Local Trends in Heart Disease and Stroke Mortality
Pennsylvania

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Division for Heart Disease and Stroke Prevention
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1 Introduction

1.1 Overview

This report provides an overview of trends in local coronary heart disease (CHD) and stroke death rates. Specifically, this report presents county (or county equivalent) estimates of stroke and CHD death rates in 2018 and trends during 2011–2018 by age group (ages 35–64 and 65 and older). The maps, graphs, and tables in this report provide federal agencies, state and local health departments, nonprofit organizations, academic institutions, and the public with important information to enhance prevention and treatment activities, plan services, allocate resources, and develop policies. The dataset used to create this report is available as a separate file.

This report contains three sections:

1. **National maps:** County (or county equivalent) maps of CHD and stroke death rates and trends by age group (ages 35–64 and 65 and older) for the entire country. These maps permit comparison of counties across the country.
2. **Pennsylvania county maps:** County (or county equivalent) maps of CHD and stroke death rates and trends by age group (ages 35–64 and 65 and older) for Pennsylvania. These maps permit comparison of counties within the state.
3. **County historical rates and trends graphs:** State-specific graphs display county (or county equivalent) CHD and stroke death rates and trends from 1999 through 2018 by age group (ages 35–64 and 65 and older). Each county's rates and trends are highlighted relative to all other counties in the state. Trends are shown for three time periods: 1999–2005, 2005–2011, and 2011–2018.

1.2 Methods

CHD deaths are defined as the 10th revision of the International Classification of Diseases (ICD-10) codes I20–I25. Stroke deaths are defined as ICD-10 codes I60-I69.

Death rates and trends were estimated using a Bayesian spatiotemporal model. Additional details of the model can be found at the end of the report. Briefly, by borrowing strength both spatially and temporally, as well as between age groups, these models generate precise, reliable rates even in the presence of small case counts and small populations (Quick et al., 2017; Vaughan et al., 2015). We fit this model with a Markov chain Monte Carlo (MCMC) algorithm using user-developed code in the R programming language. This code is available upon request. All death rates were age-standardized to the 2010 US population using 10-year age groups.

Data for an age group within a county were suppressed if that age group's population for the given county in 2018 was less than 500 people. Consequently, different counties will be suppressed for ages 35–64 and 65 and older. However, within each age group the same counties will be suppressed for each outcome. Counties that have been suppressed appear as white on the maps.

1.3 Data sources

Death data: National Vital Statistics System (NVSS) from the National Center for Health Statistics (NCHS)

Population data: US Census bridged-race intercensal estimates

The dataset used to create this report is available for download as a separate file (link to website to be added later).

1.4 Comments and questions

We are interested in your feedback on this report. Please contact Adam Vaughan with comments or questions.

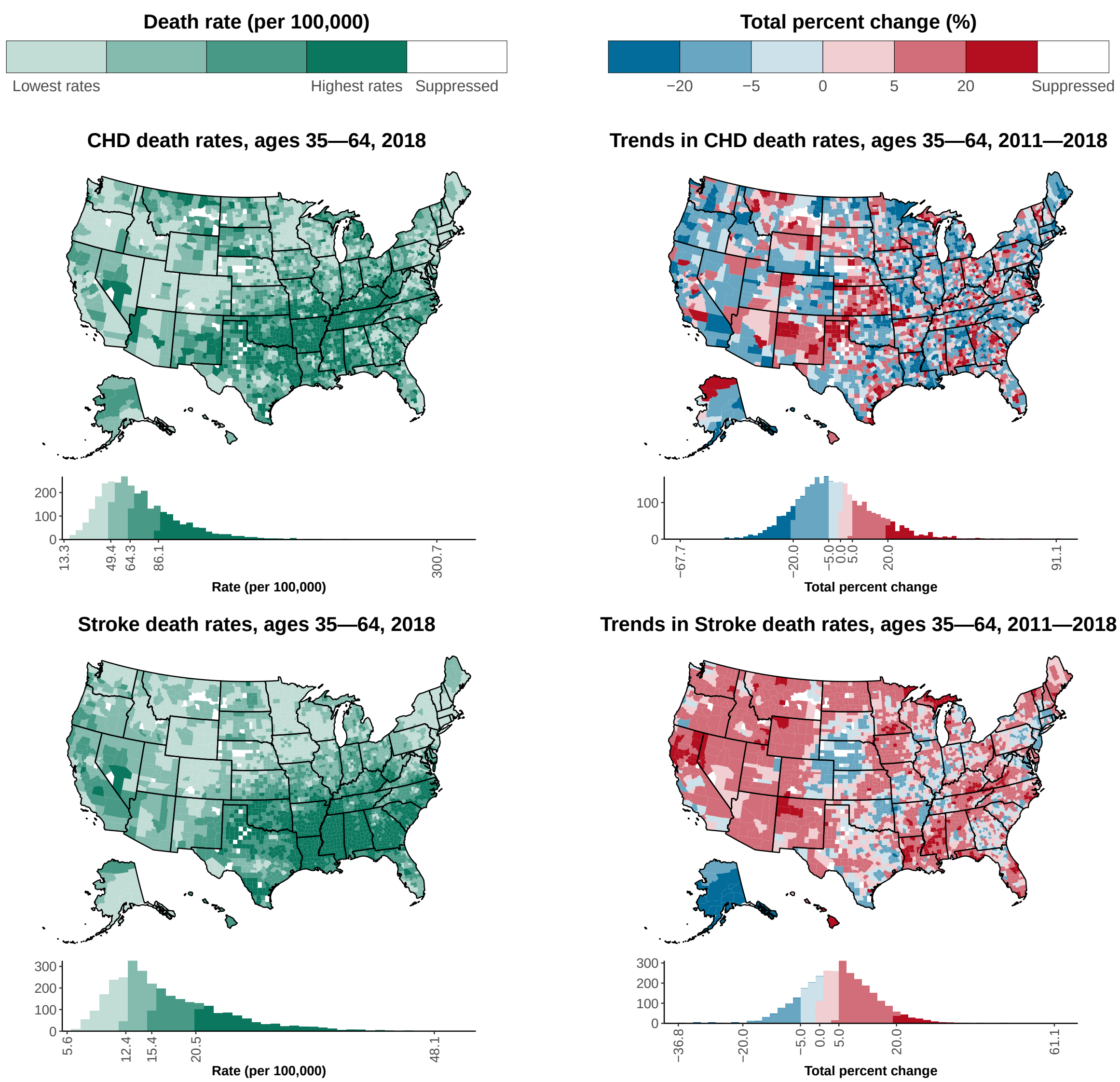
2 National maps

In these national county-level maps, rates are categorized by quartiles for each combination of age group (ages 35–64 and 65 and older) and outcome (CHD and stroke). Darker green indicates a higher rate, and lighter green indicates a lower rate. The histograms below each map show the break points for the rates, minimum value, and maximum value.

Trends (i.e., total percent change) are categorized using fixed categories. Red indicates that a county's rates are increasing, and blue indicates that a county's rates are decreasing. The histograms below each map show the break points for the trend, minimum value, and maximum value.

Data have been suppressed for counties shown in white.

2.1 Death rates and trends, ages 35–64

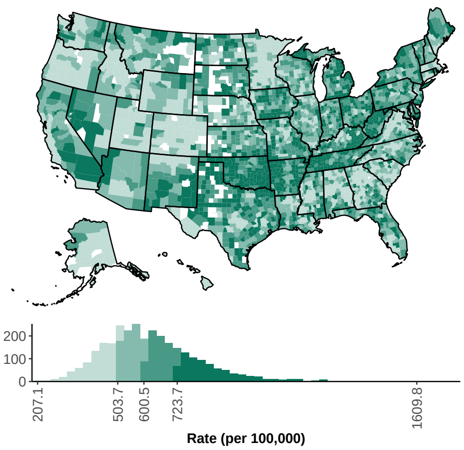


2.2 Death rates and trends, ages 65 and older

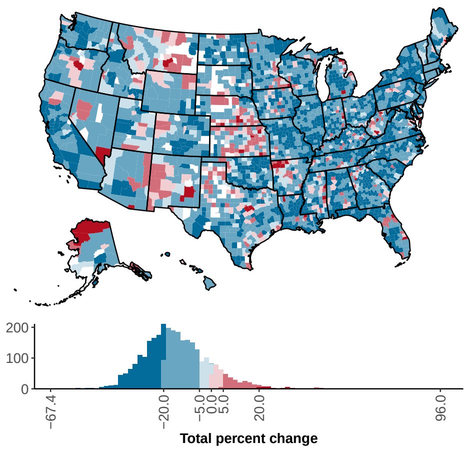
Death rate (per 100,000)

Total percent change (%)

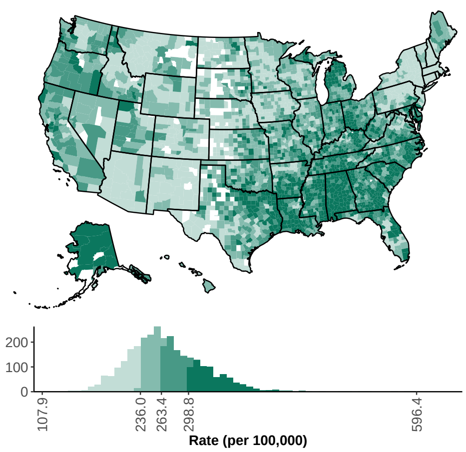
CHD death rates, ages 65 and older, 2018



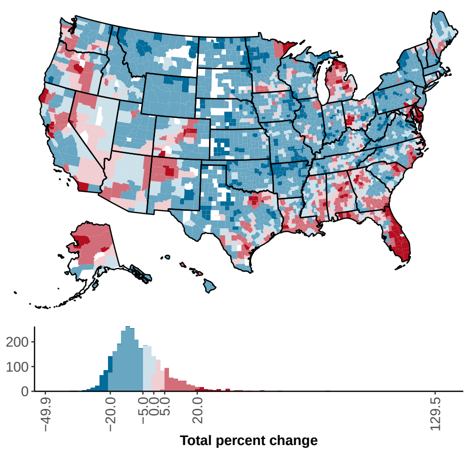
Trends in CHD death rates, ages 65 and older, 2011—2018



Stroke death rates, ages 65 and older, 2018



Trends in Stroke death rates, ages 65 and older, 2011—2018



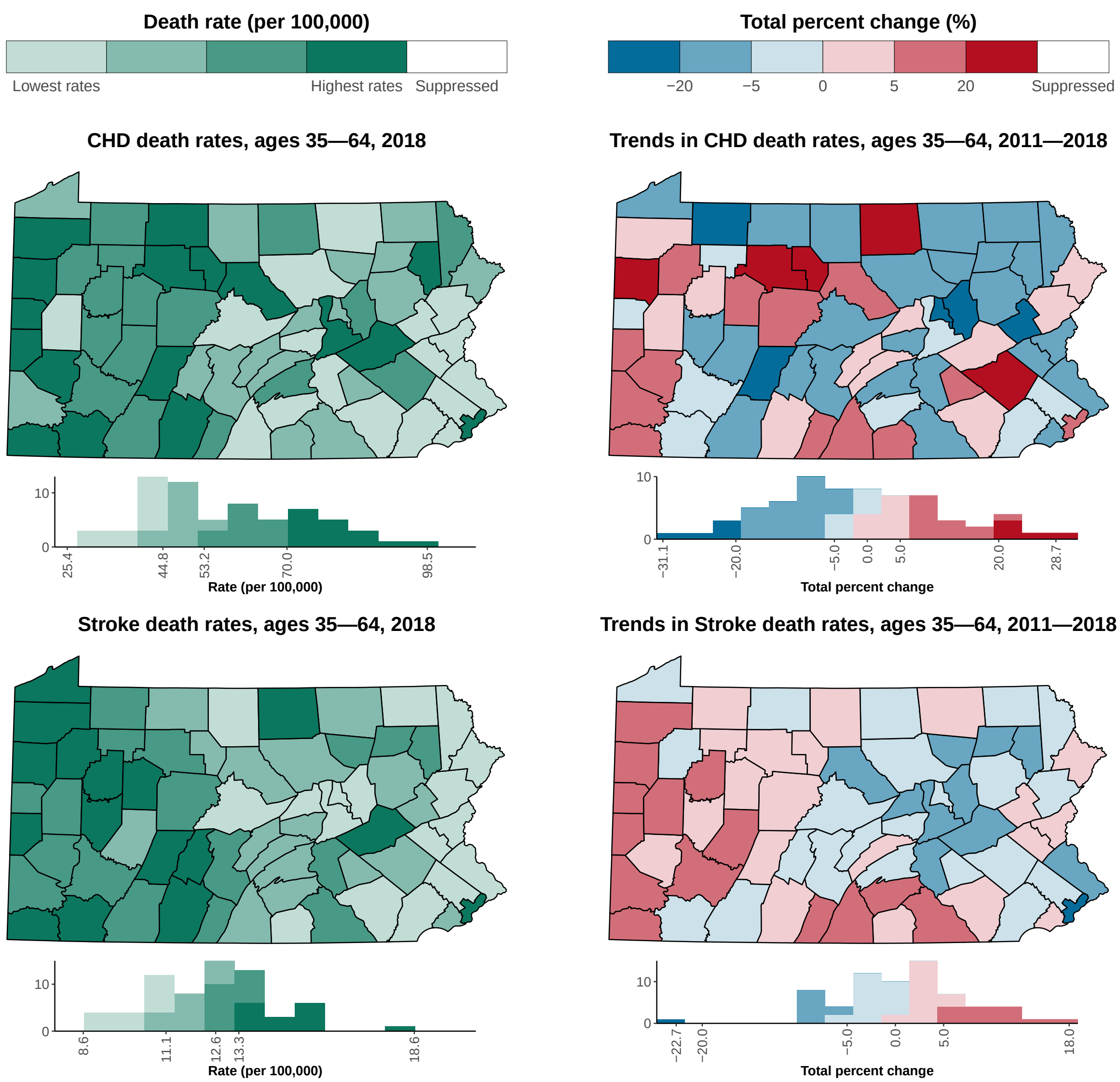
3 Pennsylvania county maps

In these county-level maps for Pennsylvania, rates are categorized by quartiles for each combination of age group (ages 35–64 and 65 and older) and outcome (CHD and stroke). Darker green indicates a higher rate, and lighter green indicates a lower rate. The histograms below each map show the break points for the rates, minimum value, and maximum value.

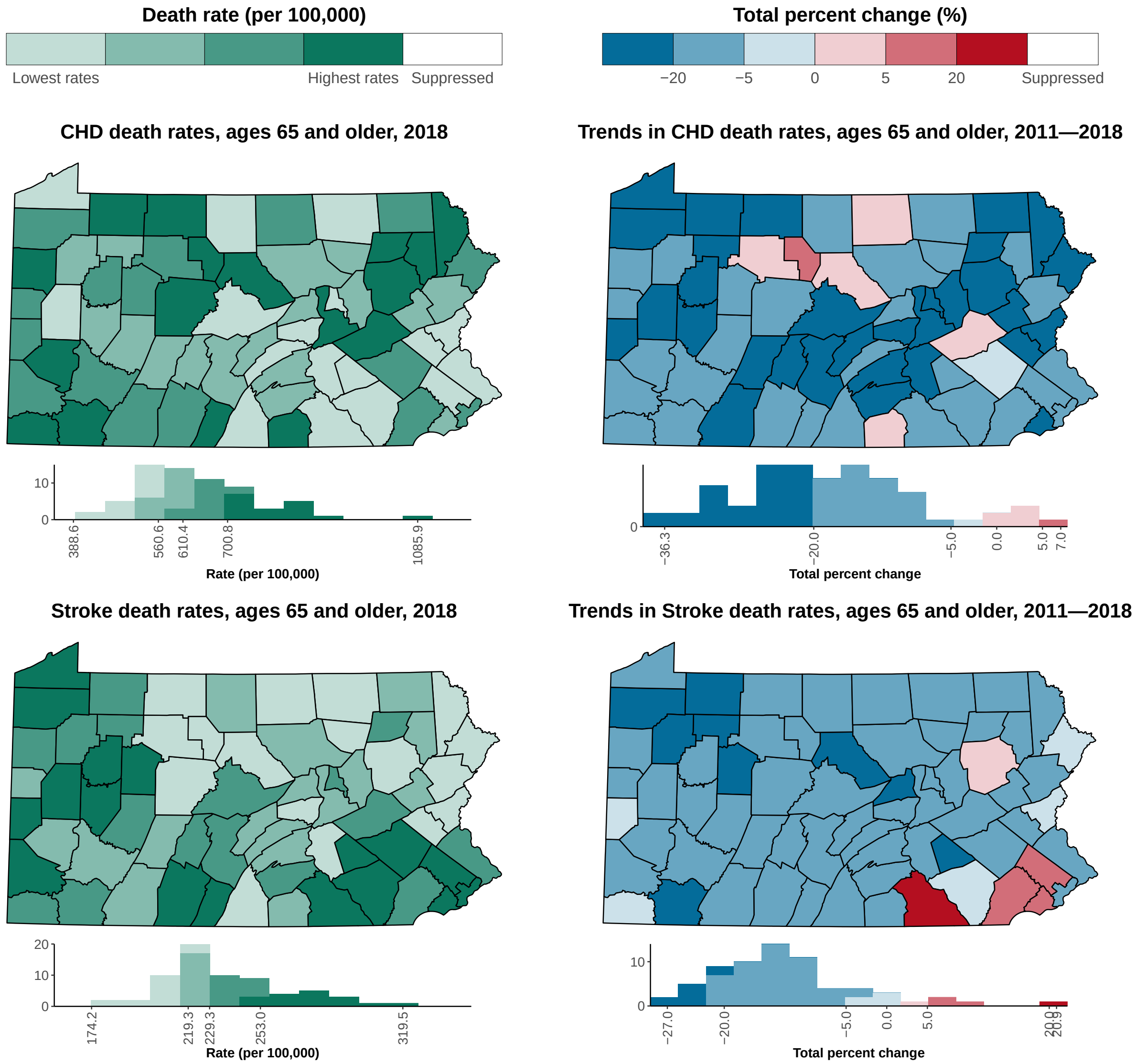
Trends (i.e., total percent change) are categorized using fixed categories. Red indicates that a county's rates are increasing, and blue indicates that a county's rates are decreasing. The histograms below each map show the break points for the trend, minimum value, and maximum value.

Data have been suppressed for counties shown in white.

3.1 Death rates and trends, ages 35–64



3.2 Death rates and trends, ages 65 and older



4 County rates and trends

4.1 Using these graphs

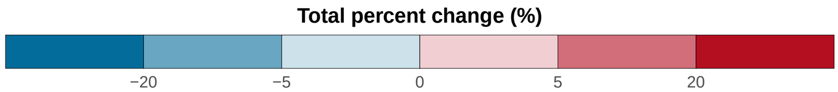
In the graphs below, each row represents a county and each column represents a combination of age group (ages 35–64 and 65 and older) and outcome (CHD and stroke). Counties are shown in alphabetical order. The scale of the y-axis differs by age group and outcome for better data visualization

On each graph, the county's rates are shown as the colored line, where the color of the line represents the trend during the time periods of 1999–2005, 2005–2011, 2011–2018. Red indicates that the county's rates are increasing, and blue indicates that the county's rates are decreasing. All other counties in the state are shown as grey lines. If a group for a county does not have a colored line, the data for that group and county have been suppressed.

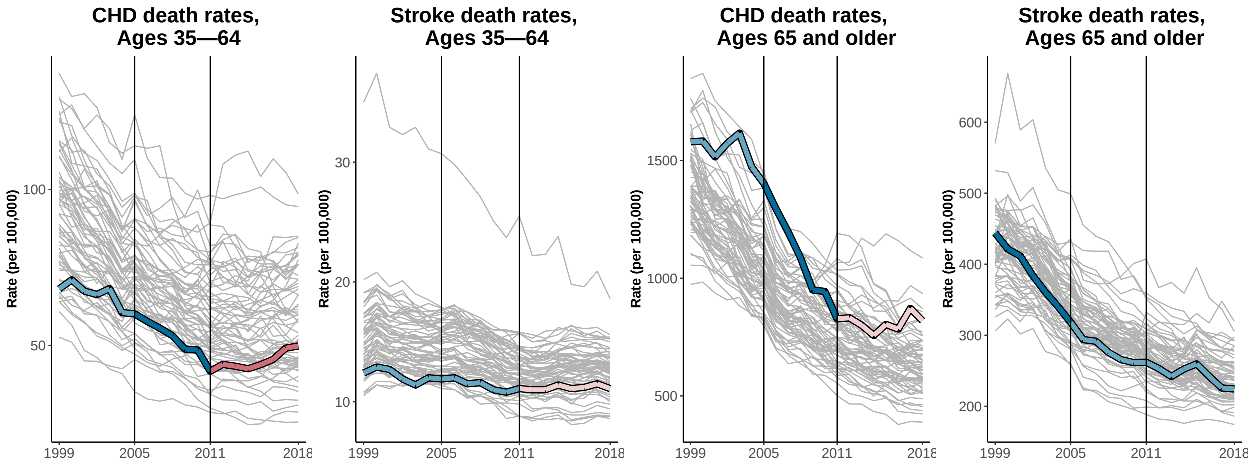
For each county, the reader can:

- View the trends in CHD and stroke mortality for ages 35–64 and 65 and older for a county.
- Compare the trends in a specific county to the trends for all other counties in the state (i.e. the gray lines).
- Determine the magnitude of change for three time intervals (i.e the color coded trend lines).

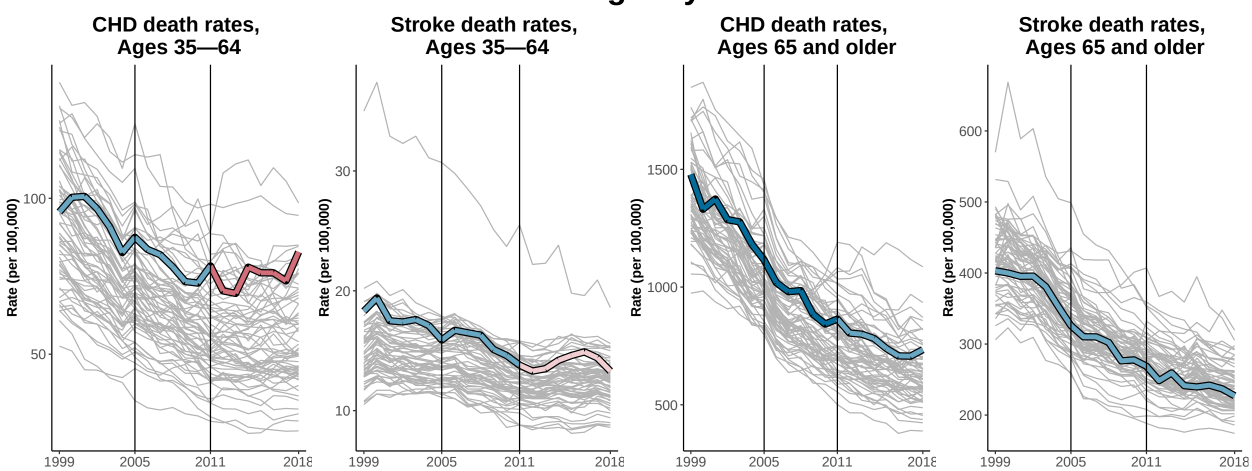
4.2 County-specific graphs



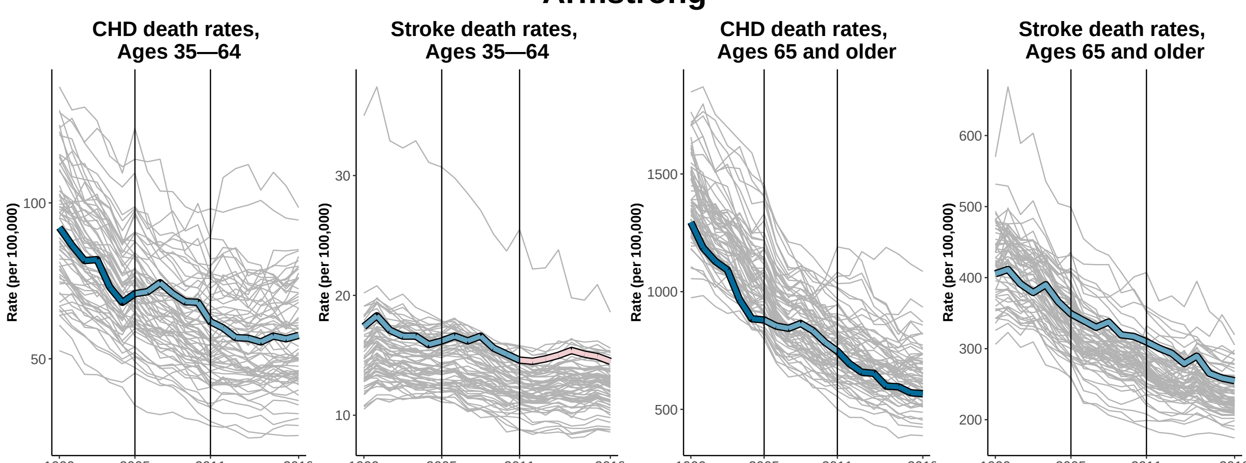
Adams

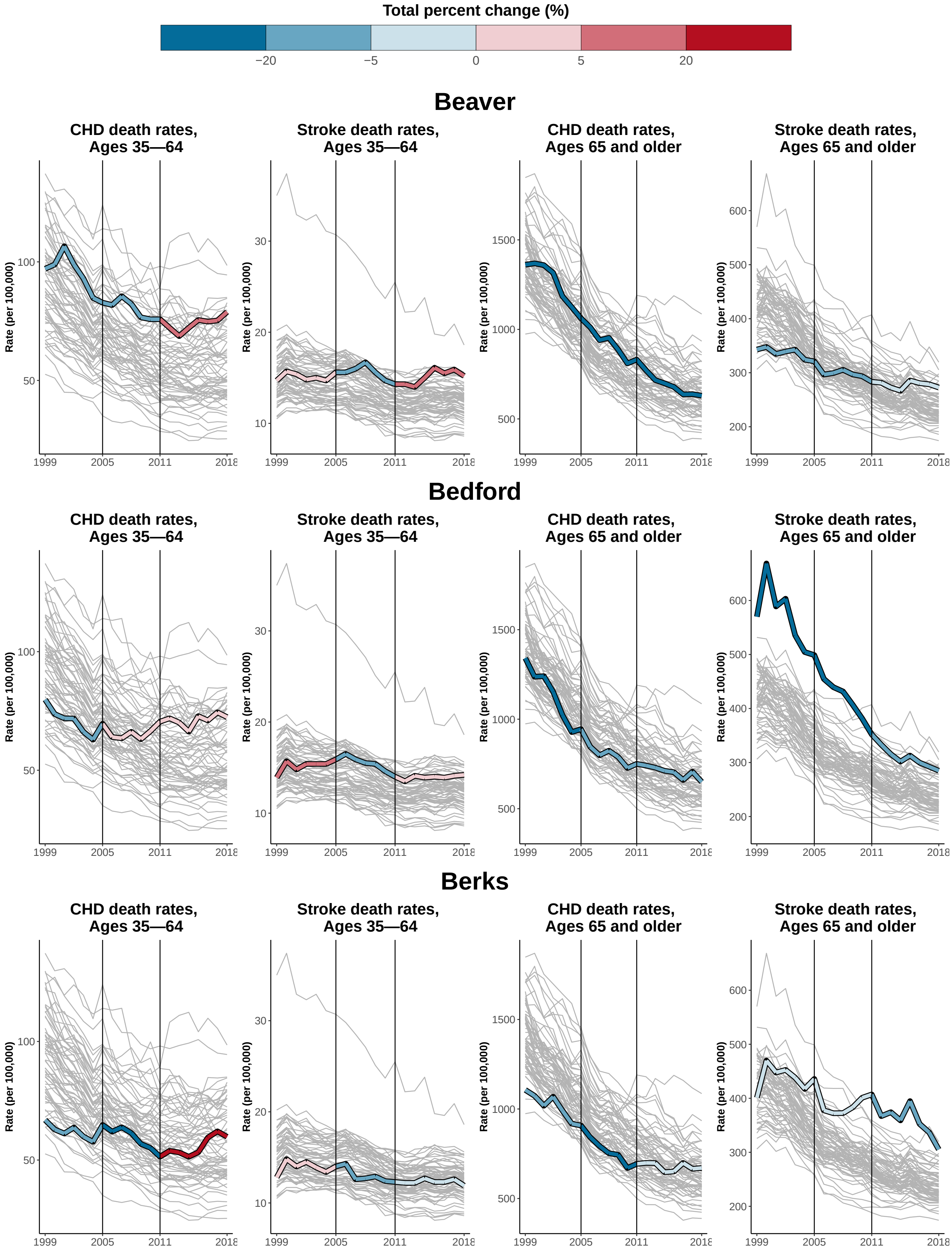


Allegheny

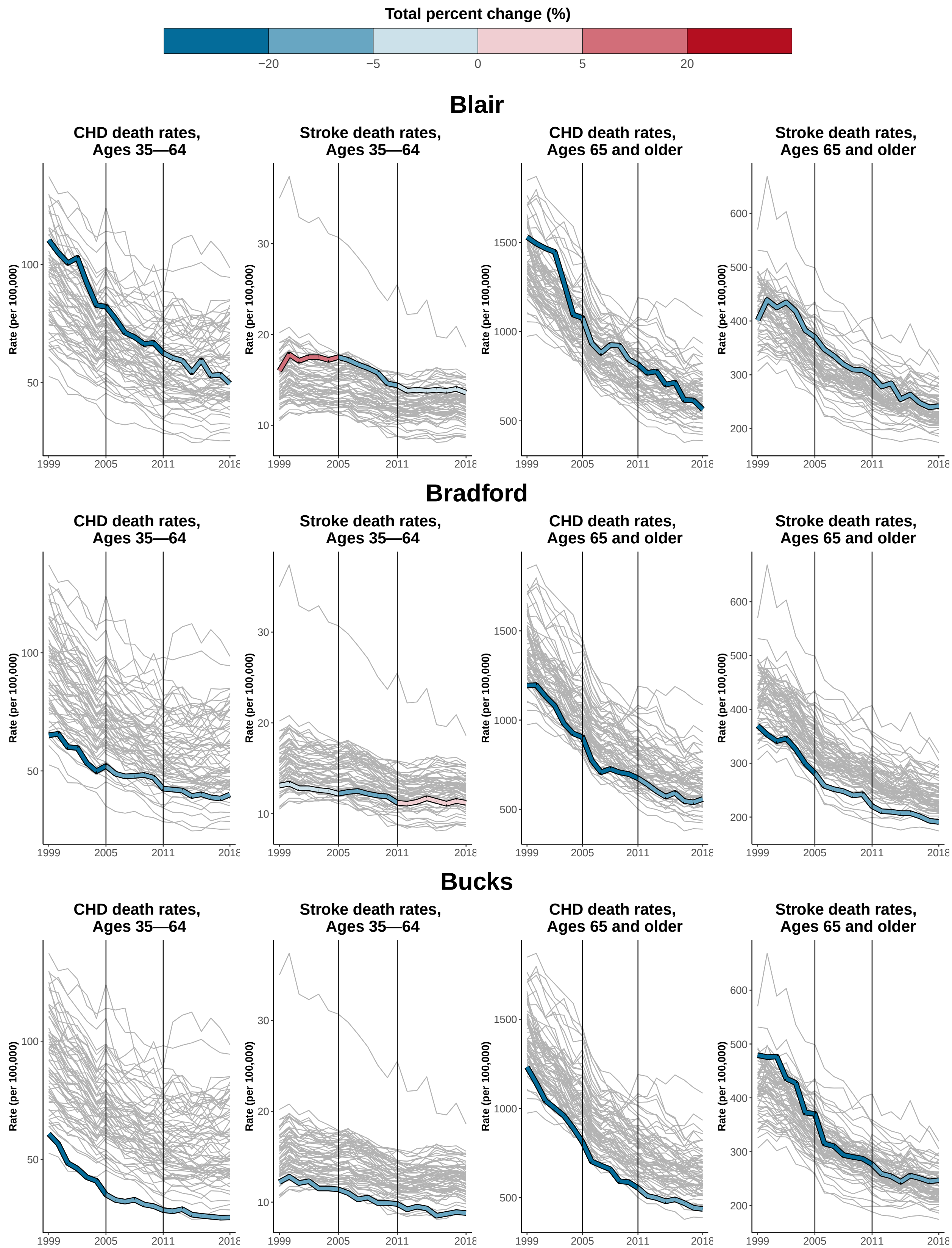


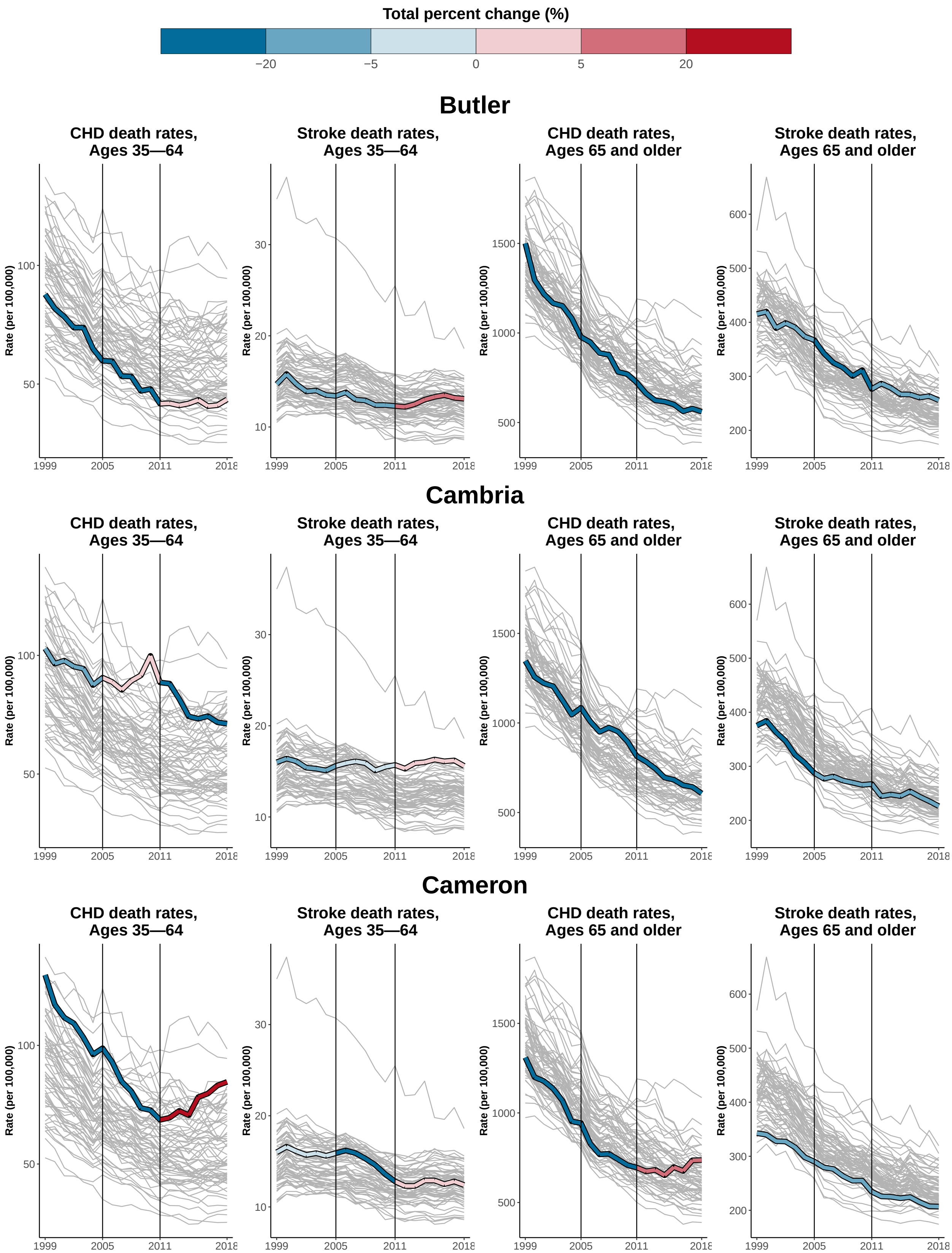
Armstrong

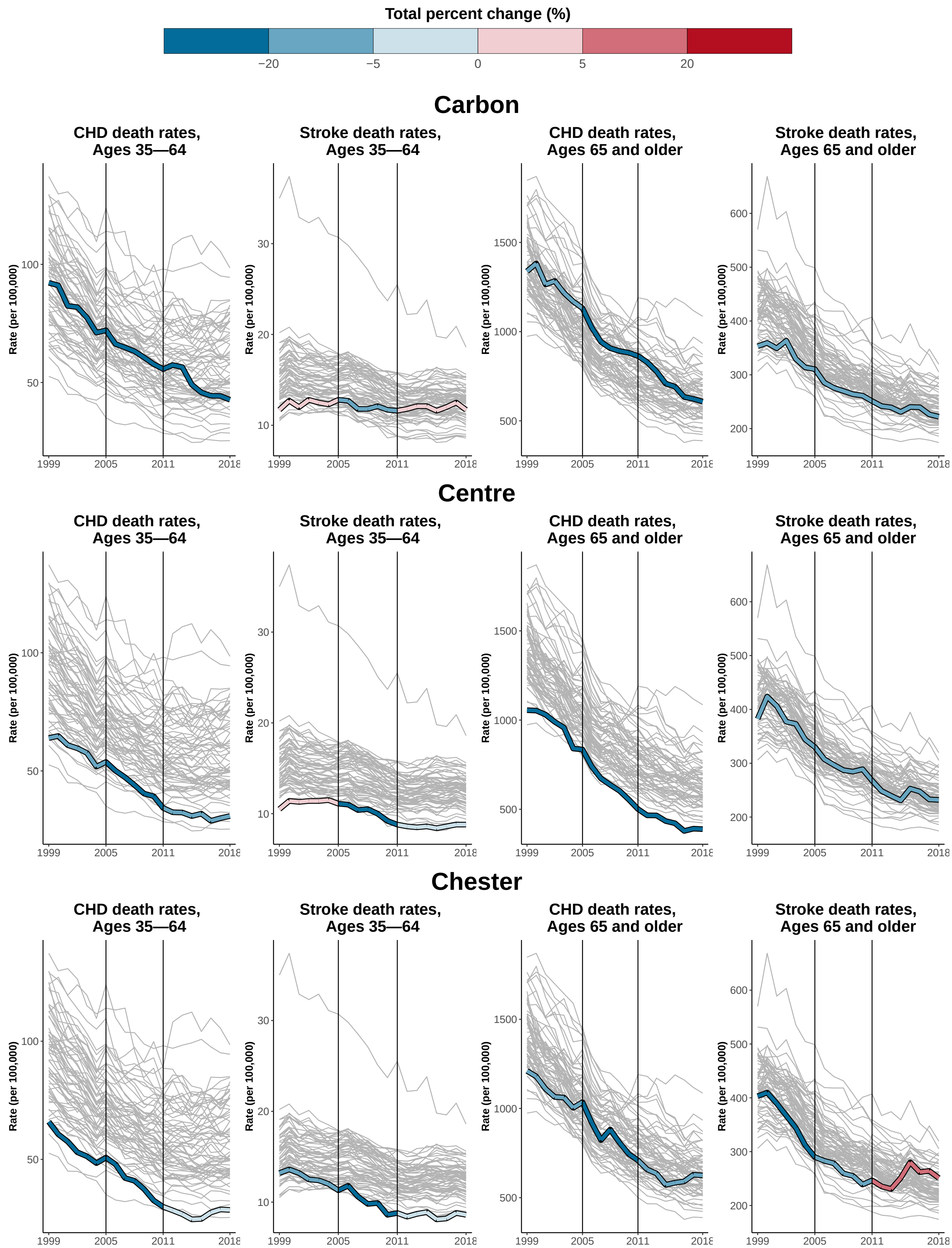


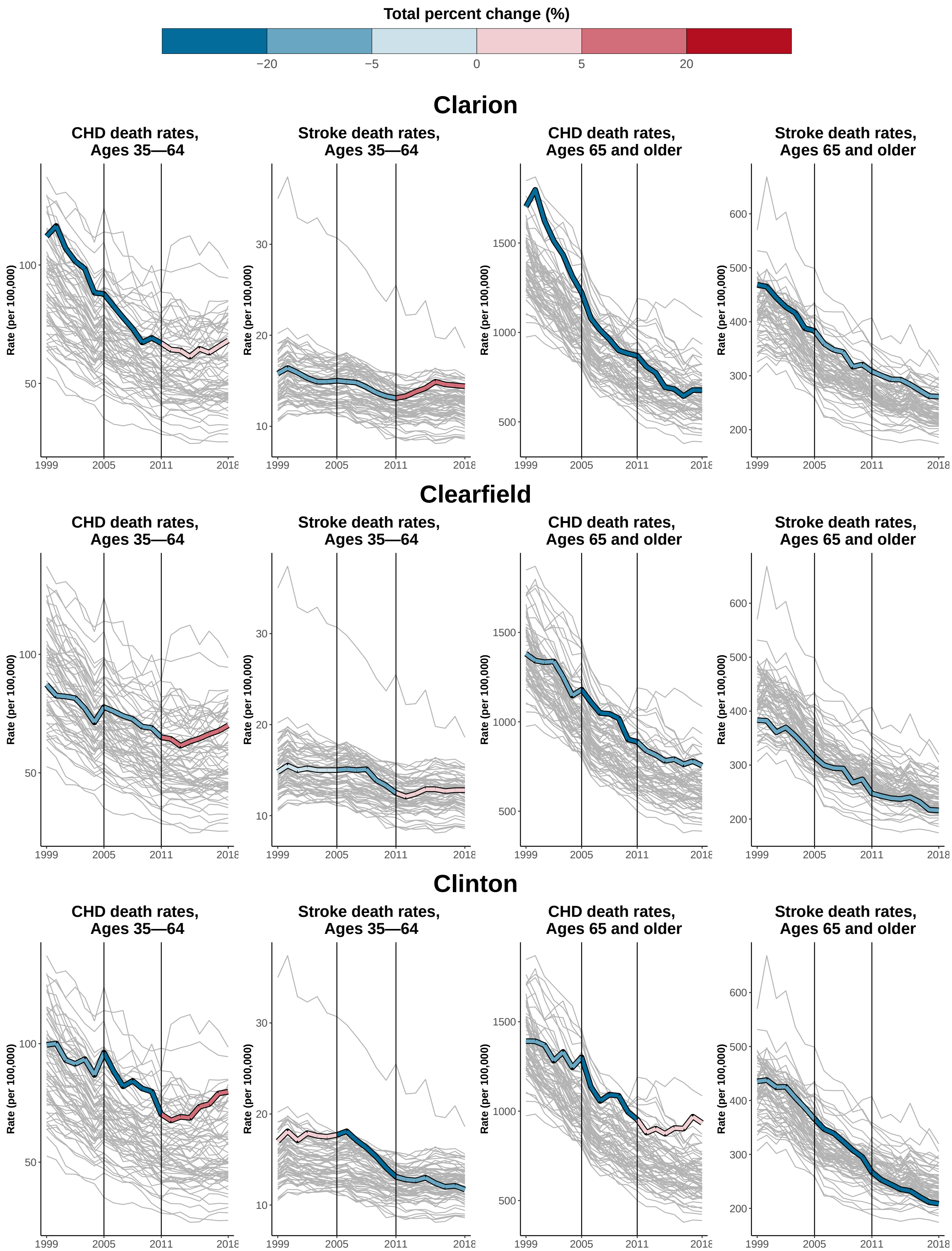


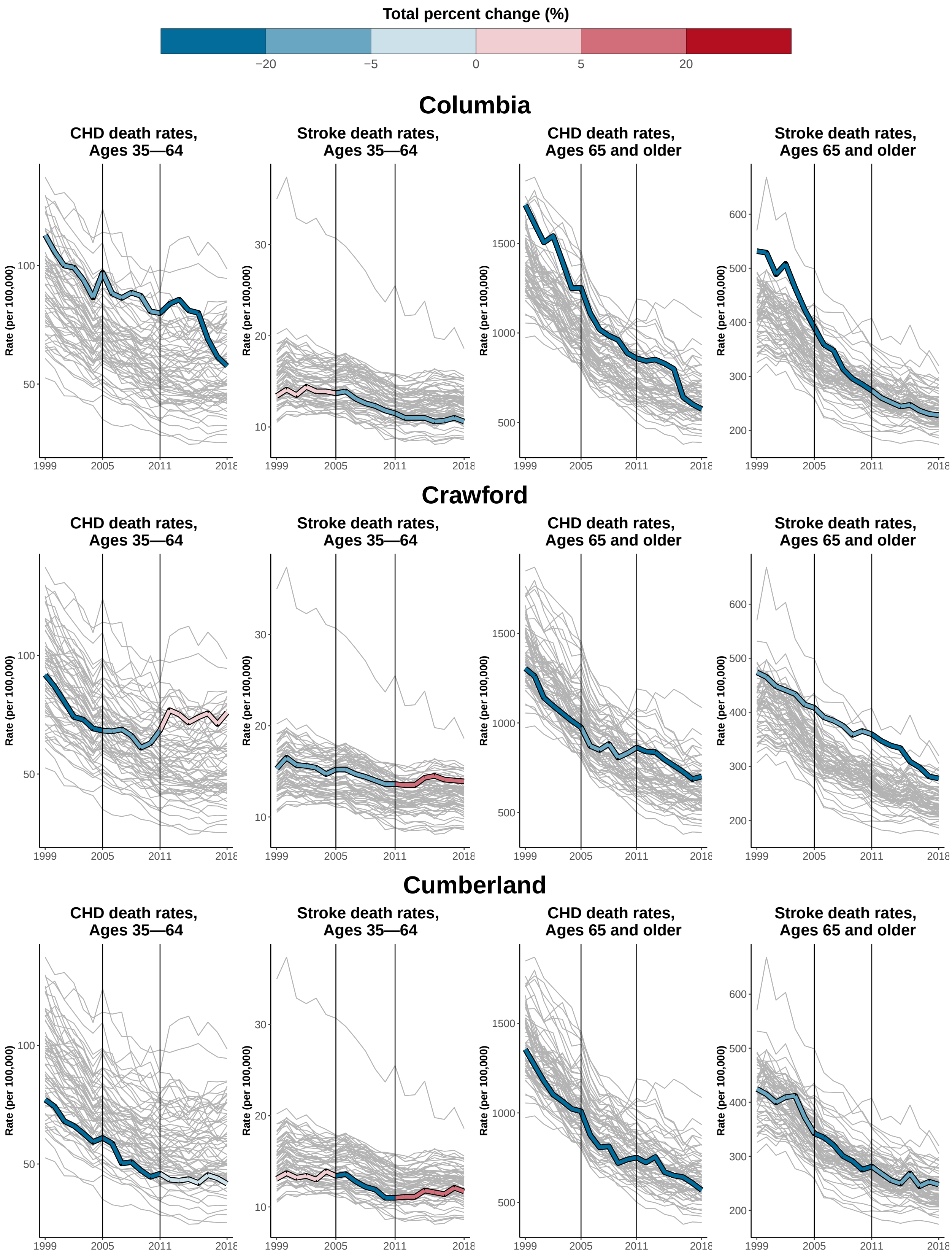
Total percent change (%)
−20
−5
0
5
20
Beaver
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Bedford
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Berks
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Rate (per 100,000)
1999
2005
2011
2018


Total percent change (%)
−20
−5
0
5
20
Blair
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Rate (per 100,000)
1999
2005
2011
2018
Bradford
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Rate (per 100,000)
Bucks
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Rate (per 100,000)

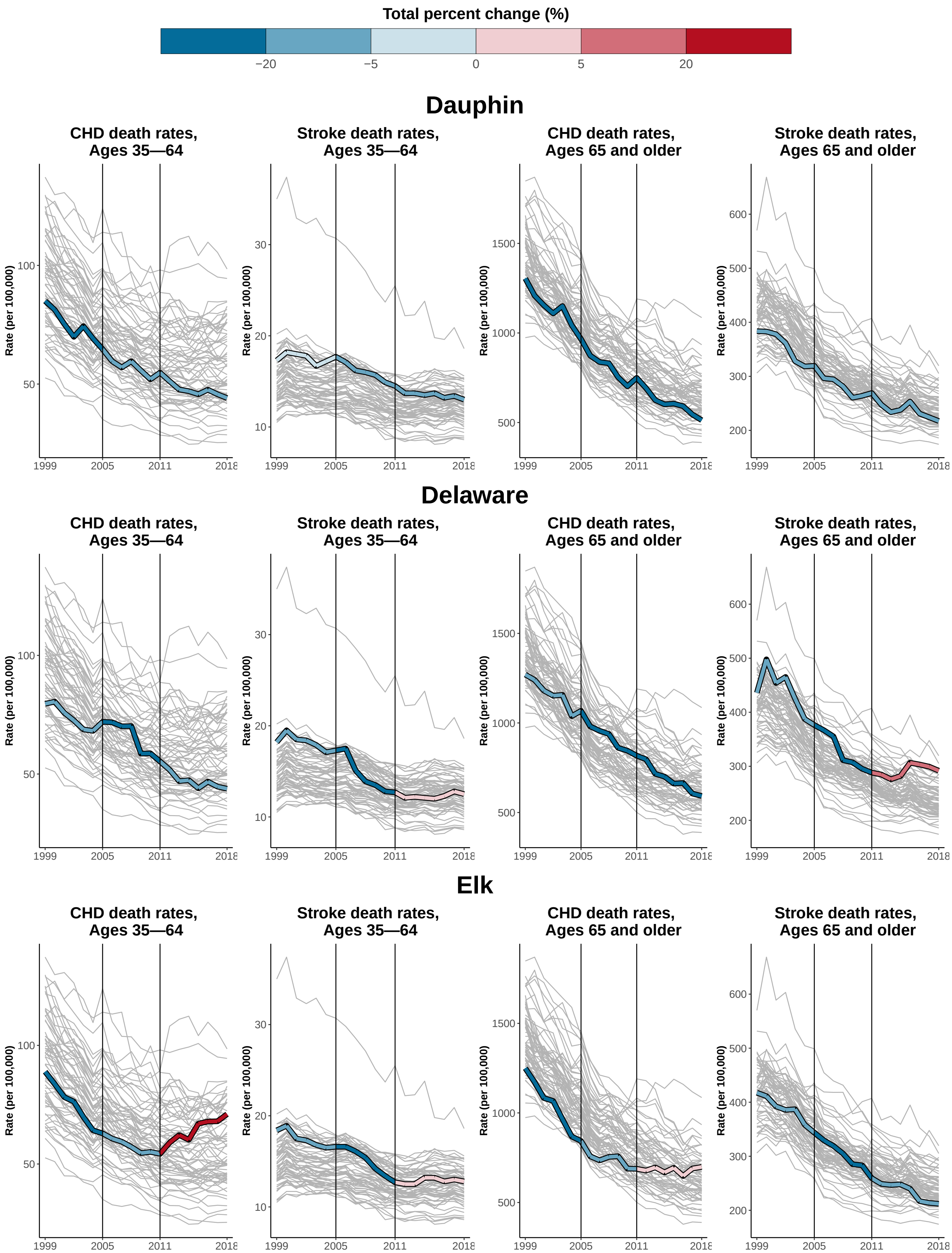

Total percent change (%)
−20
−5
0
5
20
Butler
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Cambria
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Cameron
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Rate (per 100,000)
1999
2005
2011
2018

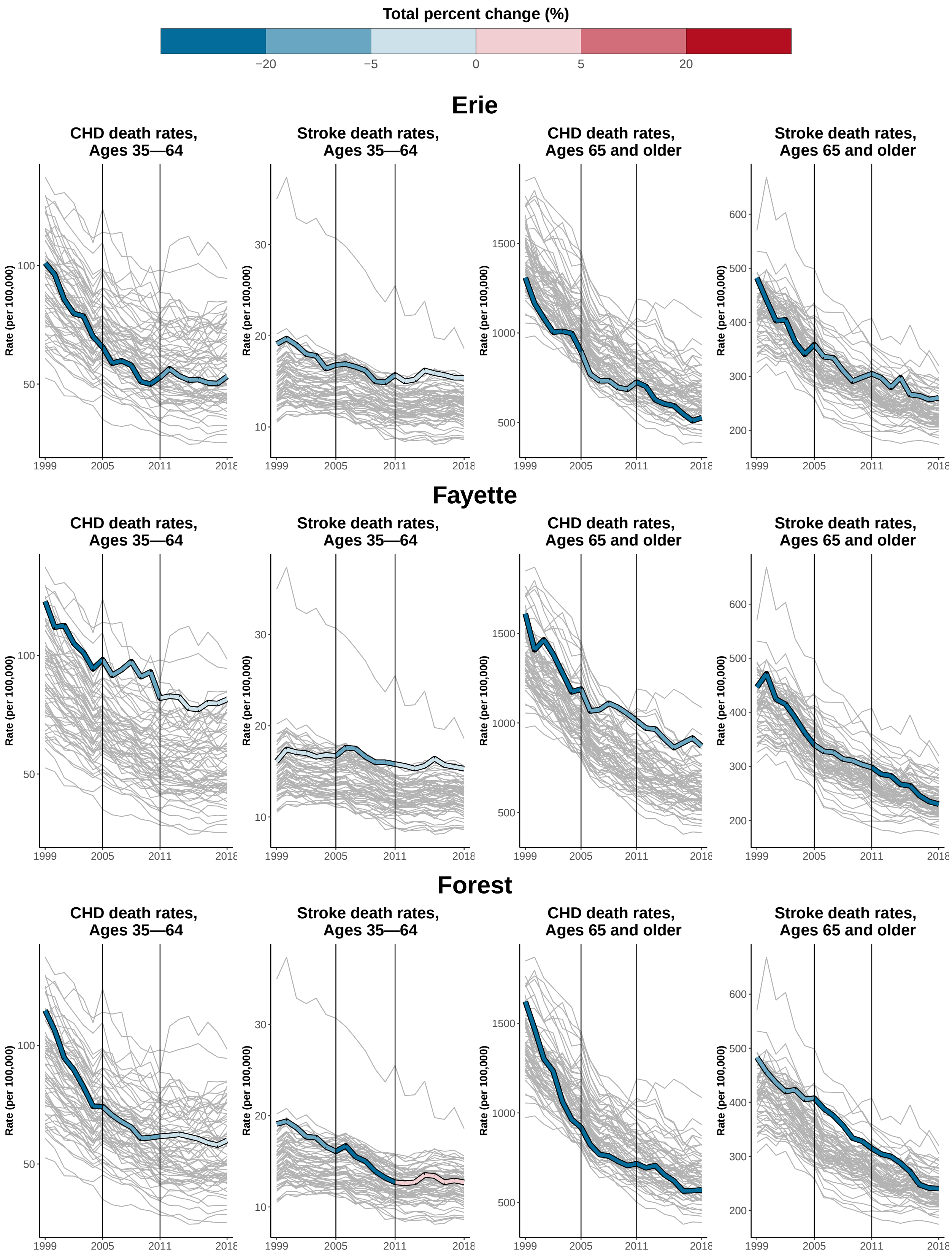

Total percent change (%)
−20
−5
0
5
20
Carbon
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Centre
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Chester
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Rate (per 100,000)
1999
2005
2011
2018

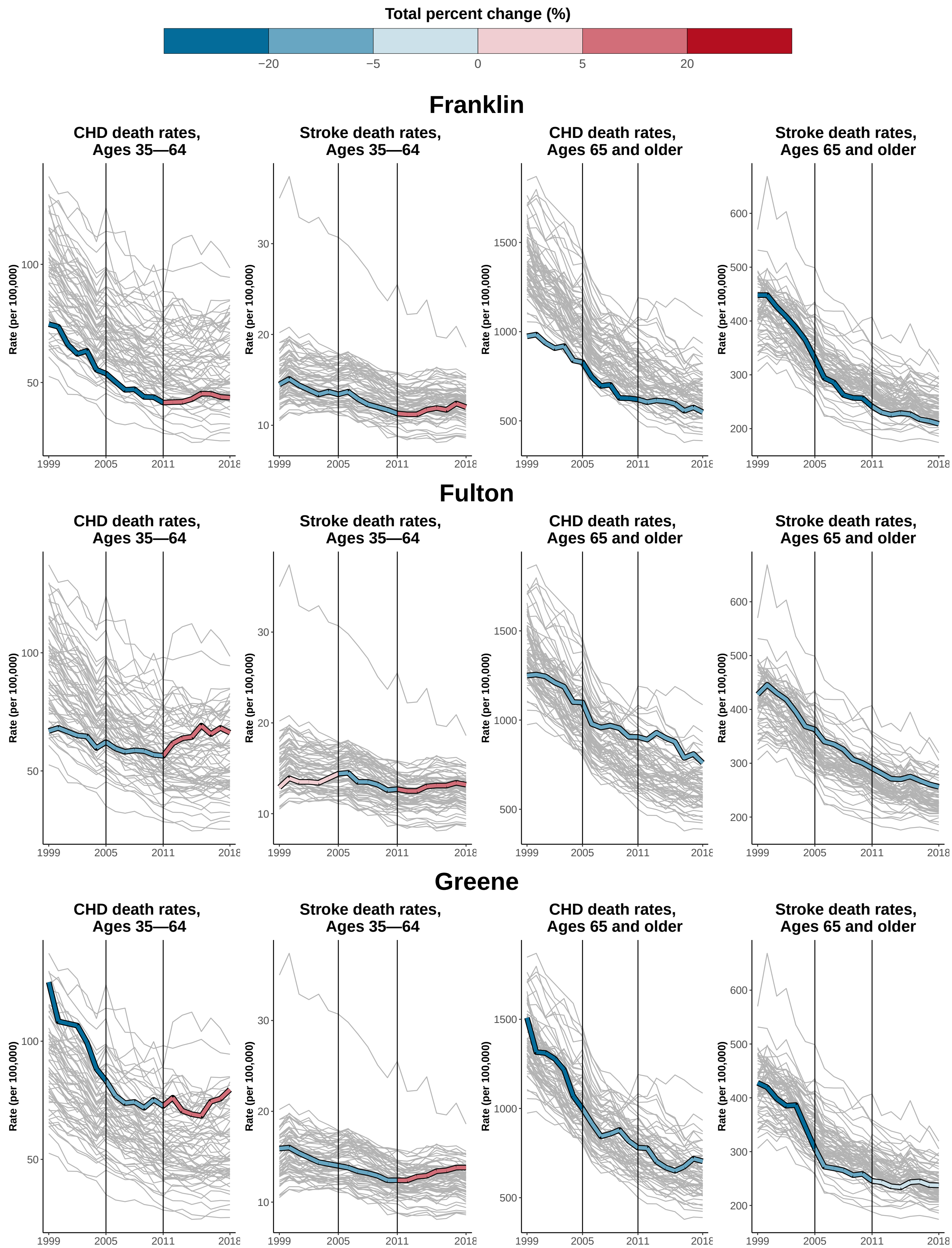

Total percent change (%)
−20
−5
0
5
20
Clarion
Clearfield
Clinton
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Rate (per 100,000)
1999
2005
2011
2018

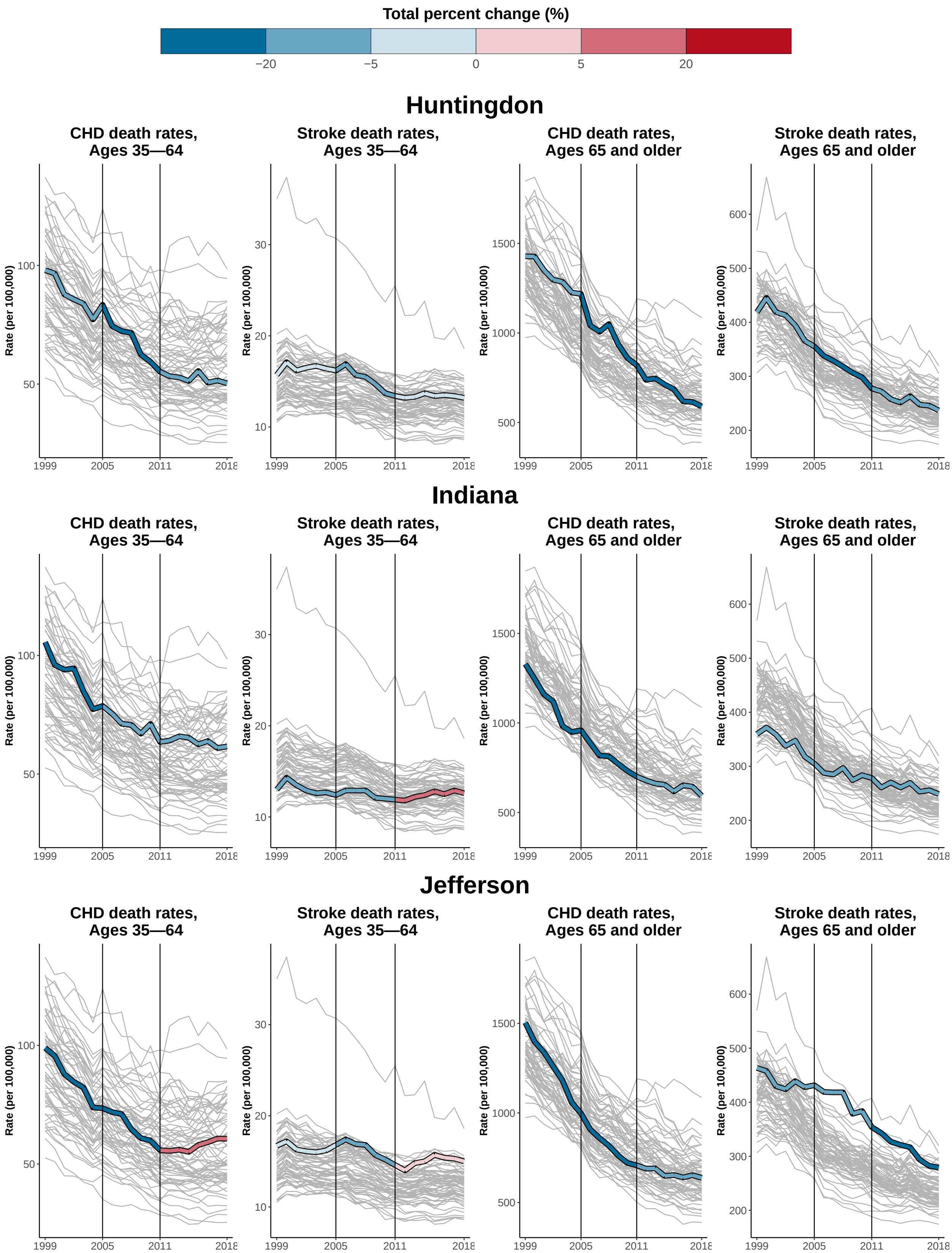


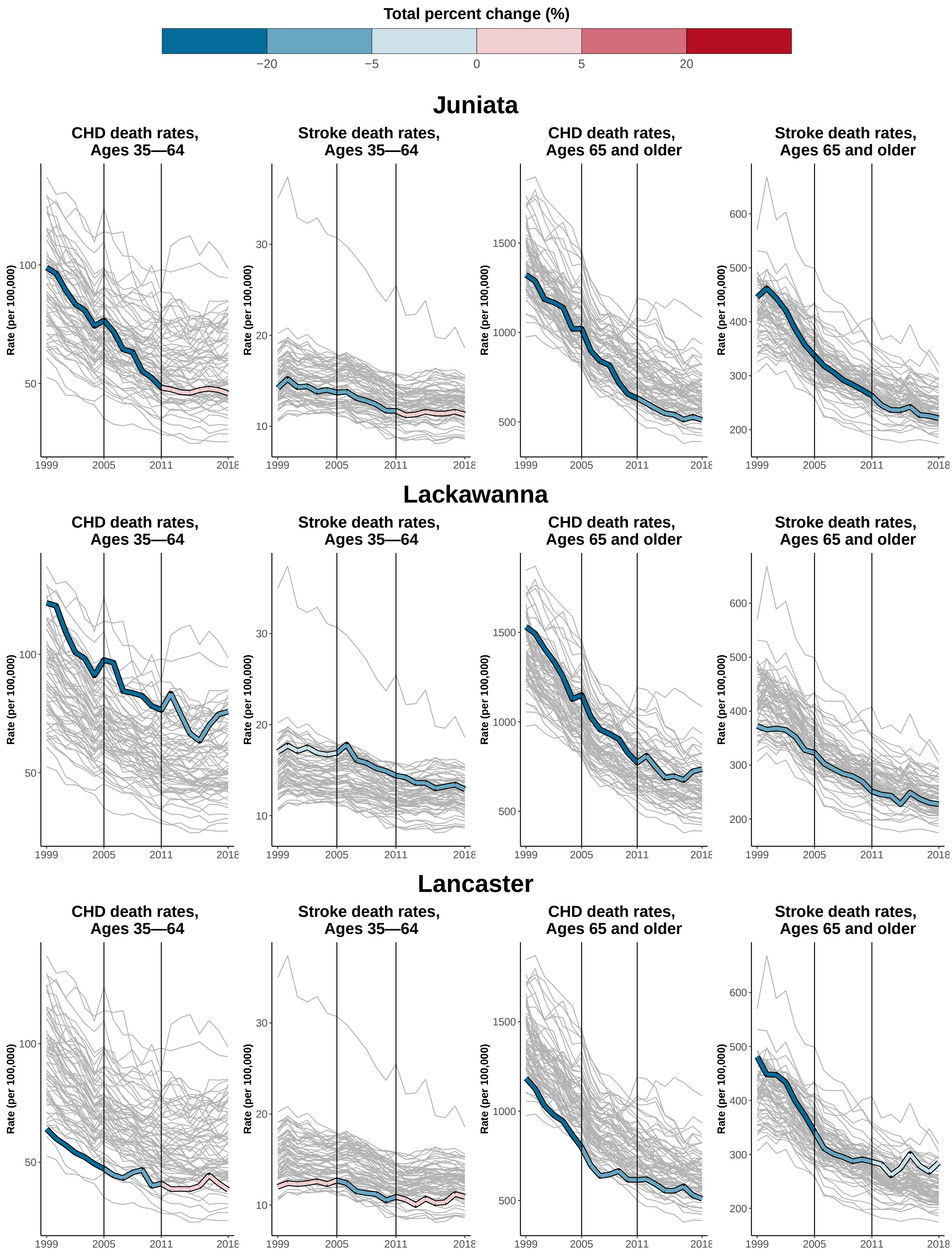
Total percent change (%)
−20
−5
0
5
20
Columbia
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Crawford
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Cumberland
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Rate (per 100,000)
1999
2005
2011
2018

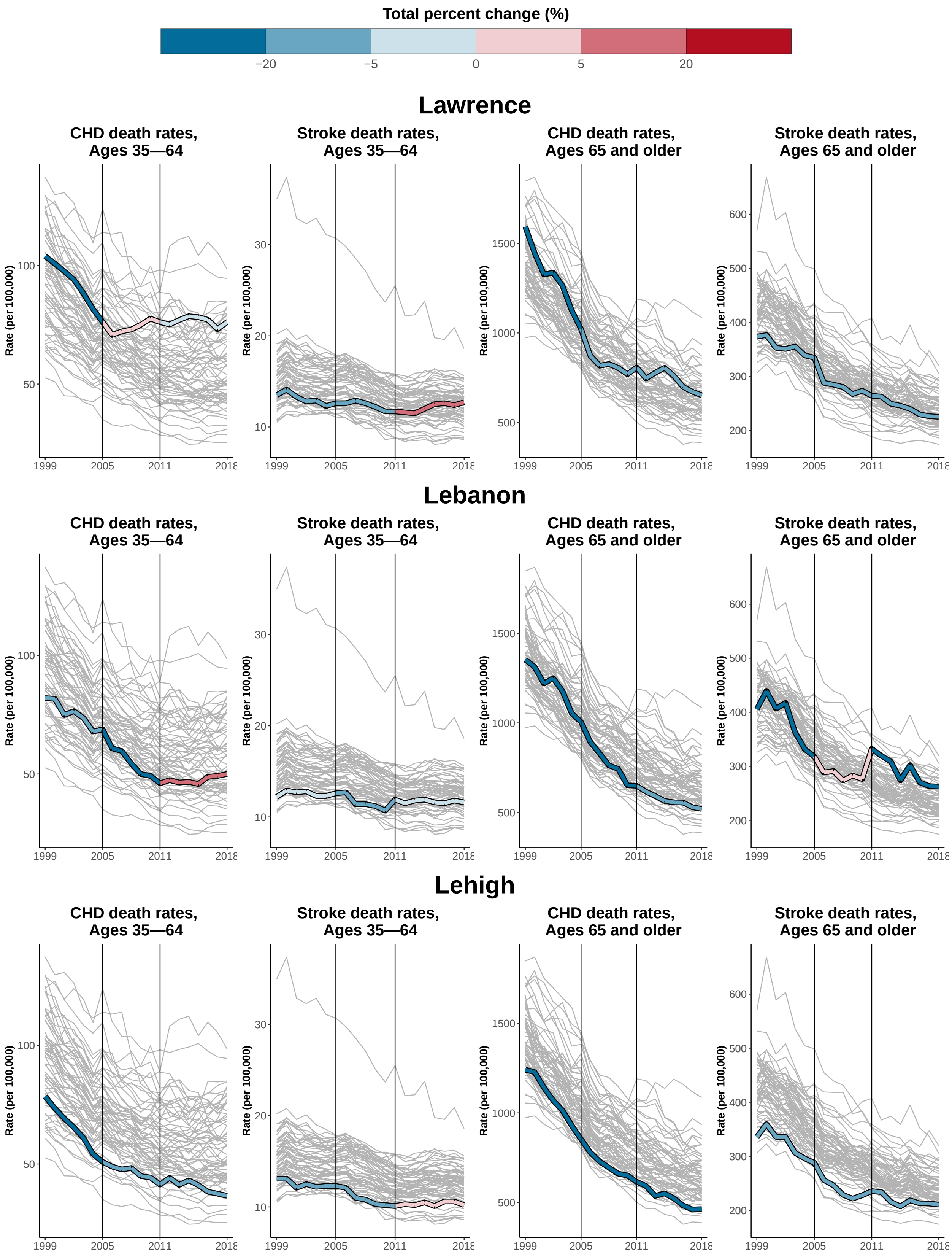

Total percent change (%)
−20
−5
0
5
20
Dauphin
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Delaware
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Elk
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Rate (per 100,000)
1999
2005
2011
2018

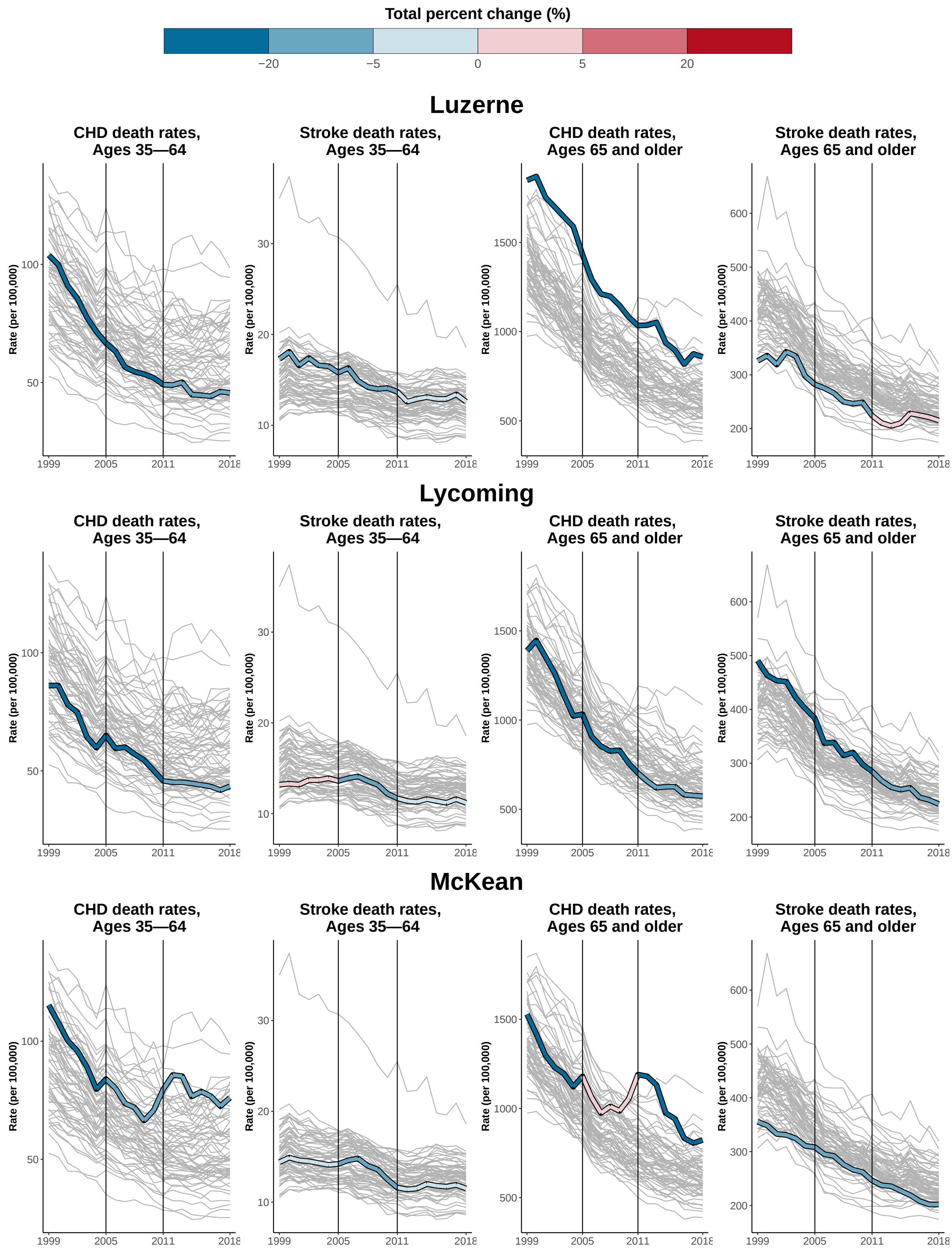

Total percent change (%)
−20
−5
0
5
20
Erie
Fayette
Forest
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Rate (per 100,000)
1999
2005
2011
2018

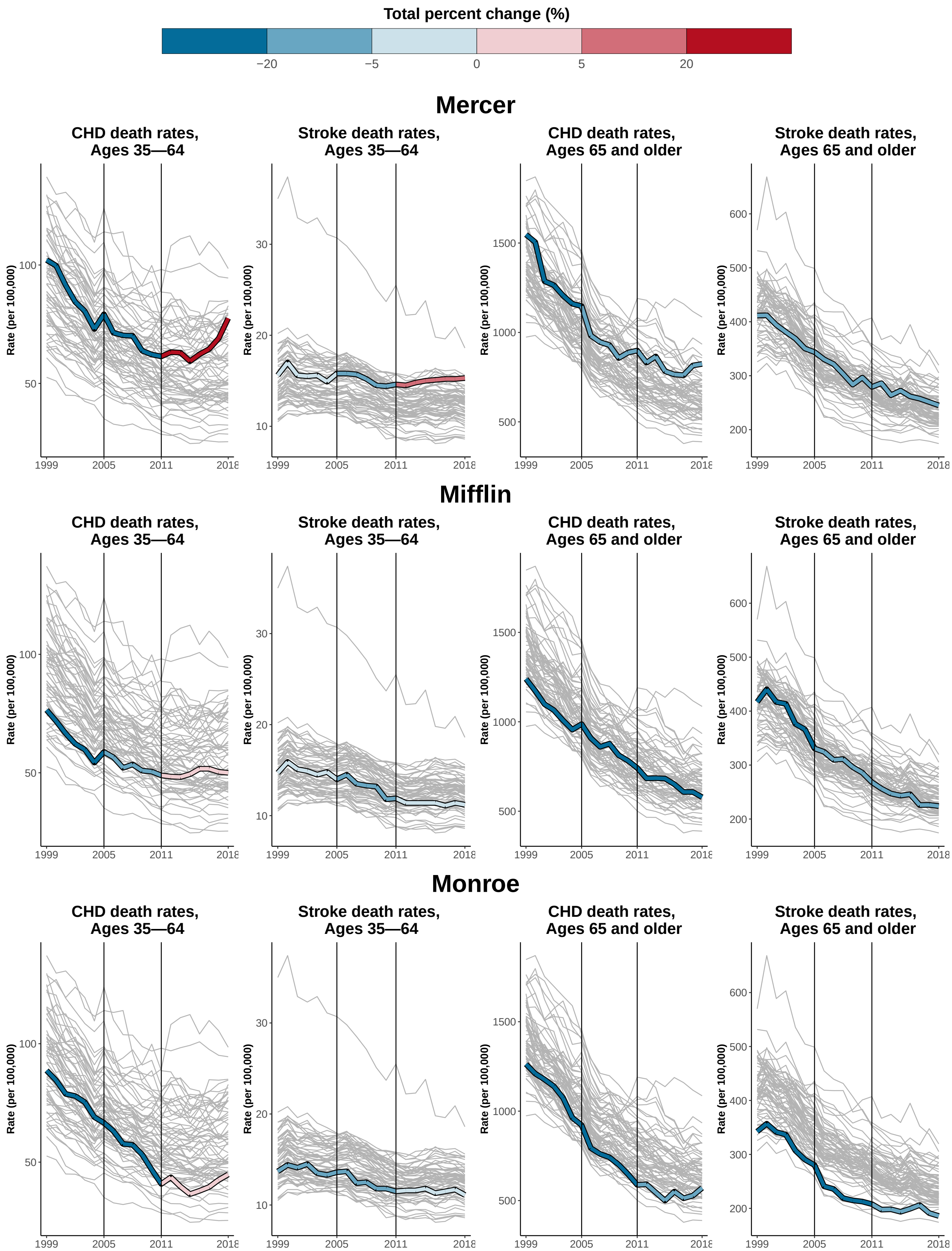

Total percent change (%)
−20
−5
0
5
20
Franklin
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Fulton
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Greene
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Rate (per 100,000)
1999
2005
2011
2018

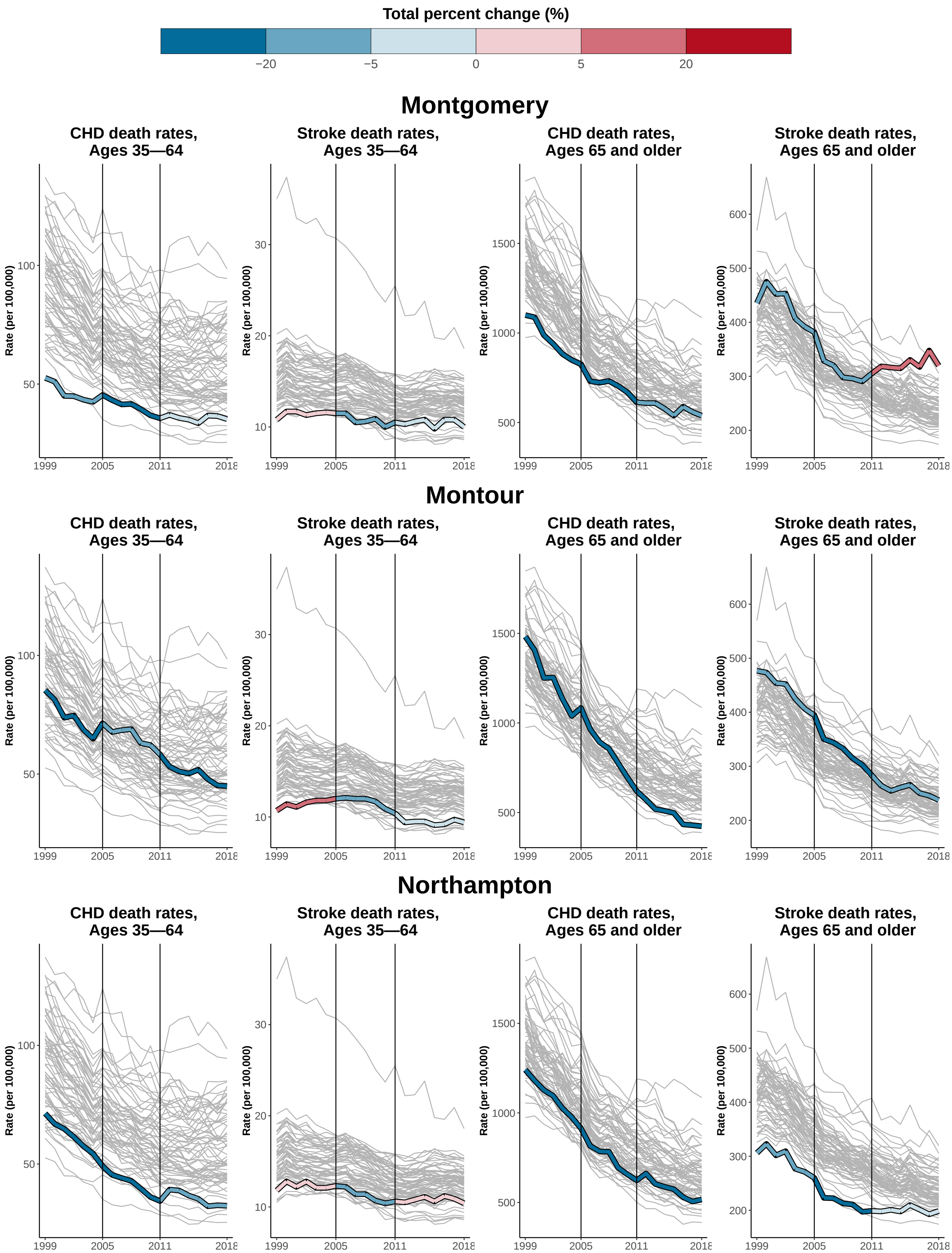

Total percent change (%)
−20
−5
0
5
20
Huntingdon
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Indiana
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Jefferson
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Rate (per 100,000)
1999
2005
2011
2018

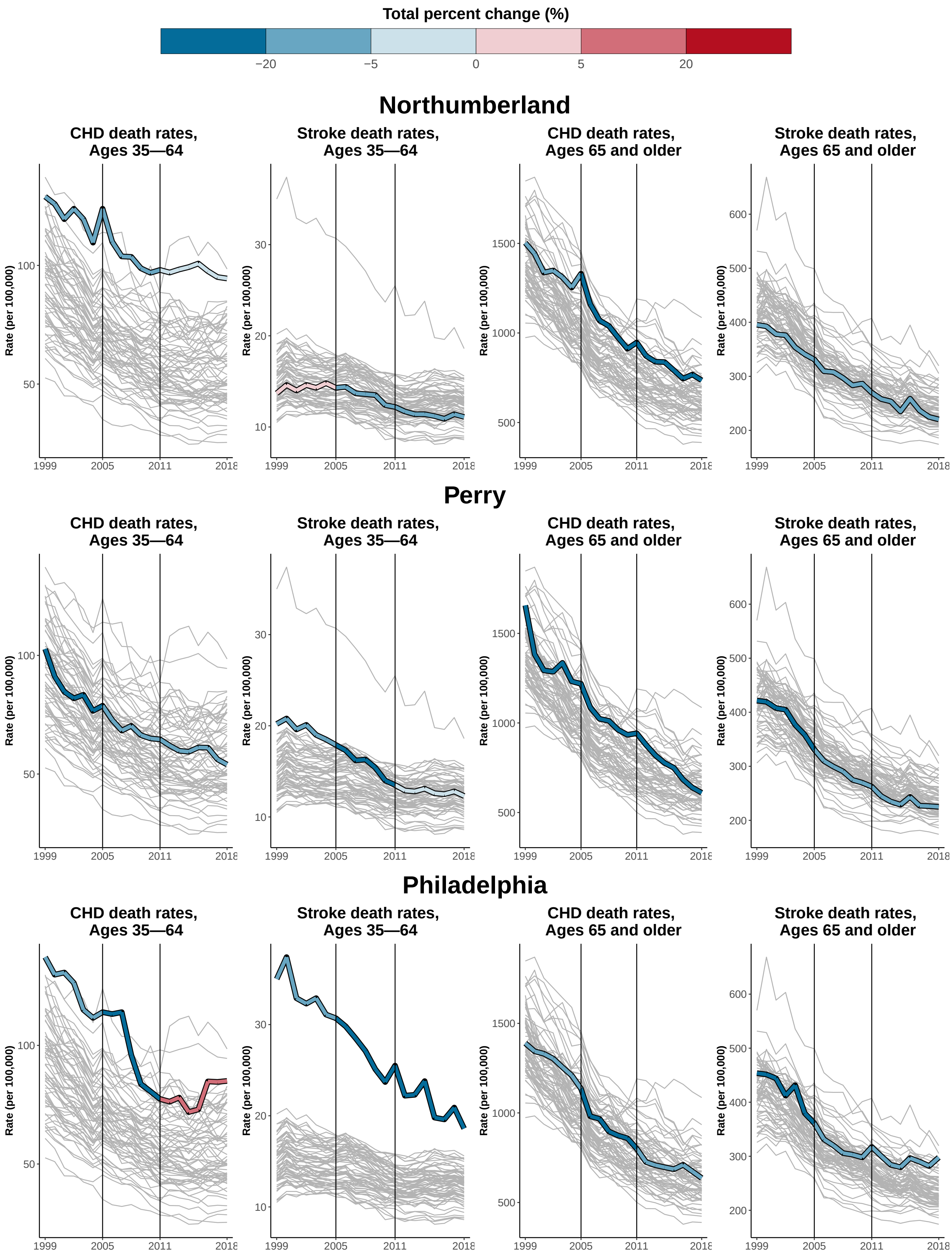

Total percent change (%)
−20
−5
0
5
20
Juniata
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Lackawanna
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Lancaster
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Rate (per 100,000)
1999
2005
2011
2018
50
100
10
20
30
500
1000
1500
200
300
400
500
600


Total percent change (%)
−20
−5
0
5
20
Lawrence
Lebanon
Lehigh
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Rate (per 100,000)
1999
2005
2011
2018


Total percent change (%)
−20
−5
0
5
20
Luzerne
Lycoming
McKean
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Rate (per 100,000)
1999
2005
2011
2018


Total percent change (%)
−20
−5
0
5
20
Mercer
Mifflin
Monroe
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Rate (per 100,000)
1999
2005
2011
2018


Total percent change (%)
−20
−5
0
5
20
Montgomery
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Rate (per 100,000)
1999
2005
2011
2018
Montour
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Northampton
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older


Total percent change (%)
−20
−5
0
5
20
Northumberland
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Perry
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Philadelphia
CHD death rates, Ages 35—64
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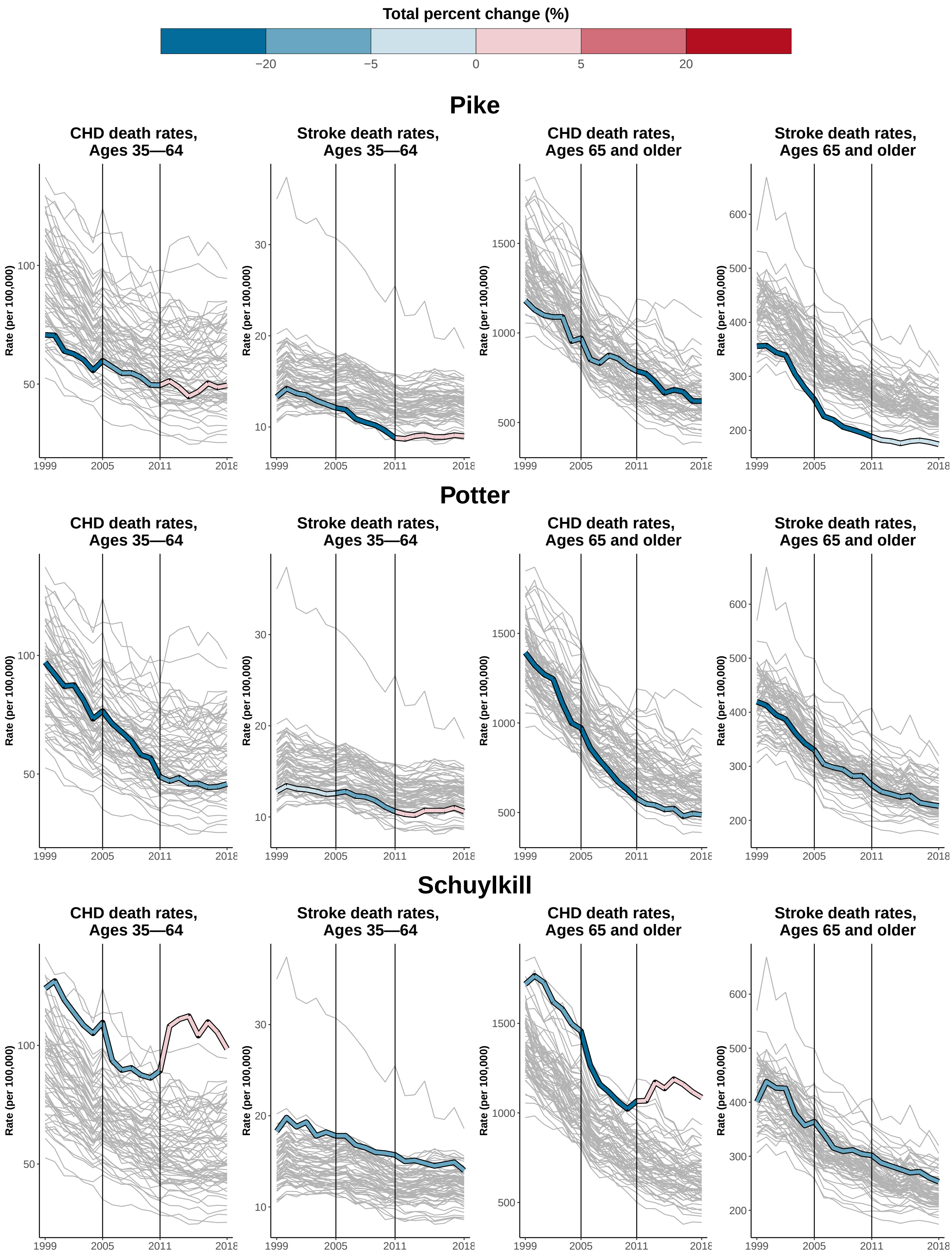
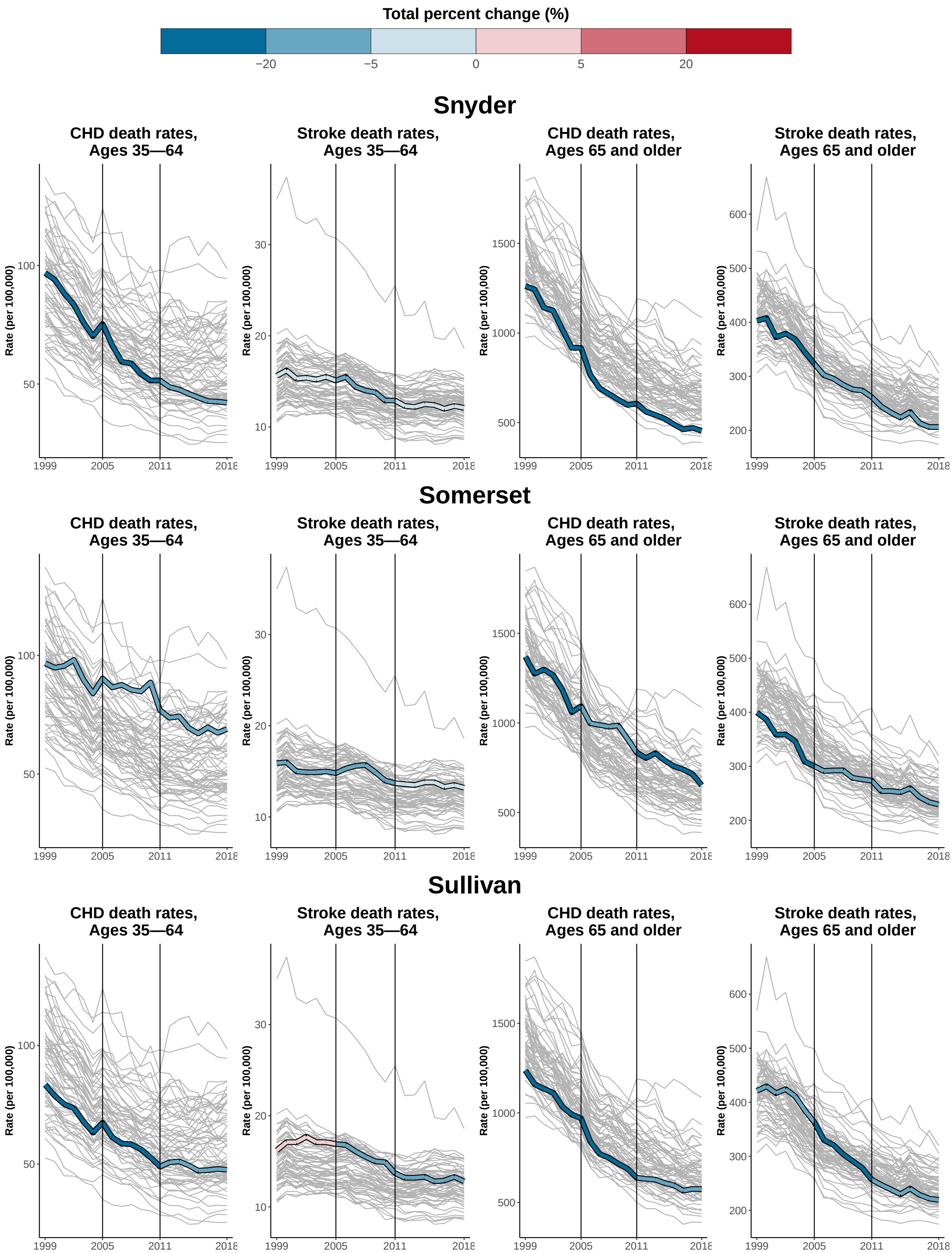
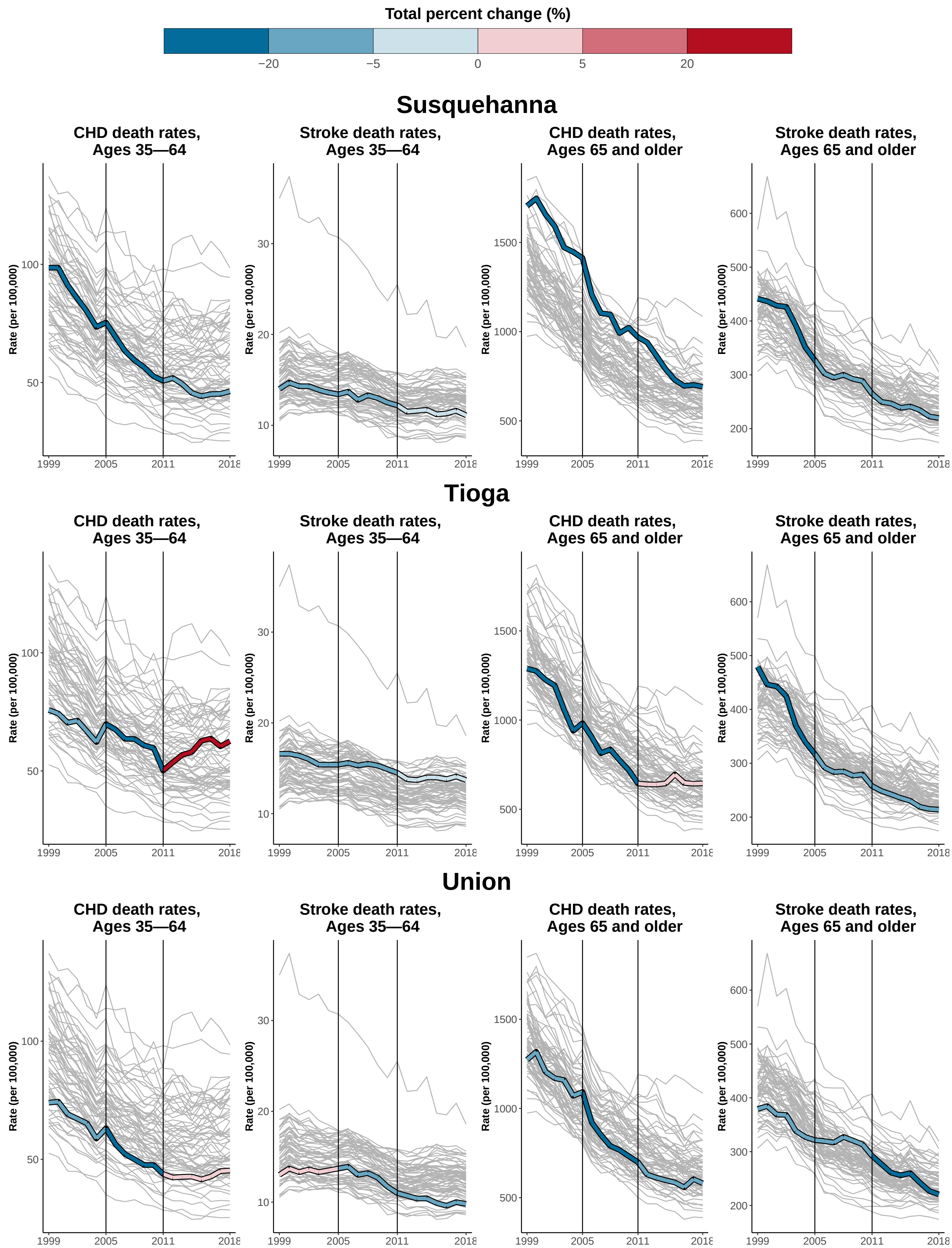
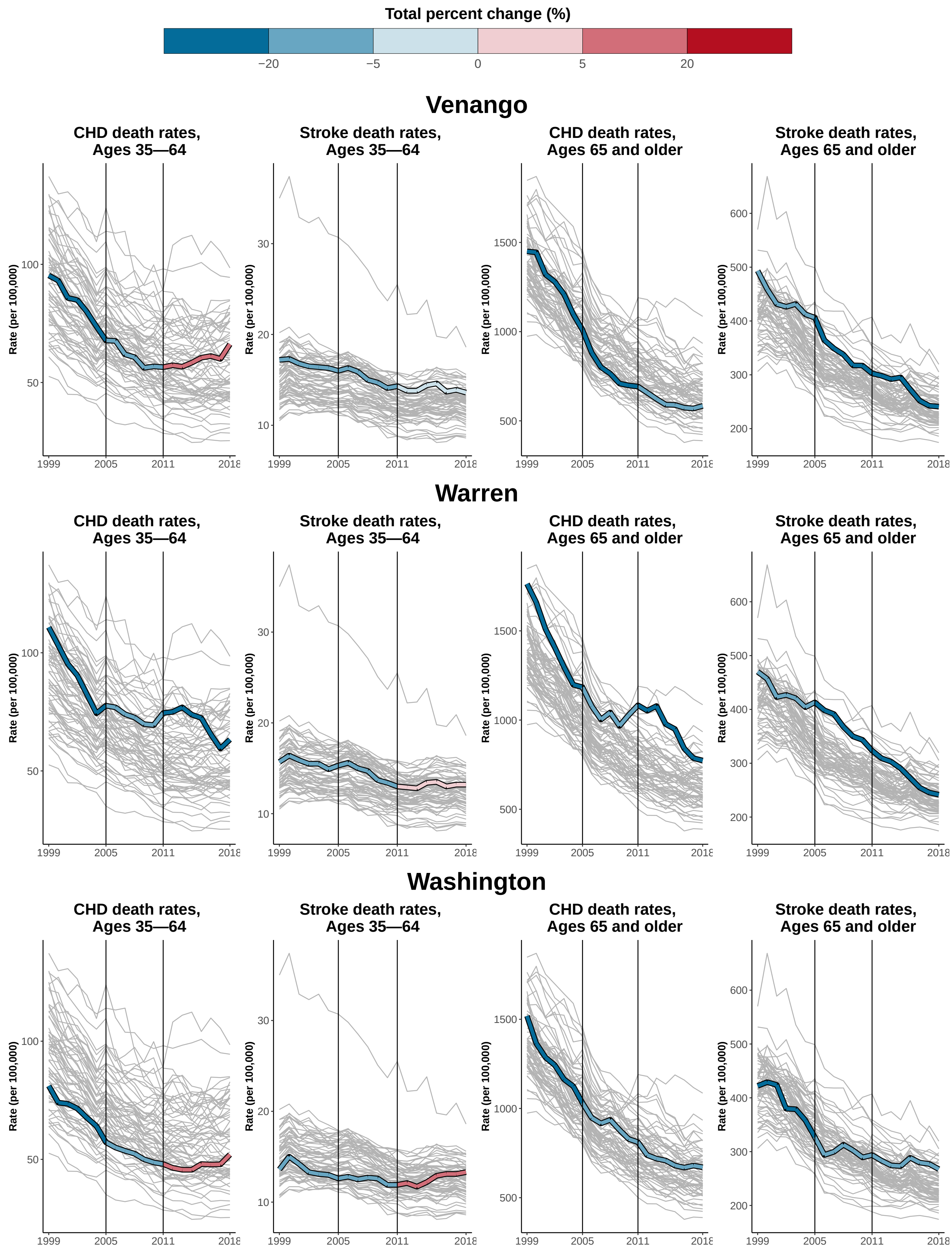
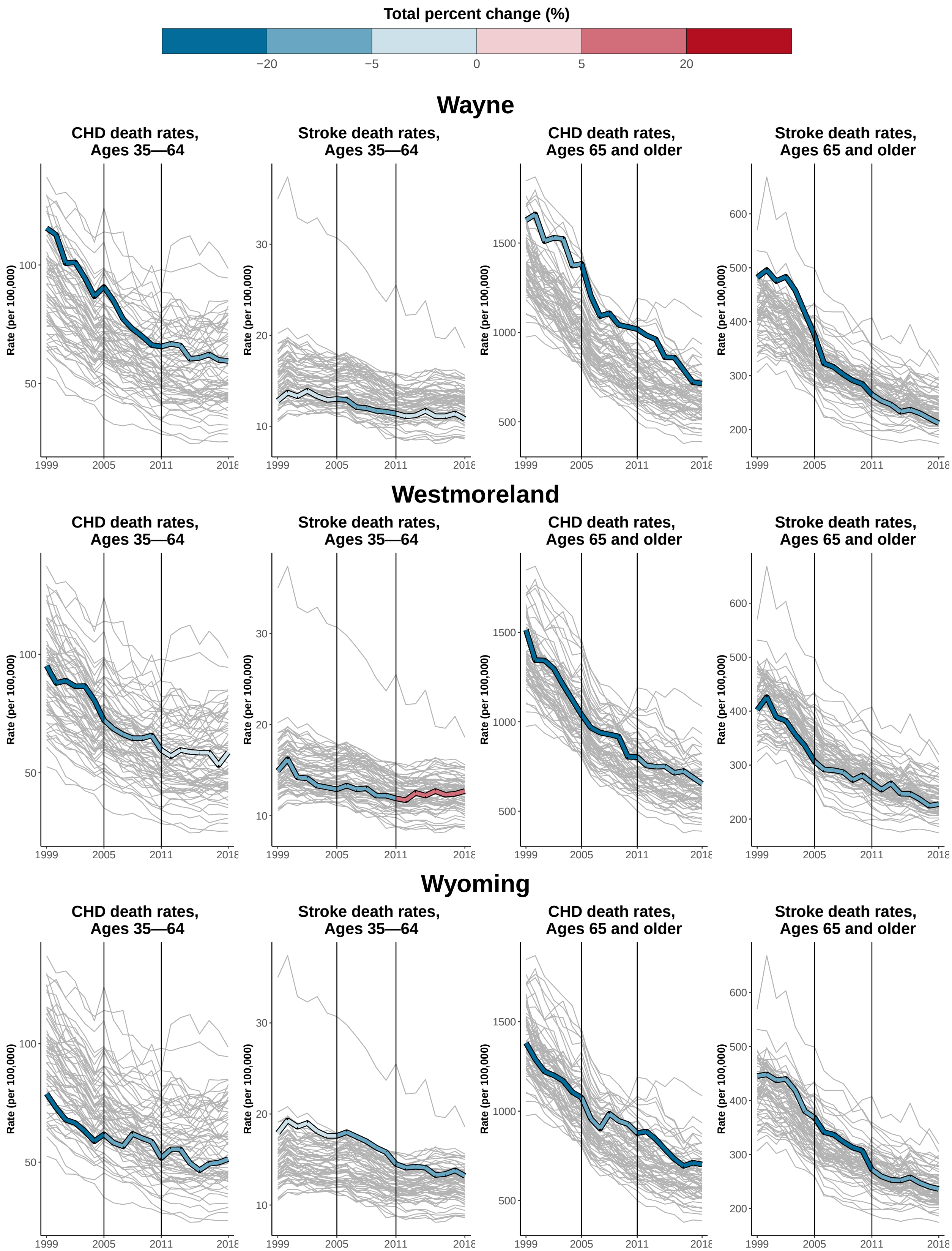
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Rate (per 100,000)
1999
2005
2011
2018

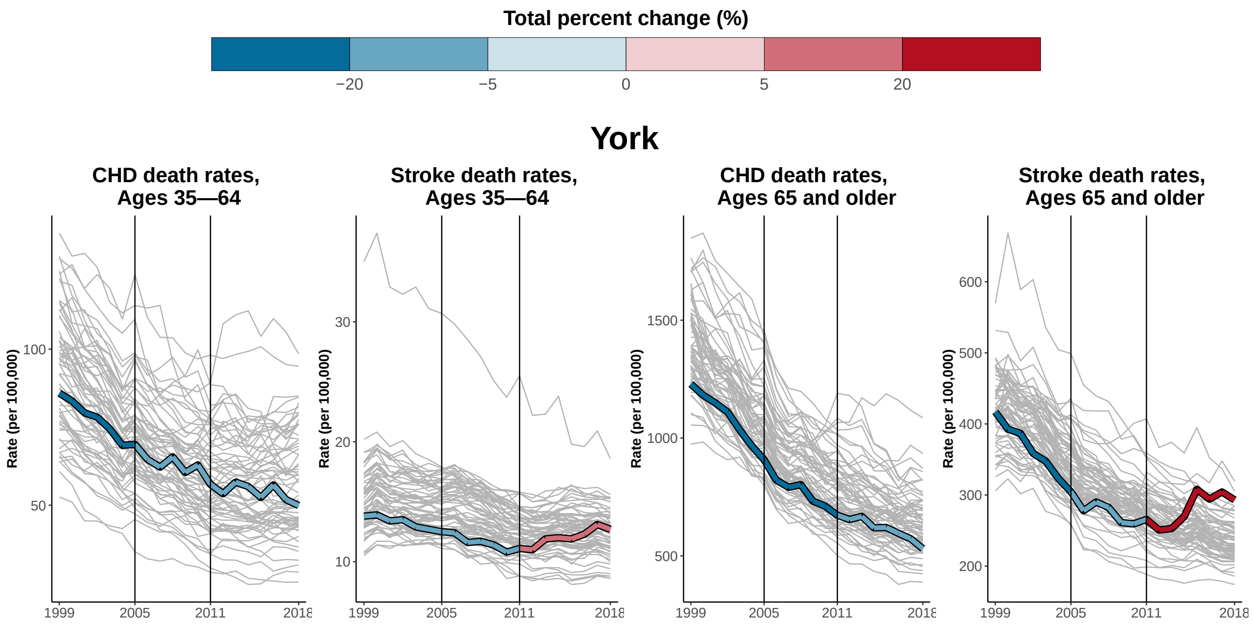

Total percent change (%)
−20
−5
0
5
20
Pike
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Rate (per 100,000)
1999
2005
2011
2018
Potter
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Schuylkill
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older


Total percent change (%)
−20
−5
0
5
20
Snyder
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Somerset
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Sullivan
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Rate (per 100,000)
1999
2005
2011
2018


Total percent change (%)
−20
−5
0
5
20
Susquehanna
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Tioga
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Union
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Rate (per 100,000)
1999
2005
2011
2018


Total percent change (%)
−20
−5
0
5
20
Venango
Warren
Washington
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Rate (per 100,000)
1999
2005
2011
2018
50
100
10
20
30
500
1000
1500
200
300
400
500
600


Total percent change (%)
−20
−5
0
5
20
Wayne
Westmoreland
Wyoming
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Rate (per 100,000)
1999
2005
2011
2018


Total percent change (%)
−20
−5
0
5
20
York
CHD death rates, Ages 35—64
Stroke death rates, Ages 35—64
CHD death rates, Ages 65 and older
Stroke death rates, Ages 65 and older
Rate (per 100,000)
1999
2005
2011
2018

5 Detailed Methods

5.1 Estimating death rates

We estimated age group-specific, county-level heart disease death rates using a previously described Bayesian multivariate space-time conditional autoregressive model (Quick et al., 2017). County-level heart disease death rates for each age group were estimated as the medians of the posterior distributions defined by the MCMC iterations. More specifically, we modeled Y_{ikt}, the number of deaths due to heart disease in county i and age group k during year t from a population of size n_{ikt}, using a Poisson distribution of the form $Y_{ikt} \sim Pois(n_{ikt}\lambda_{ikt})$, where λ_{ikt} denotes the death rate. To model λ_{ikt}, we assume $ln(\lambda_{ikt}) \sim N(\beta_{kt} + Z_{ikt}, \tau_k^2)$ where β_{kt} is a random intercept for each group for each year with a vague N(0,100) prior, Z_{ikt} is a spatiotemporal random effect that incorporates correlation between groups, and τ_k^2 is a variance parameter with a weakly informative gamma prior (Waller et al., 1997).

To account for these various sources of dependence, we modeled Z_{ikt} using the multivariate space-time conditional autoregressive (MSTCAR) model of Quick et al. (2017). A special case of the multivariate CAR (MCAR) model of (Gelfand and Vounatsou, 2003), our MSTCAR model shrinks the random effects for each county toward the values in neighboring counties. Similarly, temporal structure is accounted for within the MSTCAR model by shrinking estimates toward adjacent years using an approach similar to a standard autoregressive order 1 (AR(1)) model with a beta prior. Finally, correlations between groups are estimated via an unstructured covariance matrix with an inverse Wishart prior (Waller et al., 1997).

We ran the MCMC algorithm with four chains for 6,000 iterations, diagnosing convergence via trace plots for many of the model parameters and discarding the first 3,000 iterations as burn-in. We generated estimates based on posterior medians, and 95% credible intervals were obtained by taking the 2.5- and 97.5-percentiles from the thinned post burn-in samples.

5.2 Estimating trends

We estimated relative total percent change in death rates using log-linear regression, including all years within each interval. Using relative change instead of absolute change allowed us to compare results across outcomes and age groups. These comparisons would not be possible when using absolute change because of large variation in death rates across outcomes and age groups. This method also permitted all rates to inform estimates of percent change, which is not true when calculating percent change using differences in rates between the beginning and end of each time period.

Following the previously described estimation of rates, separate log-linear regression models were run for each county, outcome, and age group using rates for all years within each time period for each MCMC iteration. Specifically, for MCMC iteration m, county i, and age group k at year t, the model was $ln(\lambda_{iktm}) = \beta_{0ikm} + \beta_{1ikm} \cdot year$. The total percent change was then calculated as $100(e^{\beta_{1ikm}} - 1)$. We then estimated percent change for each combination of county and age group as the median total percent change across all MCMC distributions.

5.3 References

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Quick H, Casper M, Waller LA. A multivariate space-time model for analysing county level heart disease death rates by race and sex. Journal of the Royal Statistical Society Applied Statistics Series C. 2017;67:291-304. doi: 10.1111/rssc.12215.

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Waller LA, Carlin BP, Xia H, Gelfand AE. Hierarchical Spatio-Temporal Mapping of Disease Rate. Journal of the American Statistical Association. 1997;92(438):607-17.