# Treatment of High Cholesterol and High Blood Pressure among Hispanic People Living in Rural and Urban Areas of the United States.

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**Abstract**

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Cardiovascular disease (CVD) is the leading cause of death in the United States, with people who identify as Hispanic having a higher prevalence of diabetes and lower rates of hypertension control, showing disparities in access to treatment depending on the region and the differences across urban and rural areas across the US. The objective of this study was to examine the differences in blood pressure and cholesterol treatment rates among Hispanic individuals in the US to better explain geographic variation in CVD outcomes. We analyzed the data from the 2023 Behavioral Risk Factor Surveillance System (BRFSS), which includes Hispanic respondents who self-reported having high blood pressure and/or high cholesterol. We used the complex sampling methods of the BRFSS in order to better weight our data and determine more precise results. And being able to create the Unadjusted, Adjusted, Effect modification, and Interaction models. A total of 38,390 Hispanic respondents were included in this study. People living in rural areas had a similar prevalence of self-reported high blood pressure (27.3% rural vs. 25.8% urban, p=0.44), but, contrary to our hypothesis, they were more likely to report being treated for high blood pressure compared to those living in urban areas (73% rural vs. 66.9% urban, p=0.03). In the unadjusted model, the odds of treatment for high blood pressure was ~30% higher in rural vs.

urban respondents, though the effect was not statistically significant [OR 1.32 (95% CI 0.97-1.79), p=0.08]. For cholesterol, the odds of treatment were also ~30% higher for rural respondents compared to urban respondents [OR 1.32 (95% CI 1.03-1.69), p=0.03]. Adjusting for age, gender, and education did not affect the odds of blood pressure treatment for rural vs. urban respondents [OR 1.32 (95%CI 0.91-1.92), p=0.14], but did partially attenuate the rural-urban difference in cholesterol treatment [OR 1.19 (95%CI 0.88-1.62), P-value=0.26]. Our study did not demonstrate any rural-urban disparities in self-reported blood pressure and cholesterol treatment among Hispanic people. Larger, adequately powered studies are needed to confirm any rural-urban disparities in cardiovascular risk factor management in this population.

## Study objective and specific aims

The general objective of this study is to describe geographic differences in the treatment of high cholesterol and high blood pressure among Hispanic individuals living in the US. This study is significant because it will be the first to describe rural-urban treatment differences among the Hispanic population and will further identify regions of the US where differences in treatment rates are most pronounced. Future interventions could then be developed to mitigate the rural-urban treatment disparity. These interventions could be tested and implemented in regions of the US with the greatest disparities.

## Research Question

Among Hispanic individuals with high blood pressure and high cholesterol, are there differences in drug treatment rates between rural and urban areas of the US?

## The specific aims for this study are the following:

- Aim 1 (primary analysis). Using the national BRFSS survey, we will compare treatment rates of high blood pressure and high cholesterol among Hispanic people in rural and urban areas of the US.

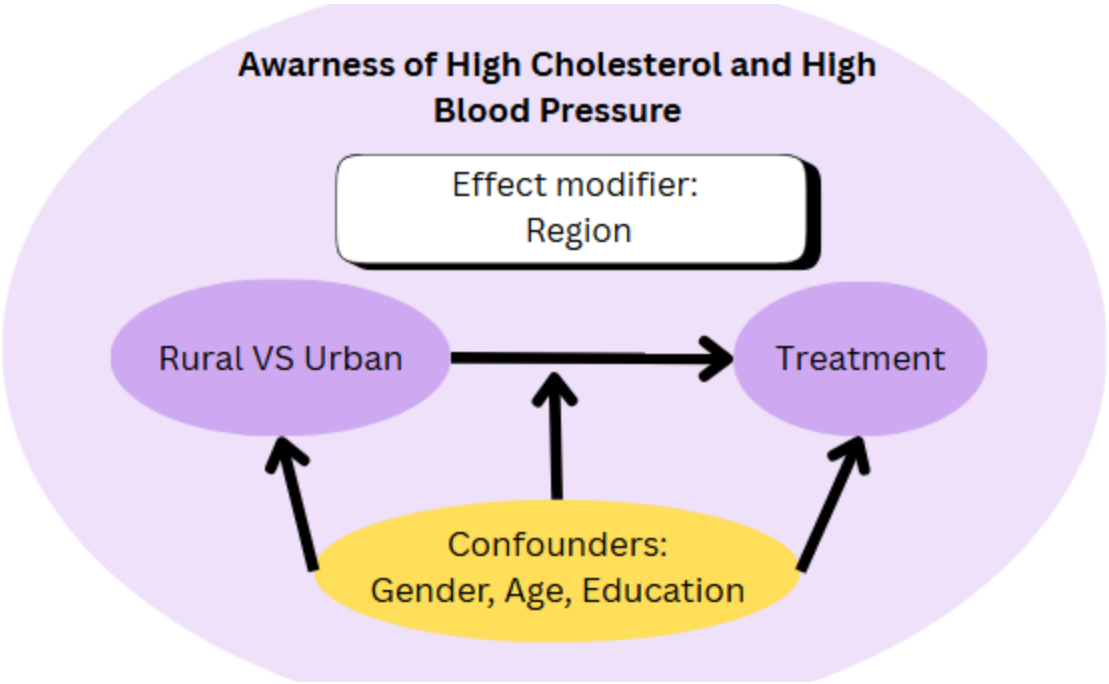
- Aim 2 (moderation analysis). We will assess whether rural/urban differences in drug treatment rates vary across regions of the US.

## Background:

Cardiovascular disease (CVD) remains at the top of causes of death in the United States, and it represents a major public health problem at a nation level (GBD 2023 Risk Factors Collaborators, 2025 ). Additionally, Hispanic population are disproportionately affected by poor conditions of daily life, shaped by structural and social factors such as macroeconomics, cultural values, income, education, occupation, and social support systems, including health services. These factors are collectively known as social determinants of health (SDoH) (Mondragon E, et al 2016). And these social factors, such as income, education, and health services, are factors that in these years still play a big role for the Hispanic community in the US (JAMA Health Forum, 2025; SAGE, 2023).

The underlying premise of our study is that differences in blood pressure and cholesterol treatment rates may explain geographic variation in CVD outcomes among US residents who identify as Hispanic. In addition, the SDoH that lead to rural-urban treatment disparities may be different in the US South compared to the Mountain West or other regions. With this in mind, we hypothesized that among participants in the US Behavioral Risk Factor Surveillance System (BRFSS) who identify as Hispanic and have been told they have high blood pressure or high cholesterol, self-reported drug treatment rates for these conditions would be lower among those who live in rural areas, even after adjustment for important demographic confounders such as age, sex, and education. We further hypothesized that this rural treatment disparity would vary across US regions. One possible mediator of the treatment disparity is access to and the type of health insurance, as shown in our conceptual framework below.

## Conceptual Framework:




## Study Design and Methodology:

This study is a cross-sectional secondary analysis of publicly available data from the Behavioral Risk Factor Surveillance System (BRFSS). We used the 2023 dataset, which is the most recently available BRFSS dataset that has the variables required for this study (Table 1). The dataset was cleaned and analyzed using SAS Studio 9.4. The variables used in this study came from 6 of the 15 core sections of the BRFSS questionnaire. Core sections included questions that states were required to ask the population. We analyzed the data using complex sampling methods, accounting for sampling weights, stratification, and primary sampling unit (cluster) variables provided by the CDC ( Complex Sampling Weights and Preparing 2023). These weight variables adjust and select data in order to create an estimate that represents a percentage and a distribution for our target population. To define rural vs. urban residence, we used the metropolitan status variable (_METSTAT), which classifies survey respondents based

on county-level designation using Office of Management and Budget (OMB) definitions. Counties in metro areas with an urban core of 50,000 or more were classified as urban, and all other counties were classified as rural. We chose the metropolitan status variable over the urban status variable (_URBSTAT), which defines only non-core counties as rural, in order to include micropolitan areas in the classification of rural (Health Resources and Services Administration, 2025). We used FIPS codes to classify states according to U.S. Census Region (Bureau U.C. 2021).

We first assessed rural-urban differences in demographics, self-reported diagnoses, and treatment rates using chi-squared tests. Then, to assess the magnitude of the difference and to control for potential confounders, a series of logistic regression models were built separately for high blood pressure and high cholesterol. An unadjusted Model 1 examined the relationship between rural/urban residence and treatment rates. Model 2 was adjusted for gender, age, and education as possible confounders. Finally, in Models 3 (unadjusted) and 4 (adjusted as in Model 2), we explored effect modification by region by adding an interaction term between region and rural/urban residence. We then separately ran the adjusted models stratified by US census region to determine the rural-urban disparity in each region. We visually displayed rural-urban treatment differences using forest plots for (a) high blood pressure, and (b) high cholesterol. Overall, missingness for the variables used in the models was quite low (<1%); however, any participant who did have missing data was excluded from the analysis.

## Results

We identified 38,390 survey respondents in the 2023 BRFSS dataset who identified as Hispanic. This represents 8.9% of the total survey respondents in the 2023 BRFSS dataset(CDC

BRFSS 2023). In the 2020 United States census, 19.5% (65,329,087 individuals) of the overall population self-identified as Hispanic (US Census Bureau 2020), which demonstrates that the Hispanic/Latino population is underrepresented in the BRFSS. The demographics of survey respondents included in our analysis are shown in Table 2. Half were between 18-39 years old, and 85% lived in urban areas. The distribution of gender and education across urban and rural areas was similar; however, educational attainment was higher, and having health insurance was more likely in urban areas.

Overall, 25.8% (n=8,738) of respondents had been told by a health professional that they had high blood pressure, and 32.9% (n=8,839) of respondents had been told by a health professional that they had high cholesterol (Table 3). Hispanic people living in rural areas had a similar prevalence of self-reported high blood pressure (27.3% rural vs. 25.8% urban, p=0.44), but, contrary to our hypothesis, they were more likely to report being treated for high blood pressure compared to those living in urban areas (73% rural vs. 66.9% urban, p=0.03). For cholesterol, Hispanic people living in rural areas were less likely to have their cholesterol checked and were less likely to report being told that their cholesterol was high (29.04% rural vs 32.9% urban, $p<0.001$). Similar to blood pressure, treatment rates were higher for rural Hispanic people who reported being told they had high cholesterol (52.8% rural vs 45.9% urban, $p<0.001$).

We then built logistic regression models with population sampling weights to quantify the magnitude of rural-urban differences in blood pressure and cholesterol treatment. In the unadjusted model, the odds of treatment for high blood pressure was ~30% higher in rural vs. urban respondents, though the effect was not statistically significant [OR 1.32 (95% CI 0.97-1.79), p=0.08]. For cholesterol, the odds of treatment were also ~30% higher for rural

respondents compared to urban respondents [OR 1.32 (95% CI 1.03-1.69), p=0.03]. Adjusting for age, gender, and education (Table 4) did not affect the odds of blood pressure treatment for rural vs. urban respondents [OR 1.32 (95%CI 0.91-1.92), p=0.14], but did partially attenuate the rural-urban difference in cholesterol treatment [OR 1.19 (95%CI 0.88-1.62), P-value=0.26]. This multi-variable model also highlights the association of age with blood pressure and cholesterol treatment.

Finally, we found no statistically significant evidence that rural-urban differences varied by US region (all p-values for interaction >0.4 ). In models stratified by US region (Table 5), the magnitude of the rural-urban difference did vary somewhat by region, but confidence intervals were wide due to smaller sample sizes. Figure 1 compares the absolute numbers and treatment rates for rural and urban respondents from each region and visually portrays the odds ratios for rurality from the weighted and adjusted models.

## Discussion:

This study examined the differences in blood pressure and cholesterol treatment rates among Hispanic individuals in the US to better understand geographic variation in CVD outcomes. We hypothesized that among participants in the US Behavioral Risk Factor Surveillance System (BRFSS) who identify as Hispanic and have been told they have high blood pressure or high cholesterol, self-reported drug treatment rates for these conditions would be lower among those who live in rural areas compared to urban areas. Contrary to our hypothesis, our results showed higher treatment rates among rural Hispanic people, although the difference was not statistically significant in models that utilized population weights and that adjusted for age, gender, and education as possible confounders. Previous research that is slightly similar to

our research has found consistent results where the treatment rates for HBP and HC are related to the education, rural/urban region, and healthcare access.

Our analysis of whether rural-urban differences varied by region showed that the urban treatment disparity for high blood pressure is greatest in the West. This was the only region in which the model odds ratio was statistically significant at $p<0.05$. The reasons for any regional variation cannot be determined from this study. This regional variation reflects how the distribution of the Hispanic population living across urban/rural areas, access to healthcare, SDoH, and the limitations of power within the BRFSS data.

This study has limitations. Most importantly, relatively small numbers of survey respondents from rural areas may have limited our statistical power to detect what appear to be clinically meaningful differences in rates of self-reported treatment of high blood pressure and high cholesterol between rural and urban areas. The samples were particularly small for some states, such as Pennsylvania and Kentucky. We had initially intended to map rural-urban treatment differences across regions and states, but were unable to do so because of limited power. Another important limitation of the BRFSS is that self-reported data are subject to recall bias and social desirability bias. Finally, the structure of the dataset limited our ability to explore other potential confounding factors, such as social determinants of health or measures of healthcare access. For future studies, researchers should consider using the non-core survey data to further explore rural-urban care differences in states that administered these questionnaires.

In conclusion, our study did not demonstrate any rural-urban disparities in self-reported blood pressure and cholesterol treatment among people who identify as Hispanic ethnicity in the

BRFSS. Larger, adequately powered studies are needed to confirm any rural-urban disparities in cardiovascular risk factor management in this population.

## Appendix 1 (Tables and Figures)

### Table 1. Variables used in SAS

| | Concept | Variable Type | Variable Names |
|---|---|---|---|
| **Defining populations** | **Awareness of high cholesterol** | **Binary (yes/no)** | **_CHOLCH3 and TOLDHI3** |
| | **Awareness of high blood pressure** | **Binary (yes/no)** | **BPHIGH6** |
| **Exposure** | **Rural and urban areas** | **Binary (metro vs non-metro)** | **_URBSTAT OR _METSTAT** |
| **Outcomes** | **Treatment** | **Binary (yes/no)** | **BPMEDS1 CHOLMED3** |
| **Confounders** | **Gender** | **Binary (man/woman)** | **_SEX** |
| | **Age** | **Categorical (18-39, 40-54, 55+ years)** | **_AGEG5YR** |
| | **Education** | **Categorical (<HS, HS grad, some college/technical, college/technical grad)** | **_EDUCAG** |

| | | | |
|---|---|---|---|
| **Effect Modifier** | **Regions** | **Categorical (Northeast, Midwest, South, West)** | **CENSUS_REGION** |
| ***Meditator**** | ***Access to Healthcare/Health Insurance*** | ***Binary (yes, no)*** | ***HLTHPL1*** |

***For future study. Mediation analysis is beyond the scope of this current study.**

**Table 2. Demographics and characteristics of study participants**

| **Characteristic**<br>**Total (n=38,390)** | **Urban (Metropolitan)**<br>**n=32,657 (85%)** | **Rural (Non-metropolitan)**<br>**n=5,733 (15%)** | **P-value** |
|---|---|---|---|
| ***Age*** | | | 0.439 |
| Young Adults 18-39 | 15,080 (49.94%) | 2,527 (51.06%) | |
| Middle Age 40-54 | 8,679 (25.88%) | 1,463 (23.39%) | |
| Older Adults 55+ | 8,594 (24.18%) | 1,690 (25.60%) | |
| Don't Know/Refused/Missing | 304 (0.01%) | 53 (0.01%) | |
| ***Gender*** | | | 0.8725 |
| Man | 15,887 (48.77%) | 2,812 (49.05%) | |
| Woman | 16,770 (51.23%) | 2,921 (50.95%) | |
| **Education** | | | <0.0001 |
| Did not graduate from high school | 7,878 (31.04%) | 1,476 (34.87%) | |
| Graduated from High School | 9,225 (27.65%) | 1,893 (30.27%) | |
| Attended College or Technical School | 6,947 (23.92%) | 1,254 (22.82%) | |
| Graduated from college or a technical School | 8,351 (16.52%) | 1,083 (11.73%) | |
| Don't know/not sure/missing | 256 (0.86%) | 27 (0.30%) | |
| **Health Insurance** | | | 0.0486 |
| Have some form of insurance | 23,329 (71.23%) | 4,112 (67.10%) | |
| Do not have some form of health insurance | 7,100 (21.84%) | 1,299 (25.36%) | |
| Don't know, refused, missing | 2,228 (6.92%) | 322 (7.53%) | |

**Table 3. Self-reported prevalence and treatment rates for high blood pressure and high cholesterol among people who identify as Hispanic ethnicity in the BRFSS**

| **Total Unweighted (n=38,390)** | **Urban (Metropolitan) Unweighted n=32,657** | **Rural (Non-metropolitan) Unweighted n=5,733** | **P-value** |
|---|---|---|---|
| ***Adults who have been told they have high blood pressure by a doctor, nurse, or other health professional*** | | | 0.44 |
| Yes | 8,738 (25.8%) | 1,633 (27.3%) | |
| No | 23,748 (73.5%) | 4,067 (72.1%) | |
| Don't know | 171 (0.6%) | 33 (0.55%) | |
| Total | 32,657 (100%) | 5,733 (100%) | |
| ***Treatment of high blood pressure*** | | | 0.03 |
| Yes | 5,983 (66.9%) | 1,209 (72.77%) | |
| No | 2,734 (32.79%) | 421 (27.13%) | |
| Don't know | 18 (0.199%) | 1 (0.0124%) | |
| Refused | 3 (0.098%) | 2 (0.07%) | |
| Total | 8,738 (100%) | 1,633 (100%) | |
| ***Cholesterol check within the past five years*** | | | <0.0001 |
| Had cholesterol checked in the past 5 years | 25,272 (77%) | 4,170 (68.1%) | |
| Did not have cholesterol checked in the past 5 years | 1,230 (3.63%) | 232 (5.6%) | |
| Have never had cholesterol checked | 3,470 (11.4%) | 823 (16.3%) | |
| Don't know/Not Sure Or Refused/Missing | 2,685 (7.99%) | 508 (9.9%) | |

| | | | |
|---|---|---|---|
| **Total** | 32,657 (100%) | 5,733 (100%) | |
| ***Cholesterol checked and have been told by a doctor, nurse, or other health professional that it was high*** | | | 0.025 |
| Yes | 8,839 (32.9%) | 1,410 (29.04%) | |
| No | 17,473 (66.45%) | 2,958 (70.5%) | |
| Don't know | 190 (0.57%) | 34 (0.46%) | |
| Total | 26,502 (100%) | 4,402 (100%) | |
| ***Treatment of high cholesterol*** | | | 0.0005 |
| Yes | 4,126 (45.9%) | 719 (52.8%) | |
| No | 4,683 (53.8%) | 685 (47.05%) | |
| Don't Know | 27 (0.24%) | 3 (0.0424%) | |
| Refused | 3 (0.0037%) | 3 (0.0821%) | |
| Total | 8,839 (100%) | 1,410 (100%) | |

**Table 4. Multi-variable logistic regression models of self-reported treatment for (A) high blood pressure and (B) high cholesterol.**

| (A) High Blood Pressure | | | | |
|---|---|---|---|---|
| **Variables** | **Categories** | ***Odds Ratio*** | ***95% Confidence limits*** | ***P-value*** |
| **Residence** | | | | |
| | Urban | 1.0 | (REF) | (REF) |
| | Rural | 1.32 | 0.92-1.91 | 0.14 |
| **Age** | | | | |
| | Young Adults 18-39 | 1.0 | (REF) | (REF) |
| | Middle Age 40-54 | 5.50 | 4.52-6.70 | <0.0001 |
| | Older Adults 55+ | 17.32 | 13.90-21.58 | <0.0001 |
| **Gender** | | | | |
| | Female | 1.0 | (REF) | (REF) |
| | Male | 0.81 | 0.66-0.99 | 0.04 |
| **Education** | | | | |
| | Did not graduate from high school | 1.0 | (REF) | (REF) |
| | Graduated from High School | 0.94 | 0.70-1.25 | 0.66 |
| | Attended College or Technical School | 0.97 | 0.72-1.30 | 0.84 |
| | Graduated from college or a technical School | 0.89 | 0.65-1.22 | 0.47 |

| (B) High Cholesterol | | | | |
|---|---|---|---|---|
| **Variables** | **Categories** | ***Odds Ratio*** | ***95% Confidence limits*** | ***P-value*** |
| **Residence** | | | | |
| | Urban | 1.0 | (REF) | (REF) |
| | Rural | 1.19 | 0.88-1.62 | 0.26 |
| **Age** | | | | |
| | Young Adults 18-39 | 1.0 | (REF) | (REF) |
| | Middle Age 40-54 | 3.14 | 2.62-3.76 | <0.0001 |
| | Older Adults 55+ | 9.47 | 7.85-11.42 | <0.0001 |
| **Gender** | | | | |
| | Female | 1.0 | (REF) | (REF) |
| | Male | 1.18 | 0.99-1.14 | 0.063 |
| **Education** | | | | |
| | Did not graduate from high school | 1.0 | (REF) | (REF) |
| | Graduated from High School | 0.94 | 0.71-1.24 | 0.66 |
| | Attended College or Technical School | 0.97 | 0.74-1.28 | 0.85 |
| | Graduated from college or a technical School | 0.93 | 0.70-1.24 | 0.62 |

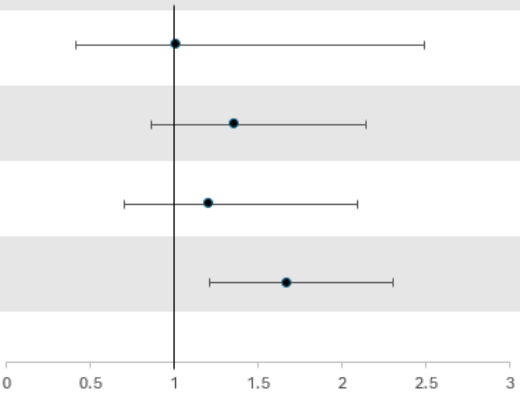
**Table 5. Odds of receiving treatment for high blood pressure vs high cholesterol in rural areas compared to urban, stratified by region**

| | High Blood Pressure | | | | | |
|---|---|---|---|---|---|---|
| | Unadjusted | | | Adjusted* | | |
| **Region** | **Odds Ratio** | **95% Confidence Limits** | **P-values** | **Odds Ratio** | **95% Confidence Limits** | **P-value** |
| **Northeast** | 1.01 | 0.41 - 2.49 | 0.99 | 1.01 | 0.41 – 2.49 | 0.99 |
| **Midwest** | 1.36 | 0.86 - 2.14 | 0.18 | 1.36 | 0.86 – 2.14 | 0.18 |
| **South** | 1.21 | 0.700 - 2.09 | 0.49 | 1.21 | 0.70 – 2.09 | 0.50 |
| **West** | 1.67 | 1.21 - 2.30 | <0.001 | 1.67 | 1.21 – 2.30 | 0.002 |
| | **High Cholesterol** | | | | | |
| | Unadjusted | | | Adjusted* | | |
| **Region** | **Odds Ratio** | **95% Confidence Limits** | **P-values** | **Odds Ratio** | **95% Confidence Limits** | **P-value** |
| **Northeast** | 1.11 | 0.52 - 2.38 | 0.78 | 0.78 | 0.27 – 2.30 | 0.66 |
| **Midwest** | 1.05 | 0.72 - 1.53 | 0.81 | 0.97 | 0.62 – 1.52 | 0.89 |
| **South** | 1.49 | 0.93 - 2.38 | 0.10 | 1.46 | 0.86 – 2.46 | 0.16 |
| **West** | 1.32 | 0.95 – 1.83 | 0.13 | 1.32 | 0.81 – 2.15 | 0.26 |

*adjusted for age, gender, and education

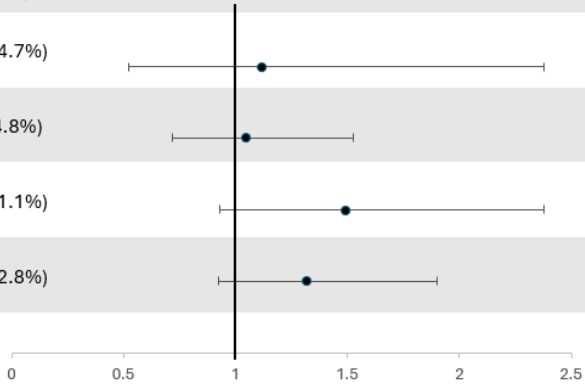
**Figure 1. Forest plot representing rural-urban treatment differences for (a) high blood pressure and (b) high cholesterol.**

| | Rural n (Row %) | | Urban n (Row %) | | Odds Ratio (95% CI) | P-value |
|---|---|---|---|---|---|---|
| Census Region | Tx* (n=1209) | No Tx** (n=421) | Tx* (n=5983) | No Tx** (n=2734) | | |
| Northeast (n=2047) | 53 (64.6%) | 29 (35.4%) | 1398 (71.1%) | 567 (28.9%) | 1.01 (0.41 – 2.49) | 0.99 |
| Midwest (n=1652) | 303 (70.8%) | 125 (29.2%) | 827 (67.6%) | 397 (32.4%) | 1.36 (0.86 - 2.14) | 0.18 |
| South (n=2596) | 247 (75.5%) | 80 (24.5%) | 1589 (70.0%) | 680 (30.0%) | 1.21 (0.7 – 2.09) | 0.50 |
| West (n=4052) | 606 (76.4%) | 187 (23.6%) | 2169 (66.6%) | 1090 (33.4%) | 1.67 (1.21 - 2.3) | 0.002 |




*Tx: Individuals reporting treatment of high blood pressure with medication.
**No Tx: Individuals reporting no treatment of high blood pressure with medication.

| | Rural n (Row %) | | Urban n (Row %) | | Odds Ratio (95% CI) | P-value |
|---|---|---|---|---|---|---|
| Census Region | Tx* (n=719) | No Tx** (n=685) | Tx* (n=4126) | No Tx** (n=4683) | | |
| Northeast (n=2273) | 41 (50.6%) | 40 (49.4%) | 992 (45.3%) | 1200 (54.7%) | 1.11 (0.52 – 2.38) | 0.78 |
| Midwest (n=1630) | 183 (48.0%) | 198 (52.0%) | 564 (45.2%) | 685 (54.8%) | 1.05 (0.72 – 1.53) | 0.81 |
| South (n=2512) | 141 (53.0%) | 125 (47.0%) | 1098 (48.9%) | 1148 (51.1%) | 1.49 (0.93 – 2.38) | 0.096 |
| West (n=3798) | 354 (52.4%) | 322 (47.6%) | 1472 (47.2%) | 1650 (52.8%) | 1.32 (0.92 – 1.9) | 0.13 |




*Tx: Individuals reporting treatment of high cholesterol with medication.
**No Tx: Individuals reporting no treatment of high cholesterol with medication.

***The numbers on the left are actual survey respondents, and are not weighted to reflect the larger general population. In contrast, the odds ratios are from models that utilize survey weights. As a result, odds ratios calculated from the 2x2 table in each region may be slightly differ from the odds ratio shown here.**

## Appendix 2: (CODE)

```
PROC IMPORT DATAFILE=REFFILE
	DBMS=CSV
	OUT=WORK.IMPORT;
	GETNAMES=YES;
RUN;

PROC CONTENTS DATA=WORK.IMPORT; RUN;


%web_open_table(WORK.IMPORT);
FILENAME REFFILE '/home/u64375998/MY DOCUMENTS/brfss_data2.csv';

PROC IMPORT DATAFILE=REFFILE
	DBMS=CSV
	OUT=WORK.IMPORT;
	GETNAMES=YES;
RUN;

PROC CONTENTS DATA=WORK.IMPORT; RUN;


%web_open_table(WORK.IMPORT);
/***Importing the file***/
PROC IMPORT DATAFILE=REFFILE
	DBMS=CSV
	OUT=WORK.IMPORT;
	GETNAMES=YES;
RUN;

PROC CONTENTS DATA=WORK.IMPORT; RUN;
%web_open_table(WORK.IMPORT);

/****creating a new dataset with variables of interest****/
data work.brfss;
  set work.import;
  where _hispanc = 1 and _state not in (66, 72, 78);

  length census_region $12;
```

```
select (_state);
   when (9, 23, 25, 33, 44, 50, 34, 36, 42)
      census_region = "Northeast";
   when (17, 18, 26, 39, 55, 19, 20, 27, 29, 31, 38, 46)
      census_region = "Midwest";
   when (10, 12, 13, 24, 37, 45, 51, 11, 54, 1, 21, 28, 47, 5, 22, 40, 48)
      census_region = "South";
   when (4, 8, 16, 30, 32, 35, 49, 56, 2, 6, 15, 41, 53)
      census_region = "West";
   otherwise census_region = "Unknown";
end;

/***create a new 3 category age variable***/
select (_AGEG5yr);
  when (1,2,3,4) _AGE3YR = 1;
  when (5,6,7)   _AGE3YR = 2;
  when (8,9,10,11,12,13) _AGE3YR = 3;
  otherwise _AGE3YR = .;
end;

educ = _EDUCAG;
if _EDUCAG = 9 then educ = .;

/**** Outcome variables ****/
hbp = (_RFHYPE6 = 2);
if _RFHYPE6 = 9 then hbp = .;

high_chol = (_RFCHOL3 = 2);
if _RFCHOL3 = 9 then high_chol = .;

chol_treat = (CHOLMED3 = 1);
if CHOLMED3 in (7,9) then chol_treat = .;

if BPMEDS1 = '1' then hbp_treat = 1;
else if BPMEDS1 = '2' then hbp_treat = 0;
else hbp_treat = .;

/**** Exposure variable ****/
if _METSTAT = 2 then nonmetro = 1;
```

```
  else if _METSTAT = 1 then nonmetro = 0;
run;

proc sort data=work.brfss;
by _metstat;
run;

/****calculating frequencies****/
proc surveyfreq DATA=work.brfss;
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  tables nonmetro;
  format nonmetro nonmetro.;
  title 'Urban/Rural';
run;

proc surveyfreq DATA=work.brfss;
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  tables sexvar;
  format sexvar sexvar.;
  title 'Gender';
run;

proc surveyfreq DATA=work.brfss;
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  tables _cholch3;
  by nonmetro;
  format _cholch3 _cholch3.;
  title 'Last Cholesterol Check';
run;

proc surveyfreq DATA=work.brfss;
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
```

```
  tables _RFHYPE6;
  by nonmetro;
  title 'High Blood Pressure';
run;

proc surveyfreq data=work.brfss;
 where _RFHYPE6 = 2;
 weight _LLCPWT;
 strata _STSTR;
 cluster _PSU;
 tables nonmetro * BPMEDS1 / chisq row col;
 format nonmetro nonmetro.;
 title 'Chi-Square Test: Blood Pressure Medication Use by Metropolitan Status';
run;

proc surveyfreq DATA=work.brfss;
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  tables _educag;
  format _educag _educag.;
  title 'Education';
run;

proc surveyfreq data=work.brfss;
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  tables census_region * nonmetro / row;
  format nonmetro nonmetro.;
  title 'Census Region Distribution by Urban/Rural (Hispanic Population)';
run;

proc surveyfreq data=work.brfss;
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  tables _AGE3YR;
  format _AGE3YR _AGE3YR.;
  title 'Age Distribution (5-Year Age Groups) – Hispanic Population';
```

```
run;

proc surveyfreq data=work.brfss;
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  tables _HLTHPL1;
  format _HLTHPL1 _HLTHPL1.;
  title 'Health Insurance Coverage';
run;

proc surveyfreq data=work.brfss;
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  tables nonmetro*_RFHYPE6 / chisq row col;
  format _RFHYPE6 _6RFHYPE. nonmetro nonmetro.;
  title 'Chi-Square Test: High Blood Pressure by Metropolitan Status';
run;

proc surveyfreq data=work.brfss;
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  tables nonmetro*_cholch3 / chisq row col;
  format _cholch3 _CHOL3CH. nonmetro nonmetro.;
  title 'Chi-Square Test: Cholesterol Test by Metropolitan Status';
run;

proc surveyfreq data=work.brfss;
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  tables nonmetro*_RFCHOL3 / chisq row col;
  format _RFCHOL3 _RF3CHOL. nonmetro nonmetro.;
  title 'Chi-Square Test: High Cholesterol by Metropolitan Status';
run;

proc surveyfreq data=work.brfss;
  where _RFCHOL3 = 2;
```

```
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  tables nonmetro*CHOLMED3 / chisq row col;
  format CHOLMED3 CHOL3MED. nonmetro nonmetro.;
  title 'Chi-Square Test: High Cholesterol Treatment (CHOLMED3) by Metropolitan Status';
run;

proc surveyfreq data=work.brfss;
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  tables _AGE3YR;
  format _AGE3YR _AGE3YR.;
  title 'Age Distribution (5-Year Age Groups) – Hispanic Population';
run;

proc surveyfreq data=work.brfss;
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  tables _AGE3YR * nonmetro / row col;
  format _AGE3YR _AGE3YR. nonmetro yesno.;
  title 'Age Distribution (5-Year Age Groups) by Urban vs Rural';
run;

proc surveyfreq DATA=work.brfss;
 weight _LLCPWT;
 strata _STSTR;
 cluster _PSU;
 tables sexvar;
 format _hispanc _hispanc. sexvar sexvar.;
 title 'Gender';
run;

proc surveyfreq data=work.brfss;
 weight _LLCPWT;
 strata _STSTR;
 cluster _PSU;
 tables sexvar*nonmetro / row col chisq;
```

```
 format sexvar sexvar. nonmetro nonmetro.;
 title 'Distribution of Rural vs Urban Residence by Sex';
run;

proc surveyfreq DATA=work.brfss;
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  tables _educag;
  format _educag _educag.;
  title 'Education';
run;

proc surveyfreq data=work.brfss;
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  tables _educag*nonmetro / row col chisq;
  format _educag _educag. nonmetro nonmetro.;
  title 'Distribution of Rural vs Urban Residence by Education Level';
run;

proc surveyfreq data=work.brfss;
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  tables _HLTHPL1;
  format _HLTHPL1 _HLTHPL1.;
  title 'Health Insurance Coverage';
run;

proc surveyfreq data=work.brfss;
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  tables _HLTHPL1*nonmetro / row col chisq;
  format _HLTHPL1 _HLTHPL1. nonmetro nonmetro.;
  title 'Distribution of Health Insurance Coverage by Rural vs Urban Residence';
run;
```

```
/*** Model 1: Unadjusted overall HBP ***/
proc surveylogistic data=work.brfss;
  where hbp = 1;
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  class nonmetro (ref='0') / param=ref;
  model hbp_treat(event='1') = nonmetro;
  title 'Model 1: Unadjusted Association Between Rural/Urban Status and High Blood Pressure
Treatment';
run;

/*** Model 1: Unadjusted overall High Cholesterol ***/
proc surveylogistic data=work.brfss;
  where high_chol = 1;
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  class nonmetro (ref='0') / param=ref;
  model chol_treat(event='1') = nonmetro;
  title 'Model 1: Unadjusted Association Between Rural/Urban Status and High Cholesterol';
run;

/*** Model 2: Adjusted overall HBP ***/
proc surveylogistic data=work.brfss;
  where hbp = 1;
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  class nonmetro (ref='0')
        SEXVAR (ref='2')
        _AGE3YR (ref='1')
        _EDUCAG (ref='1')
        / param=ref;
  model hbp_treat(event='1') =
    nonmetro
    SEXVAR
    _AGE3YR
    _EDUCAG;
  title 'Model 2: Adjusted Model for High Blood Pressure';
```

```
run;

/*** Model 2: Adjusted overall High Cholesterol ***/
proc surveylogistic data=work.brfss;
  where high_chol = 1;
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  class nonmetro (ref='0')
        SEXVAR (ref='2')
        _AGE3YR (ref='1')
        _EDUCAG (ref='1')
        / param=ref;
  model chol_treat(event='1') =
     nonmetro
     SEXVAR
     _AGE3YR
     _EDUCAG;
  title 'Model 2: Adjusted Model for High Cholesterol';
run;

/*** Interaction model for unadjusted HBP ***/
proc surveylogistic data=work.brfss;
  where hbp = 1;
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;

  class nonmetro (ref='0')
        census_region (ref='Northeast')
        / param=ref;

  model hbp_treat(event='1') =
     nonmetro
     census_region
     nonmetro*census_region;
title ' Interaction model for unadjusted HBP';
run;
/*** Interaction model for adjusted HBP ***/
proc surveylogistic data=work.brfss;
```

```
  where hbp = 1;
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  class nonmetro (ref='0')
        census_region (ref='Northeast')
        SEXVAR (ref='2')
        _AGE3YR (ref='1')
        _EDUCAG (ref='1')
        / param=ref;
  model hbp_treat(event='1') =
     nonmetro
     census_region
     nonmetro*census_region
     SEXVAR
     _AGE3YR
     _EDUCAG;
  title ' Interaction model for adjusted HBP';
run;
/*** Interaction model for unadjusted HC ***/
proc surveylogistic data=work.brfss;
  where high_chol = 1;
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;

  class nonmetro (ref='0')
        census_region (ref='Northeast')
        / param=ref;

  model chol_treat(event='1') =
     nonmetro
     census_region
     nonmetro*census_region;
title ' Interaction model for unadjusted HC';
run;
/*** Interaction model for adjusted HC ***/
proc surveylogistic data=work.brfss;
  where high_chol = 1;
  weight _LLCPWT;
```

```
  strata _STSTR;
  cluster _PSU;
  class nonmetro (ref='0')
        census_region (ref='Northeast')
        SEXVAR (ref='2')
        _AGE3YR (ref='1')
        _EDUCAG (ref='1')
        / param=ref;
  model chol_treat(event='1') =
     nonmetro
     census_region
     nonmetro*census_region
     SEXVAR
     _AGE3YR
     _EDUCAG;
  title ' Interaction model for adjusted HC';
run;
/***Unadjusted High Blood Pressure IN NORTHEAST***/
proc surveylogistic data=work.brfss;
  where hbp = 1 and census_region = "Northeast";
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  class nonmetro (ref='0') / param=ref;
  model hbp_treat(event='1') = nonmetro;
  title 'Figure 5: Unadjusted HBP Treatment - Northeast';
run;
/***Unadjusted High Blood Pressure IN MIDWEST***/
proc surveylogistic data=work.brfss;
  where hbp = 1 and census_region = "Midwest";
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  class nonmetro (ref='0') / param=ref;
  model hbp_treat(event='1') = nonmetro;
  title 'Figure 5: Unadjusted HBP Treatment - Midwest';
run;
/***Unadjusted High Blood Pressure IN SOUTH***/
proc surveylogistic data=work.brfss;
  where hbp = 1 and census_region = "South";
```

```
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  class nonmetro (ref='0') / param=ref;
  model hbp_treat(event='1') = nonmetro;
  title 'Figure 5: Unadjusted HBP Treatment - South';
run;

/***Unadjusted High Blood Pressure IN WEST***/
proc surveylogistic data=work.brfss;
  where hbp = 1 and census_region = "West";
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  class nonmetro (ref='0') / param=ref;
  model hbp_treat(event='1') = nonmetro;
  title 'Figure 5: Unadjusted HBP Treatment - West';
run;

/***Unadjusted High Cholesterol IN NORTHEAST***/
proc surveylogistic data=work.brfss;
  where high_chol = 1 and census_region = "Northeast";
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  class nonmetro (ref='0') / param=ref;
  model chol_treat(event='1') = nonmetro;
  title 'Figure 5: Unadjusted Cholesterol Treatment - Northeast';
run;
/***Unadjusted High Cholesterol IN MIDWEST***/
proc surveylogistic data=work.brfss;
  where high_chol = 1 and census_region = "Midwest";
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  class nonmetro (ref='0') / param=ref;
  model chol_treat(event='1') = nonmetro;
  title 'Figure 5: Unadjusted Cholesterol Treatment - Midwest';
run;
/***Unadjusted High Cholesterol IN SOUTH***/
```

```
proc surveylogistic data=work.brfss;
  where high_chol = 1 and census_region = "South";
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  class nonmetro (ref='0') / param=ref;
  model chol_treat(event='1') = nonmetro;
  title 'Figure 5: Unadjusted Cholesterol Treatment - South';
run;
/***Unadjusted High Cholesterol IN WEST***/
proc surveylogistic data=work.brfss;
  where high_chol = 1 and census_region = "West";
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  class nonmetro (ref='0') / param=ref;
  model chol_treat(event='1') = nonmetro;
  title 'Figure 5: Unadjusted Cholesterol Treatment - West';
run;

/***Adjusted High Blood Pressure IN NORTHEAST***/
proc surveylogistic data=work.brfss;
  where hbp = 1 and census_region = "Northeast";
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  class nonmetro (ref='0')
        SEXVAR (ref='2')
        _AGE3YR (ref='1')
        _EDUCAG (ref='1')
        / param=ref;
  model hbp_treat(event='1') =
     nonmetro
     SEXVAR
     _AGE3YR
     _EDUCAG;
  title 'Figure 5: Adjusted HBP Treatment - Northeast';
run;
/***Adjusted High Blood Pressure IN MIDWEST***/
proc surveylogistic data=work.brfss;
```

```
  where hbp = 1 and census_region = "Midwest";
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  class nonmetro (ref='0')
        SEXVAR (ref='2')
        _AGE3YR (ref='1')
        _EDUCAG (ref='1')
        / param=ref;
  model hbp_treat(event='1') =
     nonmetro
     SEXVAR
     _AGE3YR
     _EDUCAG;
  title 'Figure 5: Adjusted HBP Treatment - Midwest';
run;
/***Adjusted High Blood Pressure IN SOUTH***/
proc surveylogistic data=work.brfss;
  where hbp = 1 and census_region = "South";
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  class nonmetro (ref='0')
        SEXVAR (ref='2')
        _AGE3YR (ref='1')
        _EDUCAG (ref='1')
        / param=ref;
  model hbp_treat(event='1') =
     nonmetro
     SEXVAR
     _AGE3YR
     _EDUCAG;
  title 'Figure 5: Adjusted HBP Treatment - South';
run;
/***Adjusted High Blood Pressure IN WEST***/
proc surveylogistic data=work.brfss;
  where hbp = 1 and census_region = "West";
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
```

```
  class nonmetro (ref='0')
       SEXVAR (ref='2')
       _AGE3YR (ref='1')
       _EDUCAG (ref='1')
       / param=ref;
  model hbp_treat(event='1') =
    nonmetro
    SEXVAR
    _AGE3YR
    _EDUCAG;
  title 'Figure 5: Adjusted HBP Treatment - West';
run;

/***Adjusted Cholesterol IN NORTHEAST***/
proc surveylogistic data=work.brfss;
  where high_chol = 1 and census_region = "Northeast";
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  class nonmetro (ref='0')
       SEXVAR (ref='2')
       _AGE3YR (ref='1')
       _EDUCAG (ref='1')
       / param=ref;
  model chol_treat(event='1') =
    nonmetro
    SEXVAR
    _AGE3YR
    _EDUCAG;
  title 'Figure 5: Adjusted Cholesterol Treatment - Northeast';
run;
/***Adjusted Cholesterol IN MIDWEST***/
proc surveylogistic data=work.brfss;
  where high_chol = 1 and census_region = "Midwest";
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  class nonmetro (ref='0')
       SEXVAR (ref='2')
       _AGE3YR (ref='1')
```

```
      _EDUCAG (ref='1')
      / param=ref;
  model chol_treat(event='1') =
    nonmetro
    SEXVAR
    _AGE3YR
    _EDUCAG;
  title 'Figure 5: Adjusted Cholesterol Treatment - Midwest';
run;
/***Adjusted Cholesterol IN SOUTH***/
proc surveylogistic data=work.brfss;
  where high_chol = 1 and census_region = "South";
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  class nonmetro (ref='0')
      SEXVAR (ref='2')
      _AGE3YR (ref='1')
      _EDUCAG (ref='1')
      / param=ref;
  model chol_treat(event='1') =
    nonmetro
    SEXVAR
    _AGE3YR
    _EDUCAG;
  title 'Figure 5: Adjusted Cholesterol Treatment - South';
run;
/***Adjusted Cholesterol IN WEST***/
proc surveylogistic data=work.brfss;
  where high_chol = 1 and census_region = "West";
  weight _LLCPWT;
  strata _STSTR;
  cluster _PSU;
  class nonmetro (ref='0')
      SEXVAR (ref='2')
      _AGE3YR (ref='1')
      _EDUCAG (ref='1')
      / param=ref;
  model chol_treat(event='1') =
    nonmetro
```

```
    SEXVAR
    _AGE3YR
    _EDUCAG;
  title 'Figure 5: Adjusted Cholesterol Treatment - West';
run;
```

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