Received: 24 November 2020 | Revised: 18 January 2021 | Accepted: 26 January 2021

DOI: 10.1111/jch.14213

SHORT REPORT

WILEY

A comparison of post-stroke hypertension medication use between US Stroke Belt and Non-Stroke Belt residents

Phoebe Tran MSc, MPhil[1] | **Lam Tran MS**[2] | **Liem Tran PhD**[3]

[1]Department of Chronic Disease Epidemiology, Yale University, New Haven, CT, USA

[2]Department of Biostatistics, Michigan School of Public Health, Ann Arbor, MI, USA

[3]Department of Geography, University of Tennessee, Knoxville, TN, USA

Correspondence
Liem Tran, PhD, Department of Geography, University of Tennessee, 1000 Phillip Fulmer Way, Knoxville, TN 37916, USA.
Email: ltran1@utk.edu

Abstract

Although hypertension is a contributing factor to higher stroke occurrence in the Stroke Belt, little is known about post-stroke hypertension medication use in Stroke Belt residents. Through the use of national Behavioral Risk Factor Surveillance System surveys from 2015, 2017, and 2019; we compared unadjusted and adjusted estimates of post-stroke hypertension medication use by Stroke Belt residence status. Similar levels of post-stroke hypertension medication use were observed between Stroke Belt residents (OR: 1.09, 95% CI: 0.89, 1.33) and non-Stroke Belt residents. After adjustment, Stroke Belt residents had 1.14 times the odds of post-stroke hypertension medication use (95% CI: 0.92, 1.41) compared to non-Stroke Belt residents. Findings from this study suggest that there is little difference between post-stroke hypertension medication use between Stroke Belt and non-Stroke Belt residents. However, further work is needed to assess whether use of other non-medicinal methods of post-stroke hypertension control differs by Stroke Belt residence status.

1 | INTRODUCTION

Stroke affects nearly 795 000 people in the United States each year with the number of cases being distributed unevenly throughout the country.[1] The Stroke Belt is a region of the United States comprised of Alabama, Arkansas, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee where stroke incidence is disproportionately higher than in other US areas with stroke incidence being 25.7 cases/1000 people in Stroke Belt states and 20.2 cases/1000 people in non-Stroke Belt states.[2] Elevated stroke rates in the Stroke Belt may be partly attributed to the high prevalence of hypertension (Stroke Belt: 48.9%, non-Stroke Belt: 39.2%) seen in this region.[3-5] For Stroke Belt residents who have suffered a stroke, uncontrolled hypertension post-stroke places them at additional risk for recurrent stroke and subsequent hospitalization.[6]

Existing research on hypertension treatment in the Stroke Belt focuses on medication use before a primary stroke has occurred.[7] As a result, less is known about levels of post-stroke hypertension medication use among Stroke Belt residents. In this study, we sought to compare hypertension medication use following a stroke between Stroke Belt and non-Stroke Belt residents as well as determine whether differences in post-stroke hypertension medication use by Stroke Belt residence status remained after adjustment.

2 | MATERIALS AND METHODS

2.1 | Study population

The study population was comprised of individuals with hypertension who have had a stroke that participated in the 2015, 2017, and 2019 Behavioral Risk Factor Surveillance System (BRFSS) surveys. These three survey years were chosen as they are the most recent BRFSS surveys with information on hypertension and hypertension medication use.[8-10] Briefly, the

TABLE 1 Estimates of post-stroke hypertension medication use by Stroke Belt residence status (n = 31 372)

	Current hypertension medication use					
	Unadjusted[a]			Adjusted[b]		
	Odds Ratio	(95% Confidence Interval)	p	Odds Ratio	(95% Confidence Interval)	p
Stroke Belt residence (Reference: Non-Stroke Belt states [n = 26 080])						
Non-Stroke Belt states (n = 5292)	1.09	(0.89, 1.33)	.412	1.14	(0.92, 1.41)	.230

[a]Logistic models had BRFSS survey weighting applied to them.

[b]Model included Stroke Belt residence status, age, sex, race, household income, education, health care coverage, physical activity, drinking, and smoking as covariates.

BRFSS is a nationwide survey that is conducted annually by the Centers for Disease Control and Prevention.[8-10] Potential survey participants are randomly selected from commercially available phone listings and contacted via landline or mobile phone.[8-10] For individuals who choose to participate in the survey, information on their sociodemographic background, health conditions, and health behaviors are collected by BRFSS survey administrators.[8-10] Survey weighting and oversampling of certain racial/ethnic groups and rural residents in some US areas are used in tandem to ensure that estimates generated from BRFSS analyses are applicable to the general US population.[8-10] All BRFSS surveys are made freely available for public use by the CDC after survey responses have been anonymized.[8-10] As a result, prior informed consent and IRB approval is not needed when BRFSS surveys are used for research purposes.[8-10]

2.2 | Study variables

Following the example of other studies that have examined post-stroke hypertension medication use with national CDC surveys, we determined the stroke status, hypertension status, and hypertension medication use of study participants through the BRFSS questions "(Ever told) you had a stroke?", "Have you ever been told by a doctor, nurse or other health professional that you have high blood pressure?" and "Are you currently taking medicine for your high blood pressure?" respectively.[11,12] People were excluded from the study if their response to the BRFSS stroke question was either "No", "Don't know/Not Sure", "Refused", or "Not asked or Missing"; their response to the BRFSS hypertension question was either "Yes, but female told only during pregnancy", "No", "Told borderline high or pre-hypertensive", "Don't know/Not Sure", "Refused", or "Not asked or Missing"; and their response to the hypertension medication use question was either "Don't know/Not Sure", "Refused", or "Not asked or Missing".[8-10] Collectively, "Don't know/Not Sure", "Refused", or "Not asked or Missing" responses made up <1% of the responses to these three questions.

Individuals in the study were also categorized as living in a Stroke Belt State (Alabama, Arkansas, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee) or a non-Stroke Belt state through corresponding state Federal Information Processing Standard (FIPS) codes contained in the BRFSS.[8-10] From the literature, we identified characteristics (age, sex, race, household income, education, health care coverage, physical activity, drinking, and smoking) that are associated with stroke and hypertension.[3-5] Covariate information for study participants was ascertained from BRFSS surveys.[8-10]

2.3 | Statistical analyses

To account for survey weighting across the 2015, 2017, and 2019 BRFSS surveys, we combined these datasets using the standard method outlined in CDC guides for BRFSS analyses.[13] To obtain unadjusted and adjusted estimates of post-stroke hypertension medication use, we created logistic models that accounted for survey weighting. The model used to determine the unadjusted odds ratio (OR) included Stroke Belt residence status as the only covariate while the model used to calculate the adjusted OR included Stroke Belt residence status, age, sex, race, household income, education, health care coverage, physical activity, drinking, and smoking as covariates. In addition, we examined interactions between Stroke Belt residence status and select covariates (age, sex, race) that had somewhat large responses and whose categories were not too sparse. However, as none of these interactions were significant, separate stratified analyses by age, sex, or race are not presented. Statistical analyses were carried out in R version 4.0.

3 | RESULTS

Our study included 31 372 individuals with hypertension who had suffered a stroke, of which 16.9% resided in the Stroke Belt (Table 1). Individuals living in the Stroke Belt had similar levels of post-stroke hypertension medication use (OR: 1.09, 95% CI: 0.89, 1.33, p = .412) as those living in non-Stroke Belt states. Following adjustment, Stroke Belt residents with hypertension had 1.14 times the odds of post-stroke hypertension medication use (95% CI: 0.92, 1.41, p = .230) compared to non-Stroke Belt residents.

4 | DISCUSSION

In this nationwide study, we examined the influence of Stroke Belt residence on post-stroke hypertension medication use. Unadjusted

levels of hypertension medication use were comparable between stroke survivors in Stroke Belt states and those in non-Stroke Belt states. However, adjusted estimates of post-stroke hypertension medication use were observed to be slightly higher in Stroke Belt residents compared to non-Stroke Belt residents.

Our work expands on previous research on hypertension medication use in the Stroke Belt as existing literature focuses on medication use prior to stroke occurrence.[7] Similar to what we found for post-stroke medication use, Howard et al noted that in the prospective REasons for Geographic and Racial Differences in Stroke (REGARDS) cohort, there was little difference in pre-stroke hypertension medication use between Stroke Belt residents (89.1%) and non-Stroke Belt residents (88.7%) in unadjusted analyses while Stroke Belt residents had slightly higher pre-stroke hypertension medication use (OR: 1.11, 95% CI: 0.95-1.29) compared to non-Stroke Belt residents after adjustment.[7] When looking at the results from Howard et al and our study, they seem to demonstrate that hypertension medication use among Stroke Belt residents stays at a consistently high level prior to and after a stroke as well as Stroke Belt residence having minimal impact on pre- and post-stroke hypertension medication use.[7] Potential differences in post-stroke hypertension medication use between Stroke Belt and non-Stroke Belt residents that remain after adjustment may be due to differences in physician prescribing patterns as well as frequency of clinical visits (associated with antihypertensive use and blood pressure control) throughout the United States.[11,12] Although post-stroke hypertension medication use was observed to be similar between Stroke Belt and non-Stroke Belt residents, further research is needed to determine if use of other methods to control hypertension such as a low sodium diet and meditation differs between stroke survivors in the Stroke Belt and those in other parts of the United States.[3-5]

For the sake of completeness, we now discuss some of the limitations of our study. As all responses to the BRFSS are self-reported, there is the possibility of some misclassification in the data.[8-10] However, the BRFSS has been extensively validated by both the CDC and independent investigators, showing similar prevalences between survey responses and electronic health records for diabetes, smoking, hypertension, and obesity.[14-16] Furthermore, correlation was high between survey responses and in-clinic measurements for BMI.[14-16] Although residual confounding cannot be entirely removed, adjusting for multiple stroke and hypertension related sociodemographic factors strikes a balance between controlling for possible bias while maintaining high power in our study.

In conclusion, we found similar levels of hypertension medication use post-stroke between individuals living in Stroke Belt and non-Stroke Belt states. Levels of hypertension medication use were generally high, an encouraging sign. Yet, given the prevalence of hypertension in the United States and its aggrandizing role in recurrent strokes, our study still suggests that further work is needed to determine if levels of non-medicinal methods of hypertension control can be improved on in stroke survivors living in the Stroke Belt.

ACKNOWLEDGMENTS

None.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

AUTHOR CONTRIBUTIONS

All authors have contributed significantly and all authors are in agreement with the content of the brief report. Phoebe Tran originated the idea and the study design. Lam Tran ran the data analyses and interpreted results. Liem Tran assisted with study design. All authors contributed in writing the brief report.

RESEARCH INVOLVING HUMAN PARTICIPANTS AND/OR ANIMALS

This article does not contain any studies with human participants or animals performed by any of the authors. The BRFSS data used in this study are a secondary publicly available data source that has been completely anonymized and released for public use by the United States Centers for Disease Control and Prevention (CDC).

INFORMED CONSENT

This article is exempt from needing informed consent as no human participants were involved in the study and the data used has been completely anonymized and approved for public use by the United States Centers for Disease Control and Prevention (CDC).

ORCID

Phoebe Tran https://orcid.org/0000-0003-1735-6903
Lam Tran https://orcid.org/0000-0002-1242-3209
Liem Tran https://orcid.org/0000-0002-4444-4063

REFERENCES

1. Centers for Disease Control and Prevention. Stroke Facts. https://www.cdc.gov/stroke/facts.htm. Published 2020. Accessed.
2. Centers for Disease Control and Prevention. Interactive Atlas of Heart Disease and Stroke. https://nccd.cdc.gov/DHDSPAtlas/Reports.aspx. Published 2016. Accessed.
3. Wetmore JB, Ellerbeck EF, Mahnken JD, et al. Stroke and the "Stroke Belt" in dialysis: contribution of patient characteristics to ischemic stroke rate and its geographic variation. *J Am Soc Nephrol*. 2013;24(12):2053.
4. Howard VJ, Woolson RF, Egan BM, et al. Prevalence of hypertension by duration and age at exposure to the stroke belt. *J Am Soc Hypertens*. 2010;4(1):32-41.
5. Liao Y, Greenlund KJ, Croft JB, Keenan NL, Giles WH. Factors explaining excess stroke prevalence in the US Stroke Belt. *Stroke*. 2009;40(10):3336-3341.
6. Towfighi A, Markovic D, Ovbiagele B. Consistency of blood pressure control after ischemic stroke: prevalence and prognosis. *Stroke*. 2014;45(5):1313-1317.
7. Howard G, Prineas R, Moy C, et al. Racial and geographic differences in awareness, treatment, and control of hypertension: the REasons for Geographic And Racial Differences in Stroke study. *Stroke*. 2006;37(5):1171-1178.
8. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System 2015 Codebook Report Land-Line and

Cell-Phone data. https://www.cdc.gov/brfss/annual_data/2015/pdf/codebook15_llcp.pdf. Published 2016. Accessed.
9. Centers for Disease Control and Prevention. LLCP 2017 Codebook Report Overall version data weighted with _LLCPWT Behavioral Risk Factor Surveillance System. https://www.cdc.gov/brfss/annual_data/2017/pdf/codebook17_llcp-v2-508.pdf. Published 2018. Accessed.
10. Centers for Disease Control and Prevention. LLCP 2019 Codebook Report Overall version data weighted with _LLCPWT Behavioral Risk Factor Surveillance System. https://www.cdc.gov/brfss/annual_data/2019/pdf/codebook19_llcp-v2-508.HTML. Published 2020. Accessed.
11. Sonawane K, Zhu Y, Balkrishnan R, et al. Antihypertensive drug use and blood pressure control among stroke survivors in the United States: NHANES 2003–2014. *The J Clin Hypertens*. 2019;21(6):766-773.
12. Shah Nilay S, Huffman Mark D, Ning H, Donald LJM. Trends in vascular risk factor treatment and control in US Stroke survivors. *Circ Cardiovasc Qual Outcomes*. 2013;6(3):270-277.
13. Centers for Disease Control and Prevention. The Behavioral Risk Factor Surveillance System Complex Sampling Weights and Preparing 2017 BRFSS Module Data for Analysis. https://www.cdc.gov/brfss/annual_data/2017/pdf/Complex-Smple-Weights-Prep-Module-Data-Analysis-2017-508.pdf. Published 2018. Accessed.
14. Klompas M, Cocoros NM, Menchaca JT, et al. State and local chronic disease surveillance using electronic health record systems. *Am J Public Health*. 2017;107(9):1406-1412.
15. Pierannunzi C, Hu SS, Balluz L. A systematic review of publications assessing reliability and validity of the Behavioral Risk Factor Surveillance System (BRFSS), 2004–2011. *BMC Med Res Methodol*. 2013;13(1):1-14.
16. Scribani M, Shelton J, Chapel D, Krupa N, Wyckoff L, Jenkins P. Comparison of bias resulting from two methods of self-reporting height and weight: a validation study. *RSM Open*. 2014;5(6):1-7.

How to cite this article: Tran P, Tran L, Tran L. A comparison of post-stroke hypertension medication use between US Stroke Belt and Non-Stroke Belt residents. *J Clin Hypertens*. 2021;23:1260–1263. https://doi.org/10.1111/jch.14213