ORIGINAL RESEARCH

Stroke-Related Mortality in the United States–Mexico Border Area of the United States, 1999 to 2018

Safi U. Khan MD, MS; Ankur Kalra MD, MD*; Siva H. Yedlapati, MD, MPH; Sourbha S. Dani MD, MSc; Michael D. Shapiro DO, MCR; Khurram Nasir MD, MPH; Salim S. Virani MD, PhD; Erin D. Michos MD, MHS; Mohamad Alkhouli MD

BACKGROUND: The United States (US)-Mexico border is a socioeconomically underserved area. We sought to investigate whether stroke-related mortality varies between the US border and nonborder counties.

METHODS AND RESULTS: We used death certificates from the Centers for Disease Control and Prevention Wide-Ranging Online Data for Epidemiologic Research database to examine stroke-related mortality in border versus nonborder counties in California, Texas, New Mexico, and Arizona. We measured average annual percent changes (AAPCs) in age-adjusted mortality rates (AAMRs) per 100 000 between 1999 and 2018. Overall, AAMRs were higher for nonborder counties, older adults, men, and non-Hispanic Black adults than their counterparts. Between 1999 and 2018, AAMRs reduced from 55.8 per 100 000 to 34.4 per 100 000 in the border counties (AAPC, −2.70) and 64.5 per 100 000 to 37.6 per 100 000 in nonborder counties (AAPC, −2.92). The annual percent change in AAMR initially decreased, followed by stagnation in both border and nonborder counties since 2012. The AAPC in AAMR decreased in all 4 states; however, AAMR increased in California’s border counties since 2012 (annual percent change, 3.9). The annual percent change in AAMR decreased for older adults between 1999 and 2012 for the border (−5.10) and nonborder counties (−5.01), followed by a rise in border counties and stalling in nonborder counties. Although the AAPC in AAMR decreased for both sexes, the AAPC in AAMR differed significantly for non-Hispanic White adults in border (−2.69) and nonborder counties (−2.86). The mortality decreased consistently for all other ethnicities/races in both border and nonborder counties.

CONCLUSIONS: Stroke-related mortality varied between the border and nonborder counties. Given the substantial public health implications, targeted interventions aimed at vulnerable populations are required to improve stroke-related outcomes in the US-Mexico border area.

Key Words: epidemiology ■ mortality ■ stroke ■ US-Mexico border

The United States (US)-Mexico border region stretches ≈2000 miles and covers 62 miles north and south of the international border.1,2 A total of 44 counties in 4 US states (Arizona, California, New Mexico, and Texas) encompass 53% of ≈15 million people residing in the border region.1 This is a culturally diverse area where different civilizations from the US and Mexico connect across geographical borders.3 The US border region has witnessed a significant population growth over the years, with southwest border counties exhibiting a ≈30% population increase in the 1990s.4 Moreover, this region faces medical and socioeconomic challenges, demonstrating a wider socioeconomic gap between border counties and the rest of the US.1,2

Stroke remains the fifth leading cause of mortality in the US and the third leading cause of death in the
Khan et al. Stroke Mortality in US–Mexico Border of the US

CLINICAL PERSPECTIVE

What Is New?
- Between 1999 and 2018, residents of both border and nonborder counties in California, Texas, New Mexico, and Arizona experienced a decline in stroke-related mortality, although the decline has slowed in the past decade.
- Stroke-related mortality varied among older adults and non-Hispanic White adults in the border versus nonborder counties.

What Are the Clinical Implications?
- Overall and demographic disparities related to stroke-related mortality in border versus nonborder counties are concerning.
- Targeted interventions aimed at narrowing clinical and socioeconomic inequalities may diminish gaps in stroke-related mortality in the US–Mexico border area.

Nonstandard Abbreviations and Acronyms

| Abbreviation | Definition |
|--------------|------------|
| AAMR         | age-adjusted mortality rate |
| AAPC         | average annual percent change |

border area.\(^5\)\(^7\) Besides cardiovascular disease burden, social disparities influence stroke-related morbidity and mortality.\(^8\)\(^9\) Stroke has shown to correlate with social determinants of health, including but not limited to low education, socioeconomic depression, healthcare access, unemployment, and social isolation.\(^8\)\(^9\) Because social and health inequities in the region may influence the incidence and prevalence of stroke, it is imperative to investigate stroke-related mortality trends in border counties compared with nonborder counties. A detailed assessment of the epidemiological profile of stroke-related mortality may inform policymakers and healthcare professionals to improve care for the socially disadvantaged population residing in this dynamic area. Consequently, we compared demographic and geographical trends in stroke-related mortality in the border versus nonborder counties in 4 border states (Arizona, California, New Mexico, Texas) using a national database of death certificates.

METHODS

Data Availability Statement
The Centers for Disease Control and Prevention Wide-Ranging Online Data for Epidemiologic Research data sets used in this project are publicly available and are easily replicable from the methods described in the article.\(^10\)

Data Source
We used the Centers for Disease Control and Prevention Wide-Ranging Online Data for Epidemiologic Research—Multiple Cause of Death database for this analysis.\(^10\) The Multiple Cause of Death database is composed of death certificates for US residents. Each death certificate contains data on a single underlying cause of death, up to 20 additional causes, and demographic characteristics of the decedents. We identified natural deaths attributed to stroke—defined by the World Health Organization as the disease or injury that initiated the events leading directly to death as entered by the physician on the death certificate\(^11\)—using International Classification of Diseases, Tenth Revision (ICD-10) codes I60 to I69. We focused on stroke-related mortality in counties located in California, Texas, New Mexico, and Arizona further stratified into border counties (counties within 100 km [62 miles] of the US–Mexico border defined by the 1983 La Paz Agreement\(^12\)) and nonborder counties. This study did not require institutional review board approval because we analyzed government-issued public use data without individual identifiable information.

Data Extraction
We abstracted the data on stroke-related mortality in both border and nonborder counties in California, Texas, New Mexico, and Arizona (Table S1). We abstracted the number of stroke-related deaths and population sizes from 1999 to 2018. We abstracted the data on age, sex, ethnicity/race (non-Hispanic White, non-Hispanic Black, non-Hispanic American Indian/Alaskan Native, non-Hispanic Asian/Pacific Islander, and Hispanic), and location of death. We grouped non-Hispanic American Indian/Alaskan Native and non-Hispanic Asian/Pacific Islander adults in “other” because of the low death counts in these groups. We grouped age into young (<45 years), middle aged (45–64 years), and older (≥65 years) adults. Location of death was categorized as home, hospital (inpatient, outpatient, or emergency room), hospice, nursing home/long-term care, and others.

Statistical Analysis
We calculated crude death rates for individual years between 1999 and 2018 by dividing the number of stroke-related deaths by the total corresponding population. We applied direct standardization for age-adjustment of mortality rates using the 2000
US standard population. We examined mortality trends to identify changes in a slope using Joinpoint Regression Program version 4.7.0.0, which models consecutive linear segments on a log scale connected by joinpoints where the segments meet. Annual percent change (APC) with 95% CIs in age-adjusted mortality rates (AAMRs) were estimated for the line segments linking joinpoints. The weighted average of the annual percent change was estimated to calculate the average annual percent change (AAPC) for the entire study period—with the weights equal to the length of the annual percent change interval.

We applied the following settings to the Joinpoint Regression Program for the analyses: (1) grid search method, 2, 2, 0; (2) number of joinpoints, 0 to 3; (3) model selection method, permutation test; and (4) annual percent change/AAPC/tau 95% CI estimation, parametric method. For interpretation, slopes were considered increasing or decreasing if the estimated slope differed significantly from zero. We applied a specific procedure-comparability test to determine whether 2 regression mean functions are parallel because of different intercepts (test of parallelism). For all analyses, statistical significance was set at 5%.

RESULTS

Between 1999 and 2018, 56,019 stroke-related deaths occurred in the border counties (147,408,326 patient-years), corresponding to an overall AAMR of 39.3 (95% CI, 39.0–39.6) per 100,000 patient-years. In comparison, 516,329 stroke-related deaths occurred (1,243,119,793 patient-years) in nonborder counties, corresponding to an overall AAMR of 37.2 (95% CI, 36.9–37.6) per 100,000 patient-years. Overall, stroke-related mortality was higher in nonborder than border counties in older adults, men, and non-Hispanic Black adults versus their counterparts (Table 1).

Between 1999 and 2018, AAMR reduced from 55.8 (95% CI, 53.8–57.8) per 100,000 to 34.4 (95% CI, 33.0–35.4) per 100,000 in the border counties (AAPC, −2.70; 95% CI, −3.24 to −2.14), and 64.5 (95% CI, 63.7–65.2) per 100,000 to 37.6 (95% CI, 37.2–38.1) per 100,000 in nonborder counties (−2.92; 95% CI, −3.36 to −2.48; Table 2). The annual percent change in AAMR initially decreased, followed by stagnation in both border and nonborder counties (Figure 1).

Stroke-related mortality varied across states in relation to border versus nonborder counties. California’s border counties had the highest mortality rates, whereas those located in Texas had the lowest mortality rates (Table S2). In contrast, Texas’ nonborder counties had the highest mortality rates, and those located in Arizona had the lowest mortality rates (Table S3).

Between 1999 and 2018, AAPC in AAMR decreased in all 4 states encompassing border and nonborder areas (Tables S2 and S3). In the border area, after the initial decline, the annual percent changes in AAMRs stalled in Arizona since 2014, New Mexico since 2015, and Texas since 2004, but increased in California’s counties since 2012 (3.94; 95% CI, 1.25, 6.71; Figure 2). In the nonborder areas, after the initial decrease, the annual percent change in AAMR stalled in nonborder counties in Arizona, California, and New Mexico since 2012 and Texas since 2011.

Age-Stratified Analyses

The age-specific mortality rates increased exponentially with age for both border and nonborder counties (Figure S1). The AAPCs in AAMRs for all age categories are reported in Table 2, showing a significant difference in the middle-aged group among border and nonborder counties. In border counties, the annual percent change in AAMR remained stable for young adults during the study period but decreased in middle-aged adults since 2002 (−1.24; 95% CI, −1.88 to −0.60). For nonborder counties, after the initial decrease, the annual percent change in AAMR stalled in young adults (−0.73; 95% CI, −2.57 to 1.14) and middle-aged adults (2.28; 95% CI, −0.45 to 5.09) since 2011 and 2014, respectively.

The annual percent change in AAMR decreased for older adults between 1999 and 2012 for border (−5.10; 95% CI, −5.62 to −4.57) and nonborder counties (−5.01; 95% CI, −5.44 to −4.57), followed by the increase in the border (1.99; 95% CI, 0.19–3.83) and stagnation in nonborder counties (1.02; 95% CI, −0.47 to 2.53).

Sex-Stratified Analyses

Between 1999 and 2018, the AAPC in AAMR decreased for both sexes across the border and nonborder counties (Table 2). After an initial decline, the annual percent change in AAMR increased in men (1.91; 95% CI, 0.02–3.85) and stalled in women (1.22; 95% CI, −0.53 to 3.00) since 2012 in border counties, whereas the annual percent change in AAMR showed arrest for both sexes in nonborder counties between 2012 and 2018 (Figure 3).

Ethnicity/Race-Stratified Analyses

The AAPC in AAMR decreased for all ethnicities/races; however, it differed significantly for non-Hispanic White adults in border (−2.69; 95% CI, −3.36 to −2.02) and nonborder counties (−2.86; −3.31 to
Table 1. Stroke-Related Mortality in Counties Located in the US–Mexico Border Area Versus Nonborder Area, 1999 to 2018

|                  | Border Counties | Nonborder Counties |
|------------------|-----------------|--------------------|
|                  | Events | Patient-Years | Crude Mortality Rate (95% CI) | AAMR (95% CI) | Events | Patient-Years | Crude Mortality Rate (95% CI) | AAMR (95% CI) |
| Overall          | 56,019  | 147,408,326   | 38.0 (37.7–38.3) | 39.3 (39.0–39.6) | 516,329 | 1,243,119,793 | 41.5 (41.4–41.6) | 45.2 (45.0–45.3) |
| Age, y           |         |               |                     |               |         |               |                     |               |
| <45              | 1,447   | 96,687,275    | 1.5 (1.4–1.6)      | 1.7 (1.6–1.8) | 12,453  | 804,641,323   | 1.5 (1.4–1.6)      | 1.7 (1.6–1.8)   |
| 45–64            | 6,757   | 32,549,26     | 20.8 (20.3–21.3)   | 20.0 (19.5–20.5) | 64,322  | 294,174,671   | 21.9 (21.7–22.0)   | 21.1 (20.9–21.2)  |
| ≥65              | 47,815  | 18,171,784    | 263.1 (260.8–265.5) | 267.2 (264.8–269.6) | 439,554 | 144,303,799  | 304.6 (303.7–305.5) | 311.8 (310.9–312.7) |
| Sex              |         |               |                     |               |         |               |                     |               |
| Female           | 32,010  | 74,239,985    | 43.1 (42.6–43.6)   | 38.5 (38.1–38.9) | 304,129 | 625,194,548   | 48.6 (48.5–48.8)   | 44.6 (44.5–44.8)  |
| Male             | 24,009  | 73,168,341    | 32.8 (32.4–33.2)   | 39.6 (39.1–40.1) | 212,200 | 617,925,245   | 34.3 (34.2–34.5)   | 44.9 (44.7–45.1)  |
| Ethnicity/race   |         |               |                     |               |         |               |                     |               |
| Non-Hispanic White | 33,016 | 54,104,402    | 61.0 (60.4–61.7)  | 38.6 (38.2–39.0) | 352,560 | 582,042,221  | 60.6 (60.4–60.8)  | 44.7 (44.5–44.8)  |
| Non-Hispanic Black | 1,722  | 5,117,360     | 33.7 (32.1–35.2)  | 57.4 (54.6–60.3) | 50,220  | 106,388,091  | 47.2 (46.8–47.6)  | 66.8 (66.2–67.5)  |
| Hispanic         | 1,857   | 78,661,800    | 23.6 (23.3–23.9)  | 37.8 (37.3–38.4) | 73,775  | 423,864,173  | 17.4 (17.3–17.5)  | 39.8 (39.1–39.6)  |
| Other            | 2,724   | 9,524,764     | 28.6 (27.5–29.7)  | 37.7 (36.3–39.2) | 39,774  | 130,825,308  | 30.4 (30.1–30.7)  | 37.4 (37.1–37.5)  |

We grouped non-Hispanic American Indian/Alaskan Native and non-Hispanic Asian/Pacific Islander adults in “Other” because of the low death counts in these groups. AAMR indicates age-adjusted mortality rate.
In border counties, the annual percent change in AAMR initially decreased for all ethnicities/races, followed by stagnation in non-Hispanic Black and Hispanic adults (Figure 4). However, after an initial decrease, the annual percent change in AAMR increased in non-Hispanic White adults in both border (2.98; 95% CI, 0.97–5.03) and nonborder counties (1.38; 95% CI, 0.04–2.74) since 2012.

**Location of Death**

Between 2003 and 2018, the AAPC in the proportion of deaths from stroke in the border counties increased at home (3.15; 95% CI, 1.74–4.58), but decreased at hospice facilities (−4.21; 95% CI, −6.72 to 1.64), inpatient settings (−1.11; 95% CI, −1.60 to −0.62), and nursing home/long-term care facilities (−1.90; 95% CI, −3.48 to −0.29; Figure S2).

Similarly, the AAPC in the proportion of deaths from stroke in the nonborder counties increased at home (4.39; 95% CI, 3.13–5.67), but decreased at hospice facilities (−6.22; 95% CI, −8.24 to −4.16), inpatient settings (−1.74; 95% CI, −2.39 to −1.08), and nursing home/long-term care facilities (−2.03; 95% CI, −3.43 to −0.61; Figure S3).

**DISCUSSION**

Stroke-related mortality varied between the US–Mexico border and nonborder counties. Overall, nonborder counties had higher mortality rates than border counties, and demographically, older adults, men, and non-Hispanic Black adults had higher mortality rates than their counterparts. After the initial downtrend, mortality decline has stalled in both areas since 2012; however, there was considerable heterogeneity in mortality trends across border states and demographic subgroups. California’s border counties demonstrated a rise in mortality since 2012, whereas mortality decline has stalled in all other states. Non-Hispanic White adults of border counties experienced a significant increase in mortality than those living in nonborder counties during the second half of the study. Finally, a higher number of individuals died at home, whereas deaths decreased at hospice facilities, hospitals, or nursing home/long-term care facilities in both border and nonborder counties.
Contrasting mortality trends between the border and nonborder counties can be elucidated based on the heterogeneities related to demographic characteristics, cardiovascular risk burden, socioeconomic challenges, and limited access care among residents of border areas. In 2008, nearly 1 in 2 residents in border counties were non-Hispanic individuals. The border population is aging, and individuals aged ≥65 years may increase by 18% in the 4 border states by 2030. Hence, a rise in stroke-related deaths in older adults may predict a concerning upsurge in total mortality burden in the future. From a

Figure 2. Age-adjusted stroke-related mortality rates in the border and nonborder counties, stratified by states in the United States, 1999 to 2018.
Figure illustrates observed and model-adjusted mortality rates with APC (95% CI). APC indicates annual percent change.

Figure 3. Age-adjusted stroke-related mortality rates in the border and nonborder counties, stratified by sex in the United States, 1999 to 2018.
Figure illustrates observed and model-adjusted mortality rates with APC (95% CI). APC indicates annual percent change.
socioeconomic perspective, as per 2007 estimates, the annual income per capita was $26,842 in the border counties compared with $39,013 in the border states and $38,839 in the United States, translating into more than twice the poverty rate (25%) in the border area than the national level (13%).20,21 Of the 10 most impoverished counties in the US, 3 (Starr, Maverick, and Hudspeth) belonged to Texas.20 Of a total of 44 border counties, 48% were designated as economically distressed counties.20 Between 2000 and 2003, about 23% of the border residents lacked health insurance coverage compared with 15% health insurance coverage nationally.22 In 2008, the unemployment rate was 11.5% in the border region and 5.6% in the US.23

On the same note, the disproportionate burden of cardiometabolic risk factors in the border counties may further contribute to stroke-related mortality. For instance, the prevalence of diabetes mellitus in the border area was ~9.5% compared with 8.0% in the overall US in 2007.22 The hospital discharge rates of diabetes mellitus among border county residents were higher than their nonborder counties (16.6 per 10,000 versus 14.9 per 10,000).24 A county-level survey (1999–2008) showed suboptimal blood pressure control among men in counties along the US–Mexico border in Texas, New Mexico, and Arizona.25 A significantly higher age-adjusted prevalence of obesity (22%) and physical inactivity (43%) was reported among border residents.22 The combination of suboptimal cardiometabolic profile and less favorable social determinants of health in the border population contribute to health disparities.

As per the US–Mexico Border Health Commission 2010 update, the hospital discharge rate for stroke was significantly lower for border residents than for nonborder residents (28.0 per 10,000 versus 34.0 per 10,000).22 The lower hospital discharge rate may be attributed to a greater likelihood of border residents to die from stroke without being hospitalized, or a higher likelihood to die during or following hospitalization, thus eliminating rehospitalization for future treatment of the same condition.26 Moreover, certain ethnic/racial minorities might prefer to die at home. Our findings complement these observations demonstrating a more significant number of individuals dying at home than in the hospital setting in the border area.27

Several limitations of this study need to be acknowledged. Because vital statistics and census population data rely on death certificates, potential coding errors can exist.28 Inaccurate ascertainment of demographic data is also subject to misclassification. We could not generate subgroup analyses based on stroke subtypes. We lacked data on stroke incidence and pertinent clinical and socioeconomic variables; therefore,
we could not examine the association of clinical or social determinants of health with stroke-related mortality. Finally, vital statistics records deaths to the state of residence at the time of death and does not factor in migration across the US–Mexico border. For instance, according to Pew Hispanic Center estimates, a total of 3 million Mexican citizens immigrated to the United States between 1995 and 2000, followed by a decline to 1.4 million between 2005 and 2010.29 Meanwhile, nearly 1.4 million Mexican citizens moved from the United States to Mexico between 2005 and 2010. Moreover, recent changing patterns of border enforcement and characteristics of return migrants can further influence this area’s population composition.30 Because migration is strongly implicated in the intertwined demographic and health transitions, these aspects of demographic transition influence socioeconomic indicators, comorbidity burden, and subsequent mortality.

In summary, in the US–Mexico border counties, the initial decline in stroke-related mortality has stalled during the past decade. Our findings illustrate the demographic and state-level disparities regarding stroke-related mortality across the border and nonborder counties. The Million Hearts initiative targets to prevent 1 million heart attacks and strokes by 2022.31 Future policy efforts should advocate for integrating social determinants of health into existing cardiovascular care paradigms to identify vulnerable populations that could benefit from targeted interventions and mitigate the burden of stroke-related mortality in the unique US–Mexico border region.

ARTICLE INFORMATION
Received November 9, 2020; accepted May 7, 2021.

Affiliations
Department of Medicine, West Virginia University, Morgantown, WV (S.U.K.); Department of Cardiovascular Medicine, Heart, Vascular and Thoracic Institute, Cleveland Clinic, Cleveland, OH (A.K.); Regional Section of Interventional Cardiology, Cardiovascular Research, Cleveland Clinic Akron General, Akron, OH (A.K.); Department of Medicine, Erie County Medical Center, Buffalo, NY (S.H.Y.); Department of Cardiology, Lahey Hospital & Medical Center, Burlington, MA (S.S.D.); Section on Cardiovascular Medicine, Wake Forest University School of Medicine, Winston-Salem, NC (M.D.S.); Department of Cardiology, Houston Methodist DeBakey Heart & Vascular Center, Houston, TX (K.N.); Michael E. DeBakey Veterans Affairs Medical Center & Section of Cardiovascular Research, Department of Medicine, Baylor College of Medicine, Houston, TX (S.S.V.); Division of Cardiology, Johns Hopkins University School of Medicine, Baltimore, MD (E.D.M.); and Department of Cardiovascular Medicine, Mayo Clinic, Rochester, MN (M.A.).

Sources of Funding
makeadent.org’sRam and Sanjita Kalra Aavishaqaur Fund at Cleveland Clinic Akron General in Akron, Ohio funded the open access fee for this study.

Disclosures
Dr Kalra reports being Chief Executive Officer and Creative Director of makeadent.org. Dr Virani reports grant support from the Department of Veterans Affairs, World Heart Federation, and Tahir and Joorna Family and honorarium from the American College of Cardiology (Associate Editor for Innovations; acc.org) and is a steering committee member of the PALM (Patient and Provider Assessment of Lipid Management) registry at the Duke Clinical Research Institute (no financial remuneration). Dr Shapiro reports scientific advisory activities with Alexion, Amgen, Esperion, and Novartis. Dr. Kalra reports being Chief Executive Officer and Creative Director of makeadent.org. The remaining authors have no disclosures to report.

Supplementary Material
Tables S1–S3
Figures S1–S3

REFERENCES
1. Rosales CB, Carvajal S, de Zapien JEG. Editorial: emergent public health issues in the US-Mexico border region. Front Public Health. 2016;4:93.
2. De Heer HD, Balcázar HG, Moreira OF, Lapeyrouse L, Heyman JM, Salinas J, Zamborana RE. Barriers to care and comorbidities along the US-Mexico border. Public Health Rep. 2013;128:480–488. DOI: 10.1177/003335491312800607.
3. U. S. Department of Health Human, Services, Healthy People 2010. 2001. Available at: http://www.healthgov/healthypeople/Document/ HTML/Volume1. Accessed December 8, 2020.
4. Soden DL. At the cross roads: US-Mexico border counties in transition. 2006.
5. Osborn MF, Miller CC, Badr A, Zhang J. Metabolic syndrome associated with ischemic stroke among the Mexican Hispanic population in the El Paso/US-Mexico border region. J Stroke Cerebrovasc Dis. 2014;23:1477–1484. DOI: 10.1016/j.jstrokecerebrovasdis.2013.12.017.
6. Rodríguez CJ, Allison M, Davilus ML, Issasi CR, Keller C, Leira EC, Palaniappan L, Piña IL, Ramrez SM, Rodríguez S, et al.; American Heart Association Council on Epidemiology and Prevention; American Heart Association Council on Clinical Cardiology; American Heart Association Council on Cardiovascular and Stroke Nursing. Status of cardiovascular disease and stroke in Hispanics/Latinos in the United States: a science advisory from the American Heart Association. Circulation. 2014;130:589–625. DOI: 10.1161/CIR.0000000000000071.
7. Kim AS, Johnston SC. Global variation in the relative burden of stroke and ischemic heart disease. Circulation. 2011;124:314–323. DOI: 10.1161/CIRCULATIONAHA.111.018820.
8. Addo J, Ayerbe L, Mohan KM, Crichton S, Sheldenkar A, Chen R, Wolfe CD, McKeivit C. Socioeconomic status and stroke: an updated review. Stroke. 2012;43:1186–1191. DOI: 10.1161/STROKEAHA.111.639732.
9. Reshetnyak E, Ntamatungiro M, Pinheiro LC, Howard VJ, Carson AP, Martin KD, Saford MM. Impact of multiple social determinants of health on incident stroke. Stroke. 2020;51:2445–2453. DOI: 10.1161/STROKEAHA.120.028530.
10. Friede A, Reid JA, Ory HW. CDC WONDER: a comprehensive online public health information system of the Centers for Disease Control and Prevention. Am J Public Health. 1993;83:1289–1294. DOI: 10.2105/AJPH.83.9.1289.
11. Harris A. ‘Natural’ and ‘Unnatural’ medical deaths and coronial law: a UK and international review of the medical literature on natural and unnatural death and how it applies to medical death certification and reporting deaths to coroners: Natural/Unnatural death: a scientific review. Med Sci Law. 2017;57:105–114. DOI: 10.1177/0025802417708948.
12. Mummre SP, Collins K. The La Paz agreement 30 years on. J Environ Dev. 2014;23:303–330.
13. Klein RJ. Age Adjustment Using the 2000 Projected US Population. Hyattsville, MD: Department of Health & Human Services, Centers for Disease Control and Prevention; 2001.
14. Kim HJ, Fay MP, Feuer EJ, Midthune DN. Permutation tests for joinpoint regression with applications to cancer rates. Stat Med. 2000;19:335–351. DOI: 10.1002/(SICI)1097-0258(20000215)19:3<335::AID-SIM336>3.0.CO;2-Z.
15. Wooff SH, Schoemaker H. Life expectancy and mortality rates in the United States, 1959–2017. JAMA. 2019;322:1996–2016. DOI: 10.1001/jama.2019.16932.
16. Khan SU, Bashir ZS, Khan MZ, Khan MS, Gulati M, Blankstein R, Blumenthal RS, Michos ED. Trends in cardiovascular deaths among young adults in the United States, 1999 to 2018. Am J Cardiol. 2020;126:216–217. DOI: 10.1016/j.amjcard.2020.05.014.
17. Kim H-J, Fay MP, Yu B, Barrett MJ, Feuer EJ. Comparability of segmented line regression models. *Biometrics*. 2004;60:1005–1014. DOI: 10.1111/j.0006-341X.2004.00256.x.

18. Lackland DT, Roccella EJ, Deutsch AF, Fornage M, George MG, Howard G, Kissela BM, Kittner SJ, Lichtman JH, Lisabeth LD, et al. Factors influencing the decline in stroke mortality: a statement from the American Heart Association/American Stroke Association. *Stroke*. 2014;45:315–353. DOI: 10.1161/01.str.0000437068.30550.cf.

19. He W, Sengupta M, Velhoff VA, DeBarros KA. 65+ in the United States: 2005. Washington, DC: US Department of Commerce, Economics and Statistics Administration, Bureau of the Census; 2005.

20. Health disparities and the US-Mexico border: challenges and opportunities. United States-Mexico Border Health Commission; 2010.

21. Velasco JL. US-Mexico border health commission initiatives and activities. In: *Voices of Mexico*. Mexico City, Mexico: Universidad Nacional Autónoma de México, Coordinación de Humanidades, Centro de Investigaciones sobre América del Norte; 2014:82–87.

22. United States-Mexico Border Health Commission. *Border Lives: Health Status in the United States-Mexico Border Region*. El Paso, TX: United States-Mexico Border Commission; 2010.

23. Bureau of Labor Statistics B. Local area unemployment statistics. United States Department of Labor. 2009.

24. Albertorio-Diaz JR, Notzon FC, Rodriguez-Lainz A. Diabetes hospitalization at the U.S.-Mexico border. *Prev Chronic Dis*. 2007;4:A28.

25. Olives C, Myerson R, Mokdad AH, Murray CJL, Lim SS. Prevalence, awareness, treatment, and control of hypertension in United States counties, 2001–2009. *PLoS One*. 2013;8:e60308. DOI: 10.1371/journal.pone.0060308.

26. Hunt KJ, Resendez RG, Williams K, Haffner SM, Stern MP, Hazuda HP. All-cause and cardiovascular mortality among Mexican-American and non-Hispanic White older participants in the San Antonio Heart Study—evidence against the “Hispanic paradox”. *Am J Epidemiol*. 2003;158:1048–1057. DOI: 10.1093/aje/kwg249.

27. Cross SH, Varraich HJ. Changes in the place of death in the United States. *N Engl J Med*. 2019;381:2369–2370. DOI: 10.1056/NEJMc1911892.

28. Khan SJ, Kalra A, Kapadia SR, Khan MU, Zia Khan M, Khan MS, Mamas MA, Warraich HJ, Nasir K, Michos ED, et al. Demographic, regional, and state-level trends of mortality in patients with aortic stenosis in United States, 2008 to 2018. *J Am Heart Assoc*. 2020;9:e017433. DOI: 10.1161/JAHA.120.017433.

29. Passel JS, D’Vera CS. *Unauthorized Immigrant Population: National and State Trends*, 2010. Washington, DC: Pew Hispanic Center; 2011.

30. Roth GA, Dwyer-Lindgren L, Bertozzi-Villa A, Stubbs RW, Morozoff C, Naghavi M, Mokdad AH, Murray CJ. Trends and patterns of geographic variation in cardiovascular mortality among US counties, 1980–2014. *JAMA*. 2017;317:1976–1992. DOI: 10.1001/jama.2017.4150.

31. New US target to prevent 1 million heart attacks and strokes. *Lancet*. 2011;378:1118. DOI: 10.1016/S0140-6736(11)61490-6.
Supplemental Material
### Table S1. List of counties included in the analysis with age-adjusted stroke-related mortality, 1999-2018.

| County                | US-Mexico Non-Border region | US-Mexico Border region |
|-----------------------|-----------------------------|-------------------------|
| County                | Deaths | Population | Age-adjusted mortality rate | County | Deaths | Population | Age-adjusted mortality rate |
| Apache County, AZ     | 393    | 1407929    | 34.6                       | Cochise County, AZ | 1209   | 2514506    | 39.1                       |
| Coconino County, AZ   | 622    | 2613508    | 36.4                       | Pima County, AZ   | 8795   | 19005257   | 37.6                       |
| Gila County, AZ       | 704    | 1052445    | 42                         | Santa Cruz County, AZ | 326   | 884422     | 38.1                       |
| Graham County, AZ     | 305    | 713065     | 47.5                       | Yuma County, AZ   | 1348   | 3750385    | 31.5                       |
| Greenlee County, AZ   | 57     | 171532     | 36.6                       | Imperial County, CA | 1150   | 3305085    | 40.9                       |
| La Paz County, AZ     | 204    | 404395     | 27.2                       | San Diego County, CA | 25628  | 61348334   | 42.5                       |
| Maricopa County, AZ   | 25746  | 74588439   | 35.2                       | Dona Ana County, NM | 1365   | 3983539    | 36.7                       |
| Mohave County, AZ     | 2277   | 3808477    | 39                         | Grant County, NM  | 358    | 588685     | 39.2                       |
| Navajo County, AZ     | 763    | 2102845    | 39.9                       | Hidalgo County, NM | 65     | 99106      | 50.4                       |
| Pinal County, AZ      | 1950   | 6303557    | 29.4                       | Luna County, NM  | 272    | 496813     | 39.7                       |
| Yavapai County, AZ    | 2740   | 4058545    | 38.3                       | Otero County, NM  | 465    | 1271473    | 35.7                       |
| Alameda County, CA    | 13431  | 30420360   | 46.5                       | Sierra County, NM | 215    | 240155     | 41.4                       |
| Alpine County, CA     | 17     | 23593      |                            |                    |        |            |                            |
| Amador County, CA     | 513    | 747023     | 44                         | Brooks County, TX | 67     | 148552     | 37.5                       |
| Butte County, CA      | 2984   | 4353129    | 50.9                       | Cameron County, TX | 2330   | 7781556    | 34.1                       |
| Calaveras County, CA  | 495    | 888078     | 37.8                       | Crockett County, TX | 28     | 75906      | 31.8                       |
| Colusa County, CA     | 146    | 414000     | 36.1                       | Culberson County, TX | 17     | 50333      |                            |
| Contra Costa County, CA | 10635 | 20846589   | 48.4                       | Dimmit County, TX | 112    | 205225     | 50.7                       |
| Del Norte County, CA  | 285    | 558109     | 48.1                       | Duval County, TX  | 117    | 241380     | 41.5                       |
| El Dorado County, CA  | 1321   | 3523158    | 33.3                       | Edwards County, TX | 14     | 40232      |                            |
| Fresno County, CA     | 8188   | 18104122   | 52.6                       | El Paso County, TX | 4970   | 15413356   | 39.2                       |
| Glenn County, CA      | 283    | 551343     | 47.3                       | Frio County, TX  | 148    | 348605     | 49.5                       |
| Humboldt County, CA   | 1848   | 2650955    | 62.8                       | Hidalgo County, TX | 3393   | 14636886   | 30.5                       |
| Inyo County, CA       | 237    | 366544     | 40.4                       | Hudspeth County, TX | 21    | 70694      | 30.9                       |
| Kern County, CA       | 5553   | 15978315   | 47.3                       | Jeff Davis County, TX | 16     | 45001      |                            |
| Kings County, CA      | 875    | 2916248    | 45.2                       | Jim Hogg County, TX | 53     | 104336     | 45.1                       |
| Lake County, CA       | 969    | 1262112    | 55.1                       | Kinney County, TX | 40     | 70597      | 35.8                       |
| County               | Area  | Population | Inhabitants Per Square Mile | County               | Area  | Population | Inhabitants Per Square Mile |
|----------------------|-------|------------|----------------------------|----------------------|-------|------------|----------------------------|
| Lassen County, CA    | 209   | 668966     | 37.9                       | La Salle County, TX  | 64    | 135606     | 52.4                       |
| Los Angeles County, CA | 74568 | 196977672 | 41.6                       | Maverick County, TX  | 322   | 1057151    | 38.4                       |
| Madera County, CA    | 1150  | 2883583    | 45.2                       | Pecos County, TX     | 124   | 316209     | 45.1                       |
| Marin County, CA     | 2572  | 5035883    | 36                         | Presidio County, TX  | 56    | 148277     | 27.8                       |
| Mariposa County, CA  | 204   | 354935     | 38.9                       | Real County, TX      | 42    | 64998      | 37.5                       |
| Mendocino County, CA | 1000  | 1748676    | 45.4                       | Reeves County, TX    | 99    | 273665     | 38.4                       |
| Merced County, CA    | 1999  | 4961784    | 52.8                       | Starr County, TX     | 313   | 1194212    | 33.8                       |
| Modoc County, CA     | 138   | 186776     | 50.9                       | Sutton County, TX    | 34    | 81621      | 42.1                       |
| Mono County, CA      | 43    | 274785     | 23.1                       | Terrell County, TX   | 12    | 18713      |                            |
| Monterey County, CA  | 3263  | 8324693    | 42.5                       | Uvalde County, TX    | 280   | 530096     | 45.2                       |
| Napa County, CA      | 1788  | 2687791    | 48                         | Val Verde County, TX | 371   | 952085     | 41.3                       |
| Nevada County, CA    | 1412  | 1943051    | 46                         | Webb County, TX      | 1374  | 4778680    | 44.2                       |
| Orange County, CA    | 24553 | 60210389   | 42.4                       | Willacy County, TX   | 135   | 426279     | 34.5                       |
| Placer County, CA    | 3580  | 6610005    | 43.7                       | Zapata County, TX    | 74    | 269854     | 31.2                       |
| Plumas County, CA    | 231   | 399624     | 40.6                       | Zavala County, TX    | 101   | 235659     | 46.4                       |
| Riverside County, CA | 17462 | 41203666   | 43.7                       |                     |       |            |                            |
| Sacramento County, CA| 13499 | 27926092   | 50.5                       |                     |       |            |                            |
| San Benito County, CA| 388   | 1120139    | 43.4                       |                     |       |            |                            |
| San Bernardino County, CA | 13662 | 39604783 | 47.4                       |                     |       |            |                            |
| San Francisco County, CA | 8349 | 16173141 | 42.9                       |                     |       |            |                            |
| San Joaquin County, CA | 6453 | 13385258 | 54.5                       |                     |       |            |                            |
| San Luis Obispo County, CA | 3716 | 5326247 | 53.1                       |                     |       |            |                            |
| San Mateo County, CA | 6648  | 14451528   | 39.4                       |                     |       |            |                            |
| Santa Barbara County, CA | 4097 | 8426314 | 42.2                       |                     |       |            |                            |
| Santa Clara County, CA | 11602 | 35521209 | 35.8                       |                     |       |            |                            |
| Santa Cruz County, CA | 1931  | 5231698    | 37.5                       |                     |       |            |                            |
| Shasta County, CA    | 2207  | 3504265    | 48.1                       |                     |       |            |                            |
| Sierra County, CA    | 37    | 65108      | 37                         |                     |       |            |                            |
| Siskiyou County, CA  | 623   | 884162     | 46.5                       |                     |       |            |                            |
| Solano County, CA    | 3813  | 8331290    | 50.4                       |                     |       |            |                            |
| Sonoma County, CA    | 5603  | 9595491    | 47.1                       |                     |       |            |                            |
| County Name, State          | Population | Number of Inmates | Inmate Population Percentage |
|-----------------------------|------------|-------------------|-----------------------------|
| Stanislaus County, CA       | 4417       | 10129730          | 49                          |
| Sutter County, CA           | 947        | 1814101           | 50.6                        |
| Tehama County, CA           | 772        | 1224615           | 51.1                        |
| Trinity County, CA          | 141        | 265252            | 40.3                        |
| Tulare County, CA           | 3523       | 8490142           | 52.3                        |
| Tuolumne County, CA         | 707        | 1102879           | 41.4                        |
| Ventura County, CA         | 6541       | 16221018          | 40.8                        |
| Yolo County, CA             | 1563       | 3912498           | 46.6                        |
| Yuba County, CA             | 649        | 1389426           | 58.9                        |
| Bernalillo County, NM       | 5260       | 12688915          | 40.8                        |
| Catron County, NM           | 34         | 71233             | 26.6                        |
| Chaves County, NM           | 607        | 1275210           | 40.2                        |
| Cibola County, NM           | 174        | 539448            | 33.9                        |
| Colfax County, NM           | 134        | 269528            | 32.6                        |
| Curry County, NM            | 376        | 954430            | 43                          |
| DeBaca County, NM           | 31         | 40008             | 40.9                        |
| Eddy County, NM             | 468        | 1072422           | 38.2                        |
| Guadalupe County, NM        | 46         | 92249             | 40.1                        |
| Lea County, NM              | 520        | 1257739           | 47.9                        |
| Lincoln County, NM          | 181        | 398553            | 32.1                        |
| Los Alamos County, NM       | 110        | 363759            | 25.7                        |
| McKinley County, NM         | 378        | 1452888           | 37.7                        |
| Mora County, NM             | 47         | 97338             | 34.5                        |
| Quay County, NM             | 114        | 181227            | 42.1                        |
| Rio Arriba County, NM       | 305        | 803722            | 36.9                        |
| Roosevelt County, NM        | 141        | 382628            | 37.7                        |
| Sandoval County, NM         | 854        | 2410777           | 36.9                        |
| San Juan County, NM         | 714        | 2461378           | 33.8                        |
| San Miguel County, NM       | 213        | 581075            | 33.6                        |
| Santa Fe County, NM         | 913        | 2822912           | 29.6                        |
| Socorro County, NM          | 163        | 353727            | 46.4                        |
| County                  | Population | Area in Acres | Price Per Acre |
|------------------------|------------|---------------|---------------|
| Taos County, NM        | 232        | 641652        | 29.2          |
| Torrance County, NM    | 126        | 325205        | 40            |
| Union County, NM       | 54         | 85158         | 42.5          |
| Valencia County, NM    | 555        | 1457395       | 41.3          |
| Anderson County, TX    | 635        | 1141436       | 55.7          |
| Andrews County, TX     | 173        | 298852        | 69.2          |
| Angelina County, TX    | 2188       | 1694439       | 118.7         |
| Aransas County, TX     | 330        | 472484        | 45.2          |
| Archer County, TX      | 103        | 177611        | 49.5          |
| Armstrong County, TX   | 37         | 39532         | 57.2          |
| Atascosa County, TX    | 455        | 886435        | 54.6          |
| Austin County, TX      | 284        | 546801        | 41.7          |
| Bailey County, TX      | 57         | 139224        | 36.9          |
| Bandera County, TX     | 188        | 401233        | 35.3          |
| Bastrop County, TX     | 582        | 1439193       | 45.3          |
| Baylor County, TX      | 88         | 75827         | 60            |
| Bee County, TX         | 254        | 645645        | 46.2          |
| Bell County, TX        | 1766       | 5886631       | 40.6          |
| Bexar County, TX       | 13745      | 33364854      | 48.5          |
| Blanco County, TX      | 180        | 201365        | 62.5          |
| Bosque County, TX      | 355        | 357908        | 58.1          |
| Bowie County, TX       | 1296       | 1828413       | 61.6          |
| Brazoria County, TX    | 2059       | 6034105       | 46.3          |
| Brazos County, TX      | 1137       | 3738652       | 49.7          |
| Briscoe County, TX     | 26         | 32940         | 49            |
| Brown County, TX       | 863        | 758793        | 82.4          |
| Burleson County, TX    | 181        | 342812        | 37.2          |
| Burnet County, TX      | 480        | 828651        | 41.6          |
| Caldwell County, TX    | 327        | 750457        | 44.1          |
| Calhoun County, TX     | 221        | 424017        | 48.1          |
| Callahan County, TX    | 139        | 267224        | 39.1          |
| County                  | Population | Population Vector | Density |
|-------------------------|------------|-------------------|----------|
| Camp County, TX         | 185        | 243904            | 61.3     |
| Carson County, TX       | 78         | 125111            | 47.5     |
| Cass County, TX         | 625        | 604396            | 70       |
| Castro County, TX       | 67         | 158973            | 40.3     |
| Chambers County, TX     | 239        | 663006            | 49.3     |
| Cherokee County, TX     | 780        | 994310            | 65.3     |
| Childress County, TX    | 114        | 144547            | 62.9     |
| Clay County, TX         | 146        | 216131            | 52.6     |
| Cochran County, TX      | 31         | 64259             | 44.8     |
| Coke County, TX         | 52         | 69071             | 42.8     |
| Coleman County, TX      | 174        | 175305            | 60.1     |
| Collin County, TX       | 3303       | 14815894          | 38.6     |
| Collingsworth County, TX| 50         | 60926             | 50.8     |
| Colorado County, TX     | 267        | 413701            | 41.5     |
| Comal County, TX        | 1110       | 2116351           | 44.9     |
| Comanche County, TX     | 252        | 274426            | 57.5     |
| Concho County, TX       | 65         | 79571             | 72.7     |
| Cooke County, TX        | 576        | 764878            | 61       |
| Coryell County, TX      | 401        | 1487934           | 46.9     |
| Cottle County, TX       | 33         | 31488             | 56.4     |
| Crane County, TX        | 59         | 86233             | 70.8     |
| Crosby County, TX       | 123        | 126640            | 74.8     |
| Dallam County, TX       | 67         | 132392            | 70.9     |
| Dallas County, TX       | 17890      | 47506558          | 52       |
| Dawson County, TX       | 153        | 277723            | 48.7     |
| Deaf Smith County, TX   | 155        | 377798            | 42.3     |
| Delta County, TX        | 94         | 105585            | 58       |
| Denton County, TX       | 2779       | 12688035          | 41.5     |
| DeWitt County, TX       | 349        | 404776            | 54       |
| Dickens County, TX      | 39         | 49054             | 49.8     |
| Donley County, TX       | 50         | 73407             | 42.5     |
| County                  | Population | Population Density | Land Area |
|------------------------|------------|---------------------|-----------|
| Eastland County, TX    | 356        | 367549              | 60.9      |
| Ector County, TX       | 1226       | 2747740             | 56.7      |
| Ellis County, TX       | 1252       | 2855727             | 56        |
| Erath County, TX       | 441        | 747061              | 54.2      |
| Falls County, TX       | 234        | 355866              | 50.6      |
| Fannin County, TX      | 464        | 664844              | 52.2      |
| Fayette County, TX     | 417        | 478812              | 45.7      |
| Fisher County, TX      | 70         | 80706               | 47        |
| Floyd County, TX       | 102        | 133323              | 55.2      |
| Foard County, TX       | 41         | 27692               | 72.1      |
| Fort Bend County, TX   | 2633       | 11081222            | 40.6      |
| Franklin County, TX    | 163        | 206615              | 56.5      |
| Freestone County, TX   | 253        | 382805              | 49.4      |
| Gaines County, TX      | 106        | 343010              | 42.6      |
| Galveston County, TX   | 2763       | 5795628             | 53        |
| Garza County, TX       | 63         | 120164              | 56.3      |
| Gillespie County, TX   | 445        | 479410              | 42.3      |
| Goliad County, TX      | 70         | 144662              | 32.7      |
| Gonzales County, TX    | 252        | 394907              | 51        |
| Gray County, TX        | 293        | 449775              | 49.9      |
| Grayson County, TX     | 1388       | 2393781             | 47.5      |
| Gregg County, TX       | 1549       | 2375835             | 59.1      |
| Grimes County, TX      | 277        | 521749              | 48.9      |
| Guadalupe County, TX   | 809        | 2477083             | 35.6      |
| Hale County, TX        | 417        | 712649              | 57.5      |
| Hall County, TX        | 56         | 68556               | 47.2      |
| Hamilton County, TX    | 163        | 166297              | 48.4      |
| Hansford County, TX    | 57         | 108554              | 44.7      |
| Hardeman County, TX    | 70         | 85009               | 50.4      |
| Hardin County, TX      | 583        | 1058269             | 53.9      |
| Harris County, TX      | 26529      | 80095425            | 50.4      |
| County, TX                        | Population | Population Density | Crime Rate |
|----------------------------------|------------|--------------------|------------|
| Harrison County, TX              | 752        | 1292736            | 54.6       |
| Hartley County, TX               | 59         | 116726             | 45.2       |
| Haskell County, TX               | 130        | 117608             | 58.9       |
| Hays County, TX                  | 904        | 3029116            | 44.8       |
| Hemphill County, TX              | 48         | 74714              | 54.9       |
| Henderson County, TX             | 1225       | 1556060            | 58.3       |
| Hill County, TX                  | 584        | 688334             | 60.4       |
| Hockley County, TX               | 262        | 460590             | 57.4       |
| Hood County, TX                  | 687        | 993754             | 46.1       |
| Hopkins County, TX               | 494        | 688036             | 58.1       |
| Houston County, TX               | 325        | 465308             | 46.2       |
| Howard County, TX                | 323        | 695571             | 43.8       |
| Hunt County, TX                  | 991        | 1701610            | 56.2       |
| Hutchinson County, TX            | 267        | 445670             | 50.6       |
| Irion County, TX                 | 17         | 32347              |            |
| Jack County, TX                  | 130        | 178621             | 66.5       |
| Jackson County, TX               | 146        | 286050             | 39.6       |
| Jasper County, TX                | 561        | 711115             | 65.3       |
| Jefferson County, TX             | 3173       | 5032413            | 58.8       |
| Jim Wells County, TX             | 376        | 812139             | 46.1       |
| Johnson County, TX               | 1541       | 2948083            | 62.9       |
| Jones County, TX                 | 223        | 403353             | 50.3       |
| Karnes County, TX                | 159        | 302240             | 45.6       |
| Kaufman County, TX               | 908        | 1954080            | 57.1       |
| Kendall County, TX               | 333        | 653766             | 38.5       |
| Kent County, TX                  | 18         | 15956              |            |
| Kerr County, TX                  | 844        | 964983             | 44.4       |
| Kimble County, TX                | 54         | 90116              | 34.3       |
| Kleberg County, TX               | 259        | 632004             | 46         |
| Knox County, TX                  | 107        | 77121              | 75.9       |
| Lamar County, TX                 | 696        | 986609             | 53.9       |
| County                | Population | Median Income |
|-----------------------|-------------|---------------|
| Lamb County, TX       | 185         | 281,488       |
| Lampasas County, TX   | 201         | 391,007       |
| Lavaca County, TX     | 348         | 387,922       |
| Lee County, TX        | 178         | 329,429       |
| Leon County, TX       | 250         | 328,707       |
| Liberty County, TX    | 684         | 1,519,619     |
| Limestone County, TX  | 401         | 460,864       |
| Lipscomb County, TX   | 59          | 650,55       |
| Live Oak County, TX   | 104         | 236,815       |
| Llano County, TX      | 287         | 378,904       |
| Lubbock County, TX    | 2,346       | 546,2714      |
| Lynn County, TX       | 86          | 120,913       |
| McCulloch County, TX  | 166         | 163,492       |
| McLennan County, TX   | 2,649       | 462,8105      |
| Madison County, TX    | 161         | 270,310       |
| Marion County, TX     | 167         | 212,462       |
| Martin County, TX     | 47          | 98,784        |
| Mason County, TX      | 58          | 78,762        |
| Matagorda County, TX  | 397         | 740,532       |
| Medina County, TX     | 421         | 898,017       |
| Menard County, TX     | 49          | 44,567        |
| Midland County, TX    | 1,022       | 274,5883      |
| Milam County, TX      | 360         | 494,420       |
| Mills County, TX      | 93          | 98,462        |
| Mitchell County, TX   | 125         | 18,4829       |
| Montague County, TX   | 453         | 389,873       |
| Montgomery County, TX | 2,861       | 86,53388      |
| Moore County, TX      | 143         | 423,545       |
| Morris County, TX     | 214         | 258,077       |
| Motley County, TX     | 27          | 24,939        |
| Nacogdoches County, TX | 831         | 125,8763      |
| County                  | Pop. | Area     | Density |
|------------------------|------|----------|---------|
| Navarro County, TX     | 726  | 945270   | 66      |
| Newton County, TX      | 167  | 288791   | 50.6    |
| Nolan County, TX       | 199  | 302174   | 50.3    |
| Nueces County, TX      | 3075 | 6738595  | 47.5    |
| Ochiltree County, TX   | 84   | 197461   | 51.8    |
| Oldham County, TX      | 12   | 41453    | 56.4    |
| Orange County, TX      | 994  | 1668077  | 56.4    |
| Palo Pinto County, TX  | 411  | 555084   | 60.7    |
| Panola County, TX      | 283  | 467484   | 49.1    |
| Parker County, TX      | 1112 | 2229008  | 56      |
| Parmer County, TX      | 98   | 200422   | 48.1    |
| Polk County, TX        | 676  | 909530   | 60.7    |
| Potter County, TX      | 1314 | 2380615  | 57.7    |
| Rains County, TX       | 189  | 214258   | 65.8    |
| Randall County, TX     | 944  | 2367232  | 41.8    |
| Reagan County, TX      | 57   | 68187    | 109.2   |
| Red River County, TX   | 251  | 261751   | 59.1    |
| Refugio County, TX     | 98   | 149094   | 46.4    |
| Robertson County, TX   | 171  | 330040   | 39.1    |
| Rockwall County, TX    | 535  | 1436479  | 48.4    |
| Runnels County, TX     | 157  | 213198   | 44.3    |
| Rusk County, TX        | 564  | 1026539  | 46.1    |
| Sabine County, TX      | 246  | 210165   | 67.1    |
| San Augustine County, TX| 190 | 176209   | 60.2    |
| San Jacinto County, TX | 259  | 513317   | 42.2    |
| San Patricio County, TX| 657  | 1331710  | 53.4    |
| San Saba County, TX    | 85   | 120177   | 43.7    |
| Schleicher County, TX  | 39   | 62405    | 56.5    |
| Scurry County, TX      | 191  | 333488   | 49.6    |
| Shackelford County, TX | 42   | 66603    | 43.2    |
| Shelby County, TX      | 436  | 508537   | 70.5    |
| County                  | Pop.  | Acres   | Population % |
|-------------------------|-------|---------|--------------|
| Sherman County, TX      | 28    | 61358   | 40.6         |
| Smith County, TX        | 2031  | 4054786 | 43.7         |
| Somervell County, TX    | 122   | 161080  | 61.5         |
| Stephens County, TX     | 133   | 189985  | 48.9         |
| Sterling County, TX     | 13    | 25216   | 47.4         |
| Stonewall County, TX    | 19    | 29338   | 47.4         |
| Swisher County, TX      | 119   | 157155  | 57.4         |
| Tarrant County, TX      | 13991 | 35062294| 54.4         |
| Taylor County, TX       | 1674  | 2613223 | 60.2         |
| Terry County, TX        | 134   | 252038  | 47.7         |
| Throckmorton County, TX | 16    | 33180   | 47.7         |
| Titus County, TX        | 309   | 616052  | 50.4         |
| Tom Green County, TX    | 1095  | 2198836 | 44.6         |
| Travis County, TX       | 5265  | 20086290| 42.6         |
| Trinity County, TX      | 243   | 286131  | 54.7         |
| Tyler County, TX        | 268   | 425219  | 45.6         |
| Upshur County, TX       | 512   | 773195  | 57.5         |
| Upton County, TX        | 35    | 67179   | 45.2         |
| Van Zandt County, TX    | 683   | 1038915 | 49.8         |
| Victoria County, TX     | 865   | 1746851 | 47.1         |
| Walker County, TX       | 577   | 1335182 | 54.8         |
| Waller County, TX       | 302   | 831184  | 46.6         |
| Ward County, TX         | 118   | 217090  | 48.3         |
| Washington County, TX   | 406   | 656830  | 40.9         |
| Wharton County, TX      | 478   | 824050  | 48.8         |
| Wheeler County, TX      | 61    | 106216  | 40.5         |
| Wichita County, TX      | 1758  | 2627275 | 63.4         |
| Wilbarger County, TX    | 269   | 272128  | 71.4         |
| Williamson County, TX   | 2160  | 7970607 | 38.6         |
| Wilson County, TX       | 360   | 823210  | 42.5         |
| Winkler County, TX      | 81    | 144435  | 58.5         |
| County            | Population | Code | Median Income |
|-------------------|------------|------|---------------|
| Wise County, TX   | 606        | 1157861 | 60.8          |
| Wood County, TX   | 634        | 820728  | 47.7          |
| Yoakum County, TX | 42         | 156576  | 29.9          |
| Young County, TX  | 315        | 362296  | 56.1          |
Table S2. Trends in Age-Adjusted Stroke Mortality in Counties located in the U.S. Mexican Border Area, 1999-2018.

| Year | Arizona | California | New Mexico | Texas |
|------|---------|------------|------------|-------|
| 1999 | 49.1    | 62.4       | 51.6       | 50.2  |
| 2000 | 55.2    | 63.9       | 42.2       | 45.9  |
| 2001 | 47.8    | 64.2       | 41.9       | 43.1  |
| 2002 | 48.1    | 57.6       | 41.2       | 46.4  |
| 2003 | 45.1    | 58.0       | 44.3       | 41.5  |
| 2004 | 45.7    | 53.9       | 43.8       | 37.9  |
| 2005 | 41.9    | 45.0       | 45.1       | 38.0  |
| 2006 | 36.2    | 41.3       | 38.3       | 38.3  |
| 2007 | 36.8    | 41.7       | 40.3       | 39.5  |
| 2008 | 34.8    | 39.1       | 38         | 42.5  |
| 2009 | 34.8    | 36.9       | 32.8       | 36.3  |
| 2010 | 34.4    | 34.4       | 39.2       | 32.5  |
| 2011 | 31.7    | 32.8       | 34.9       | 35.4  |
| 2012 | 32.5    | 30.6       | 35.5       | 32.7  |
| 2013 | 30.9    | 33.3       | 34.8       | 33.3  |
| 2014 | 28.9    | 33         | 33.5       | 31.6  |
| 2015 | 31.6    | 32.3       | 28.1       | 32    |
| 2016 | 32      | 37.6       | 35.4       | 32.5  |
| 2017 | 33      | 37.3       | 34.2       | 30.4  |
| 2018 | 33.3    | 38.6       | 34.4       | 28.8  |

APC [95% CI], Segment 1  -3.84 [-4.42, -3.26]  -5.96 [-6.73, -5.20]  -2.40 [-3.13, -1.66]  -3.84 [-7.25, -0.31]
APC [95% CI], Segment 2  4.08 [-0.52, 8.9]    3.94 [1.25, 6.71]    3.26 [-6.36, 13.86]  -2.13 [-2.87, -1.39]
Joinpoint year           2014                  2012                  2015                  2004
AAPC [95% CI]            -2.23 [-3.18, -1.26] -2.94 [-3.83, -2.05] -1.53 [-3.02, -0.00] -2.58 [-3.57, -1.59]

Observed age-adjusted mortality rates are reported per 100,000 persons. APC stands for Annual Percentage Change and AAPC stands for Average Annual Percent Change. Segments 1 and 2 are APCs before and after joinpoint year. Bold indicates that annual percent change is significantly different from zero at the alpha = 0.05
Table S3. Trends in Age-Adjusted Stroke Mortality in Counties located in the Non-Border Area, 1999-2018.

| Year | Arizona | California | New Mexico | Texas |
|------|---------|------------|------------|-------|
| 1999 | 55.9    | 64.7       | 52.7       | 67.4  |
| 2000 | 52.9    | 64.0       | 52.3       | 68.6  |
| 2001 | 49.3    | 61.9       | 51.7       | 67.1  |
| 2002 | 49.4    | 59.5       | 42.5       | 65.4  |
| 2003 | 45.6    | 58.2       | 44.6       | 62.8  |
| 2004 | 44.2    | 54.7       | 40.5       | 58.9  |
| 2005 | 41.2    | 49.4       | 39.1       | 53.9  |
| 2006 | 37.9    | 46.8       | 39.1       | 51.5  |
| 2007 | 35.5    | 43.9       | 41.4       | 52.7  |
| 2008 | 33.5    | 41.3       | 38.1       | 50.0  |
| 2009 | 30.8    | 38.6       | 35.8       | 46.0  |
| 2010 | 31.2    | 38.4       | 38.3       | 45.7  |
| 2011 | 30.3    | 36.7       | 33.3       | 42.6  |
| 2012 | 29.0    | 35.9       | 29.1       | 42.7  |
| 2013 | 27.9    | 35.1       | 29.0       | 40.9  |
| 2014 | 28.0    | 34.0       | 34.8       | 42.7  |
| 2015 | 30.3    | 36.5       | 33.5       | 43.8  |
| 2016 | 29.0    | 36.8       | 35.7       | 43.0  |
| 2017 | 29.9    | 37.6       | 34.8       | 42.5  |
| 2018 | 30.2    | 36.8       | 31.1       | 41.5  |

APC [95% CI], Segment 1  
-5.24 [-4.82, -25.94]  
-5.07 [-5.52, -4.62]  
-3.74 [-4.76, -2.71]  
-4.15 [-4.67, -3.63]

APC [95% CI], Segment 2  
1.41 [-0.03, 2.86]  
1.33 [-0.22, 2.91]  
1.12 [-2.28, 4.64]  
0.31 [-1.53, 0.92]

Joinpoint year  
2012  
2012  
2012  
2011

AAPC [95% CI]  
-3.19 [-3.67, -2.70]  
-3.09 [-3.62, -2.57]  
-2.23 [-3.39, -1.05]  
-2.75 [-3.26, -2.24]

Observed age-adjusted mortality rates are reported per 100,000 persons. APC stands for Annual Percentage Change and AAPC stands for Average Annual Percent Change. Segments 1 and 2 are APCs before and after joinpoint year. Bold indicates that annual percent change is significantly different from zero at the alpha = 0.05
Figure S1. Age-specific mortality rates in the Counties located in the U.S. Mexican Border vs. Non-Border Area, 1999-2018.
Figure S2. Joinpoint chart illustrating proportion of patients dying due to stroke in counties located in the U.S. Mexican Border Area, 2003-2018.

APC: Annual percent change; ER: Emergency room
Figure S3. Joinpoint chart illustrating proportion of patients dying due to stroke in counties located in the non-border area, 2003-2018.

APC: Annual percent change; ER: Emergency room