.0)	
Past	1 (.1)	825 (99.9)	
Never	3 (.3)	1,051 (99.7)	
Alcohol Use			.572‡
Heavy	0 (.0)	28 (100.0)	
Moderate	0 (.0)	437 (100.0)	
None	4 (.2)	1,666 (99.8)	
Exercise			.737‡
None	1 (.1)	930 (99.9)	
1 to 3 times per week	2 (.3)	734 (99.7)	
4 or more times per week	1 (.2)	489 (99.8)	
General Health			.787‡
Poor	0 (0.0)	165 (100.0)	
Fair	0 (0.0)	649 (100.0)	
Good	3 (.3)	891 (99.7)	
Very good	1 (.3)	371 (99.7)	
Excellent	0 (.0)	93 (100.0)	
Drive time (Mean ± SD)	15.00 ± 0.00	23.70 ± 21.25	.479‡
Age (Mean ± SD)	73.00 ± 11.02	64.67 ± 8.73	.057‡

† All p values were based on a Pearson's χ^2 and an independent samples t-test (for the last two variables with mean ± standard deviation).

‡ Insufficient number of observations per category for comparison.

Control of Diabetes

The 1,158 (53.8%) participants who were treated for diabetes also had their diabetes at a controlled state (Table 8). Individuals controlled ($\bar{x}$ = 65.31 years; SD ± 8.66) for diabetes had a significantly ($p<.001$) higher mean age than those not controlled for diabetes ($\bar{x}$ = 63.85 years; SD ± 8.75). Only education and perception of general health displayed a significant difference between the proportions of their categories. The inclination for education now is that participants with higher levels of education are more controlled for diabetes than those with lower levels ($p<.001$). Perception of general health also followed a trend for controlled diabetes. Perception of general health ranged from "poor" as the least frequent group (48.5%) to "excellent" as the most frequent group (61.3%) to be controlled for diabetes.

The unadjusted logistic model, with only rural/urban status as a predictor variable, does not significantly ($p=.282$) increase the ability to predict the probability of being controlled for diabetes over the base model (Table 9). Even with the adjustment for drive time, the model still lacks evidence ($p=.474$) to support any increase in predictability from the base model. The adjustment for demographic, socioeconomic, behavioral, and perception of general health factors exhibited a significant ($p=.030$) increase in the ability to predict control of diabetes from the model with no independent variables. A significant interaction ($p=.003$) was noted between rural/urban status and income for the association with a controlled diabetic. However, the Hosmer & Lemeshow test revealed a violation of model fit ($p=.050$); therefore, the model without interaction is used for interpretation.

Only age and education were shown to have a significant association with control of diabetes in the logistic model (Table 10). Age, although statistically significant (OR, 1.02; 95% CI, 1.01 to 1.03), does not offer much practical relevance for making inferences between age and the probability of participants being controlled for diabetes. Yet, education does seem to be of importance with regard to control of diabetes. College graduates and above are 51% more likely (OR, 1.51; 95% CI, 1.08 to 2.10) to be controlled for diabetes than participants with less than a high school education, and those who have finished high school are 40% more likely (OR, 1.40; 95% CI, 1.03 to 1.91) to be controlled for diabetes.

Table 8.

Sample characteristics, according to control of diabetes.

Characteristic	**Control**		**p value†**
	Not Controlled	Controlled	
Total [No. (%)]	996 (46.2)	1,158 (53.8)	
Rural/Urban			.283
Rural	218 (47.6)	240 (52.4)	
Urban	668 (44.7)	825 (55.3)	
Race			.453
Black	611 (46.9)	692 (53.1)	
White	385 (45.2)	466 (54.8)	
Gender			.989
Male	371 (46.3)	431 (53.7)	
Female	625 (46.2)	727 (53.8)	
Income			.076
Less than $20k	260 (50.5)	255 (49.5)	
$20k - $34k	267 (46.0)	313 (313)	
$35k - $74k	234 (41.8)	326 (58.2)	
$75k and above	91 (46.2)	106 (53.8)	
Refused	144 (47.7)	158 (52.3)	
Education			<.001
Less than high school	214 (54.3)	180 (45.7)	
High school graduate	283 (47.7)	310 (52.3)	
Some college	260 (45.0)	318 (55.0)	
College graduate and above	235 (40.2)	349 (59.8)	
Smoking Status			.301
Current	146 (50.5)	143 (49.5)	
Past	373 (45.8)	442 (54.2)	
Never	475 (45.5)	568 (54.5)	
Alcohol Use			.998
Heavy	13 (46.4)	15 (53.6)	
Moderate	199 (46.4)	230 (53.6)	
None	763 (46.2)	888 (53.8)	
Exercise			.186
None	423 (46.1)	495 (53.9)	
1 to 3 times per week	353 (48.4)	376 (51.6)	
4 or more times per week	208 (43.1)	275 (56.9)	
General Health			.012
Poor	85 (51.5)	80 (48.5)	
Fair	317 (49.7)	321 (50.3)	
Good	406 (46.1)	475 (53.9)	
Very good	149 (40.4)	220 (59.6)	
Excellent	36 (38.7)	57 (61.3)	
Drive time (Mean ± SD)	23.58 ± 20.74	23.86 ± 21.82	.765
Age (Mean ± SD)	63.85 ± 8.75	65.31 ± 8.66	<.001

† All p values were based on a Pearson's χ^2 and an independent samples t-test (for the last two variables with mean ± standard deviation)

Table 9.

Model statistics of incremental logistic regression models for the association between the likelihood of being controlled for diabetes and other factors.

	Unadjusted (n = 1,951)		**Adjusted for Drive Time (n = 1,840)**		**Adjusted for Other Independent Variables (n = 1,767)**		**Adjusted for Interactions with Other Independent Variables (n = 1,767)**	
Max-Rescaled R^2	<.001		.001		.028		.041	
Parameter	**χ^2 (*df*)**	**p value**	**χ^2 (*df*)**	**p value**	**χ^2 (*df*)**	**p value**	**χ^2 (*df*)**	**p value**
Global $H_0: \beta = 0$	1.158 (1)	.282†	1.494 (2)	.474†	36.006 (22)	.030†	52.655 (31)	.009†
Type 3 Analysis								
Rural/Urban	1.158 (1)	.282†	1.486 (1)	.223†	.093 (1)	.760†	3.558 (1)	.059†
Drive Time	-	-	.008 (1)	.929†	.083 (1)	.773†	.204 (1)	.652†
Age	-	-	-	-	9.300 (1)	.002†	10.347 (1)	.001†
Race	-	-	-	-	.889 (1)	.346†	.024 (1)	.878†
Gender	-	-	-	-	.932 (1)	.334†	1.854 (1)	.173†
Income	-	-	-	-	4.683 (4)	.321†	11.758 (4)	.019†
Education	-	-	-	-	6.866 (3)	.076†	.455 (3)	.929†
Smoking	-	-	-	-	.322 (2)	.852†	.372 (2)	.830†
Alcohol	-	-	-	-	.377 (2)	.828†	.168 (2)	.919†
Exercise	-	-	-	-	3.632 (2)	.163†	3.336 (2)	.189†
Gen. Health	-	-	-	-	3.124 (4)	.537†	3.751 (4)	.441†
Rural/Urban* Race	-	-	-	-	-	-	.487 (1)	.485†
Rural/Urban* Gender	-	-	-	-	-	-	1.013 (1)	.314†
Rural/Urban* Income	-	-	-	-	-	-	15.841 (4)	.003†
Rural/Urban* Education	-	-	-	-	-	-	1.834 (3)	.608†
Hosmer & Lemeshow	NA	NA	12.540 (6)	.051‡	3.629 (8)	.889‡	15.498 (8)	.050‡

df degrees of freedom
† p value based on Wald χ^2 statistic.
‡ p value based on χ^2 Goodness-of-Fit statistic.

Table 10.

Association between likelihood of being controlled for diabetes and other factors with incremental logistic regression models.

	Unadjusted (n = 1,951)		Adjusted for Drive Time (n = 1,840)		Adjusted for Other Independent Variables (n = 1,767)		Adjusted for Interactions with Other Independent Variables (n = 1,767)	
Predictor Variable	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**
Rural/Urban								
Rural	Reference		Reference		Reference		Reference	
Urban	1.12 (.91, 1.38)	.282	1.15 (.92, 1.42)	.223	1.04 (.82, 1.31)	.760	1.95	.059
Drive Time	NA	NA	1.00 (.99, 1.01)	.929	1.00 (.99, 1.01)	.773	1.00 (.99, 1.01)	.652
Age	NA	NA	NA	NA	1.02 (1.01, 1.03)	.003	1.02 (1.01, 1.03)	.001
Race	NA	NA	NA	NA				
Black	-	-	-	-	Reference		Reference	
White	-	-	-	-	.91 (.74, 1.11)	.346	1.04	.878
Gender	NA	NA	NA	NA				
Male	-	-	-	-	Reference		Reference	
Female	-	-	-	-	1.11 (.90, 1.37)	.334	1.36	.173
Income	NA	NA	NA	NA				
Less than $20k	-	-	-	-	Reference		Reference	
$20k - $34k	-	-	-	-	1.13 (.86, 1.49)	.385	2.35	.003
$35k - $74k	-	-	-	-	1.32 (.98, 1.78)	.069	1.50	.208
$75k and above	-	-	-	-	1.02 (.69, 1.53)	.907	3.05	.015
Refused	-	-	-	-	1.01 (.73, 1.39)	.965	1.87	.074
Education	NA	NA	NA	NA				
Less than H.S.	-	-	-	-	Reference		Reference	
H.S. graduate	-	-	-	-	1.21 (.90, 1.63)	.206	1.21	.511
Some college	-	-	-	-	1.40 (1.03, 1.91)	.031	1.14	.707
College grad and above	-	-	-	-	1.51 (1.08, 2.10)	.015	1.10	.788
Smoking Status	NA	NA	NA	NA				
Current	-	-	-	-	Reference		Reference	
Past	-	-	-	-	1.09 (.80, 1.49)	.573	1.10 (.80, 1.50)	.561
Never	-	-	-	-	1.06 (.78, 1.45)	.692	1.05 (.77, 1.44)	.743

† All p values were based on the Wald χ^2 statistic.

Table 10 (continued).

Association between likelihood of being controlled for diabetes and other factors with incremental logistic regression models.

	Unadjusted (n = 1,951)		Adjusted for Drive Time (n = 1,840)		Adjusted for Other Independent Variables (n = 1,767)		Adjusted for Interactions with Other Independent Variables (n = 1,767)	
Predictor Variable	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**
Rural/Urban								
Rural	Reference		Reference		Reference		Reference	
Urban	1.12 (.91, 1.38)	.282	1.15 (.92, 1.42)	.223	1.04 (.82, 1.31)	.760	1.95	.059
Drive Time	NA	NA	1.00 (.99, 1.01)	.929	1.00 (.99, 1.01)	.773	1.00 (.99, 1.01)	.652
Alcohol Use	NA		NA	NA				
Heavy	-		-	-	Reference		Reference	
Moderate	-		-	-	.79 (.33, 1.84)	.578	.88 (.37, 2.10)	.781
None	-		-	-	.77 (.33, 1.78)	.543	.86 (.37, 2.00)	.723
Exercise	NA		NA	NA				
None	-		-	-	Reference		Reference	
1 to 3 times per week	-		-	-	.88 (.70, 1.10)	.251	.87 (.69, 1.09)	.218
≥ 4 times per week	-		-	-	1.13 (.87, 1.45)	.361	1.10 (.85, 1.42)	.471
General Health	NA		NA	NA				
Poor	-		-	-	Reference		Reference	
Fair	-		-	-	.89 (.61, 1.30)	.548	.88 (.60, 1.29)	.514
Good	-		-	-	.94 (.65, 1.38)	.765	.93 (.64, 1.37)	.723
Very good	-		-	-	1.12 (.74, 1.70)	.597	1.13 (.74, 1.73)	.565
Excellent	-		-	-	1.18 (.66, 2.12)	.571	1.20 (.67, 2.17)	.537

† All p values were based on the Wald χ^2 statistic.

Table 10 (continued).

Association between likelihood of being controlled for diabetes and other factors with incremental logistic regression models.

	Unadjusted (n = 1,951)		Adjusted for Drive Time (n = 1,840)		Adjusted for Other Independent Variables (n = 1,767)		Adjusted for Interactions with Other Independent Variables (n = 1,767)	
Predictor Variable	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**
Rural/Urban								
Rural	Reference		Reference		Reference		Reference	
Urban	1.12 (.91, 1.38)	.282	1.15 (.92, 1.42)	.223	1.04 (.82, 1.31)	.760	1.95	.059
Drive Time	NA	NA	1.00 (.99, 1.01)	.929	1.00 (.99, 1.01)	.773	1.00 (.99, 1.01)	.652
Rural/Urban* Race	NA	NA	NA	NA	NA	NA		
Rural, Black	-	-	-	-	-	-	Reference	
Urban, White	-	-	-	-	-	-	.84	.485
Rural/Urban* Gender	NA	NA	NA	NA	NA	NA		
Rural, Male	-	-	-	-	-	-	Reference	
Urban, Female	-	-	-	-	-	-	.78	.314
Rural/Urban* Income	NA	NA	NA	NA	NA	NA		
Rural, Less than 20k	-	-	-	-	-	-	Reference	
Urban, $20k - $34k	-	-	-	-	-	-	.38	.003
Urban, $35k - $74k	-	-	-	-	-	-	.82	.595
Urban, $75k and above	-	-	-	-	-	-	.25	.007
Urban, Refused	-	-	-	-	-	-	.44	.040
Rural/Urban* Education	NA	NA	NA	NA	NA	NA		
Rural, Less than H.S.	-	-	-	-	-	-	Reference	
Urban, H.S. graduate	-	-	-	-	-	-	.97	.936
Urban, Some college	-	-	-	-	-	-	1.29	.505
Urban, ≥ college grad.	-	-	-	-	-	-	1.47	.325

† All p values were based on the Wald χ^2 statistic.

Discussion

Results from this investigation found no differences between the proportion of rural and urban participants who were aware of or controlled for diabetes. Significant differences were noted for the demographic factors of age ($p=.003$) and race ($p<.001$) for the aware population, but only age showed a mean difference between the controlled and uncontrolled groups ($p<.001$). The two measures of socioeconomic status indicated that both a lower level of education and income were conducive to being more aware of diabetes, but participants with higher levels of education were more controlled. Individuals who were classified as heavy drinkers made up the lowest proportion of those who were aware; however, no significant differences were shown for either alcohol or smoking use for control of diabetes. Contrary results for perception of general health were also found when examining awareness and control of diabetes. Participants who were aware of their diabetes showed a pattern of perceiving their health as less favorable, while the largest proportion of controlled diabetics consisted of participants who perceived their health as "excellent."

Findings from the multivariable model showed age as the only demographic variable to have a significant association with being aware of or controlled for diabetes. However, in both instances, the odds of being aware and controlled increased by only 2% with each year increase in age. When examining income, only the "refused" category showed a significant relationship when compared with the "less than $20k" category. This finding is difficult to generalize without knowing why people refused to disclose financial information. Unlike what was found for the aware population, a significant association was not shown between income and being controlled for diabetes, although a significant association was demonstrated between education and diabetes control. Having at least some level of college education gave participants a 40% or greater chance of being controlled for diabetes. No factors involving behavior or perception of health were associated with control of diabetes. Being aware of diabetes did have a strong relationship with alcohol use. Participants with moderate drinking habits were more than twice as likely to be aware of diabetes, and those who never drink were more than four times as likely to be aware of diabetes. Also, participants viewing themselves in better health were much less likely to be aware of their diabetic condition than those who were in "poor" perceived health.

A search of the literature in regard to this investigation found no previous investigations with similar comparisons between awareness, treatment, and control of diabetes and access to care from the rural and urban perspective. Voeks et al, from which the this study's methods of defining awareness, treatment, and control of diabetes are based, examined many of the same demographic and health indicator variables but focused on geographical disparities from a regional stand point.[27] Their findings showed that diabetes is a substantial contributor to racial and geographic disparities in stroke mortality. Geographic inequalities were noted between blacks residing in the "Stroke Buckle," (coastal regions of Georgia, South Carolina, and North Carolina) and the rest of the nation. Blacks in the "Stroke Buckle" region were more likely to be aware of, but less likely to be treated and controlled for, diabetes than blacks in other regions. Even though our study examines geography from a different viewpoint, we also found similar racial trends in regard to awareness and control of diabetes. The current investigation did not find any differences or relationships between A-T-C of diabetes and rural or urban place of residence. However, this study did inspect the relationship between A-T-C of diabetes and rural/urban status from a stand-alone and an interaction position, which limited some specific comparisons, such as comparing rural blacks to urban blacks or the rural socioeconomic indicators to the urban socioeconomic indicators.

Access to care is often studied from several dimensions. Research from Weingarten et al investigated quality of care indicator rates of diabetes for Medicare beneficiaries in rural and urban areas.[28] Their findings show quality of care indicator rates for diabetes to be higher in rural areas than in urban areas. However, these findings were not consistent across all regions of the country. Southern states actually experienced lower quality of care in rural areas when compared with urban areas. This reinforces the Voeks et al study that variations in awareness, treatment, and control of diabetes and stroke management exist. The means of investigating geographic diabetes disparities in our study did not reveal an association between the management of diabetes and an individual's rural/urban status. Findings from our study compared with Weingarten et al do show similarities. While their study's outcome measures were quality of care indicators for clinics, comparisons can be inferred due to the overlap these measures should have with A-T-C of diabetes. Even though our study, which compared the United States as a whole, lacked evidence to support dissimilarities for diabetes management between rural and urban locations, it should be noted that the differences found by Weingarten et al were marginal.

Other studies have identified associations of increased prevalence of diabetes with race, socioeconomic status, and geographic dimensions.[3,29-31] Denham et al focused on rural and urban differences in the prevalence of diabetes primarily concentrated in the Ohio River Valley and Appalachia.[3] They reported greater shortages of diabetes specialists in rural areas of Appalachia and noted that physicians in rural areas were less likely to follow the American Diabetes Association standards of care.[32] Compared to our study, this study also examined rural disparities within a specific region of the United States. However, while Denham et al inspected rural/urban disparities within Appalachia, their focus was on the prevalence of diabetes whereas our focus is on management of diabetes. Even so, inconsistent geographic results for matters pertaining to diabetes were found between the two studies. This suggests that rural and urban differences pertaining to diabetes exist, but that those differences are specific to certain sections of the country.

The strengths and weaknesses of this study are of importance. The study sample encompassed data collected from the REGARDS study's examination of underlying causes for stroke. The use of this data allowed for a substantial sample size and for the investigation to be national in scope. The considerable sample size, along with self-reports and in-home exam measurements collected from the baseline survey, afforded us the proficiency to comprehensively investigate association between awareness, treatment, and control of diabetic individuals and their rural or urban residency. To our knowledge, the association between A-T-C of diabetes and rural or urban status has yet to be thoroughly explored, thus making this study unique in its efforts. The study is also innovative because of its assessment of any consequence travel time to a usual source of medical care may pose to A-T-C of diabetes, or if travel time modifies the effect of rural and urban designation. Although rural and urban representation in this study originated from a census tract classification scheme, the independent variable of interest included only one category for rural and one for urban; therefore, the different natures of rural and urban locales are not fully represented. For example, individuals residing in isolated rural areas are possibly exposed to different barriers to care than those in small or large townships. Also, race disparities were examined only between black and white participants. Inspection of differences and associations within race by rural or urban designation has yet to be explored. In other words, do differences exist between rural blacks and urban blacks with regard to A-T-C of diabetes?

Not only are there varying degrees within which rural and urban locales differ, but rural and urban areas are also different in separate regions of the United States. Assessments of various cardiovascular disease and stroke risk factors, such as diabetes, should be scrutinized for the possibility that these influences may exhibit different outcomes when examined from a perspective that separates rural and urban by region. Follow-up studies should meticulously inspect discrepancies that may exist between rural and urban locations by separate regions of the United States. For example, do Southern rural blacks have a different A-T-C of diabetes than rural blacks from the Midwest? There are several components of this study that are designed to provide an additional awareness that will have an impact beyond this investigation. Diabetes disparities have yet to be explored from several geographic perspectives. A continued comprehensive approach to investigating major risk factors for cardiovascular disease and stroke will afford a better understanding of the degree to which geographical inequalities exist.

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Association between Awareness, Treatment, and Control of Dyslipidemia and Rural/Urban Access to Care

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Tables

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Abstract

Background and Purpose – Dyslipidemia is one of the major controllable risk factors for cardiovascular disease (CVD). The lack of access patients have to health care facilities, because they reside in a rural area or have extended travel times to their sources of health care, possibly presents barriers for individuals when managing CVD and stroke-risk factors.

Methods – The association between A-T-C of dyslipidemia and an individual's rural/urban status was investigated using data from the REGARDS study to identify geographic disparities. Furthermore, travel time to a participant's usual source of health care was explored for its relationship to these stages of cholesterol management and to determine how travel time might influence the association between dyslipidemia and rural/urban status.

Results – No associations were identified between the likelihood of A-T-C of dyslipidemia and living in rural and urban settings. Drive time showed no relationship with these stages of cholesterol management, nor did it modify the effect rural or urban status had on the dependent variables. Disparities were noted for demographic, socioeconomic, and health behavioral traits.

Conclusion – Results from this study suggest that living in rural and urban settings has no implication on an individual's awareness of, treatment, or control for managing cholesterol levels, even when examined with travel time to a usual source of health. Rural/urban status is, however, a dynamic variable and could be scrutinized from a more specific perspective to investigate rural/urban differences by region with regard to dyslipidemia.

Introduction

Cardiovascular disease (CVD) is the leading cause of death in the United States, accounting for more than 600,000 deaths annually, or 200 deaths per 100,000 population.[1] Dyslipidemia is one of the major controllable risk factors for CVD. Data from the National Health and Nutrition Examination Survey (NHANES) 2003-2006 indicate that 16.2% of U.S. adults 20 years of age and older have total serum cholesterol levels at or above 240 mg/dL. This amounts to an estimated 35,700,000 U.S. adults with hypercholesterolemia.[2,3] Previous studies have provided evidence that indicates lowering serum cholesterol levels can significantly decrease the risk for coronary heart disease (CHD), including cardiac death, myocardial infarction, and stroke.[4-7] The Third Report of the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults declares that fewer than half of persons who qualify for lipid-modifying treatment for CHD risk reduction are receiving it and about one-third of treated patients are achieving their LDL goal, while less than 20% of CHD patients are at their LDL goal.[8] Much of the morbidity and mortality commencing from illnesses such as cardiovascular disease (CVD) and stroke may be lessened with adequate awareness, treatment, and control (A-T-C) of dyslipidemia and other risk factors.[9] People often manage such diseases through the care of Family Medicine or Internal Medicine facilities. However, the fact remains that many patients with high blood cholesterol are not successful in maintaining healthy lipid levels. This failure is plausibly the result of a number of circumstances concerning patients and their environment. One such consideration to poor lipid management may be the lack of access patients have to a health care facility because they reside in a rural area or have extended travel times to their source of medical care. Describing any association with this dynamic will lead to a more comprehensive understanding of cholesterol management and afford awareness for patients and health care providers. This study focuses its efforts on the role access to primary care has on the Reasons for Geographic and Racial Disparities in Stroke (REGARDS) study participants with regard to management of dyslipidemia.

Rural inhabitants are often considered to have limited access to health care, thus frequently decreasing the likelihood of individuals' being aware of, treated, or controlled for dyslipidemia. Although, access to care is a dynamic point of interest and involves many factors, this study considers rural or urban place of residence and travel time to a usual source of medical care as surrogate measures of access to care, but we acknowledge that access may also be confounded with factors such as socio-economic status. For example, even with the same travel time, a low-SES individual who does not own a car may have poor access to care compared to a higher-SES individual who does own a car. The data will provide an avenue for exploration into the association that nontraditional risk factors for cardiovascular disease, rural/urban designation, and travel time to a usual source of health care has on A-T-C of dyslipidemia. These possible barriers to accessing health care could potentially be the cause for people to postpone preventive medical services until significant advancement of a disease has occurred. This study seeks to investigate the possible differences and associations nontraditional risk factors and access to health care (rural/urban status and travel time to medical care) has on individuals' adeptness in their management of dyslipidemia

The study will utilize the REGARDS study data set to identify participants with dyslipidemia. The data, combined with the U.S. Department of Agriculture's rural-urban commuting area (RUCA) codes, will provide an avenue for exploration into the associations that these nontraditional risk factors have on cholesterol control.   This investigation will explore the differences and associations of A-T-C of dyslipidemia relative to individuals' access to health care as characterized by rural/urban designation and travel time to their usual source of medical care. Specifically,

- Is there an association between A-T-C of dyslipidemia for REGARDS study participants when considering the rural or urban designation of their residency?
- Is there an association between driving time to a usual source of medical care and A-T-C of dyslipidemia?
- Is the association between rural or urban designation and A-T-C of dyslipidemia different when considering drive time to a usual source of medical care? That is, does travel time act as an effect modifier to the impact of rural/urban designation?

Methods

This study seeks to identify and measure geographic, particularly rural and urban, and racial variations pertaining to the awareness, treatment, and control (A-T-C) of dyslipidemia. Recognition of these differences provides insight into varying geographic degrees at which dyslipidemia A-T-C disparities occur. Furthermore, the project aims to investigate the association between dyslipidemia and access to an individual's usual source of health care. These objectives will be pursued through secondary data analysis of the REGARDS study data combined with rural-urban commuting area codes (RUCA).

REGARDS Study

The REGARDS study, funded by the National Institutes of Health (NIH), is a national, longitudinal cohort collected from January 2003 to October 2007 consisting of 50% African-American and 50% Caucasian participants. The observational study is comprised of more than 30,000 adults 45 years of age and older with a focus of learning more about factors that increase the risk of stroke. Participants were selected from a commercially available, nationwide list purchased from Genesys Inc. The recruitment goal for REGARDS was 30,000 participants, including 30% from the "Stroke Belt" states (North Carolina, South Carolina, Georgia, Alabama, Arkansas, Louisiana, Tennessee, and Mississippi), 20% from the region known as the "Stroke Buckle" (coastal region of North Carolina, South Carolina, and Georgia), and the remainder from throughout the continental United States. The racial and gender demographics for each region is approximately 50% black and 50% white, and 50% male and 50% female.[10,11]

A letter and brochure about the REGARDS study was sent to potential participants two weeks prior to attempting contact by telephone. Random household members were selected for accurate representation. Interviewers called throughout the day and evening, both weekdays and weekends. Once contact was made, participants 45 years of age and older were screened for eligibility. Exclusions included race other than black or white, active treatment for cancer, medical conditions preventing long-term participation, cognitive impairment as judged by the interviewer, residence in or waiting for admittance to a nursing facility, or an inability to communicate in English. Verbal informed consent was requested upon establishment of eligibility. After consent was obtained, a medical history, including risk-factor evaluation, was collected by computer assisted telephone interviewing (CATI).[12,13] CATI was used for quality control. Following the telephone interview, an in-home exam was scheduled at the participant's convenience. Participants were asked to fast for 10 to 12 hours before the visit and to have medications present for recording. Examination Management Services Inc. (EMSI) technicians trained for the REGARDS study conducted the in-home exams and shipped samples to a central laboratory. Participants wishing not to go forth with the exam were classified as partial participants. Written informed consent was obtained by EMSI personnel. Standardized methods were used to collect physical measurements, resting ECG, medication inventory, as well as blood and urine samples. Self-administered questionnaires were left with participants to collect additional information about demographics and risk factors. These forms were completed by participants after the visit and returned to the Operation Center via self-addressed, prepaid envelopes. One of the forms requested information about participants' primary medical care. This form included questions about participants' travel time to their usual source of health care, their perception of the medical care, and their confidence in their doctor. Six to eight weeks following the in-home visit, participants were mailed a thank you letter and check for $30.[14]

Table 1.

REGARDS Study components and method of collection.

Component	**Telephone interview**	**In-home interview**	**Self-administered**
Medical history	X		
Personal history, demographics, SES	X		
Stroke-free status	X		
Physical activity	X		
Depression	X		
Cognitive screening	X		
Perceived health/quality of life	X		
Social support	X		
Social network	X		
Potential caregivers	X		
Laboratory assays		X	
Urine		X	
Height, weight, waist circumference		X	
Blood pressure, pulse		X	
Electrocardiography		X	
Medication in past two weeks		X	
Residential history			X
Dietary intake			X
Family history			X

Elements of the REGARDS study data are found in Table 1. The components are made up of variables including age, race, and gender of the participant, history of heart disease, kidney disease, reproductive history, aspirin use, cigarette smoking (including smoking status, pack-years exposure, and exposure to passive cigarette smoke), alcohol intake, physical activity level, general health (MOS short form-12),[15] access to health care, insurance status, marital status, measures of socioeconomic status (education and income),social networks,[26] psychosocial factors (social network, depressive symptoms, and stress), history of cardiovascular procedures (endarterectomy, coronary artery bypass surgery, peripheral vascular surgery, and percutaneous transluminal coronary angioplasty), myocardial infarction, or stroke. Data pertaining to previous stroke symptoms were determined using the Questionnaire for Verifying Stroke-Free Status.[16] Depressive symptoms were determined by use of the Center for Epidemiologic Studies Depression Scale[17] and Cohen's Perceived Stress Scale.[18] Cognitive function was measured by the Six-Item Cognitive Screener.[19] Information regarding participant's residence included city and state of birth and all other cities and states lived in up to the present residence.

RUCA Codes and Rural Health Research Center

Rural-Urban Commuting Area (RUCA) codes are a census tract-based classification scheme developed by the U.S. Department of Agriculture to characterize census tracts about their rural and urban status and relationship.[20] RUCA version 2.0 was created based on 2000 census commuting and census tract information. The purpose of the codes is to identify urban cores and adjacent territory that are economically integrated to the core. RUCA designations have been used previously in health-related research to classify rural and urban status and offer geographic guidance about access to health care concerns.[21-24] The designations provide an appropriate and innovative classification scheme for this study because they recognize how limited access to health care may affect A-T-C of hypertension. The classification scheme is made up of 10 primary codes and 30 secondary codes (Table 2). The codes offer a delineation of metropolitan and non-metropolitan settlements based on size and direction of commuting flows.

The RUCA codes for this project are reduced to a two category classification collapsed from established information provided by the Rural Health Research Center.[25]

The Rural Health Research Center is one of six research centers funded by the Health Resources and Services Administration's Federal Office of Rural Health Policy and is tasked to perform policy-oriented research on matters related to rural health care. Methods developed from the center combine RUCA code designations to highlight distinctions between rural and urban sections of a state.[25] Previous studies have made use of this data aggregation to compare geographic access to health care and quality of care for myocardial infarction in rural and urban hospitals.[26,27] The two categories for rural or urban designation examine the urban category against a collapsed category that combines large rural, small rural, and isolated codes[20,25] (Table 3). Although the analysis performed in this study only specifies whether or not an area is rural or urban, this binary grouping is based on RUCA categorized census tracts and is, therefore, derived from a more specific stratification than rural/urban designations resulting from just county-level classification.

Table 2.

Rural-Urban Commuting Areas (RUCAs), 2000

1 Metropolitan area core: primary flow within an urbanized area (UA)
- 1.0 No additional code
- 1.1 Secondary flow 30% to 50% to a larger UA

2 Metropolitan area high commuting: primary flow 30% or more to a UA
- 2.0 No additional code
- 2.1 Secondary flow 30% to 50% to a larger UA

3 Metropolitan area low commuting: primary flow 5% to 30% to a UA
- 3.0 No additional code

4 Micropolitan area core: primary flow within an Urban Cluster of 10,000 to 49,999 (large UC)
- 4.0 No additional code
- 4.1 Secondary flow 30% to 50% to a UA
- 4.2 Secondary flow 10% to 30% to a UA

5 Micropolitan high commuting: primary flow 30% or more to a large UC
- 5.0 No additional code
- 5.1 Secondary flow 30% to 50% to a UA
- 5.2 Secondary flow 10% to 30% to a UA

6 Micropolitan low commuting: primary flow 10% to 30% to a large UC
- 6.0 No additional code
- 6.1 Secondary flow 10% to 30% to a UA

7 Small town core: primary flow within an Urban Cluster of 2,500 to 9,999 (small UC)
- 7.0 No additional code
- 7.1 Secondary flow 30% to 50% to a UA
- 7.2 Secondary flow 30% to 50% to a large UC
- 7.3 Secondary flow 10% to 30% to a UA
- 7.4 Secondary flow 10% to 30% to a large UC

8 Small town high commuting: primary flow 30% or more to a small UC
- 8.0 No additional code
- 8.1 Secondary flow 30% to 50% to a UA
- 8.2 Secondary flow 30% to 50% to a large UC
- 8.3 Secondary flow 10% to 30% to a UA
- 8.4 Secondary flow 10% to 30% to a large UC

9 Small town low commuting: primary flow 10% to 30% to a small UC
- 9.0 No additional code
- 9.1 Secondary flow 10% to 30% to a UA
- 9.2 Secondary flow 10% to 30% to a large UC

10 Rural areas: primary flow to a tract outside a UA or UC
10.0 No additional code
10.1 Secondary flow 30% to 50% to a UA
10.2 Secondary flow 30% to 50% to a large UC
10.3 Secondary flow 30% to 50% to a small UC
10.4 Secondary flow 10% to 30% to a UA
10.5 Secondary flow 10% to 30% to a large UC
10.6 Secondary flow 10% to 30% to a small UC

Table 3.

Two and Four Category Rural/Urban Classification.

2 Category	4 Category	RUCA Code
Rural	Isolated	10.0
		10.2
		10.3
		10.4
		10.5
		10.6
	Small Rural	7.0
		7.2
		7.3
		7.4
		8.0
		8.2
		8.3
		8.4
		9.0
		9.1
		9.2
	Large Rural	4.0
		4.2
		5.0
		5.2
		6.0
		6.1
Urban	Urban	1.0
		1.1
		2.0
		2.1
		3.0
		4.1
		5.1
		7.1
		8.1
		10.1

Analysis

Awareness, treatment, and control (A-T-C) of dyslipidmia is defined using the approach of Zweifler et al.[27] Measurements for cholesterol were obtained as part of the REGARDS in-home examination survey. Dyslipidemia was defined as being on lipid-controlling medication or, if not on therapy, having a low density lipoprotein cholesterol (LDL-C) exceeding the risk-specific threshold in the Adult Treatment Panel (ATP) III. Participants were considered to have dyslipidemia if they had a total cholesterol reading of $\geq$ to 240 mg/dL, or an LDL $\geq$ 160 mg/dL, or a HDL < 40 mg/dL. Data from the REGARDS baseline survey and the in-home exam was also used to define dyslipidemia "awareness," "treatment," and "control." Participants considered "aware" of dyslipidemia answered "yes" to "Have you ever been told by a doctor that you have high cholesterol or an abnormal level of fats in your blood?" Participants considered as "treated" for dyslipidemia were the proportion of the "aware" population that answered "yes" to having self-reported taking medication for the condition. Participants considered as "under control" for dyslipidemia were the proportion of the "treated" population that had a total cholesterol < 240 mg/dL and an LDL < 160 mg/dL and a HDL $\geq$ 40 mg/dL. Additional variables from the REGARDS baseline survey were used to examine and control for other areas of interest, including demographics, smoking and alcohol use, physical activity, and general health.

Participants from the REGARDS study were geographically matched based on rural/urban designation as per address information collected from the REGARDS baseline survey, which has already been geo-coded to the census track level (the level required for RUCA code assignment). A total of 30,239 individuals completed the telephone interview followed by an in-home physical exam, which constitutes the sample for the baseline survey. The "You and Your Doctor" form, where drive time to the participants' usual source of health care was collected, was part of the mail-in questionnaires received six to eight weeks after the in-home exam. The resulting sample after participants from the baseline survey were assigned a RUCA code and matched to those who completed and returned the "You and Your Doctor" questionnaire was 14,374. In order to identify participants with dyslipidemia, subjects must have had a total cholesterol reading of $\geq$ 240 mg/dL, or an LDL $\geq$ 160 mg/dL, or a HDL $<$ 40 mg/dL, or be on lipid-lowering medication. After controlling for these measures, the sample resulted in 8,210 participants with dyslipidemia.

Statistical analysis was done using Statistical Analysis Software (SAS) version 9.2. Descriptive analysis provided the sample characteristics. Information regarding sample size, as well as strata on basic demographic and geographic values such as gender, race, and rural/urban designation, is provided. Pearson's chi-square and an independent sample t-test were used for comparison of the sample characteristics table between the "dyslipidemia A-T-C" variables and the independent variables (Tables 4,7,10). The association between A-T-C of dyslipidemia and rural/urban status was investigated in a series of logistic regression models. The first model examined the unadjusted relationship between A-T-C of dyslipidemia and the participant's rural or urban designation. Second, a model making an adjustment for drive time to a usual source of health care in order to expose any effect modification this variable may render on the relationship between A-T-C of dyslipidemia and the participant's rural/urban status was used. The final two logistic regression models were enhanced to include demographic and behavioral descriptions, as well as interactions between race, gender, and socio-economic variables, to expose underlying relationships of known inconsistencies.

Results

Awareness of Dyslipidemia

Of the 14,374 REGARDS study participants, 8,210 were considered to have abnormal readings for cholesterol. Of those, 6,204 (75.6%) were aware of their condition (Table 4). No significant difference (p=.399) in awareness was noted between participants living in rural (75.0%) or urban (76.0%) areas. Additionally, there was no mean difference (p=.162) for travel time between aware and unaware participants. Age and gender both displayed differences, with the mean age of those aware ($\bar{x}$ = 64.86; SD ± 9.07) of dyslipidemia approximately two years older than those not aware ($\bar{x}$ = 62.41; SD ± 10.13), and a higher percentage of females (79.1%) were aware than males (70.5%). There was also a significant difference (p=.001) for income; however, no specific pattern emerged. Smoking status indicated differences (p<.001) as the proportion of those aware of their dyslipidemia for both past smokers (78.2%) and those who have never smoked (74.9%) was greater than current smokers (70.8%). The final difference (p<.001) was noted for general health perception. The results signify a small tendency for those with the best perceptions of health to be the least aware of high cholesterol.

The model statistics for the series of logistic regression procedures examined whether rural/urban status (p=.399) or an adjustment for drive time (p=.148) offered any evidence of these variables' ability to increase the prediction of being aware of dyslipidemia above the base model (Table 5). The adjustment for the other independent variables did offer substantial improvement (p<.001) for prediction. The Type III analysis indicates age (p<.001), gender (p<.001), income (p=.002), smoking status (p<.001), alcohol use (p=.018), exercise (p=.037), and perception of general health (p<.001) are all beneficial for predicting awareness of dyslipidemia. No interactions between rural/urban status and the demographic and socioeconomic variables were identified.

Age was statistically significant ($p<.001$) but with only a marginal increase in the odds of being aware of dyslipidemia (OR, 1.03; 95% CI, 1.02 to 1.04) (Table 6). Females were also at significantly greater odds of being aware of high cholesterol than males (OR, 1.76; 95% CI, 1.55 to 1.99). All categories of income were at significantly greater odds of being aware of dyslipidemia than the reference category of earning less than $20,000 annually. The category with the most increased likelihood for being aware of dyslipidemia over the reference was the $20,000 to $34,000 annual income category (OR, 1.53; 95% CI, 1.25 to 1.86), thus indicating no definite trend. Only past smokers were at an increased odds of being aware of high cholesterol than current smokers (OR, 1.45; 95% CI, 1.21 to 1.73). Alcohol users, conversely, showed that individuals who did not use alcohol were only 65% as likely to be aware of dyslipidemia as compared to heavy drinkers (OR, .65; 95% CI, .46 to .94). Participants who exercised four or more times per week were 23% more likely to be aware (OR, 1.23; 95% CI, 1.05 to 1.43) of high cholesterol than those who did not exercise, but participants with perceptions that their health was “very good” (OR, .59; 95% CI, .42 to .83) and “excellent” (OR, .41; 95% CI, .28 to .58) were less likely to be aware of dyslipidemia.

Table 4.

Sample characteristics, according to awareness of dyslipidemia.

Characteristic	**Awareness**		**p value†**
	Not Aware	Aware	
Total [No. (%)]	2,006 (24.4)	6,204 (75.6)	
Rural/Urban			.399
Rural	407 (25.0)	1,223 (75.0)	
Urban	1,364 (24.0)	4,330 (76.0)	
Race			.707
Black	824 (24.7)	2,519 (75.4)	
White	1,182 (24.3)	3,685 (75.7)	
Gender			<.001
Male	1,002 (29.5)	2,397 (70.5)	
Female	1,004 (20.9)	3,807 (79.1)	
Income			.001
Less than $20k	365 (26.4)	1,016 (73.6)	
$20k - $34k	467 (23.8)	1,496 (76.2)	
$35k - $74k	579 (23.3)	1,908 (76.7)	
$75k and above	360 (27.2)	964 (72.8)	
Refused	235 (22.3)	820 (77.7)	
Education			.635
Less than high school	231 (23.1)	769 (76.9)	
High school graduate	516 (23.9)	1,640 (76.1)	
Some college	559 (24.8)	1,700 (75.3)	
College graduate and above	694 (24.9)	2,092 (75.1)	
Smoking Status			<.001
Current	367 (29.2)	889 (70.8)	
Past	691 (21.8)	2,485 (78.2)	
Never	942 (25.1)	2,805 (74.9)	
Alcohol Use			.282
Heavy	55 (20.4)	215 (79.6)	
Moderate	616 (24.7)	1,875 (75.3)	
None	1,296 (24.5)	4,003 (75.5)	
Exercise			.462
None	695 (23.6)	2,253 (76.4)	
1 to 3 times per week	728 (24.6)	2,229 (75.4)	
4 or more times per week	547 (25.0)	1,643 (75.0)	
General Health			<.001
Poor	79 (23.3)	260 (76.7)	
Fair	254 (17.5)	1,201 (82.5)	
Good	703 (23.0)	2,360 (77.1)	
Very good	614 (26.3)	1,718 (73.7)	
Excellent	348 (34.7)	654 (65.3)	
Drive time (Mean ± SD)	21.30 ± 14.68	21.85 ± 14.68	.162
Age (Mean ± SD)	62.41 ± 10.13	64.86 ± 9.07	<.001

† All p values were based on a Pearson's χ^2 and an independent samples t-test (for the last two variables with mean ± standard deviation).

Table 5.

Model statistics of incremental logistic regression models for the association between the likelihood of being aware of dyslipidemia and other factors.

	Unadjusted (n = 7,324)		**Adjusted for Drive Time (n = 6,866)**		**Adjusted for Other Independent Variables (n = 6,614)**		**Adjusted for Interactions with Other Independent Variables (n = 6,614)**	
Max-Rescaled R^2	<.001		<.001		.066		.068	
Parameter	**χ^2 (*df*)**	**p value**	**χ^2 (*df*)**	**p value**	**χ^2 (*df*)**	**p value**	**χ^2 (*df*)**	**p value**
Global $H_0: \beta = 0$	.711 (1)	.399†	3.819 (2)	.148†	278.010 (22)	<.001†	286.222 (31)	<.001†
Type 3 Analysis								
Rural/Urban	.711 (1)	.399†	2.512 (1)	.113†	2.100 (1)	.147†	4.671 (1)	.031†
Drive Time	-	-	1.230 (1)	.267†	.979 (1)	.322†	.857 (1)	.355†
Age	-	-	-	-	73.819 (1)	<.001†	72.975 (1)	<.001 †
Race	-	-	-	-	2.666 (1)	.103†	.334 (1)	.563†
Gender	-	-	-	-	77.330 (1)	<.001†	24.773 (1)	<.001†
Income	-	-	-	-	17.595 (4)	.002†	7.981 (4)	.092†
Education	-	-	-	-	1.499 (3)	.683†	1.427 (3)	.699†
Smoking	-	-	-	-	18.876 (2)	<.001†	18.773 (2)	<.001†
Alcohol	-	-	-	-	8.060 (2)	.018†	7.944 (2)	.019†
Exercise	-	-	-	-	6.585 (2)	.037†	6.481 (2)	.039†
Gen. Health	-	-	-	-	106.858 (4)	<.001†	106.757 (4)	<.001†
Rural/Urban* Race	-	-	-	-	-	-	.032 (1)	.859†
Rural/Urban* Gender	-	-	-	-	-	-	.559 (1)	.455†
Rural/Urban* Income	-	-	-	-	-	-	4.168 (4)	.384†
Rural/Urban* Education	-	-	-	-	-	-	3.924 (3)	.270†
Hosmer & Lemeshow	NA	NA	16.285 (8)	.039‡	9.467 (8)	.304‡	10.527 (8)	.230‡

df degrees of freedom

† p value based on Wald χ^2 statistic.

‡ p value based on χ^2 Goodness-of-Fit statistic.

Table 6.

Association between likelihood of being aware of dyslipidemia and other factors with incremental logistic regression models.

Predictor Variable	Unadjusted (n = 7,324) Odds Ratio [e^{β}(95% CI)]	p value†	Adjusted for Drive Time (n = 6,866) Odds Ratio [e^{β}(95% CI)]	p value†	Adjusted for Other Independent Variables (n = 6,614) Odds Ratio [e^{β}(95% CI)]	p value†	Adjusted for Interactions with Other Independent Variables (n = 6,614) Odds Ratio [e^{β}(95% CI)]	p value†
Rural/Urban								
Rural	Reference		Reference		Reference		Reference	
Urban	1.06 (.93, 1.20)	.399	1.11 (.98, 1.27)	.113	1.11 (.96, 1.28)	.147	1.74	.031
Drive Time	NA	NA	1.00 (1.00, 1.01)	.267	1.00 (1.00, 1.01)	.322	1.00 (.99, 1.01)	.355
Age	NA	NA	NA	NA	1.03 (1.02, 1.04)	<.001	1.03 (1.02, 1.04)	<.001
Race	NA	NA	NA	NA				
Black	-	-	-	-	Reference		Reference	
White	-	-	-	-	1.11 (.98, 1.27)	.103	1.09	.563
Gender	NA	NA	NA	NA				
Male	-	-	-	-	Reference		Reference	
Female	-	-	-	-	1.76 (1.55, 1.99)	<.001	1.91	<.001
Income	NA	NA	NA	NA				
Less than $20k	-	-	-	-	Reference		Reference	
$20k - $34k	-	-	-	-	1.29 (1.06, 1.57)	.011	1.40	.086
$35k - $74k	-	-	-	-	1.53 (1.25, 1.86)	<.001	1.51	.036
$75k and above	-	-	-	-	1.39 (1.10, 1.75)	.006	1.96	.006
Refused	-	-	-	-	1.33 (1.05, 1.67)	.017	1.47	.096
Education	NA	NA	NA	NA				
Less than H.S.	-	-	-	-	Reference		Reference	
H.S. graduate	-	-	-	-	.95 (.77, 1.18)	.657	1.18	.393
Some college	-	-	-	-	.90 (.73, 1.13)	.371	1.29	.236
College grad and above	-	-	-	-	.98 (.78, 1.24)	.888	1.18	.445
Smoking Status	NA	NA	NA	NA				
Current	-	-	-	-	Reference		Reference	
Past	-	-	-	-	1.45 (1.21, 1.73)	<.001	1.44 (1.20, 1.73)	<.001
Never	-	-	-	-	1.17 (.98, 1.39)	.088	1.16 (.97, 1.38)	.097

† All p values were based on the Wald χ^2 statistic.

Table 6 (continued).

Association between likelihood of being aware of dyslipidemia and other factors with incremental logistic regression models.

Predictor Variable	**Unadjusted (n = 7,324)**		**Adjusted for Drive Time (n = 6,866)**		**Adjusted for Other Independent Variables (n = 6,614)**		**Adjusted for Interactions with Other Independent Variables (n = 6,614)**	
	Odds Ratio [e^{β}(95% CI)]	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**
Rural/Urban								
Rural	Reference		Reference		Reference		Reference	
Urban	1.06 (.93, 1.20)	.399	1.11 (.98, 1.27)	.113	1.11 (.96, 1.28)	.147	1.74	.031
Drive Time	NA	NA	1.00 (1.00, 1.01)	.267	1.00 (1.00, 1.01)	.322	1.00 (.99, 1.01)	.355
Alcohol Use	NA		NA	NA				
Heavy	-		-	-	Reference		Reference	
Moderate	-		-	-	.75 (.52, 1.08)	.125	.76 (.53, 1.09)	.130
None	-		-	-	.65 (.46, .94)	.021	.66 (.46, .94)	.022
Exercise	NA		NA	NA				
None	-		-	-	Reference		Reference	
1 to 3 times per week	-		-	-	1.11 (.96, 1.28)	.148	1.11 (.96, 1.28)	.147
≥ 4 times per week	-		-	-	1.23 (1.05, 1.43)	.011	1.22 (1.05, 1.43)	.011
General Health	NA		NA	NA				
Poor	-		-	-	Reference		Reference	
Fair	-		-	-	1.25 (.88, 1.77)	.207	1.24 (.88, 1.76)	.224
Good	-		-	-	.80 (.58, 1.11)	.189	.80 (.57, 1.11)	.178
Very good	-		-	-	.59 (.42, .83)	.002	.59 (.42, .82)	.002
Excellent	-		-	-	.41 (.28, .58)	<.001	.40 (.28, .57)	<.001

† All p values were based on the Wald χ^2 statistic.

Table 6 (continued).

Association between likelihood of being aware of dyslipidemia and other factors with incremental logistic regression models.

	Unadjusted (n = 7,324)		**Adjusted for Drive Time (n = 6,866)**		**Adjusted for Other Independent Variables (n = 6,614)**		**Adjusted for Interactions with Other Independent Variables (n = 6,614)**	
Predictor Variable	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**
Rural/Urban								
Rural	Reference		Reference		Reference		Reference	
Urban	1.06 (.93, 1.20)	.399	1.11 (.98, 1.27)	.113	1.11 (.96, 1.28)	.147	1.74	.031
Drive Time	NA	NA	1.00 (1.00, 1.01)	.267	1.00 (1.00, 1.01)	.322	1.00 (.99, 1.01)	.355
Rural/Urban* Race	NA	NA	NA	NA	NA	NA		
Rural, Black	-	-	-	-	-	-	Reference	
Urban, White	-	-	-	-	-	-	1.03	.859
Rural/Urban* Gender	NA	NA	NA	NA	NA	NA		
Rural, Male	-	-	-	-	-	-	Reference	
Urban, Female	-	-	-	-	-	-	.90	.455
Rural/Urban* Income	NA	NA	NA	NA	NA	NA		
Rural, Less than 20k	-	-	-	-	-	-	Reference	
Urban, $20k - $34k	-	-	-	-	-	-	.90	.637
Urban, $35k - $74k	-	-	-	-	-	-	1.01	.962
Urban, $75k and above	-	-	-	-	-	-	.65	.116
Urban, Refused	-	-	-	-	-	-	.86	584
Rural/Urban* Education	NA	NA	NA	NA	NA	NA		
Rural, Less than H.S.	-	-	-	-	-	-	Reference	
Urban, H.S. graduate	-	-	-	-	-	-	.73	.186
Urban, Some college	-	-	-	-	-	-	.61	.054
Urban, ≥ college grad.	-	-	-	-	-	-	.77	.290

† All p values were based on the Wald χ^2 statistic.

Treatment of Dyslipidemia

Of the population that was aware of dyslipidemia, 6,197 (79.0%) were treated for the condition (Table 7). No significant differences (p=.509) were observed for those who were treated for high cholesterol in rural (78.5%) and urban (79.4%) locations. There was also no significant difference (p=.141) of mean drive time between participants who were treated ($\bar{x}$ = 21.99; SD ± 14.65) and those who were not treated ($\bar{x}$ = 21.29; SD ± 14.84). However, the age (p<.001) and gender (p<.001) demographic factors did show proportional differences for treatment of dyslipidemia. A significantly higher percentage of males (81.7%) than females (77.4%) were treated for dyslipidemia, while participants who were being treated ($\bar{x}$ = 65.63; SD ± 8.95) for dyslipidemia were on average almost four years older than those who were not treated ($\bar{x}$ = 61.91; SD ± 8.88). There was a significant difference (p<.001) for those being treated in regard to their levels of education but no clear pattern emerged. All three behavioral measures, smoking status (p<.001), alcohol use (p=.014), and exercise (p=.008), displayed proportional differences for being treated for abnormal levels of cholesterol. Smoking status and alcohol use both indicated participants with the greatest consumption were the highest proportion of those being treated. On the contrary, participants who did not exercise (81.2%) and those who viewed their health as least favorable (83.9%) were the highest proportion of those being treated for dyslipidemia.

The logistic models for rural/urban status (p=.509) as a predictor of treatment of dyslipidemia and with an adjustment for drive time (p=.695) were not significant for being better predictive than the model with no independent variables (Table 8). After the adjustment for the additional independent variables, there was a significant (p<.001) increase for predicting the probability of being treated for dyslipidemia. Type III analysis indicates age (p<.001), gender (p=.001), income (p=.005), education (p=.041), smoking (p=.033), and perception of general health (p<.001) all contribute to this result. No significant interactions between rural/urban status and the demographic and socioeconomic variables exist.

The odds of being treated for dyslipidemia increase 5% for every year increase in age (OR, 1.05; 95% CI, 1.05 to 1.06), and females are 23% less likely to be treated (OR, .77; 95% CI, .66 to .90) than males. Both measures of socioeconomic status showed significance; however, results for income were contradictory to results for education. Participants with annual incomes between $20,000 and $35,000 (OR, 1.47; 95% CI, 1.16 to 1.87) and $75,000 and above (OR, 1.45; 95% CI, 1.09 to 1.94) were more likely to be treated for dyslipidemia, while those with higher levels of education were less likely to be treated. Smoking status was the only lifestyle variable that denoted an increased odds for being treated, with past smokers 33% more likely (OR, 1.33; 95% CI, 1.07 to 1.65) to be treated. Regarding individuals' self-perceptions of general health, those specifying "very good" health were 61% as likely (OR, .61; 95% CI, .41 to .92) and those specifying "excellent" health were 40% as likely (OR, .40; 95% CI, .26 to .61) to be treated than those indicating "poor" health.

Table 7.

Sample characteristics, according to treatment of dyslipidemia.

Characteristic	**Treatment**		**p value†**
	Not Treated	Treated	
Total [No. (%)]	1,299 (21.0)	4,898 (79.0)	
Rural/Urban			.509
Rural	263 (21.5)	959 (78.5)	
Urban	893 (20.7)	3,431 (79.4)	
Race			.526
Black	517 (20.6)	1,997 (79.4)	
White	782 (21.2)	2,901 (78.8)	
Gender			<.001
Male	439 (18.3)	1,955 (81.7)	
Female	860 (22.6)	2,943 (77.4)	
Income			.053
Less than $20k	202 (19.9)	813 (80.1)	
$20k - $34k	322 (21.5)	1,174 (78.5)	
$35k - $74k	376 (19.7)	1,529 (80.3)	
$75k and above	234 (24.3)	730 (75.7)	
Refused	165 (20.2)	652 (79.8)	
Education			<.001
Less than high school	123 (16.0)	644 (83.7)	
High school graduate	335 (20.4)	1,305 (79.6)	
Some college	401 (23.6)	1,297 (76.4)	
College graduate and above	440 (21.1)	1,649 (78.9)	
Smoking Status			<.001
Current	219 (24.6)	670 (75.4)	
Past	462 (18.6)	2,021 (81.4)	
Never	614 (21.9)	2,186 (78.1)	
Alcohol Use			.014
Heavy	61 (28.4)	154 (71.6)	
Moderate	404 (21.6)	1,467 (78.4)	
None	813 (20.3)	3,187 (79.7)	
Exercise			.008
None	424 (18.9)	1,825 (81.2)	
1 to 3 times per week	501 (22.5)	1,726 (77.5)	
4 or more times per week	354 (21.6)	1,288 (78.4)	
General Health			<.001
Poor	42 (16.2)	217 (83.8)	
Fair	193 (16.1)	1,005 (83.9)	
Good	473 (20.1)	1,884 (79.9)	
Very good	390 (22.7)	1,328 (77.3)	
Excellent	198 (30.3)	456 (69.7)	
Drive time (Mean ± SD)	21.29 ± 14.84	21.99 ± 14.65	.141
Age (Mean ± SD)	61.91 ± 8.88	65.63 ± 8.95	<.001

† All p values were based on a Pearson's χ^2 and an independent samples t-test (for the last two variables with mean ± standard deviation).

Table 8.

Model statistics of incremental logistic regression models for the association between the likelihood of being treated for dyslipidemia and other factors.

	Unadjusted (n = 5,546)		**Adjusted for Drive Time (n = 5,258)**		**Adjusted for Other Independent Variables (n = 5,072)**		**Adjusted for Interactions with Other Independent Variables (n = 5,072)**	
Max-Rescaled R^2	<.001		<.001		.080		.082	
Parameter	**χ^2 (*df*)**	**p value**	**χ^2 (*df*)**	**p value**	**χ^2 (*df*)**	**p value**	**χ^2 (*df*)**	**p value**
Global $H_0: \beta = 0$	.437 (1)	.509†	.729 (2)	.695†	241.345 (22)	<.001†	246.737 (31)	<.001†
Type 3 Analysis								
Rural/Urban	.437 (1)	.509†	.175 (1)	.676†	.109 (1)	.741†	.154 (1)	.695†
Drive Time	-	-	.540 (1)	.462†	.364 (1)	.546†	.357 (1)	.550†
Age	-	-	-	-	140.275 (1)	<.001†	140.558 (1)	<.001†
Race	-	-	-	-	.068 (1)	.795†	.300 (1)	.584†
Gender	-	-	-	-	10.924 (1)	.001†	6.342 (1)	.012†
Income	-	-	-	-	15.057 (4)	.005†	2.725 (4)	.605†
Education	-	-	-	-	8.239 (3)	.041†	3.052 (3)	.384†
Smoking	-	-	-	-	6.846 (2)	.033†	6.566 (2)	.038†
Alcohol	-	-	-	-	3.411 (2)	.182†	3.440 (2)	.179†
Exercise	-	-	-	-	.750 (2)	.687†	.733 (2)	.693†
Gen. Health	-	-	-	-	60.549 (4)	<.001†	60.107 (4)	<.001†
Rural/Urban* Race	-	-	-	-	-	-	.566 (1)	.452†
Rural/Urban* Gender	-	-	-	-	-	-	1.186 (1)	.276†
Rural/Urban* Income	-	-	-	-	-	-	3.111 (4)	.540†
Rural/Urban* Education	-	-	-	-	-	-	3.706 (3)	.295†
Hosmer & Lemeshow	NA	NA	1.661 (7)	.976‡	6.439 (8)	.598‡	11.141 (8)	.194‡

df degrees of freedom

† p value based on Wald χ^2 statistic.

‡ p value based on χ^2 Goodness-of-Fit statistic.

Table 9.

Association between likelihood of being treated for dyslipidemia and other factors with incremental logistic regression models.

Predictor Variable	Unadjusted (n = 5,546) Odds Ratio [e^{β}(95% CI)]	Unadjusted p value†	Adjusted for Drive Time (n = 5,258) Odds Ratio [e^{β}(95% CI)]	Adjusted for Drive Time p value†	Adjusted for Other Independent Variables (n = 5,072) Odds Ratio [e^{β}(95% CI)]	Adjusted for Other Independent Variables p value†	Adjusted for Interactions with Other Independent Variables (n = 5,072) Odds Ratio [e^{β}(95% CI)]	Adjusted for Interactions with Other Independent Variables p value†
Rural/Urban								
Rural	Reference		Reference		Reference		Reference	
Urban	1.05 (.90, 1.23)	.509	1.04 (.88, 1.22)	.676	1.03 (.87, 1.22)	.741	.87	.695
Drive Time	NA	NA	1.00 (1.00, 1.01)	.462	1.00 (1.00, 1.01)	.546	1.00 (1.00, 1.01)	.550
Age	NA	NA	NA	NA	1.05 (1.05, 1.06)	<.001	1.05 (1.05, 1.06)	<.001
Race	NA	NA	NA	NA				
Black	-	-	-	-	Reference		Reference	
White	-	-	-	-	1.02 (.87, 1.19)	.795	.90	.584
Gender	NA	NA	NA	NA				
Male	-	-	-	-	Reference		Reference	
Female	-	-	-	-	.77 (.66, .90)	.001	.65	.012
Income	NA	NA	NA	NA				
Less than $20k	-	-	-	-	Reference		Reference	
$20k - $34k	-	-	-	-	1.06 (.84, 1.34)	.602	.82	.411
$35k - $74k	-	-	-	-	1.47 (1.16, 1.87)	.002	1.14	.615
$75k and above	-	-	-	-	1.45 (1.09, 1.94)	.011	.97	.909
Refused	-	-	-	-	1.19 (.91, 1.56)	.212	1.09	.761
Education	NA	NA	NA	NA				
Less than H.S.	-	-	-	-	Reference		Reference	
H.S. graduate	-	-	-	-	.89 (.68, 1.16)	.386	1.10	.708
Some college	-	-	-	-	.72 (.55, .94)	.016	.93	.798
College grad and above	-	-	-	-	.85 (.64, 1.13)	.258	1.33	.301
Smoking Status	NA	NA	NA	NA				
Current	-	-	-	-	Reference		Reference	
Past	-	-	-	-	1.33 (1.07, 1.65)	.010	1.32 (1.07, 1.64)	.011
Never	-	-	-	-	1.19 (.96, 1.47)	.108	1.19 (.96, 1.46)	.114

† All p values were based on the Wald χ^2 statistic.

Table 9 (continued).

Association between likelihood of being treated for dyslipidemia and other factors with incremental logistic regression models.

	Unadjusted (n = 5,546)		Adjusted for Drive Time (n = 5,258)		Adjusted for Other Independent Variables (n = 5,072)		Adjusted for Interactions with Other Independent Variables (n = 5,072)	
Predictor Variable	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**
Rural/Urban								
Rural	Reference		Reference		Reference		Reference	
Urban	1.05 (.90, 1.23)	.509	1.04 (.88, 1.22)	.676	1.03 (.87, 1.22)	.741	.87	.695
Drive Time	NA	NA	1.00 (1.00, 1.01)	.462	1.00 (1.00, 1.01)	.546	1.00 (1.00, 1.01)	.550
Alcohol Use	NA		NA	NA				
Heavy	-		-	-	Reference		Reference	
Moderate	-		-	-	1.40 (.97, 2.01)	.071	1.40 (.97, 2.01)	.071
None	-		-	-	1.39 (.97, 1.98)	.074	1.39 (.97, 1.99)	.071
Exercise	NA		NA	NA				
None	-		-	-	Reference		Reference	
1 to 3 times per week	-		-	-	.95 (.81, 1.13)	.581	.95 (.80, 1.13)	.567
≥ 4 times per week	-		-	-	.92 (.77, 1.11)	.392	.92 (.77, 1.11)	.401
General Health	NA		NA	NA				
Poor	-		-	-	Reference		Reference	
Fair	-		-	-	1.14 (.76, 1.72)	.521	1.15 (.76, 1.73)	.518
Good	-		-	-	.75 (.51, 1.11)	.144	.75 (.50, 1.10)	.142
Very good	-		-	-	.61 (.41, .92)	.017	.61 (.41, .92)	.018
Excellent	-		-	-	.40 (.26, .61)	<.001	.40 (.26, .61)	<.001

† All p values were based on the Wald χ^2 statistic.

Table 9 (continued).

Association between likelihood of being treated for dyslipidemia and other factors with incremental logistic regression models.

Predictor Variable	Unadjusted (n = 5,546) Odds Ratio [e^{β}(95% CI)]	p value†	Adjusted for Drive Time (n = 5,258) Odds Ratio [e^{β}(95% CI)]	p value†	Adjusted for Other Independent Variables (n = 5,072) Odds Ratio [e^{β}(95% CI)]	p value†	Adjusted for Interactions with Other Independent Variables (n = 5,072) Odds Ratio [e^{β}(95% CI)]	p value†
Rural/Urban								
Rural	Reference		Reference		Reference		Reference	
Urban	1.05 (.90, 1.23)	.509	1.04 (.88, 1.22)	.676	1.03 (.87, 1.22)	.741	.87	.695
Drive Time	NA	NA	1.00 (1.00, 1.01)	.462	1.00 (1.00, 1.01)	.546	1.00 (1.00, 1.01)	.550
Rural/Urban* Race	NA	NA	NA	NA	NA	NA		
Rural, Black	-	-	-	-	-	-	Reference	
Urban, White	-	-	-	-	-	-	1.16	.452
Rural/Urban* Gender	NA	NA	NA	NA	NA	NA		
Rural, Male	-	-	-	-	-	-	Reference	
Urban, Female	-	-	-	-	-	-	1.23	.276
Rural/Urban* Income	NA	NA	NA	NA	NA	NA		
Rural, Less than 20k	-	-	-	-	-	-	Reference	
Urban, $20k - $34k	-	-	-	-	-	-	1.41	.213
Urban, $35k - $74k	-	-	-	-	-	-	1.42	.226
Urban, $75k and above	-	-	-	-	-	-	1.71	.112
Urban, Refused	-	-	-	-	-	-	1.13	.714
Rural/Urban* Education	NA	NA	NA	NA	NA	NA		
Rural, Less than H.S.	-	-	-	-	-	-	Reference	
Urban, H.S. graduate	-	-	-	-	-	-	.74	.323
Urban, Some college	-	-	-	-	-	-	.70	.262
Urban, ≥ college grad.	-	-	-	-	-	-	.55	.062

† All p values were based on the Wald χ^2 statistic.

Control of Dyslipidemia

There were 3,262 (66.6%) participants who were controlled for dyslipidemia from the treated population (Table 10). Proportions of controlled individuals living in rural (65.5%) and urban (67.1%) areas were too close to be considered statistically different (p=.341). There was also no difference (p=.655) noted for the mean drive time between participants who were controlled ($\bar{x}$ = 22.06; SD ± 14.58) and those who were uncontrolled ($\bar{x}$ = 21.86; SD ± 14.78) for abnormal cholesterol. A significant difference (p<.001) was shown between the mean age for the controlled population ($\bar{x}$ = 66.27; SD ± 8.95) and the mean age for the uncontrolled population ($\bar{x}$ = 64.38; SD ± 8.84). Gender also displayed differences for control of dyslipidemia with 16.8% more females (73.3%) having their condition controlled than males (56.5%). All three lifestyle factors showed significant results. Smoking status trended toward having never smoked (69.7%) as the largest controlled group, while alcohol use trended in the opposite direction with heavy alcohol users (85.7%) as the most controlled group. Participants exercising four or more times a week (70.4%) made up the highest percent of the controlled population. Perception of one's general health showed a definite trend toward those with a better outlook on their health being more controlled for high cholesterol.

Corresponding statistics show no increase (p=.341, p=.636) in the ability of the logistic regression model to predict control of dyslipidemia from the rural/urban or drive time variables (Table 11). When adjusting for the additional independent variables, the model showed significant (p<.001) improvement over the base model. Age (p<.001), race (p=.005), gender (p<.001), smoking status (p=.002), alcohol use (p<.001), exercise (p=.012), and general health (p<.001) all contributed to this enhancement. The model with the adjustment for the interactions between rural/urban status and the demographic and socioeconomic factors exposed a significant interaction between rural/urban status and race. However, the Hosmer & Lemeshow chi-square test for measuring model fit was statistically significant (p=.015), thus violating the assumption of appropriately fitting the data for modeling the probability of being controlled for dyslipidemia. This results in the decision to explain the logistic model without interactions.

Age was a significant predictor of control of dyslipidemia but only showed a 2% increase in the odds of being controlled for hypertension for every one year increase in age (OR, 1.02; 95% CI, 1.01 to 1.03) (Table 12). Whites were only 80% as likely to be controlled for high cholesterol as blacks (OR, .80; 95% CI, .69 to .94), and females were 2.5 times more likely to be controlled than males (OR, 2.57; 95% CI, 2.21 to 2.99). No significant associations were revealed for socioeconomic factors. Past smokers (OR, 1.33, 95% CI, 1.07 to 1.65) and those who have never smoked (OR, 1.48; 95% CI, 1.19 to 1.84) were both more likely to be controlled than current smokers, but participants who did not drink alcohol (OR, .18; 95% CI, .10 to .31) or who did so only moderately (OR, .30; 95% CI, .17 to .51) were at lower odds of being controlled for high cholesterol than heavy drinkers. Exercising four or more times per week put participants at 28% greater odds of being controlled for dyslipidemia (OR, 1.28; 95% CI, 1.07 to 1.54). Participants who perceived their health as more satisfactory tended to have greater odds of being controlled for abnormal cholesterol.

Table 10.

Sample characteristics, according to control of dyslipidemia.

Characteristic	**Control**		**p value†**
	Not Controlled	Controlled	
Total [No. (%)]	1,636 (33.4)	3,262 (66.6)	
Rural/Urban			.341
Rural	331 (34.5)	628 (65.5)	
Urban	1,128 (32.9)	2,303 (67.1)	
Race			.056
Black	636 (31.9)	1,361 (68.2)	
White	1,000 (34.5)	1,901 (65.5)	
Gender			<.001
Male	850 (43.5)	1,105 (56.5)	
Female	786 (26.7)	2,157 (73.3)	
Income			.563
Less than $20k	271 (33.3)	542 (66.7)	
$20k - $34k	376 (32.0)	798 (68.0)	
$35k - $74k	532 (34.8)	997 (65.2)	
$75k and above	248 (34.0)	482 (66.0)	
Refused	209 (32.1)	443 (67.9)	
Education			.063
Less than high school	230 (35.7)	414 (64.3)	
High school graduate	441 (33.8)	864 (66.2)	
Some college	453 (34.9)	844 (65.1)	
College graduate and above	511 (31.0)	1,138 (69.0)	
Smoking Status			<.001
Current	271 (40.5)	399 (59.6)	
Past	698 (34.5)	1,323 (65.5)	
Never	663 (30.3)	1,523 (69.7)	
Alcohol Use			<.001
Heavy	22 (14.3)	132 (85.7)	
Moderate	438 (29.9)	1,029 (70.1)	
None	1,146 (36.0)	2,041 (64.0)	
Exercise			.003
None	633 (34.7)	1,192 (65.3)	
1 to 3 times per week	602 (34.9)	1,124 (65.1)	
4 or more times per week	381 (29.6)	907 (70.4)	
General Health			<.001
Poor	99 (45.6)	118 (54.4)	
Fair	391 (38.9)	614 (61.1)	
Good	635 (33.7)	1,249 (66.3)	
Very good	393 (29.6)	935 (70.4)	
Excellent	115 (25.2)	341 (74.8)	
Drive time (Mean ± SD)	21.86 ± 14.78	22.06 ± 14.58	.655
Age (Mean ± SD)	64.38 ± 8.84	66.27 ± 8.95	<.001

† All p values were based on a Pearson's χ^2 and an independent samples t-test (for the last two variables with mean ± standard deviation)

Table 11.

Model statistics of incremental logistic regression models for the association between the likelihood of being controlled for dyslipidemia and other factors.

	Unadjusted (n = 4,390)		**Adjusted for Drive Time (n = 4,179)**		**Adjusted for Other Independent Variables (n = 4,029)**		**Adjusted for Interactions with Other Independent Variables (n = 4,029)**	
Max-Rescaled R^2	<.001		<.001		.105		.111	
Parameter	**χ^2 (*df*)**	**p value**	**χ^2 (*df*)**	**p value**	**χ^2 (*df*)**	**p value**	**χ^2 (*df*)**	**p value**
Global $H_0: \beta = 0$	.907 (1)	.341†	.906 (2)	.636†	279.827 (22)	<.001†	294.876 (31)	<.001†
Type 3 Analysis								
Rural/Urban	.907 (1)	.341†	.906 (1)	.341†	.024 (1)	.878†	.036 (1)	.850†
Drive Time	-	-	.000 (1)	.997†	.124 (1)	.725†	.092 (1)	.762†
Age	-	-	-	-	28.920 (1)	<.001†	28.473 (1)	<.001†
Race	-	-	-	-	7.988 (1)	.005†	9.277 (1)	.002†
Gender	-	-	-	-	149.718 (1)	<.001†	23.300 (1)	<.001†
Income	-	-	-	-	1.404 (4)	.844†	5.253 (4)	.262†
Education	-	-	-	-	1.226 (3)	.747†	5.610 (3)	.132†
Smoking	-	-	-	-	12.427 (2)	.002†	11.595 (2)	.003†
Alcohol	-	-	-	-	66.424 (2)	<.001†	65.823 (2)	<.001†
Exercise	-	-	-	-	8.823 (2)	.012†	9.233 (2)	.010†
Gen. Health	-	-	-	-	26.902 (4)	<.001†	26.940 (4)	<.001†
Rural/Urban* Race	-	-	-	-	-	-	4.031 (1)	.045†
Rural/Urban* Gender	-	-	-	-	-	-	1.780 (1)	.182†
Rural/Urban* Income	-	-	-	-	-	-	9.308 (4)	.053†
Rural/Urban* Education	-	-	-	-	-	-	6.623 (3)	.085†
Hosmer & Lemeshow	NA	NA	6.723 (7)	.458‡	11.222 (8)	.189‡	18.890 (8)	.015‡

df degrees of freedom
† p value based on Wald χ^2 statistic.
‡ p value based on χ^2 Goodness-of-Fit statistic.

Table 12.

Association between likelihood of being controlled for dyslipidemia and other factors with incremental logistic regression models.

Predictor Variable	Unadjusted (n = 4,390)		Adjusted for Drive Time (n = 4,179)		Adjusted for Other Independent Variables (n = 4,029)		Adjusted for Interactions with Other Independent Variables (n = 4,029)	
	Odds Ratio [e^{β}(95% CI)]	p value†	Odds Ratio [e^{β}(95% CI)]	p value†	Odds Ratio [e^{β}(95% CI)]	p value†	Odds Ratio [e^{β}(95% CI)]	p value†
Rural/Urban								
Rural	Reference		Reference		Reference		Reference	
Urban	1.08 (.93, 1.25)	.341	1.08 (.92, 1.26)	.341	.99 (.83, 1.17)	.878	.94	.850
Drive Time	NA	NA	1.00 (1.00, 1.01)	.997	1.00 (1.00, 1.01)	.725	1.00 (1.00, 1.01)	.762
Age	NA	NA	NA	NA	1.02 (1.01, 1.03)	<.001	1.02 (1.01, 1.03)	.015
Race	NA	NA	NA	NA				
Black	-	-	-	-	Reference		Reference	
White	-	-	-	-	.80 (.69, .94)	.005	.58	.002
Gender	NA	NA	NA	NA				
Male	-	-	-	-	Reference		Reference	
Female	-	-	-	-	2.57 (2.21, 2.99)	<.001	2.14	<.001
Income	NA	NA	NA	NA				
Less than $20k	-	-	-	-	Reference		Reference	
$20k - $34k	-	-	-	-	1.04 (.83, 1.32)	.733	.74	.205
$35k - $74k	-	-	-	-	.93 (.74, 1.18)	.570	.97	.912
$75k and above	-	-	-	-	.94 (.70, 1.26)	.669	.98	.958
Refused	-	-	-	-	.96 (.73, 1.25)	.736	1.34	.302
Education	NA	NA	NA	NA				
Less than H.S.	-	-	-	-	Reference		Reference	
H.S. graduate	-	-	-	-	1.05 (.83, 1.33)	.696	1.68	.029
Some college	-	-	-	-	1.07 (.84, 1.36)	.599	1.67	.048
College grad and above	-	-	-	-	1.14 (.89, 1.46)	.310	1.39	.190
Smoking Status	NA	NA	NA	NA				
Current	-	-	-	-	Reference		Reference	
Past	-	-	-	-	1.33 (1.07, 1.65)	.010	1.31 (1.06, 1.64)	.015
Never	-	-	-	-	1.48 (1.19, 1.84)	<.001	1.46 (1.17, 1.82)	<.001

† All p values were based on the Wald χ^2 statistic.

Table 12 (continued).

Association between likelihood of being controlled for dyslipidemia and other factors with incremental logistic regression models.

	Unadjusted (n = 4,390)		Adjusted for Drive Time (n = 4,179)		Adjusted for Other Independent Variables (n = 4,029)		Adjusted for Interactions with Other Independent Variables (n = 4,029)	
Predictor Variable	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**
Rural/Urban								
Rural	Reference		Reference		Reference		Reference	
Urban	1.08 (.93, 1.25)	.341	1.08 (.92, 1.26)	.341	.99 (.83, 1.17)	.878	.94	.850
Drive Time	NA	NA	1.00 (1.00, 1.01)	.997	1.00 (1.00, 1.01)	.725	1.00 (1.00, 1.01)	.762
Alcohol Use	NA		NA	NA				
Heavy	-		-	-	Reference		Reference	
Moderate	-		-	-	.30 (.17, .51)	<.001	.30 (.17, .51)	<.001
None	-		-	-	.18 (.10, .31)	<.001	.18 (.10, .31)	<.001
Exercise	NA		NA	NA				
None	-		-	-	Reference		Reference	
1 to 3 times per week	-		-	-	1.00 (.85, 1.18)	.982	1.01 (.86, 1.19)	.932
≥ 4 times per week	-		-	-	1.28 (1.07, 1.54)	.008	1.29 (1.07, 1.55)	.007
General Health	NA		NA	NA				
Poor	-		-	-	Reference		Reference	
Fair	-		-	-	1.40 (.99, 1.99)	.061	1.40 (.99, 2.00)	.060
Good	-		-	-	1.56 (1.11, 2.20)	.010	1.56 (1.11, 2.20)	.011
Very good	-		-	-	2.00 (1.40, 2.86)	<.001	2.00 (1.40, 2.87)	<.001
Excellent	-		-	-	2.37 (1.57, 3.58)	<.001	2.40 (1.58, 3.63)	<.001

† All p values were based on the Wald χ^2 statistic.

Table 12 (continued).

Association between likelihood of being controlled for dyslipidemia and other factors with incremental logistic regression models.

	Unadjusted (n = 4,390)		Adjusted for Drive Time (n = 4,179)		Adjusted for Other Independent Variables (n = 4,029)		Adjusted for Interactions with Other Independent Variables (n = 4,029)	
Predictor Variable	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**	**Odds Ratio [e^{β}(95% CI)]**	**p value†**
Rural/Urban								
Rural	Reference		Reference		Reference		Reference	
Urban	1.08 (.93, 1.25)	.341	1.08 (.92, 1.26)	.341	.99 (.83, 1.17)	.878	.94	.850
Drive Time	NA	NA	1.00 (1.00, 1.01)	.997	1.00 (1.00, 1.01)	.725	1.00 (1.00, 1.01)	.762
Rural/Urban* Race	NA	NA	NA	NA	NA	NA		
Rural, Black	-	-	-	-	-	-	Reference	
Urban, White	-	-	-	-	-	-	1.49	.045
Rural/Urban* Gender	NA	NA	NA	NA	NA	NA		
Rural, Male	-	-	-	-	-	-	Reference	
Urban, Female	-	-	-	-	-	-	1.27	.182
Rural/Urban* Income	NA	NA	NA	NA	NA	NA		
Rural, Less than 20k	-	-	-	-	-	-	Reference	
Urban, $20k - $34k	-	-	-	-	-	-	1.56	.105
Urban, $35k - $74k	-	-	-	-	-	-	.96	.872
Urban, $75k and above	-	-	-	-	-	-	.95	.879
Urban, Refused	-	-	-	-	-	-	.66	.197
Rural/Urban* Education	NA	NA	NA	NA	NA	NA		
Rural, Less than H.S.	-	-	-	-	-	-	Reference	
Urban, H.S. graduate	-	-	-	-	-	-	.54	.025
Urban, Some college	-	-	-	-	-	-	.57	.057
Urban, ≥ college grad.	-	-	-	-	-	-	.76	.355

† All p values were based on the Wald χ^2 statistic.

Discussion

Findings from this investigation observed no statistical differences between rural and urban populations with regard to the awareness (p=.399), treatment (p=.509), and control of dyslipidemia (p=.341). Additionally, travel time for the participants to their usual source of medical care was non-significant when comparing their management of the stages of abnormal levels of cholesterol. Proportional differences of the A-T-C of dyslipidemia for race were marginal and never displayed statistical significance. Interestingly, more females were aware (79.1%) and controlled (73.3%) for dyslipidemia than males (aware, 70.5%; controlled, 56.5%), but more males were treated (81.7%). Older participants were on average more aware of, treated, and controlled for high cholesterol. Socioeconomic factors differed by measure and management stage. Differences were seen between the income categories when assessing awareness but with no identifiable array, while education showed that participants with the lowest levels of income were the most treated for high cholesterol. Variables reflecting health behaviors were significant for all levels of dyslipidemia management. Current smokers were the least aware of and controlled for dyslipidemia, while counter-intuitvely heavy alcohol users were the least treated but most controlled for high cholesterol. More treated individuals performed no weekly exercise, but those who were active four or more times per week were the most controlled. Perception of general health was significant ($p<.001$) for all phases of cholesterol management. Awareness of dyslipidemia indicated no noticeable arrangement of the categories, but the treated population that viewed health as less favorable were the highest proportion, while the opposite was true for the controlled population.

Age of participants showed a significant association with awareness, treatment, and control of dyslipidemia. The most substantial relationship was with treatment of the condition, where a 5% increase in the odds of being treated was the result of a one year increase in age. Females were 76% more likely to be aware and more than 2.5 times likely to be controlled for high cholesterol than males but were 23% less likely to be treated. The only racial disparity was with control of dyslipidemia, where whites were at 20% lower odds of being controlled. Participants in the aware and treated populations with higher incomes showed greater odds for awareness and treatment but no association with control. Variables relating to behavioral health risk presented interesting results. Past smokers and those who have never smoked were more likely to be aware of, treated, and controlled for dyslipidemia; however, limited or no alcohol consumption was less conducive to being aware and controlled. Exercise was only beneficial if performed at least four times per week and only in the aware and controlled populations. Participants' perceptions of their health were important for all three stages of high cholesterol management. Individuals viewing their health as "very good" or "excellent" were both less likely to be aware and treated, although when measuring the probability of being controlled for dyslipidemia, the better they viewed their health, the more likely they were to have control of their high cholesterol.

Geographic and racial disparities for cardiovascular disease and stroke have been identified in several studies.[28-30] Given such disproportions it is possible that similar trends occur with the risk factors, such as unhealthy measures of cholesterol, that are associated with these conditions. Conversely, this hypothesis goes against a Howard et al study that examines geographic variations in risk factors contributing to geographic inequalities in cardiovascular disease and stroke.[31] Their findings specify the unlikelihood that differences in risk factors underlie geographic distinctions of these illnesses. However, relatively little, if any, previous research has investigated changes in risk-factor management from a rural/urban access-to-care perspective. Subsequently though, this study was unable to establish differences or associations between A-T-C of dyslipidemia and rural/urban status. Still, several facets of this study are comparable with other research. Although our definitions of A-T-C of dyslipidemia were derived from the Zweifler et al study, their geographic investigations were from a regional outlook.[27] Still, aspects for A-T-C of dyslipidemia can be linked. Given that both studies utilized REGARDS cohort study data, similar findings are expected for cholesterol management. This study demonstrated slightly lower percentages for the aware (75.6%), treated (79.0%), and controlled (66.6%) populations, although these measurements are still considerably better than those percentages found with prior studies of NHANES 1999-2004, which reported a control population of 25%, and the Lipid Treatment Assessment Project (L-TAP), which reported 38% for those considered controlled for high cholesterol.[32,33] Unlike Zweifler et al, this study found no proportional racial differences for A-T-C of dyslipidemia. The one identified racial association was for control of dyslipidemia where whites were 20% less likely to be controlled. This result is contradictory to the findings of Zweifler and others.[27,33-35]

The strengths and weaknesses of this study are worthy of mention. The study sample encompassed data collected from the REGARDS study that examined underlying causes for stroke. The use of this data allowed for a substantial sample size and for the investigation to be national in scope. The considerable sample size, along with self-reports and in-home exam measurements collected from the baseline survey, afforded us the proficiency to comprehensively investigate association between awareness, treatment, and control of dyslipidemic individuals and if they live in a rural or urban setting. To our knowledge, the association between A-T-C of dyslipidemia and rural or urban status has yet to be thoroughly explored, thus making this study unique in its efforts. The study is also innovative due to the assessment of any consequence travel time to a usual source of medical care may pose to A-T-C of dyslipidemia, or if travel time modifies the effect of rural and urban designation. Although rural and urban representation in this study originated from a census tract classification scheme, the independent variable of interest included only one category for rural and one for urban; therefore, the different natures of rural and urban locales are not fully represented. For example, individuals residing in isolated rural areas are possibly exposed to different barriers to care than those residing in small or large townships. Also, race disparities were examined only between black and white participants. Inspection of differences and associations within race by rural or urban designation has yet to be explored. That is, do differences exist between rural blacks and urban blacks with regard to cholesterol management?

Not only are there varying degrees within which rural and urban locales differ, but rural and urban areas are also different in separate regions of the United States. Assessments of various cardiovascular disease and stroke risk factors such as high cholesterol should be scrutinized for the consideration that these influences may exhibit different outcomes when examined from a perspective that separates rural and urban by region. Follow-up studies should meticulously inspect discrepancies that may exist between rural and urban locations by separate regions of the United States. For example, do Southern rural blacks have a different A-T-C of dyslipidemia than rural blacks from the Midwest? There are several components of this study that have been designed to lead to a gain in awareness that will have an impact beyond this investigation. Cardiovascular disease and stroke risk factor disparities have yet to be explored from several geographic perspectives. A continued comprehensive approach to investigating major risk factors for these conditions affords a better understanding of the degree geographical inequalities exist.

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APPENDIX

Office for Research

Institutional Review Board for the
Protection of Human Subjects

THE UNIVERSITY OF
ALABAMA
RESEARCH

March 31, 2011

Jason M. Parton
Institute for Rural Health Research
College of Community Health Sciences
The University of Alabama

Re: IRB # EX-11-CM-016 "Access to Care on ATC of Hypertension"

Dear Mr. Parton:

The University of Alabama Institutional Review Board has granted approval for your proposed research.

Your protocol has been given exempt approval according to 45 CFR part 46.101(b)(4) as outlined below:

(4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

Your application will expire on March 30, 2012. If your research will continue beyond this date, complete the relevant portions of Continuing Review and Closure From. If you wish to modify the application, complete the Modification of an Approved Protocol Form. <u>When the study closes, complete the appropriate portions of FORM: Continuing Review and Closure.</u>

Should you need to submit any further correspondence regarding this proposal, please include the above application number.

Good luck with your research.

Sincerely,

Carpantato T. Myles, MSM, CIM
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