

BRIEF COMMUNICATION

# Rural Residence and Antihypertensive Medication Use in US Stroke Survivors

Phoebe M. Tran , PhD; Lam T. Tran, MS; Cenjing Zhu , MPhil; Tiffany Chang , MPH; Inna P. Powers, MD; Larry B. Goldstein , MD; Judith H. Lichtman , PhD

**BACKGROUND:** Relatively greater increases in hypertension prevalence among US rural residents may contribute to geographic disparities in recurrent stroke. There is limited US information on poststroke antihypertensive medication use by rural/urban residence. We assessed antihypertensive use and lifestyle characteristics for US rural compared with urban stroke survivors and residence-based trends in use between 2005 and 2019.

**METHODS AND RESULTS:** US stroke survivors with hypertension were identified in the 2005 to 2019 national Behavioral Risk Factor Surveillance System surveys. We ascertained the survey-weighted prevalence of reported antihypertensive use and lifestyle characteristics (ie, physical activity, diabetes, cholesterol, body mass index, and smoking) among respondents with hypertension in odd years over this period by rural/urban residence. Separate trend analyses were used to detect changes in use over time. Survey-weighted logistic regression was used to calculate unadjusted and adjusted (sociodemographic and lifestyle factors) odds ratios for antihypertensive use by year. Our study included 82 175 individuals (36.4% rural residents). Lifestyle characteristics were similar between rural and urban residents except for higher smoking prevalence among rural residents. Antihypertensive use was similar between rural and urban stroke survivors in unadjusted and adjusted analyses (>90% in both populations). Trend analyses showed a small but significant increase in antihypertensive use over time among urban ( $P=0.033$ ) but not rural stroke survivors ( $P=0.587$ ).

**CONCLUSIONS:** Our findings indicate that poststroke antihypertensive use is comparable in rural and urban residents with a reported history of hypertension, but additional work is merited to identify reasons for a trend for increased use of these drugs among urban residents.

**Key Words:** hypertension, secondary prevention ■ rural/urban ■ stroke

**B**lood pressure control is an important component of secondary stroke prevention because persistent hypertension is associated with increased recurrent stroke risk.<sup>1</sup> The American Heart Association recommends treatment with antihypertensive medications as part of its secondary stroke prevention guidelines.<sup>1</sup> Between 2006 and 2017, hypertension prevalence increased relatively more in rural (from 27.9% to 40.0%) compared with urban (from 21.1% to 29.4%) areas of the United States, potentially contributing to a geographic disparity in the rates of recurrent stroke.<sup>2,3</sup> Although several US studies compare rural and urban residents' use of antihypertensive medications,<sup>4–6</sup> there

is only limited information on poststroke antihypertensive medication use among US rural compared with urban residents and little is known about potential differences in trends in antihypertensive medication use in these populations.<sup>7</sup> Because rural areas have both fewer clinicians to prescribe antihypertensive medications and pharmacies where these medications can be obtained, we hypothesized that US rural residents would have lower poststroke antihypertensive medication use than their urban counterparts.<sup>8</sup> We compared antihypertensive medication use by rural/urban residence status in a nationally representative sample of US stroke survivors and trends in use over time based

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on location of residence. Differences in lifestyle characteristics between rural and urban stroke survivors were also assessed.

## METHODS

### Study Data

All data for this study are publicly available and can be found at the Centers for Disease Control and Prevention's (CDC) website. We extracted data from the 2005, 2007, 2009, 2011, 2013, 2015, 2017, and 2019 Behavioral Risk Factor Surveillance System (BRFSS) surveys because only odd-year surveys during the study period included information on hypertension and antihypertensive medication use. The BRFSS is a nationally representative survey of noninstitutionalized US residents age  $\geq 18$  years conducted annually by the CDC.<sup>9</sup> Survey weighting and oversampling of underrepresented groups (eg, rural residents and racial/ethnic minorities) are used by the CDC to ensure that BRFSS survey estimates are applicable to the general US population.<sup>9</sup> In preparation for the 2011 BRFSS, the survey underwent several updates: (1) changing from administration by landline to landline or mobile phone; (2) a more complex survey-weighting process to account for landline and mobile phone collected responses; and (3) changes in the physical activity assessment questions. Additional institutional review board approval and informed consent are not needed for research using BRFSS data because these have already been obtained by the CDC and BRFSS data are deidentified before being made available for public use.<sup>9</sup>

### Outcome and Covariates

Individuals aged  $\geq 18$  years with a history of stroke were identified from the BRFSS survey by the question, "(Ever told) you had a stroke? (Yes/No)."<sup>10</sup> A self-reported history of hypertension was based on the response to the question, "Have you ever been told by a doctor, nurse or other health professional that you have high blood pressure? (Yes/No)."<sup>10</sup> Current antihypertensive medication use was ascertained only among those who reported a history of hypertension by the survey question, "Are you currently taking medicine for your high blood pressure? (Yes/No)."<sup>10</sup> Rural/urban classification was based on BRFSS metropolitan status codes.<sup>10</sup>

Information on sociodemographic (ie, age, race, sex, income, education, and health care coverage) and lifestyle characteristics included in the American Heart Association's Life's Simple 7 for cardiovascular health (ie, cholesterol, diabetes, overweight/obesity, smoking, and physical activity) were extracted from the BRFSS.<sup>10,11</sup> Although diet is included in the Simple 7, we were unable to include it as a lifestyle characteristic

because the BRFSS does not collect the necessary dietary information.<sup>10</sup> Details on variable coding are given in Table S1.

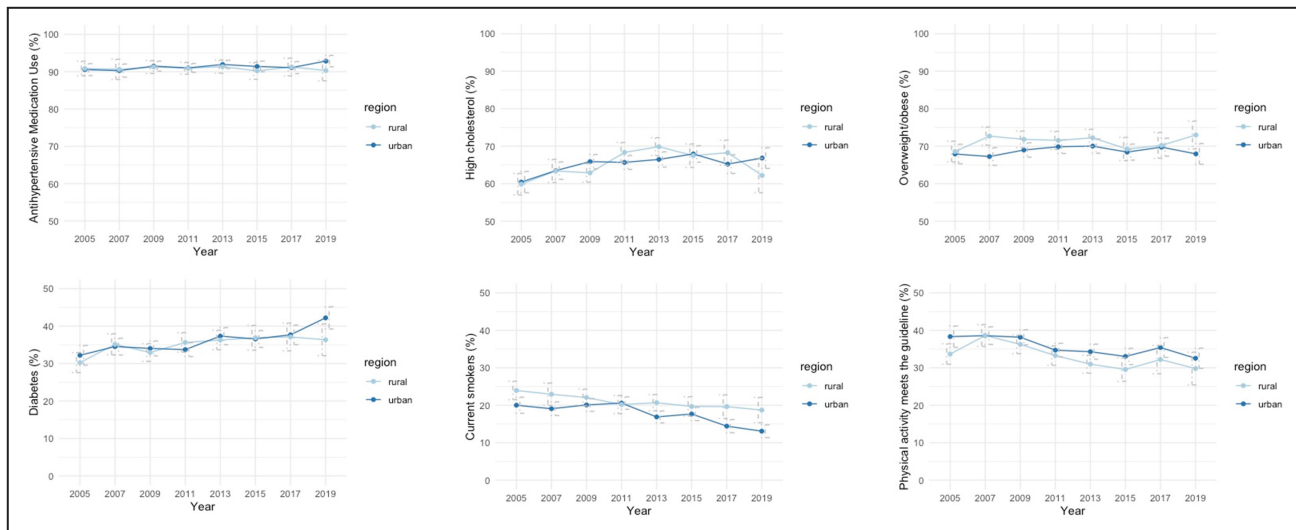
### Statistical Analysis

We compared the survey-weighted prevalence of antihypertensive medication use and lifestyle factors between rural and urban stroke survivors for each year with available data. Because of differences in the BRFSS weighting methodology before and after 2011, pooling of survey data across these 2 periods is not appropriate.<sup>12</sup> As a result, these analyses were conducted separately for each survey year. For each survey year, survey-weighted logistic regression was used to calculate unadjusted odds ratios for reported antihypertensive medication use and odds ratios adjusted for the sociodemographic and lifestyle characteristics reflected above. Indicator variables were included in the models for each sociodemographic and lifestyle factor with missing responses. To detect potential changes in antihypertensive medication use between rural and urban stroke survivors over time, trend analyses were performed within these populations using the survey-weighted prevalence estimates calculated for each individual year (Table S2). Analyses were carried out with SAS, version 9.4 (SAS Institute Inc, Cary, NC) using SAS Survey procedures to incorporate the complex survey design and weights. Two-sided statistical testing was conducted at significance level  $\alpha=0.05$ .

## RESULTS

The study included 82 175 stroke survivors (36.4% residing in rural areas). All included stroke survivors responded "Yes" to the BRFSS question "Have you ever been told by a doctor, nurse or other health professional that you have high blood pressure? (Yes/No)". On average, rural stroke survivors were more likely to be White race, have a lower income, and completed fewer years of education than their urban counterparts. Lifestyle characteristics did not vary by rural/urban residence status except that rural stroke survivors had a higher prevalence of current smoking (Figure 1; weighted distribution of factors by survey year are provided in Table S3).

Antihypertensive medication use was similarly high for rural (range 90.2%–91.4%) and urban stroke survivors (range 90.3%–92.8%) over time (Figure 1, Table S3). There were no differences in antihypertensive medication use based on residence before or after adjustment for sociodemographic and lifestyle factors defined above (Figure 2A and 2B). Trend analyses showed a small but significant increase in antihypertensive medication use over time among urban stroke survivors ( $P=0.033$ ) but no difference for rural stroke survivors ( $P=0.587$ ) (Table S2).



**Figure 1. Antihypertensive medication use and lifestyle factors in Behavioral Risk Factor Surveillance System stroke survivors by rural/urban residence.**

## DISCUSSION

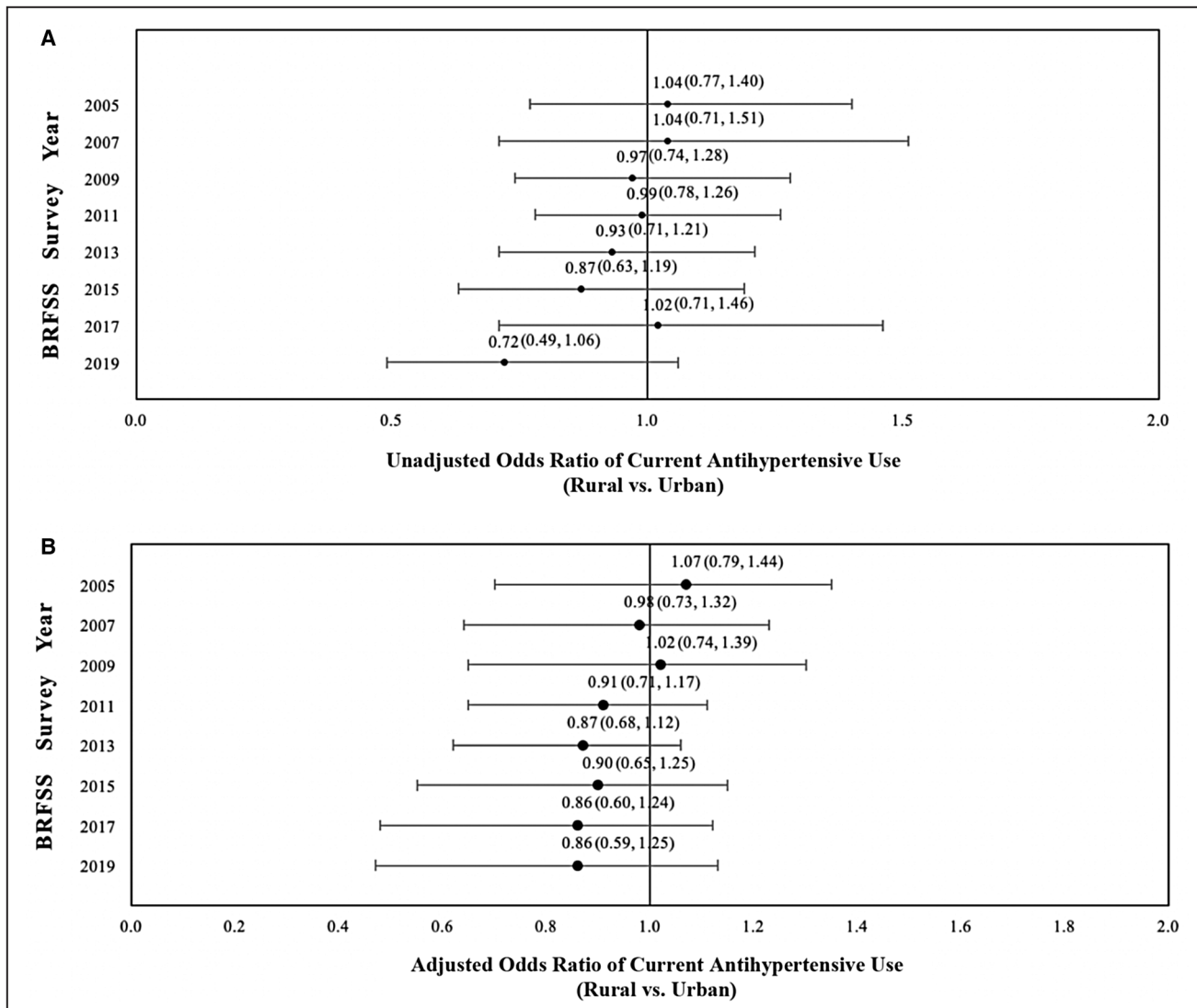
We found that >90% of stroke survivors with high blood pressure reported they were taking antihypertensive medications regardless of residing in an urban or rural area of the United States. Antihypertensive medication use was comparable between rural and urban stroke survivors throughout the study period, although trends analysis showed slightly increased antihypertensive medication use in urban but not rural stroke survivors over time.

Prior US research examining antihypertensive medication use by rural/urban residence has yielded inconsistent results, and the majority of these studies did not separately analyze data for stroke survivors.<sup>4-6</sup> One study using National Health and Nutritional Examination Survey III (1988–1994) data for individuals aged 40 to 59 years with hypertension reported that antihypertensive medication use for all races/ethnicities was <68% in rural areas and <75% in urban areas.<sup>4</sup> Using the 2007 BRFSS data, another study found no significant difference in antihypertensive medication use between rural and urban residents with hypertension (87.9%–89.5% versus 87.1%–88.9%).<sup>5</sup> An updated analysis using the 2017 BRFSS survey data reported more frequent antihypertensive medication use for individuals with hypertension in rural (80.2% [95% CI, 79.1%–81.4%]) compared with urban residents (76.0% [95% CI, 75.5%–76.4%]).<sup>6</sup> Our finding of no rural/urban difference is consistent with the sole US study that assessed rural/urban differences in poststroke antihypertensive medication use.<sup>7</sup> This study of patients enrolled in the AVAIL (Adherence Evaluation After Ischemic Stroke Longitudinal) registry between 2006 and 2008 found that antihypertensive medication use

at 3-months poststroke hospitalization was 93.6% for rural stroke survivors and 92.2% for urban stroke survivors ( $P=0.3873$ ).<sup>7</sup>

Our study adds to previous research by showing that poststroke antihypertensive medication use and common cardiovascular lifestyle factors do not vary by rural/urban residence. Although such findings are encouraging, antihypertensive medication use comprises only a part of hypertension management.<sup>1</sup> In addition to medication, guidelines recommend that stroke survivors be encouraged to follow other management strategies such as reducing salt intake, increasing vegetable and fruit consumption, engaging in exercise, and quitting smoking.<sup>1</sup> By examining rural/urban differences in common cardiovascular lifestyle factors, our study was able to include some of these relevant aspects of poststroke hypertension management; however, further research on rural/urban differences in hypertension management among US stroke survivors is needed, particularly regarding diet-based strategies. Additionally, our BRFSS dataset did not include antithrombotic, diabetes, and lipid-lowering medications. Whether poststroke use of these secondary stroke preventive medications differs by rural/urban residence should be explored in future work.

Our study has several limitations, including potential nonresponse bias and that the BRFSS does not include information on achievement of blood pressure targets, the types of antihypertensive medications used, or the date and type of stroke. In addition, BRFSS responses are self-reported; however, CDC-conducted validation studies found they have good agreement with in-person and administrative health record data, particularly for prevalence of cardiovascular risk factors such as hypertension (BRFSS: 29.6%, electronic



**Figure 2.** Odds ratios for antihypertensive medication use comparing rural to urban stroke survivors in the Behavioral Risk Factor Surveillance System (BRFSS) surveys.

**A,** Unadjusted. **B,** Adjusted for age, race, sex, income, education, health care coverage, cholesterol, diabetes, overweight/obesity, smoking, and physical activity.

health records: 26.3%), diabetes (BRFSS: 9.7%, electronic health records: 9.4%), and obesity (BRFSS: 23.8%, electronic health records: 22.8%).<sup>11,13</sup> It should also be noted that study estimates reflect stroke survivors' current antihypertensive medication use at the time the survey was administered and that the time since the stroke occurred could impact adherence to antihypertensive medication; however, the current antihypertensive medication use estimates captured by our study represent an estimate of use for the general population of US stroke survivors on a given day.

## CONCLUSIONS

In this nationwide study of stroke survivors with self-reported hypertension, poststroke antihypertensive

medication use was high and did not differ by rural/urban residence. Antihypertensive medication use, however, increased among urban residents whereas it remained stable among rural residents over the study period. Additional work is needed to identify the reasons for this difference and to determine whether other aspects of hypertension management vary between US rural and urban stroke survivors.

## ARTICLE INFORMATION

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### Disclosures

None.

### Supplemental Material

Tables S1–S3

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## **SUPPLEMENTAL MATERIAL**



**Table S1. Variable Assessment**

<b>Self-reported Variables</b>	<b>Behavioral Risk Factor Surveillance System (BRFSS) question</b>
Stroke status	<u>2005, 2007, 2009, 2011, 2013, 2015, 2017, 2019</u> Question: “(Ever told) you had a stroke.” Variable: CVDSTRK3
Hypertension status	<u>2005, 2007, 2009, 2011, 2013, 2015, 2017, 2019</u> Question: “Have you EVER been told by a doctor, nurse or other health professional that you have high blood pressure?” Variable: BPHIGH4
Hypertension medication use	<u>2005, 2007, 2009, 2011, 2013, 2015, 2017, 2019</u> Question: “Are you currently taking medicine for your high blood pressure?” Variable: BPMEDS
Metropolitan status code	<u>2005, 2007, 2009, 2011, 2013, 2015, 2017, 2019</u> Question: “Metropolitan Status Code” Variable: MSCODE
Age	<u>2005, 2007, 2009, 2011, 2013, 2015, 2017, 2019</u> Question: “Six-level imputed age category” Variable: AGE_G
Sex	<u>2005, 2007, 2009, 2011, 2013, 2015, 2017</u> Question: “Indicate sex of respondent.” Variable: SEX  <u>2019</u> Question: “Sex of Respondent” Variable: SEXVAR
Race	<u>2005, 2007, 2009, 2011</u> Question: “Race groups used for internet prevalence tables” Variable: _RACE_G  <u>2013, 2015, 2017, 2019</u> Question: “Race/ethnicity categories” Variable: RACE
Household income	<u>2005, 2007, 2009, 2011, 2013, 2015, 2017, 2019</u> Question: “Income categories” Variable: INCOMG
Education	<u>2005, 2007, 2009, 2011, 2013, 2015, 2017, 2019</u> Question: “What is the highest grade or year of school you completed?” Variable: EDUCA
Health Care Coverage	<u>2005, 2007, 2009</u> Question: “Do you have any kind of health care coverage, including health insurance, prepaid plans such as HMOs, or government plans such as Medicare?” Variable: HLTHPLAN

	<p><u>2011, 2013, 2015, 2017, 2019</u></p> <p>Question: “Do you have any kind of health care coverage, including health insurance, prepaid plans such as HMOs, or government plans such as Medicare, or Indian Health Service?”</p> <p>Variable: HLTHPLN1</p>
Smoking	<p><u>2005, 2007, 2009, 2011, 2013, 2015, 2017, 2019</u></p> <p>Question: “Four-level smoker status: Everyday smoker, Someday smoker, Former smoker, Non-smoker”</p> <p>Variable: SMOKER3</p>
Physical activity	<p><u>2005, 2007, 2009</u></p> <p>Questions:  “Total minutes of moderate physical activity”- _MODPAMN  “Moderate Physical Activity Days”-MODPADAY  “Total minutes of vigorous physical activity”- _VIGPAMN  “Vigorous Physical Activity Days”-VIGPADAY  Variables: _MODPAMN, MODPADAY, _VIGPAMN, VIGPADAY</p> <p><u>2011</u></p> <p>Question: “Physical Activity Categories”</p> <p>Variable: _PACAT</p> <p><u>2013, 2015, 2017</u></p> <p>Question: “Physical Activity Categories”</p> <p>Variable: _PACAT1</p> <p><u>2019</u></p> <p>Question: “Physical Activity Categories”</p> <p>Variable: _PACAT2</p> <p>*BRFSS surveys prior to 2011 do not have a variable with already defined physical activity categories.<sup>14-16</sup> The pre-2011 method of physical activity assessment resulted in a greater percentage of missing physical activity responses (pre 2011 BRFSS: ≈37% missing, 2011 and later BRFSS: &lt;14%). To categorize a categorical physical activity variable for pre-2011 surveys, we calculated the total number of moderate exercise minutes per week using the CDC provided equation: Total number of moderate exercise minutes per week=Vigorous Physical Activity Days per week*Total minutes of vigorous physical activity*2 + Moderate Physical Activity Days per week*Total minutes of moderate physical activity.<sup>17</sup> The total number of moderate exercise minutes per week for each eligible study participant in the 2005, 2007, 2009 surveys was then categorized using the groupings found in 2011 and later surveys which were highly active (≥300 minutes per week of moderate physical activity), active (150-300 minutes</p>



	per week of moderate physical activity), insufficiently active (<150 minutes per week of moderate physical activity), and inactive (no moderate physical activity per week). <sup>18-22</sup>
BMI	<p><u>2005, 2007</u> Question: “Body Mass Index (BMI)” Variable: _BMI4</p> <p><u>2009</u> Question: “Body Mass Index (BMI)” Variable: _BMI5</p> <p><u>2011, 2013, 2015, 2017, 2019</u> Question: “Four-categories of Body Mass Index (BMI)” (Underweight: BMI&lt;18.50 kg/m<sup>2</sup>, Normal Weight: 18.50 kg/m<sup>2</sup>≤BMI&lt;25.00 kg/m<sup>2</sup>, Overweight: 25kg/m<sup>2</sup>≤BMI&lt;30.00 kg/m<sup>2</sup>, Obese: BMI≥30.00 kg/m<sup>2</sup>) Variable: _BMI5CAT</p>
High cholesterol	<p><u>2005, 2007, 2009, 2011, 2013, 2015, 2017, 2019</u> Question: “Have you EVER been told by a doctor, nurse or other health professional that your blood cholesterol is high?” Variable: TOLDHI2</p>
Diabetes	<p><u>2005, 2007, 2009</u> Question: “Have you ever been told by a doctor that you have diabetes (If "Yes" and respondent is female, ask "Was this only when you were pregnant?" Variable: DIABETE2</p> <p><u>2011, 2013, 2015, 2017</u> Question: “(Ever told) you have diabetes (If "Yes" and respondent is female, ask "Was this only when you were pregnant?" Variable: DIABETE3</p> <p><u>2019</u> Question: “(Ever told) (you had) diabetes?” Variable: DIABETE4</p>
Survey weighting variables	<p><u>2005, 2007, 2009, 2011, 2013, 2015, 2017, 2019</u> Questions: “Primary Sampling Unit (Equal to Annual Sequence Number)”- _PSU “Sample Design Stratification Variable”- _STSTR Variables: _PSU, _STSTR</p> <p><u>2005, 2007, 2009</u> Question: “Final weight assigned to each respondent (Post-stratification weight (_POSTSTR) multiplied by design weight (_WT2).)” Variable: _FINALWT</p>

2011, 2013, 2015, 2017, 2019

Question: “Final weight assigned to each respondent: Land-line and cell-phone data (Raking derived weight)”

Variable: \_LLCPWT

\*To ensure that all results are appropriately survey weighted, the primary sampling unit, sample design stratification, and final weight variable must be used together in analyses.<sup>23</sup>

**Table S2.** Trend analysis of antihypertensive use in rural and urban stroke survivors

a) Model for rural stroke survivors ( $R^2=0.0519$ )

<b>Parameter Estimates</b>					
<b>Variable</b>	<b>DF</b>	<b>Parameter Estimate</b>	<b>Standard Error</b>	<b>t Value</b>	<b>Pr &gt;  t </b>
<b>Intercept</b>	<b>1</b>	131.56905	71.05577	1.85	0.1135
<b>Year</b>	<b>1</b>	-0.02024	0.03532	-0.57	0.5874

b) Model for urban stroke survivors ( $R^2=0.5603$ )

<b>Parameter Estimates</b>					
<b>Variable</b>	<b>DF</b>	<b>Parameter Estimate</b>	<b>Standard Error</b>	<b>t Value</b>	<b>Pr &gt;  t </b>
<b>Intercept</b>	<b>1</b>	-155.62155	89.31414	-1.74	0.1321
<b>Year</b>	<b>1</b>	0.12274	0.04439	2.76	0.0326

**Table S3.** Survey weighted distribution of sociodemographic and lifestyle factors and antihypertensive medication use of rural and urban stroke survivors with a self-reported history of hypertension by Behavioral Risk Factor Surveillance System (BRFSS) survey year

	Survey weighted % (95% CI)					
	2005 (N=8203)		2007 (N=11325)		2009 (N=12096)	
	Rural (N=3138)	Urban (N=5065)	Rural (N=4257)	Urban (N=7068)	Rural (N=4493)	Urban (N=7603)
<b>Age</b>						
18-44	6.2 (4.5, 8.0)	8.5 (6.5, 10.4)	6.6 (3.7, 9.5)	8.2 (6.4, 10.1)	7.4 (5.7, 9.0)	6.5 (5.1, 7.9)
45-64	34.6 (31.9, 37.3)	33.3 (30.6, 36.0)	37.6 (34.8, 40.4)	34.9 (32.7, 37.1)	32.9 (30.4, 35.4)	37.1 (35, 39.1)
65+	59.2 (56.3, 62.0)	58.3 (55.4, 61.1)	55.8 (52.7, 58.9)	56.9 (54.6, 59.2)	59.7 (57.1, 62.3)	56.4 (54.3, 58.5)
<b>Sex</b>						
Men	42.8 (39.9, 45.7)	45.0 (42.2, 47.8)	48.7 (45.7, 51.7)	46.0 (43.5, 48.5)	44.6 (42.1, 47.2)	45 (42.9, 47.1)
Women	57.2 (54.3, 60.1)	55.0 (52.2, 57.8)	51.3 (48.3, 54.3)	54.0 (51.5, 56.5)	55.4 (52.8, 57.9)	55 (52.9, 57.1)
<b>Race</b>						
NH White	78.8 (76.4, 81.2)	65.7 (62.8, 68.7)	79.1 (76.6, 81.6)	63.3 (60.8, 65.8)	79 (76.7, 81.4)	63.3 (61.2, 65.4)
NH Black	9.9 (8.1, 11.6)	17.0 (14.9, 19.2)	8.6 (7.0, 10.3)	17.8 (16.1, 19.6)	10.6 (8.9, 12.3)	17.6 (15.8, 19.3)
Hispanic	3.6 (2.2, 5.0)	9.7 (6.9, 12.5)	3.8 (2.3, 5.3)	11.5 (9.0, 14.0)	3.8 (2.2, 5.4)	11.3 (9.6, 13.1)
Other race	6.3 (4.9, 7.6)	6.3 (4.8, 7.9)	6.3 (4.9, 7.7)	6.2 (5.0, 7.5)	5.5 (4.3, 6.6)	6.4 (5.2, 7.6)
Missing	1.4 (0.9, 2.0)	1.2 (0.8, 1.6)	2.2 (1.3, 3.0)	1.2 (0.8, 1.5)	1.1 (0.7, 1.5)	1.4 (1.0, 1.9)
<b>Income</b>						
<\$15,000	25.9 (23.5, 28.4)	22.9 (20.1, 25.7)	21.2 (19.1, 23.3)	19.3 (17.4, 21.2)	22.8 (20.7, 24.8)	20.1 (18.4, 21.8)
\$15,000 to <\$25,000	25 (22.4, 27.7)	21.7 (19.6, 23.7)	25 (22.0, 28.0)	22.6 (20.7, 24.5)	26.3 (24, 28.7)	23.2 (21.4, 25)
\$25,000 to <\$35,000	12.6 (10.5, 14.6)	12.2 (10.1, 14.4)	14.1 (12.0, 16.2)	11.8 (10.3, 13.3)	13.1 (11.4, 14.9)	10.7 (9.6, 11.7)
\$25,000 to <\$35,000	8.5 (6.8, 10.2)	10.2 (8.7, 11.6)	9.9 (8.0, 11.8)	10.9 (9.3, 12.4)	10.6 (9.1, 12.2)	10.5 (9.2, 11.8)
\$50,000 or more	8.7 (7.0, 10.5)	15.4 (13.5, 17.2)	11.8 (9.9, 13.7)	18.3 (16.2, 20.4)	10.7 (9.1, 12.2)	19.2 (17.6, 20.7)
Missing	19.2 (17.0, 21.5)	17.7 (15.8, 19.7)	17.9 (16.0, 19.9)	17.2 (15.5, 18.8)	16.5 (14.6, 18.4)	16.3 (14.8, 17.8)
<b>Education</b>						
Never attended school or only kindergarten	0.6 (0.0, 1.4)	0.8 (0.0, 2.0)	0.4 (0.1, 0.8)	0.4 (0.1, 0.8)	0.2 (0, 0.3)	0.2 (0.0, 0.4)

Elementary	11.9 (10.3, 13.6)	8.1 (6.1, 10.0)	9.9 (8.3, 11.5)	7.5 (5.8, 9.2)	8.6 (7.3, 9.9)	7.8 (6.4, 9.1)
Some high school	15.3 (13.3, 17.3)	14.5 (12.1, 16.9)	15.8 (13.0, 18.6)	10.8 (9.7, 11.9)	13.4 (11.7, 15.1)	11.4 (10.0, 12.8)
High school graduate	41.3 (38.4, 44.2)	30.6 (28.3, 32.9)	39.1 (36.2, 41.9)	34.1 (31.9, 36.2)	40.8 (38.3, 43.4)	32.3 (30.5, 34.1)
Some college or technical school	19.7 (17.4, 22.1)	26.3 (23.7, 28.8)	22.4 (20.1, 24.7)	25.8 (23.5, 28.1)	23 (20.9, 25.1)	25.7 (23.9, 27.5)
College graduate	11.0 (9.4, 12.6)	19.2 (17.1, 21.4)	12.3 (10.4, 14.2)	21.1 (19.2, 23.1)	13.4 (11.8, 15)	21.7 (20.1, 23.4)
Missing	0.1 (0.0, 0.2)	0.5 (0.1, 0.9)	0.2 (0.0, 0.3)	0.4 (0.0, 0.7)	0.6 (0.2, 1.0)	0.9 (0.4, 1.5)
<b>Health insurance</b>						
Yes	89 (86.9, 91.1)	92.3 (91.1, 93.5)	89.1 (86.2, 91.9)	90.3 (88.6, 91.9)	91.3 (89.7, 92.9)	92.2 (90.9, 93.4)
No	10.2 (8.2, 12.2)	7.5 (6.3, 8.7)	10.6 (7.8, 13.5)	9.4 (7.8, 11.0)	8.5 (6.9, 10.1)	7.6 (6.3, 8.8)
Missing	0.8 (0.1, 1.5)	0.2 (0.1, 0.4)	0.3 (0.0, 0.6)	0.3 (0.0, 0.7)	0.2 (0.0, 0.5)	0.2 (0.1, 0.4)
<b>Smoking</b>						
Current smoker	23.9 (21.5, 26.4)	20.0 (17.9, 22.2)	22.9 (19.9, 25.9)	19.1 (17.2, 20.9)	22.1 (19.8, 24.3)	20.1 (18.4, 21.8)
Former smoker	35 (32.2, 37.8)	39.8 (37.0, 42.5)	38.3 (35.5, 41.1)	38.3 (35.9, 40.6)	37.3 (34.8, 39.8)	39.0 (37.1, 40.9)
Never smoker	40.5 (37.6, 43.4)	39.8 (37.2, 42.4)	38.6 (35.8, 41.3)	42.3 (39.9, 44.7)	39.5 (37.0, 42.0)	39.9 (37.9, 41.9)
Missing	0.6 (0.2, 1.0)	0.5 (0.2, 0.7)	0.2 (0.0, 0.4)	0.4 (0.2, 0.6)	1.1 (0.4, 1.9)	1.0 (0.5, 1.6)
<b>High cholesterol</b>						
Yes	59.9 (57.0, 62.8)	60.4 (57.6, 63.3)	63.4 (60.3, 66.5)	63.5 (61.2, 65.8)	62.9 (60.4, 65.4)	65.9 (64, 67.8)
No	32.1 (29.3, 34.9)	32.4 (29.7, 35.2)	29.7 (27.1, 32.4)	29.7 (27.5, 31.9)	29.9 (27.5, 32.3)	27.9 (26.2, 29.7)
Missing	8.0 (6.5, 9.6)	7.1 (5.8, 8.5)	6.9 (4.2, 9.5)	6.8 (5.5, 8.2)	7.2 (5.8, 8.6)	6.2 (5.2, 7.2)
<b>Diabetes</b>						
Yes	30.3 (27.6, 32.9)	32.2 (29.6, 34.8)	35.1 (32.3, 37.9)	34.5 (32.3, 36.8)	32.9 (30.6, 35.3)	34.0 (32.1, 36)
No	69.5 (66.8, 72.2)	67.5 (64.9, 70.1)	64.8 (61.9, 67.6)	65.3 (63.1, 67.6)	66.8 (64.5, 69.2)	65.7 (63.7, 67.7)
Missing	0.3 (0.0, 0.5)	0.3 (0.1, 0.5)	0.1 (0.0, 0.3)	0.2 (0.0, 0.3)	0.2 (0.0, 0.5)	0.3 (0.1, 0.4)
<b>Body Mass Index</b>						
Underweight	1.3 (0.8, 1.7)	1.9 (1.3, 2.5)	1.1 (0.7, 1.5)	1.5 (1.1, 1.8)	1.5 (0.9, 2.0)	1.2 (0.8, 1.5)
Normal	26.5 (23.9, 29.1)	26.5 (24.0, 29.0)	23.5 (21.2, 25.8)	26.8 (24.5, 29.1)	23.5 (21.4, 25.6)	25.7 (23.9, 27.5)
Overweight/Obese	68.6 (65.8, 71.4)	67.9 (65.3, 70.5)	72.7 (70.3, 75.1)	67.2 (64.9, 69.6)	71.8 (69.6, 74.0)	69 (67.1, 70.9)
Missing	3.6 (2.5, 4.8)	3.6 (2.8, 4.5)	2.7 (1.9, 3.4)	4.5 (3.1, 5.8)	3.2 (2.5, 3.9)	4.1 (3.3, 5.0)

<b>Met physical activity guidelines (<math>\geq 150</math> moderate exercise minutes/week)</b>						
Yes	33.7 (31.0, 36.4)	38.3 (35.5, 41.2)	38.6 (35.7, 41.5)	38.6 (36.2, 40.9)	36.3 (33.8, 38.7)	38.2 (36.2, 40.2)
No	25.1 (22.6, 27.7)	24.7 (22.3, 27.1)	23.3 (21.1, 25.6)	23.5 (21.5, 25.5)	25.2 (22.8, 27.5)	23.7 (22.0, 25.4)
Missing	41.2 (38.3, 44.0)	37.0 (34.5, 39.5)	38.1 (35.1, 41.0)	37.9 (35.6, 40.3)	38.6 (36.1, 41.0)	38.2 (36.1, 40.2)
<b>Current Antihypertensive Medication Use</b>						
Yes	90.9 (88.9, 92.8)	90.6 (89.0, 92.2)	90.6 (87.9, 93.3)	90.3 (88.5, 92.1)	91.3 (89.5, 93)	91.5 (90.2, 92.8)
No	9.1 (7.2, 11.1)	9.4 (7.8, 11.0)	9.4 (6.7, 12.1)	9.7 (7.9, 11.5)	8.7 (7.0, 10.5)	8.5 (7.2, 9.8)

	Survey weighted % (95% CI)					
	2011 (N=13816)		2013 (N=12836)		2015 (N=9557)	
	Rural (N=5035)	Urban (N=8781)	Rural (N=4997)	Urban (N=7839)	Rural (N=3186)	Urban (N=6371)
<b>Age</b>						
18-44	3.6 (2.4, 4.7)	5.7 (4.7, 6.8)	3.9 (2.3, 5.6)	3.5 (2.6, 4.3)	3.7 (1.8, 5.6)	3.7 (2.7, 4.7)
45-64	35.8 (33.1, 38.6)	36.9 (35, 38.8)	31.3 (28.8, 33.9)	33.7 (31.4, 36)	32.7 (29.3, 36.0)	32.3 (30.0, 34.5)
65+	60.6 (57.9, 63.4)	57.4 (55.4, 59.3)	64.7 (62.1, 67.4)	62.8 (60.5, 65.1)	63.6 (60.2, 67.1)	64.1 (61.8, 66.4)
<b>Sex</b>						
Men	46.0 (43.3, 48.8)	45.0 (43.0, 46.9)	42.5 (39.8, 45.1)	45.0 (42.7, 47.3)	45.3 (42.0, 48.7)	43.3 (41, 45.6)
Women	54.0 (51.2, 56.7)	55.0 (53.1, 57.0)	57.6 (54.9, 60.2)	55.0 (52.7, 57.3)	54.7 (51.4, 58.0)	56.7 (54.4, 59)
<b>Race</b>						
NH White	81.9 (80.0, 83.8)	64.2 (62.2, 66.1)	80.4 (78.3, 82.5)	65.9 (63.6, 68.3)	80.5 (77.9, 83.1)	67.7 (65.3, 70.1)
NH Black	7.7 (6.5, 8.8)	18.8 (17.1, 20.4)	10.4 (9.0, 11.8)	18.4 (16.7, 20.1)	10.0 (8.0, 12.1)	16.8 (15, 18.5)
Hispanic	3.1 (2.2, 4.0)	9.2 (7.7, 10.7)	2.6 (1.5, 3.7)	8.0 (6.1, 9.8)	2.7 (1.8, 3.6)	7.7 (6.1, 9.4)
Other race	4.8 (3.8, 5.8)	6.2 (5.2, 7.3)	4.6 (3.6, 5.7)	6.0 (4.5, 7.5)	4.7 (3.3, 6.1)	5.4 (4.0, 6.8)
Missing	2.5 (1.6, 3.5)	1.7 (1.2, 2.1)	2.0 (1.2, 2.8)	1.7 (1.3, 2.2)	2.1 (1.3, 2.9)	2.4 (1.5, 3.4)
<b>Income</b>						
<\$15,000	25.3 (23, 27.6)	19.4 (17.8, 20.9)	19.4 (17.6, 21.2)	18.2 (16.5, 19.9)	20.3 (17.5, 23.1)	15.8 (14.1, 17.6)
\$15,000 to <\$25,000	27.0 (24.5, 29.5)	26.2 (24.3, 28.0)	26.6 (24.3, 29)	22.0 (20.1, 23.8)	24.3 (21.5, 27.1)	21.6 (19.6, 23.5)
\$25,000 to <\$35,000	11.7 (10.0, 13.4)	11.3 (10.2, 12.5)	10.5 (9.0, 12.0)	12.0 (10.7, 13.4)	10.9 (8.7, 13.1)	10.9 (9.6, 12.3)
\$25,000 to <\$35,000	9.9 (7.9, 11.9)	10.2 (9.2, 11.3)	10.8 (9.0, 12.6)	12.1 (10.7, 13.5)	10.8 (8.8, 12.8)	11.4 (10.0, 12.7)
\$50,000 or more	11.1 (9.3, 12.9)	17.0 (15.6, 18.4)	12.1 (10.3, 13.9)	19.3 (17.3, 21.2)	10.4 (8.6, 12.3)	20.8 (18.8, 22.8)
Missing	15.1 (13.5, 16.8)	16.0 (14.6, 17.3)	20.5 (18.3, 22.7)	16.5 (15.1, 18.0)	23.3 (20.4, 26.1)	19.5 (17.7, 21.3)
<b>Education</b>						
Never attended school or only kindergarten	0.3 (0.0, 0.6)	0.5 (0.0, 1.0)	0.2 (0.0, 0.3)	0.9 (0.2, 1.5)	0.2 (0.0, 0.3)	0.2 (0.1, 0.3)
Elementary	11.8 (9.8, 13.7)	7.2 (6.0, 8.3)	9.0 (7.5, 10.4)	7.6 (6.3, 8.9)	11.8 (9.2, 14.4)	7.1 (5.6, 8.6)
Some high school	20.5 (18.0, 23.0)	15.9 (14.4, 17.5)	19.2 (16.8, 21.6)	14.8 (12.8, 16.7)	17.8 (15.2, 20.5)	14.9 (13.0, 16.8)



High school graduate	34.9 (32.3, 37.4)	33.0 (31.2, 34.9)	39.7 (37.1, 42.2)	31.1 (29.1, 33.1)	38.3 (35.1, 41.5)	32.3 (30.1, 34.5)
Some college or technical school	23.9 (21.6, 26.1)	27.1 (25.4, 28.7)	21.4 (19.4, 23.4)	29.2 (27.2, 31.2)	23.8 (21, 26.6)	30.1 (28.0, 32.2)
College graduate	8.4 (7.4, 9.5)	15.8 (14.6, 17.1)	10.5 (9.2, 11.8)	16.0 (14.8, 17.3)	7.6 (6.6, 8.7)	15.2 (13.8, 16.5)
Missing	0.3 (0.1, 0.4)	0.5 (0.2, 0.7)	0.1 (0.0, 0.3)	0.5 (0.2, 0.7)	0.5 (0.0, 1.0)	0.3 (0.2, 0.5)
<b>Health insurance</b>						
Yes	91.8 (90.3, 93.4)	90.8 (89.2, 92.3)	94.2 (92.9, 95.6)	94.6 (93.6, 95.6)	94.5 (92.9, 96.1)	96.1 (95.2, 97)
No	7.9 (6.4, 9.5)	9.0 (7.4, 10.5)	5.6 (4.3, 6.9)	5.1 (4.1, 6.0)	5.0 (3.5, 6.4)	3.7 (2.8, 4.5)
Missing	0.2 (0.1, 0.4)	0.3 (0.1, 0.5)	0.2 (0.0, 0.3)	0.3 (0.1, 0.6)	0.6 (0.0, 1.2)	0.2 (0.1, 0.4)
<b>Smoking</b>						
Current smoker	20.2 (17.7, 22.6)	20.6 (18.9, 22.2)	20.7 (18.5, 22.9)	16.9 (15.3, 18.5)	19.7 (17.1, 22.3)	17.7 (15.9, 19.4)
Former smoker	39.6 (36.9, 42.3)	40.1 (38.2, 42)	38.0 (35.4, 40.5)	38.9 (36.8, 41.0)	37.6 (34.3, 40.9)	38.9 (36.5, 41.2)
Never smoker	39.1 (36.5, 41.7)	38.7 (36.8, 40.6)	39.0 (36.5, 41.5)	41.0 (38.9, 43.1)	39.2 (36.1, 42.4)	39.6 (37.3, 41.9)
Missing	1.1 (0.0, 2.2)	0.7 (0.4, 0.9)	2.4 (1.7, 3.1)	3.2 (2.6, 3.8)	3.5 (2.4, 4.7)	3.9 (3.1, 4.7)
<b>High cholesterol</b>						
Yes	68.3 (65.7, 71.0)	65.7 (63.8, 67.5)	69.9 (67.5, 72.3)	66.5 (64.4, 68.5)	67.5 (64.4, 70.6)	67.9 (65.7, 70.2)
No	25.5 (22.9, 28.1)	27.9 (26.2, 29.6)	25.0 (22.7, 27.2)	27.4 (25.5, 29.3)	27.6 (24.6, 30.6)	27.7 (25.6, 29.9)
Missing	6.2 (5.0, 7.4)	6.4 (5.3, 7.5)	5.2 (4.1, 6.3)	6.1 (5.0, 7.3)	4.9 (3.6, 6.2)	4.4 (3.6, 5.1)
<b>Diabetes</b>						
Yes	35.6 (33.0, 38.3)	33.7 (31.9, 35.6)	36.3 (33.7, 38.9)	37.3 (35.1, 39.6)	36.9 (33.6, 40.2)	36.6 (34.3, 38.8)
No	64.2 (61.6, 66.8)	66.1 (64.3, 68)	63.6 (60.9, 66.2)	62.6 (60.3, 64.9)	63 (59.7, 66.3)	63.2 (61, 65.5)
Missing	0.2 (0.0, 0.4)	0.2 (0.1, 0.3)	0.2 (0.0, 0.3)	0.1 (0.0, 0.2)	0.1 (0.0, 0.1)	0.2 (0.1, 0.4)
<b>Body Mass Index</b>						
Underweight	1.7 (1.0, 2.4)	2.1 (1.5, 2.8)	1.4 (1.0, 1.9)	1.7 (1.1, 2.2)	2.2 (1.2, 3.1)	1.7 (1.1, 2.2)
Normal	23.9 (21.5, 26.2)	24.1 (22.4, 25.8)	22.7 (20.5, 24.8)	24.4 (22.6, 26.2)	22.8 (19.9, 25.7)	23.9 (21.9, 25.9)
Overweight/Obese	71.6 (69.1, 74)	69.9 (68.1, 71.7)	72.2 (70.0, 74.5)	70.0 (68.1, 71.9)	69.3 (66.1, 72.4)	68.4 (66.3, 70.6)
Missing	2.9 (2.2, 3.6)	3.9 (3.3, 4.6)	3.6 (2.7, 4.6)	3.9 (3.2, 4.7)	5.8 (4.4, 7.3)	6.0 (4.9, 7.1)
<b>Met physical activity guidelines</b>						

<b>(≥150 moderate exercise minutes/week)</b>						
Yes	33.3 (30.7, 35.9)	34.7 (32.9, 36.6)	31.0 (28.6, 33.4)	34.3 (32.3, 36.3)	29.6 (26.4, 32.7)	33 (30.9, 35.2)
No	57.8 (55.1, 60.5)	55.5 (53.6, 57.5)	55.9 (53.3, 58.6)	53.9 (51.8, 56.1)	57.1 (53.8, 60.5)	52.4 (50.1, 54.7)
Missing	9.0 (7.6, 10.4)	9.8 (8.7, 10.8)	13.1 (11.1, 15.1)	11.8 (10.5, 13.0)	13.3 (11.0, 15.7)	14.6 (13.0, 16.2)
<b>Current Antihypertensive Medication Use</b>						
Yes	90.9 (89.3, 92.5)	91.0 (89.8, 92.2)	91.4 (89.6, 93.1)	91.9 (90.8, 93.1)	90.2 (88, 92.5)	91.4 (90.0, 92.8)
No	9.1 (7.5, 10.7)	9.0 (7.8, 10.2)	8.6 (6.9, 10.4)	8.1 (6.9, 9.2)	9.8 (7.5, 12.0)	8.6 (7.2, 10.0)

	Survey weighted % (95% CI)			
	2017 (N=7761)		2019 (N=6581)	
	Rural (N=2641)	Urban (N=5120)	Rural (N=2370)	Urban (N=4211)
<b>Age</b>				
18-44	2.8 (0.6, 5.0)	3.3 (2.1, 4.5)	2 (0.8, 3.3)	1.7 (0.9, 2.4)
45-64	27.2 (24.2, 30.3)	26.9 (24.6, 29.3)	28.5 (24.4, 32.7)	25 (22.5, 27.6)
65+	70.0 (66.6, 73.3)	69.8 (67.3, 72.2)	69.4 (65.2, 73.7)	73.3 (70.7, 75.9)
<b>Sex</b>				
Men	40.0 (36.5, 43.5)	41.6 (38.9, 44.3)	40 (35.4, 44.6)	43.1 (40.2, 46)
Women	60.0 (56.5, 63.6)	58.4 (55.7, 61.1)	60 (55.4, 64.6)	56.9 (54, 59.8)
<b>Race</b>				
NH White	81.4 (78.6, 84.1)	69.1 (66.7, 71.6)	82.1 (79.3, 84.8)	67.4 (64.5, 70.4)
NH Black	9.7 (7.9, 11.5)	18.5 (16.3, 20.6)	8.7 (6.7, 10.7)	19.1 (16.7, 21.5)
Hispanic	0.9 (0.3, 1.5)	5.6 (4.2, 6.9)	2.8 (1.8, 3.9)	5.9 (4.3, 7.5)
Other race	5.2 (3.5, 7.0)	4.3 (3.4, 5.2)	3.4 (2.3, 4.4)	5.8 (3.8, 7.7)
Missing	2.8 (1.5, 4.1)	2.6 (1.6, 3.6)	3 (2, 4)	1.8 (1.2, 2.3)
<b>Income</b>				
<\$15,000	17.1 (14.7, 19.6)	12.9 (11.1, 14.7)	16 (13.2, 18.8)	11.9 (10.1, 13.6)
\$15,000 to <\$25,000	25.9 (22.6, 29.3)	23.3 (20.8, 25.8)	24 (19.9, 28.1)	20.1 (17.5, 22.7)
\$25,000 to <\$35,000	11.5 (9.3, 13.7)	9.9 (8.6, 11.3)	8.5 (6.7, 10.3)	10.1 (8.7, 11.4)
\$25,000 to <\$35,000	8.6 (7.0, 10.2)	10.9 (9.3, 12.6)	10.6 (8.2, 13.1)	10 (8.4, 11.7)
\$50,000 or more	14.8 (12.2, 17.4)	22.3 (20.3, 24.4)	17.1 (13.3, 20.8)	20.4 (18.3, 22.4)
Missing	22.1 (18.7, 25.5)	20.6 (18.4, 22.8)	23.9 (19.5, 28.3)	27.6 (24.7, 30.5)
<b>Education</b>				
Never attended school or only kindergarten	0.4 (0.1, 0.7)	0 (0, 0.1)	0.6 (0, 1.7)	0.6 (0, 1.3)
Elementary	9.6 (6.8, 12.5)	4.8 (3.3, 6.2)	8.9 (5.6, 12.2)	5.9 (4.1, 7.8)
Some high school	19.6 (16.2, 23.0)	14.1 (11.9, 16.2)	14.9 (10.7, 19.2)	12.4 (10.3, 14.4)
High school graduate	37.1 (33.6, 40.7)	32.7 (30.3, 35.2)	34.2 (30.1, 38.3)	32.5 (29.9, 35.1)
Some college or technical school	23.8 (20.9, 26.8)	31.7 (29.3, 34.2)	29.8 (25.4, 34.1)	31.3 (28.5, 34.1)
College graduate	9.3 (7.9, 10.7)	16.3 (14.8, 17.9)	11.6 (9.6, 13.6)	16.9 (15.2, 18.6)
Missing	0.2 (0.0, 0.5)	0.4 (0.2, 0.6)	0.1 (0, 0.1)	0.3 (0.1, 0.5)
<b>Health insurance</b>				
Yes	96.3 (95.0, 97.6)	95.4 (94.1, 96.8)	95.3 (93.1, 97.5)	96.5 (95.5, 97.5)
No	3.1 (2.1, 4.0)	4.2 (2.9, 5.6)	4.4 (2.3, 6.5)	3.1 (2.2, 4.1)
Missing	0.6 (0.0, 1.6)	0.4 (0.2, 0.5)	0.3 (0, 0.7)	0.4 (0.1, 0.7)
<b>Smoking</b>				
Current smoker	19.6 (16.5, 22.8)	14.4 (12.7, 16.2)	18.7 (15.3, 22.1)	13.1 (11.3, 14.8)
Former smoker	34.3 (30.8, 37.8)	38.3 (35.8, 40.9)	33.4 (28.9, 37.9)	41.9 (39, 44.8)

Never smoker	43.0 (39.3, 46.7)	43.6 (40.9, 46.2)	44.8 (40.5, 49.1)	39.4 (36.5, 42.4)
Missing	3.1 (1.8, 4.4)	3.7 (2.7, 4.7)	3.1 (1.5, 4.8)	5.6 (4, 7.1)
<b>High cholesterol</b>				
Yes	68.3 (64.9, 71.6)	65.2 (62.7, 67.7)	62.2 (57.6, 66.8)	66.8 (64.1, 69.6)
No	28.3 (25.1, 31.5)	32.2 (29.7, 34.6)	33 (28.4, 37.5)	30.8 (28.1, 33.5)
Missing	3.4 (2.2, 4.6)	2.6 (1.9, 3.3)	4.9 (2.9, 6.9)	2.4 (1.6, 3.1)
<b>Diabetes</b>				
Yes	37.1 (33.4, 40.8)	37.7 (35.1, 40.3)	36.3 (32.1, 40.6)	42.2 (39.2, 45.2)
No	62.7 (59, 66.5)	62.2 (59.6, 64.8)	63.4 (59.1, 67.6)	57.6 (54.6, 60.6)
Missing	0.2 (0.0, 0.3)	0.1 (0, 0.2)	0.3 (0, 0.6)	0.2 (0, 0.4)
<b>Body Mass Index</b>				
Underweight	1.0 (0.4, 1.6)	1.7 (1.1, 2.2)	1.3 (0.8, 1.9)	1.9 (0.9, 3)
Normal	22.5 (19.4, 25.6)	22.3 (20.2, 24.4)	20.1 (16.8, 23.5)	21.4 (19.2, 23.6)
Overweight/Obese	70.2 (66.8, 73.7)	69.8 (67.4, 72.2)	73 (69.3, 76.7)	68 (65.2, 70.7)
Missing	6.3 (4.4, 8.2)	6.3 (5, 7.5)	5.6 (4.1, 7.1)	8.7 (6.8, 10.7)
<b>Met physical activity guidelines (≥150 moderate exercise minutes/week)</b>				
Yes	32.2 (28.4, 36.0)	35.4 (32.8, 38.1)	29.8 (25.4, 34.2)	32.5 (29.8, 35.2)
No	56.9 (53.2, 60.5)	52.9 (50.2, 55.6)	56.7 (51.9, 61.5)	53.1 (50.2, 56)
Missing	11.0 (8.7, 13.2)	11.7 (10, 13.3)	13.5 (9.4, 17.7)	14.4 (12, 16.8)
<b>Current Antihypertensive Medication Use</b>				
Yes	91.3 (88.9, 93.7)	91.1 (89.5, 92.7)	90.3 (87.5, 93.1)	92.8 (91.3, 94.4)
No	8.7 (6.3, 11.1)	8.9 (7.3, 10.5)	9.7 (6.9, 12.5)	7.2 (5.6, 8.7)