

APPENDIX

Contents

Suppression Rates.....	2
Generalized Additive Models.....	3
Appendix Exhibit 1.....	4
Appendix Exhibit 2.....	5
Appendix Exhibit 3.....	6
Appendix Exhibit 4.....	7
Appendix Exhibit 5.....	8
Appendix Exhibit 6.....	9
Appendix Exhibit 7.....	10
Appendix Exhibit 8.....	11
Appendix Exhibit 9.....	12
Appendix Exhibit 10.....	13-15
Appendix Exhibit 11.....	16-21

Suppression Rates

None of the 969 total mortality rates (51 states/DC, 19 years) were suppressed or deemed unreliable. In sub-analyses by year, there was high suppression among Asian/Pacific Islander (91.8%) and Native Alaskan/American Indian (90.0%), as well as the youngest age groups (100.0% for <1 and 1-4, and 94.9% for ages 5-14) and the age 85+ group (80.3%). Unintentional death (77.2%) was also highly suppressed; each of those categories were excluded from the sub-population analyses. The next most censored category, which was largely state-specific, was Hispanic white (58.3%). Among the remaining 14,535 rates (15 categories, 51 states/DC, 19 years), 2,989 (20.6%) were suppressed, and 506 (16.9%) of those could be interpolated as described above.

In the aggregated analyses of 1999-2014 and 2015-2017 there was far less suppression but some groups still required exclusion due to high suppression. Age under 1 was suppressed in 98.0% of states/DC in 1999-2014, and 100.0% of states/DX in 2015-2017. Age 1-4 was suppressed in 98.0% and 60.8% of cases in 1999-2014 and 2015-2017, respectively. Age 5-14 was suppressed in 17.6% of cases in 1999-2014 and 56.9% of cases in 2015-2017. Native Alaskan/American Indian and Asian/Pacific Islander required omission due to high suppression in both 1999-2014 (39.2% and 25.5%, respectively) and 2015-2017 (66.7% and 51.0%, respectively). Among the remaining categories, 23 (2.5%) were suppressed in 1999-2014 and 51 (5.6%) were suppressed in 2015-2017, primarily owing to unintentional death, Hispanic ethnicity, and the older age groups (75-84, 85+).

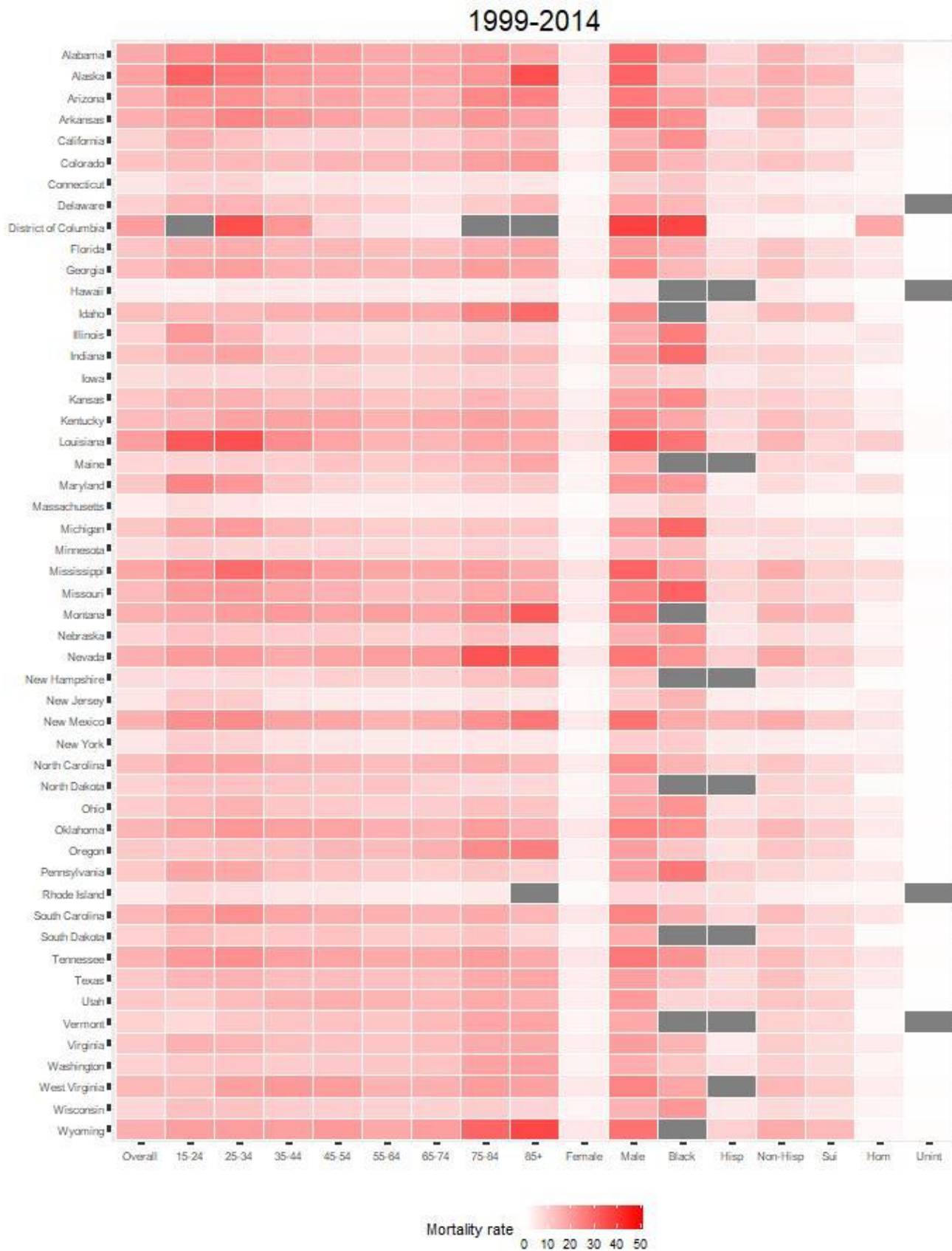
Generalized Additive Models

We characterized trajectories of firearm mortality using generalized additive models (GAMs),¹ a regression-based approach to estimating the relationship between variables – year and age-adjusted mortality rate in this case – without pre-specifying its nature (e.g., linear). GAMs allow us to borrow information across years to generate a smoothly varying trajectory of mortality that is ultimately more interpretable than the raw trajectory of rates, for which the underlying trend may be obscured by random year-to-year fluctuation. A particular advantage of the GAM framework is that it empirically determines the characteristics of the temporal trajectory. Specifically, the software empirically determines the appropriate level of smoothness (between the smoothest possible function—linear—and the fully non-parametric estimate—a separate value for each of the 19 time points) using a generalized cross-validation procedure² to empirically determine. We used the R package *mgcv* to fit these models.¹ Within this framework, we conducted trend tests by testing whether the temporal smooth is different from zero³, comparing the GAM model with the model that constrains the temporal trajectory to be constant.

Within each demographic sub-population, and sub-type of firearm mortality, we characterized the trajectories using the GAM framework described above, slightly modified to handle highly suppressed trajectories. If over half of the trajectory was suppressed, then linear regression was used instead. If fewer than four time points were unsuppressed, no modeling was performed and raw values were reported. These trends, in addition to the overall trend, expressed as relative changes from 1999, were jointly displayed at the state level using a heatmap with the columns based on years and the rows based on the aforementioned sub-categories.

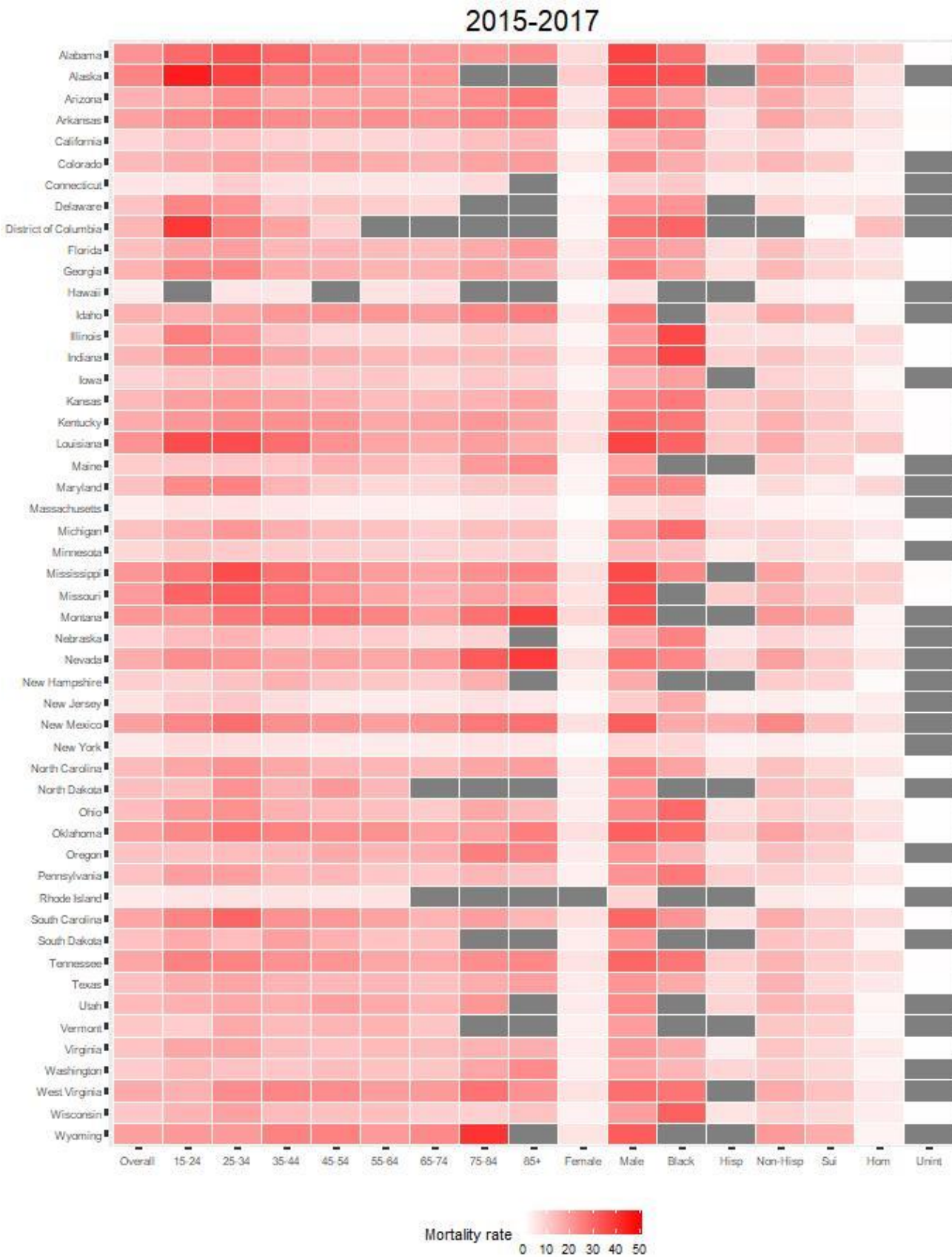
1. Wood S. *Generalized additive models: an introduction with R*. Chapman and Hall/CRC; 2017
2. Wood, S.N. (2004) Stable and efficient multiple smoothing parameter estimation for generalized additive models. *J. Amer. Statist. Ass.* 99:673-686
3. Wood, S.N. (2013a) On p-values for smooth components of an extended generalized additive model. *Biometrika* 100:221-228

Appendix Exhibit 1: Firearm mortality per 100k population, by state, sub-population and mechanism, 1999-2014.



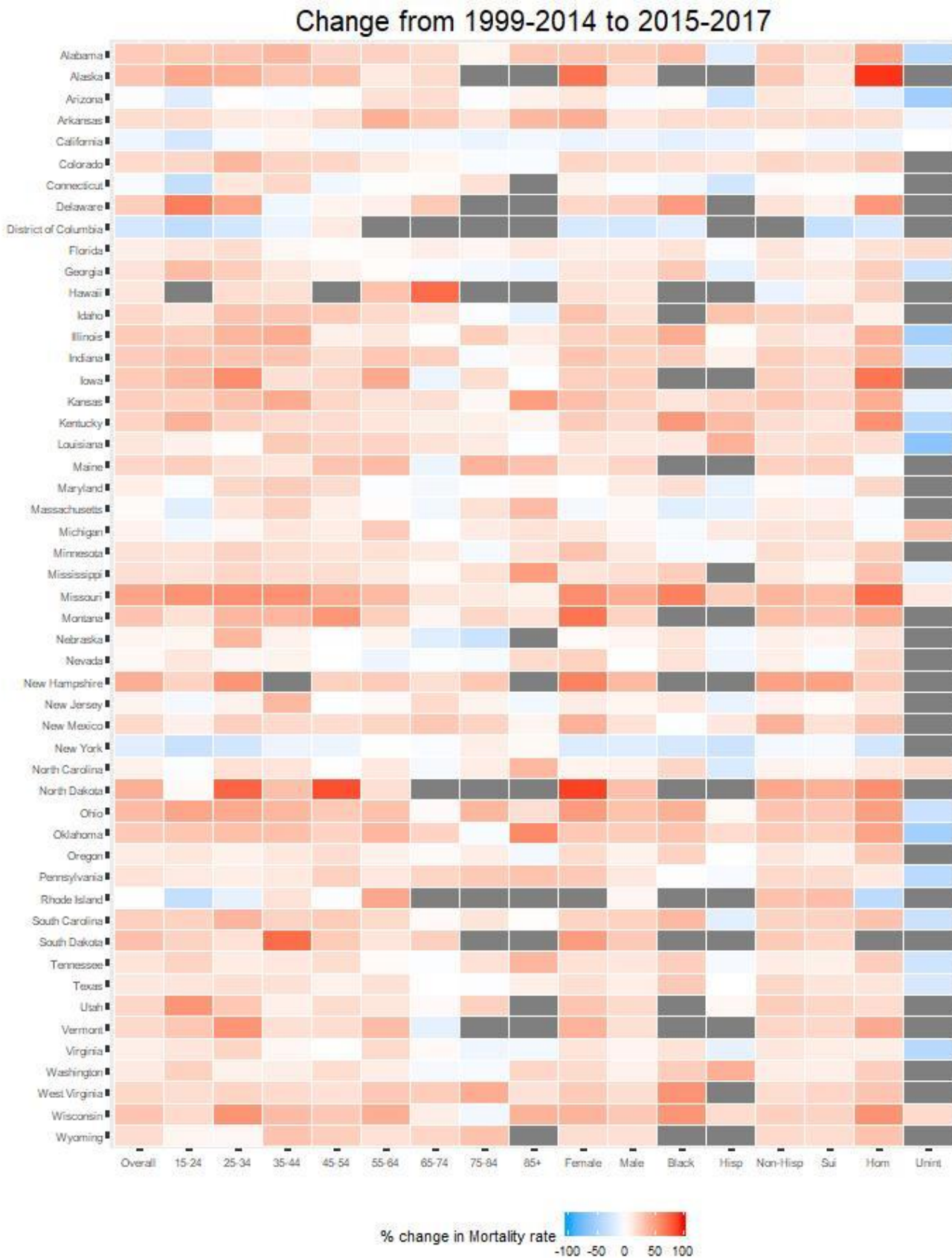
Note: Gray cells indicate suppressed counts. Rates are age-adjusted (except age-specific rates).

Appendix Exhibit 2: Firearm mortality per 100k population, by state, sub-population and mechanism, 2015-2017.



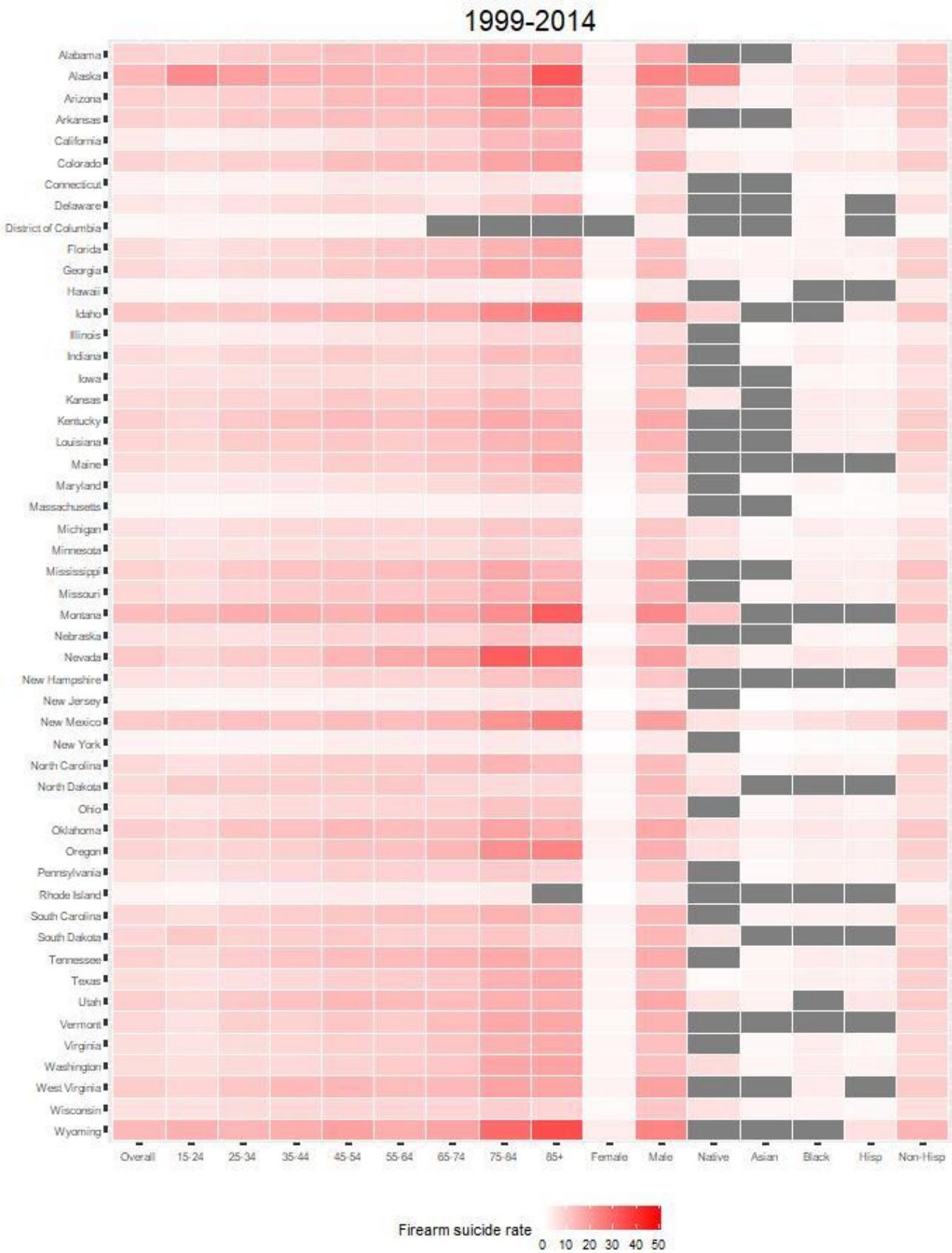
Note: Gray cells indicate suppressed counts. Rates are age-adjusted (except age-specific rates).

Appendix Exhibit 3: % change in firearm mortality, by state, sub-population and mechanism, 1999-2014 vs. 2015-2017.



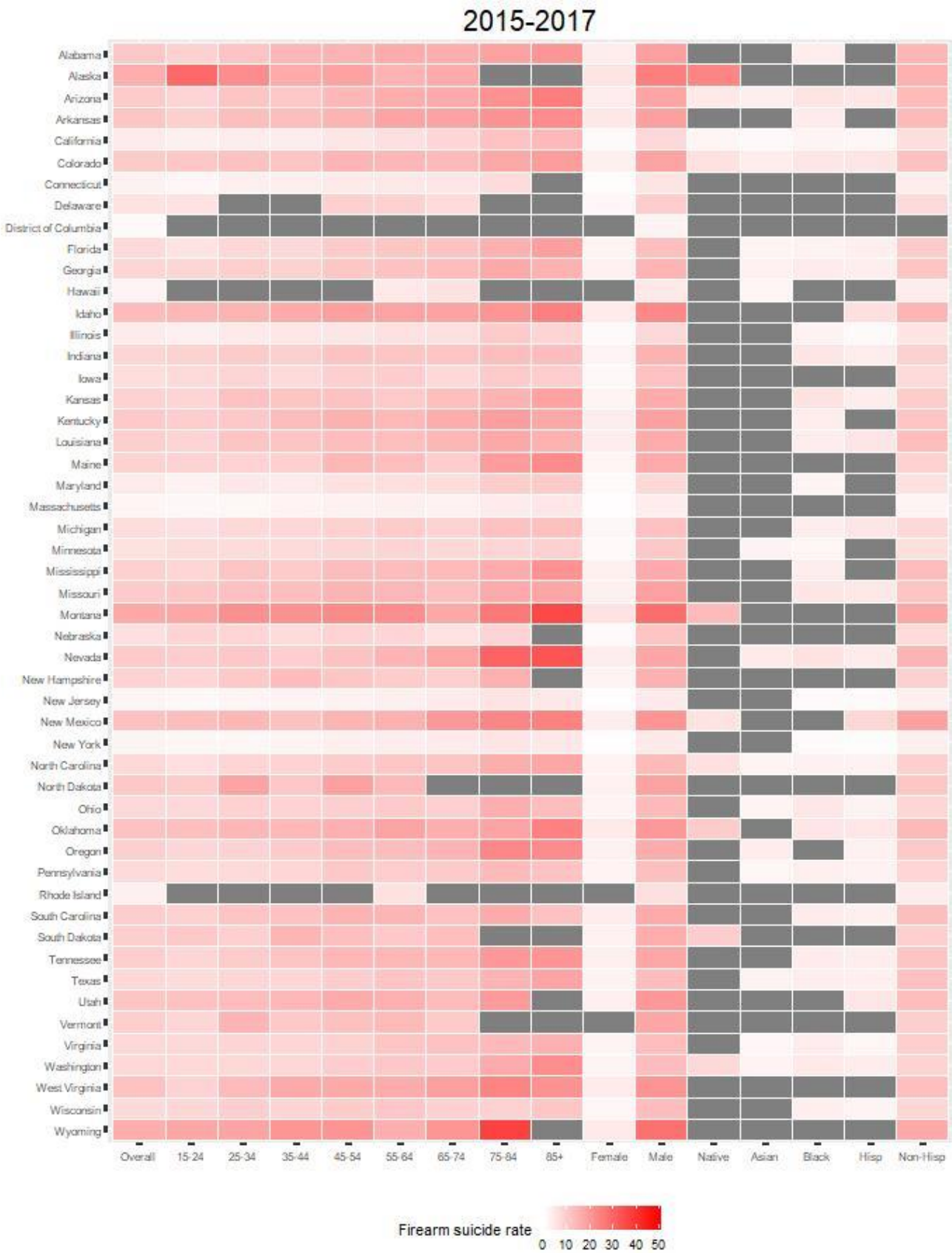
Note: Gray cells indicate suppressed counts. Rates are age-adjusted (except age-specific rates).

Appendix Exhibit 4: Firearm suicide per 100k population, by state and sub-population, 1999-2014.



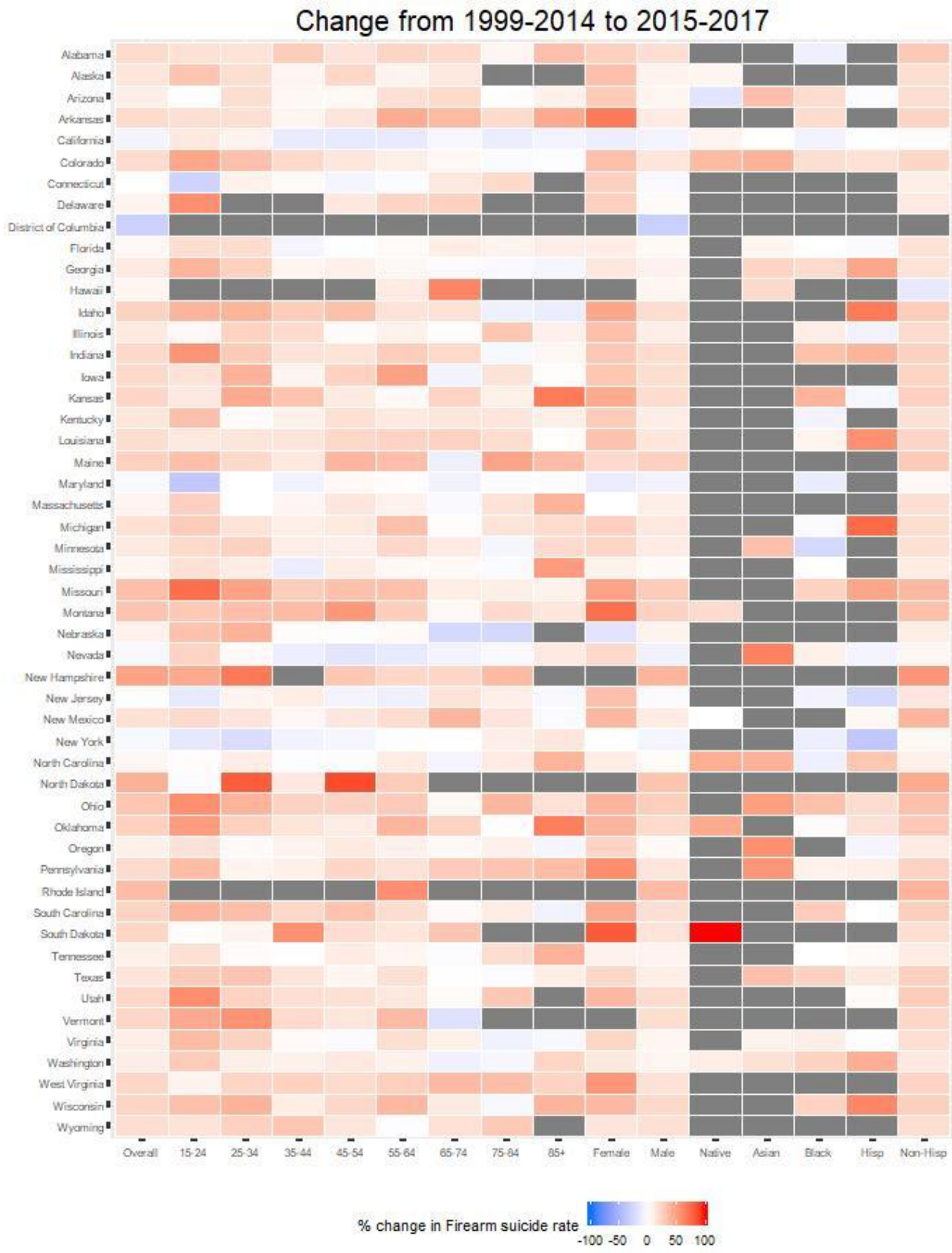
Note: Gray cells indicate suppressed counts. Rates are age-adjusted (except age-specific rates).

Appendix Exhibit 5: Firearm suicide per 100k population, by state and sub-population, 2015-2017.



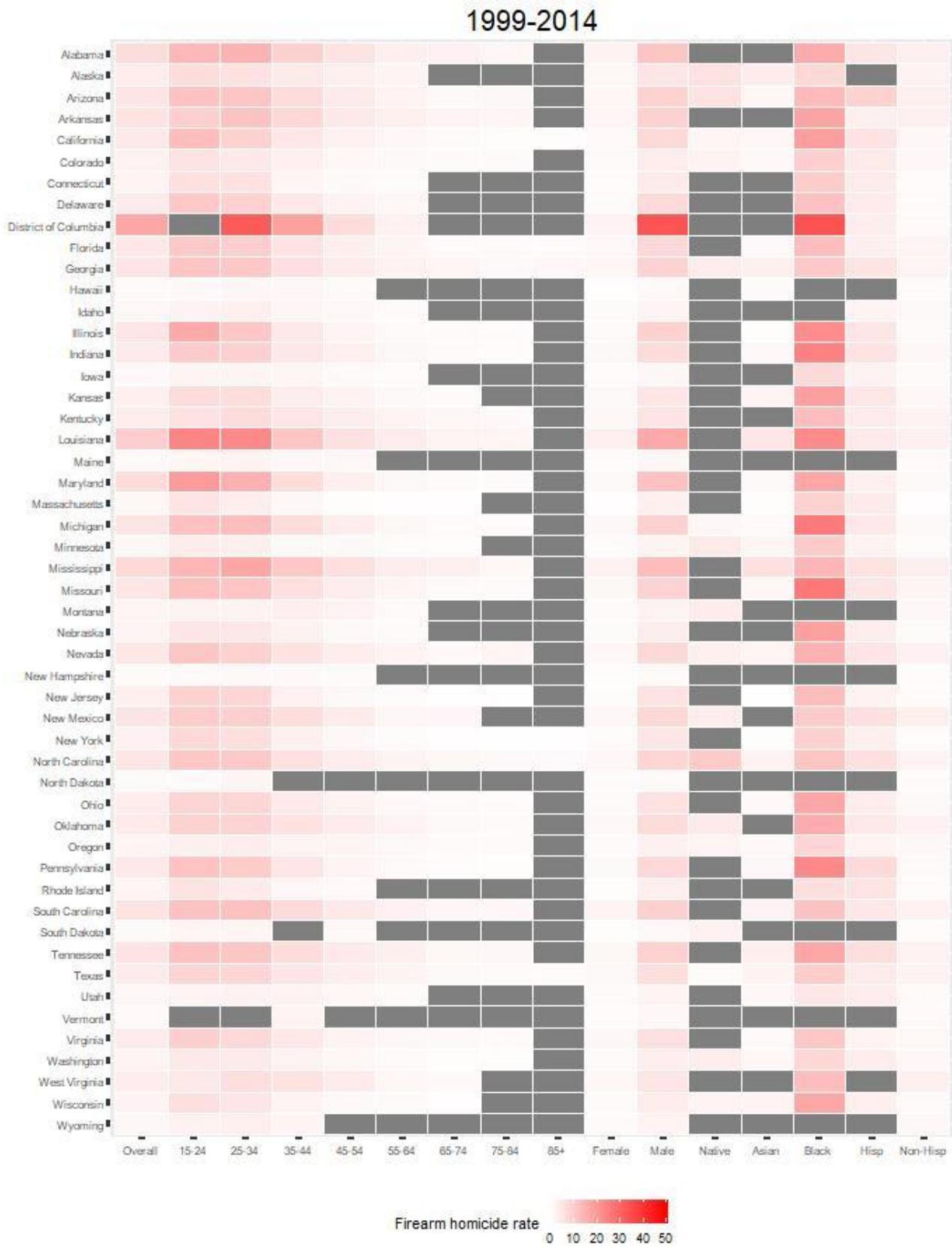
Note: Gray cells indicate suppressed counts. Rates are age-adjusted (except age-specific rates).

Appendix Exhibit 6: % change in firearm suicide, by state and sub-population, 1999-2014 vs. 2015-2017.



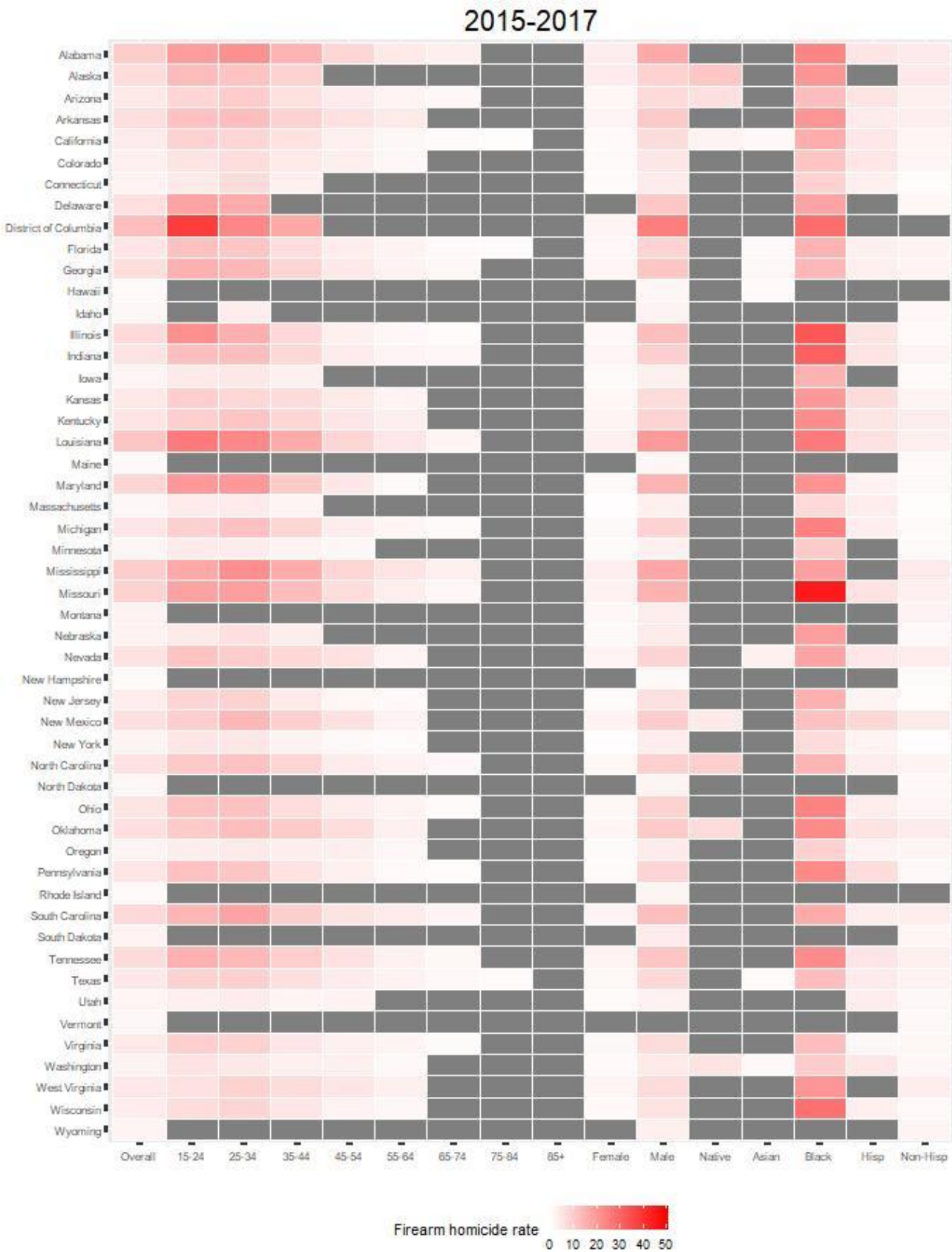
Note: Gray cells indicate suppressed counts. Rates are age-adjusted (except age-specific rates).

Appendix Exhibit 7: Firearm homicide per 100k population, by state and sub-population, 1999-2014.



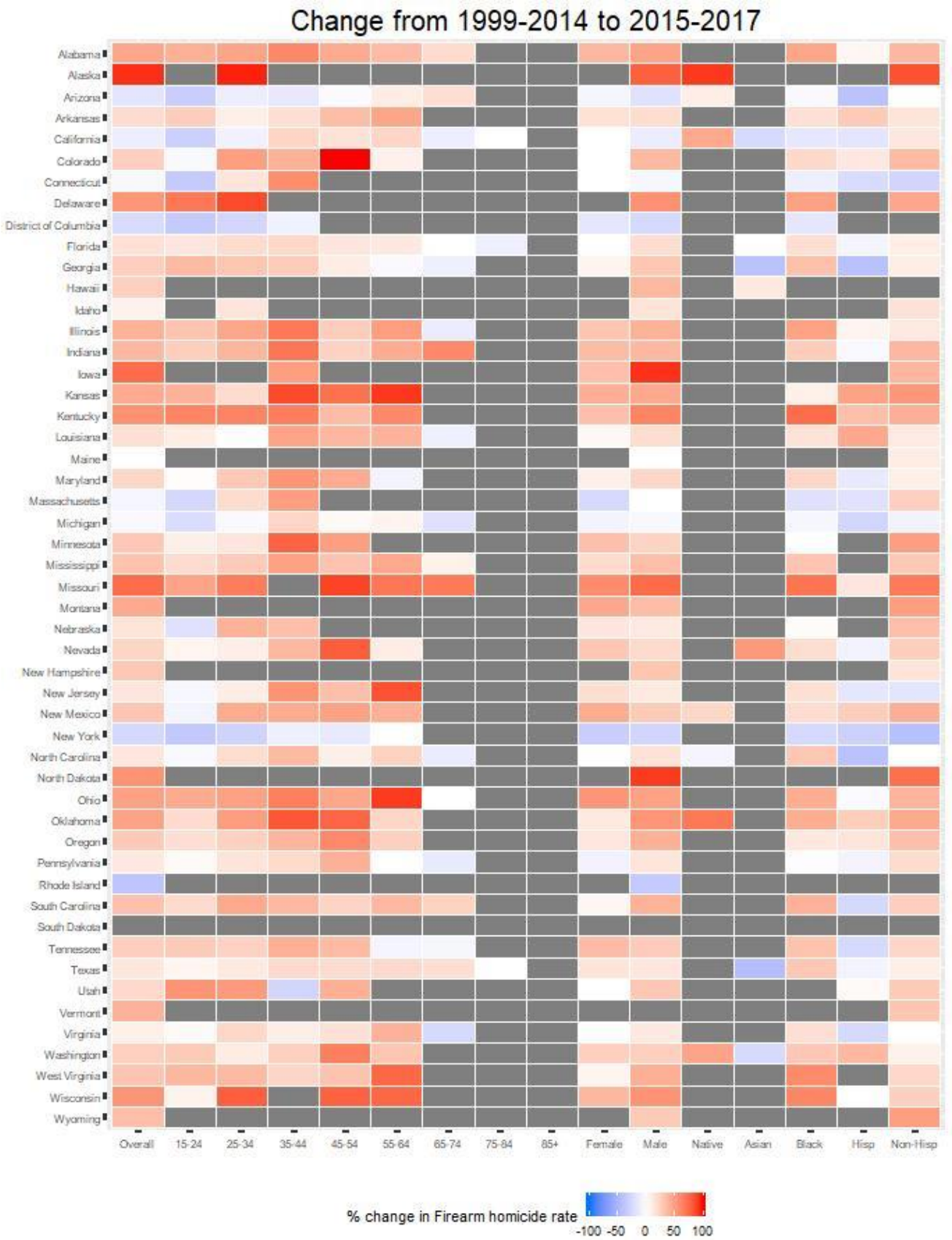
Note: Gray cells indicate suppressed counts. Rates are age-adjusted (except age-specific rates).

Appendix Exhibit 8: Firearm homicide per 100k population, by state and sub-population, 2015-2017.



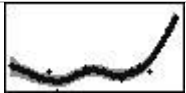
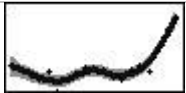
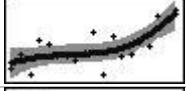









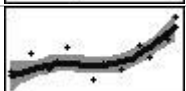

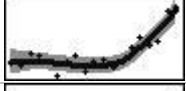
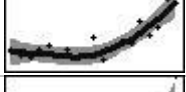
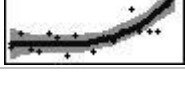

Note: Gray cells indicate suppressed counts. Rates are age-adjusted (except age-specific rates).

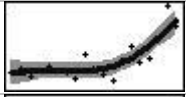

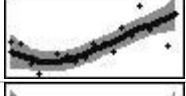





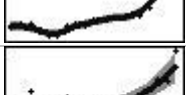







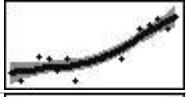
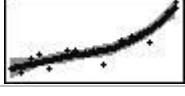

Appendix Exhibit 9: % change in firearm homicide, by state and sub-population, 1999-2014 vs. 2015-2017.



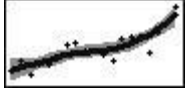
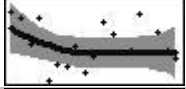

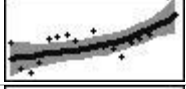






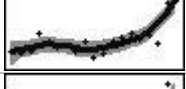
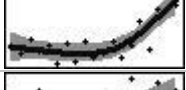



Note: Gray cells indicate suppressed counts. Rates are age-adjusted (except age-specific rates).

Appendix Exhibit 10: State-level trends in overall firearm mortality, 1999-2017.

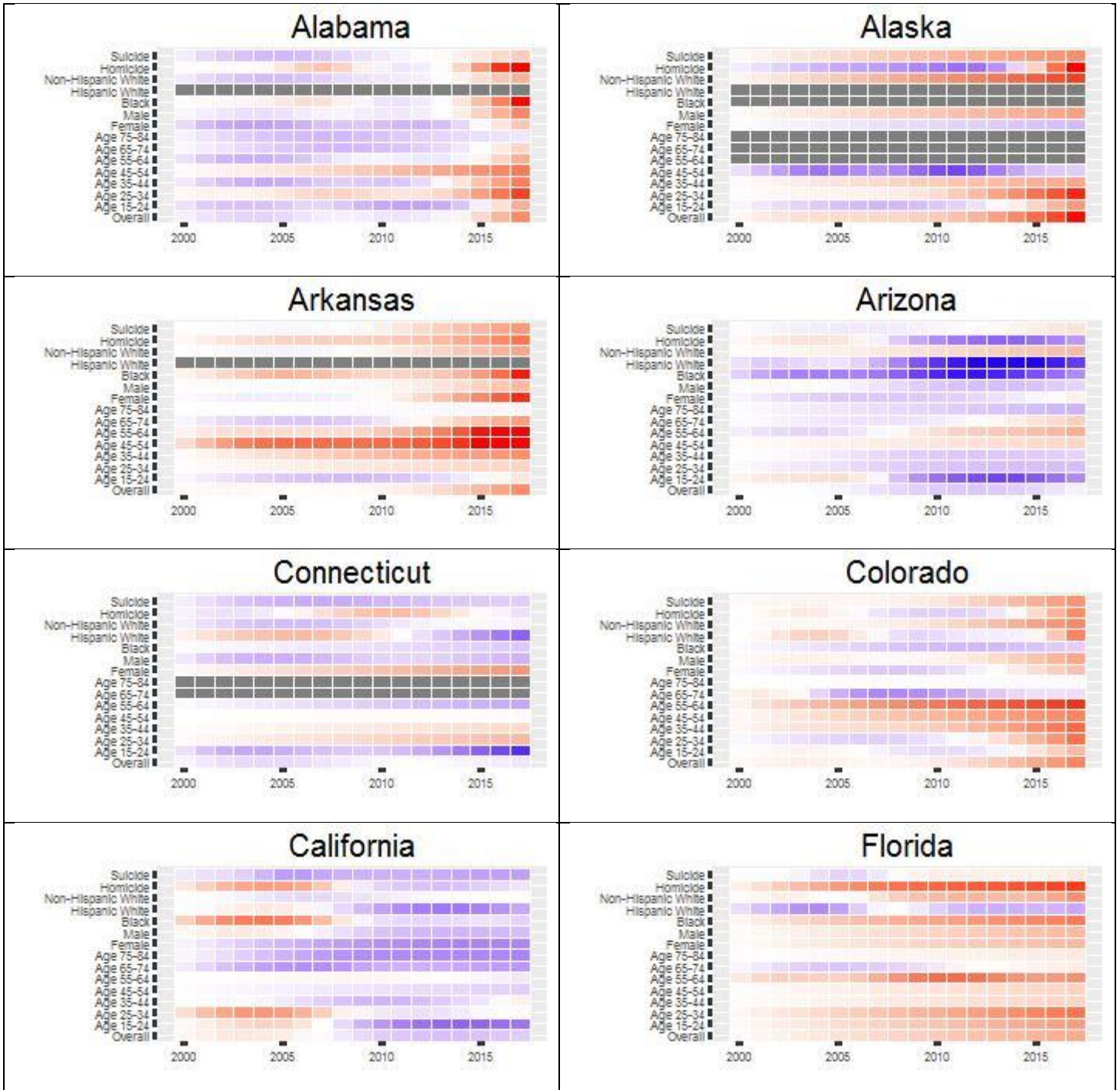
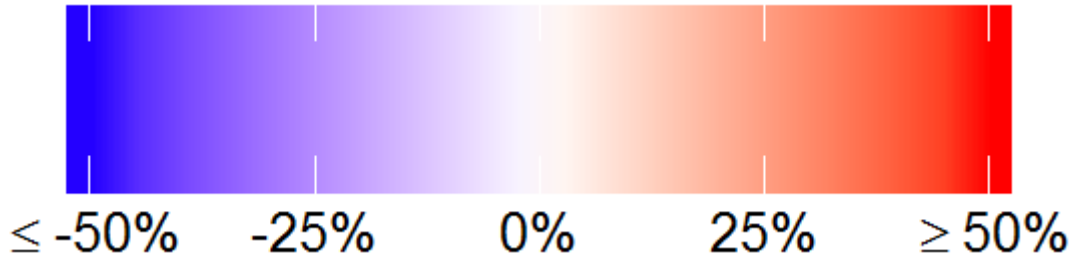
	<u>Age-Adjusted Mortality Rate</u>			<i>p</i> (1999-2014)	<i>p</i> (1999-2017)	
	1999	2014	2017			
Alabama	17.7 (16.5-18.9)	16.9 (15.7-18.1)	22.9 (21.5-24.3)	0.680	<0.001	
Alaska	15.8 (12.3-20.0)	19.2 (16.0-22.4)	24.5 (20.8-28.2)	0.193	0.002	
Arizona	16.3 (15.2-17.5)	13.5 (12.6-14.4)	15.8 (14.8-16.7)	<0.001	0.003	
Arkansas	14.6 (13.1-16.1)	16.6 (15.1-18.1)	20.3 (18.7-21.9)	0.020	<0.001	
California	9.3 (8.9-9.6)	7.4 (7.1-7.7)	7.9 (7.6-8.2)	<0.001	<0.001	
Colorado	10.8 (9.8-11.8)	12.2 (11.3-13.2)	13.4 (12.4-14.3)	0.203	<0.001	
Connecticut	5.9 (5.1-6.8)	5.0 (4.2-5.7)	5.1 (4.4-5.9)	0.802	0.510	
Delaware	8.7 (6.7-11.0)	11.1 (8.9-13.3)	11.7 (9.4-13.9)	0.006	<0.001	
District of Columbia	25.5 (21.5-29.5)	11.7 (9.2-14.5)	13.1 (10.4-15.8)	<0.001	<0.001	
Florida	10.7 (10.1-11.2)	11.5 (11.1-12.0)	12.4 (11.9-12.9)	<0.001	<0.001	
Georgia	13.7 (12.9-14.5)	13.7 (13.0-14.4)	15.4 (14.7-16.2)	0.135	<0.001	
Hawaii	3.4 (2.5-4.7)	2.6 (1.9-3.6)	2.5 (1.7-3.4)	0.016	0.281	
Idaho	12.2 (10.2-14.1)	13.2 (11.4-15.0)	16.4 (14.5-18.4)	0.127	0.001	
Illinois	9.7 (9.1-10.2)	9.0 (8.5-9.6)	12.1 (11.5-12.7)	0.008	<0.001	
Indiana	11.2 (10.3-12.0)	12.4 (11.5-13.2)	15.3 (14.3-16.2)	0.293	<0.001	
Iowa	6.8 (5.8-7.7)	7.5 (6.5-8.4)	9.0 (7.9-10.1)	0.083	<0.001	
Kansas	10.0 (8.8-11.2)	11.3 (10.1-12.6)	16.0 (14.5-17.5)	0.034	<0.001	

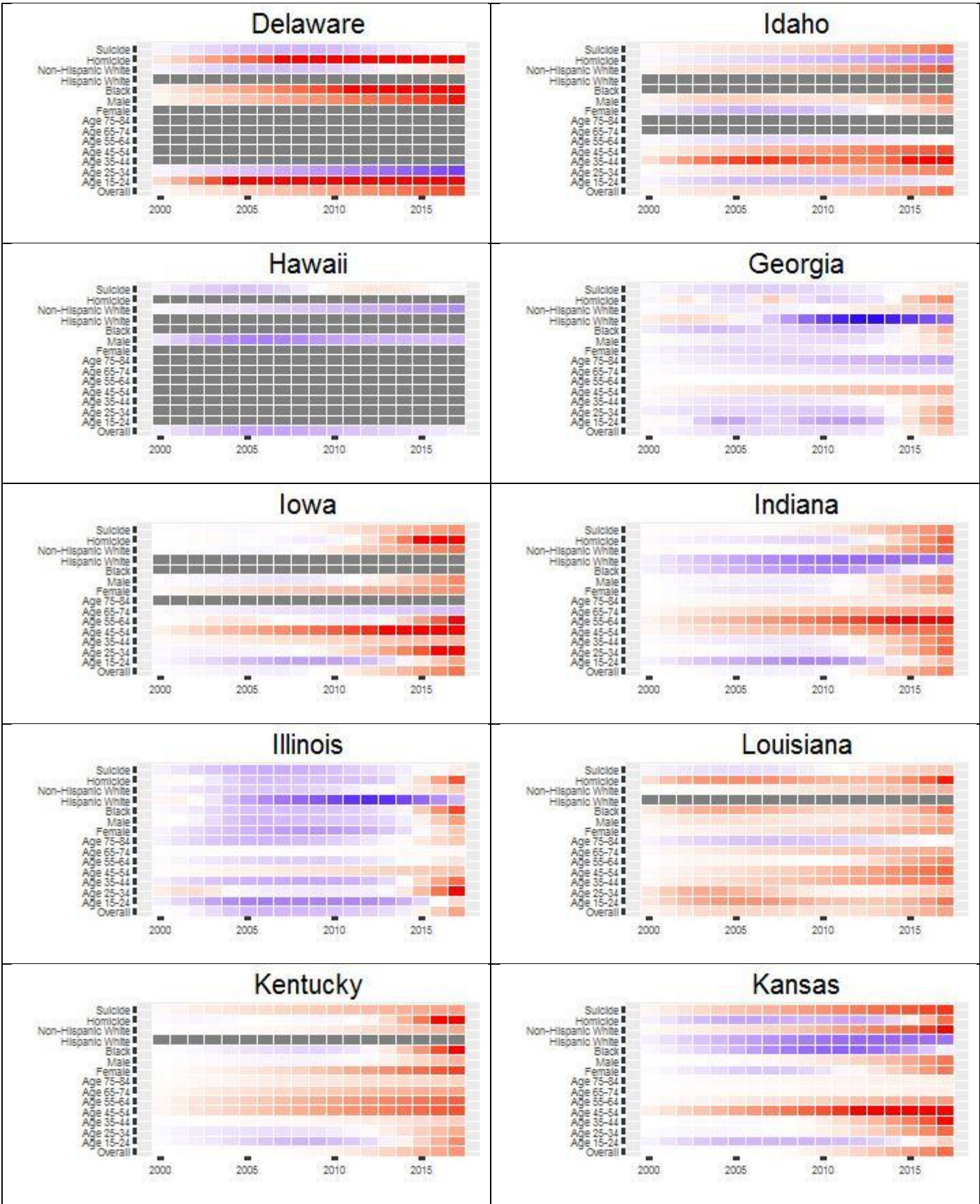
Kentucky	12.9 (11.8-14.0)	13.9 (12.8-15.1)	16.2 (15.0-17.3)	0.061	<0.001	
Louisiana	17.5 (16.3-18.8)	19.0 (17.8-20.3)	21.7 (20.4-23.1)	0.081	<0.001	
Maine	8.7 (7.1-10.3)	9.4 (7.8-11.1)	11.7 (9.8-13.5)	0.002	0.001	
Maryland	12.7 (11.7-13.7)	9.0 (8.2-9.8)	12.3 (11.4-13.2)	<0.001	<0.001	
Massachusetts	3.0 (2.6-3.5)	3.2 (2.8-3.6)	3.7 (3.3-4.2)	0.055	0.065	
Michigan	11.0 (10.3-11.6)	11.1 (10.4-11.8)	11.3 (10.6-12.0)	0.007	0.001	
Minnesota	6.1 (5.4-6.8)	6.6 (6.0-7.3)	8.2 (7.4-8.9)	0.011	<0.001	
Mississippi	18.2 (16.7-19.8)	18.3 (16.8-19.9)	21.5 (19.8-23.2)	0.312	0.001	
Missouri	12.7 (11.8-13.7)	15.3 (14.3-16.3)	21.5 (20.3-22.6)	<0.001	<0.001	
Montana	13.4 (11.1-15.8)	16.1 (13.6-18.6)	22.5 (19.6-25.4)	0.160	<0.001	
Nebraska	8.6 (7.2-10.0)	9.5 (8.1-10.9)	8.3 (6.9-9.6)	0.006	0.005	
Nevada	20.0 (17.9-22.0)	14.8 (13.4-16.2)	16.7 (15.3-18.2)	<0.001	<0.001	
New Hampshire	5.8 (4.6-7.4)	8.7 (7.1-10.3)	10.4 (8.6-12.1)	0.035	<0.001	
New Jersey	4.4 (3.9-4.8)	5.3 (4.8-5.8)	5.3 (4.8-5.8)	0.008	0.002	
New Mexico	16.3 (14.4-18.2)	16.0 (14.2-17.7)	18.5 (16.7-20.4)	0.068	<0.001	
New York	5.3 (5.0-5.7)	4.2 (4.0-4.5)	3.7 (3.5-4.0)	<0.001	<0.001	
North Carolina	13.1 (12.3-13.8)	11.8 (11.1-12.5)	13.7 (13.0-14.5)	<0.001	<0.001	
North Dakota	7.5 (5.5-9.9)	12.3 (9.9-15.1)	13.2 (10.6-15.8)	<0.001	<0.001	
Ohio	8.2 (7.7-8.8)	10.3 (9.7-10.9)	13.7 (13.0-14.4)	<0.001	<0.001	

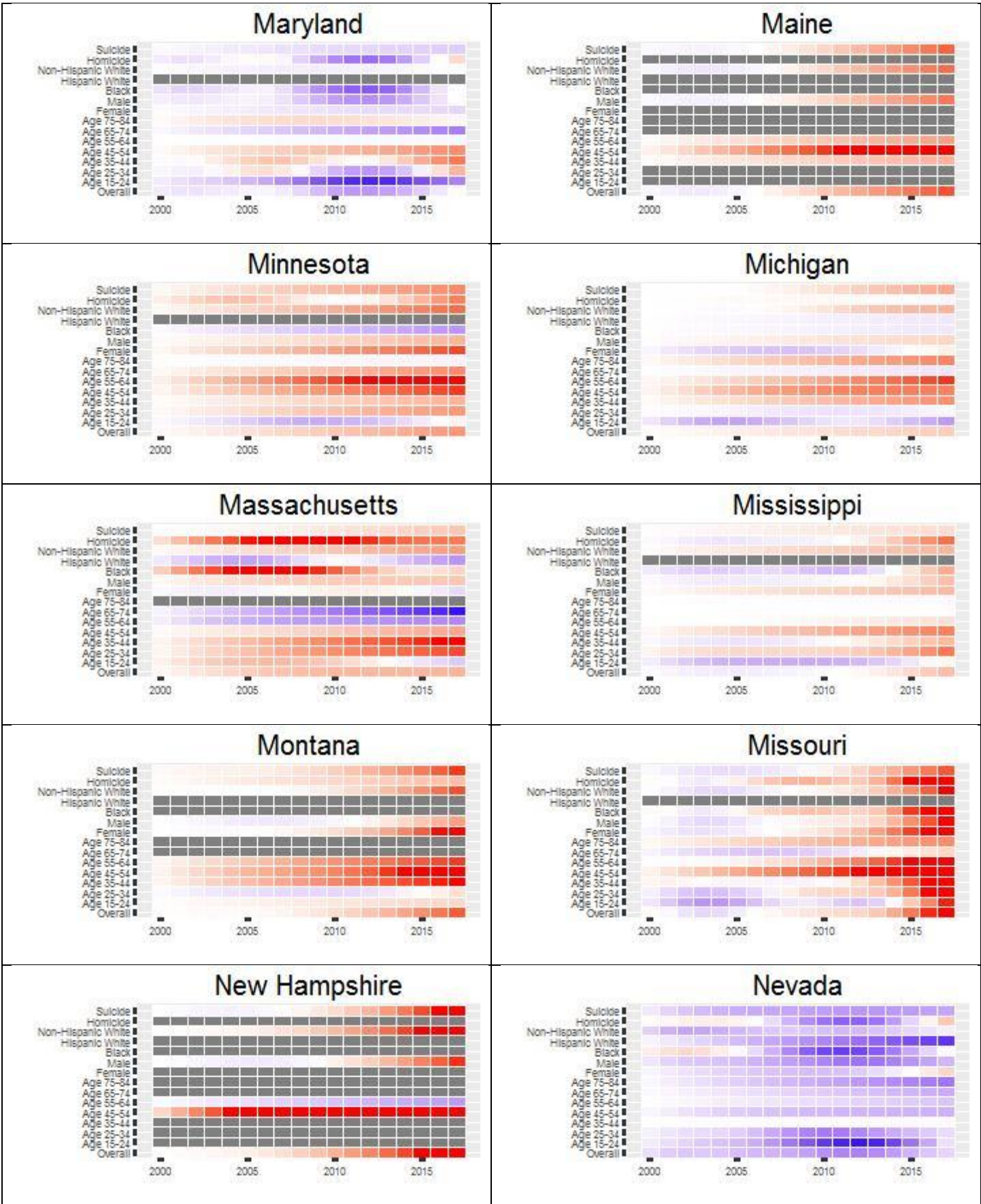
Oklahoma	14.8 (13.5-16.1)	15.7 (14.4-17.0)	17.2 (15.9-18.5)	<0.001	<0.001	
Oregon	11.3 (10.2-12.5)	11.7 (10.6-12.7)	12.1 (11.1-13.2)	0.028	<0.001	
Pennsylvania	9.7 (9.1-10.2)	10.5 (9.9-11.0)	12.5 (11.9-13.1)	<0.001	<0.001	
Rhode Island	5.3 (4.0-6.9)	3.0 (2.0-4.2)	3.9 (2.8-5.2)	0.243	0.405	
South Carolina	13.8 (12.6-14.9)	15.5 (14.4-16.7)	17.7 (16.5-18.9)	<0.001	<0.001	
South Dakota	9.7 (7.6-12.2)	10.3 (8.3-12.8)	11.9 (9.5-14.2)	0.193	0.012	
Tennessee	14.8 (13.8-15.8)	15.1 (14.2-16.1)	18.4 (17.4-19.5)	0.990	<0.001	
Texas	10.5 (10.1-11.0)	10.7 (10.3-11.1)	12.4 (12.0-12.8)	0.350	<0.001	
Utah	9.4 (8.1-10.8)	12.3 (11.0-13.7)	14.0 (12.6-15.4)	<0.001	<0.001	
Vermont	9.3 (7.0-12.0)	10.3 (7.9-13.2)	11.7 (9.0-14.9)	0.140	0.010	
Virginia	11.7 (10.9-12.5)	10.3 (9.6-11.0)	11.9 (11.2-12.7)	<0.001	0.002	
Washington	10.1 (9.3-10.9)	9.7 (9.0-10.4)	11.1 (10.3-11.9)	0.175	0.021	
West Virginia	13.3 (11.6-14.9)	14.6 (12.8-16.3)	18.6 (16.5-20.6)	0.058	<0.001	
Wisconsin	8.3 (7.6-9.1)	8.2 (7.5-9.0)	10.6 (9.7-11.4)	0.477	<0.001	
Wyoming	15.2 (11.9-19.1)	16.2 (13.0-20.0)	18.8 (15.2-22.4)	0.074	0.008	

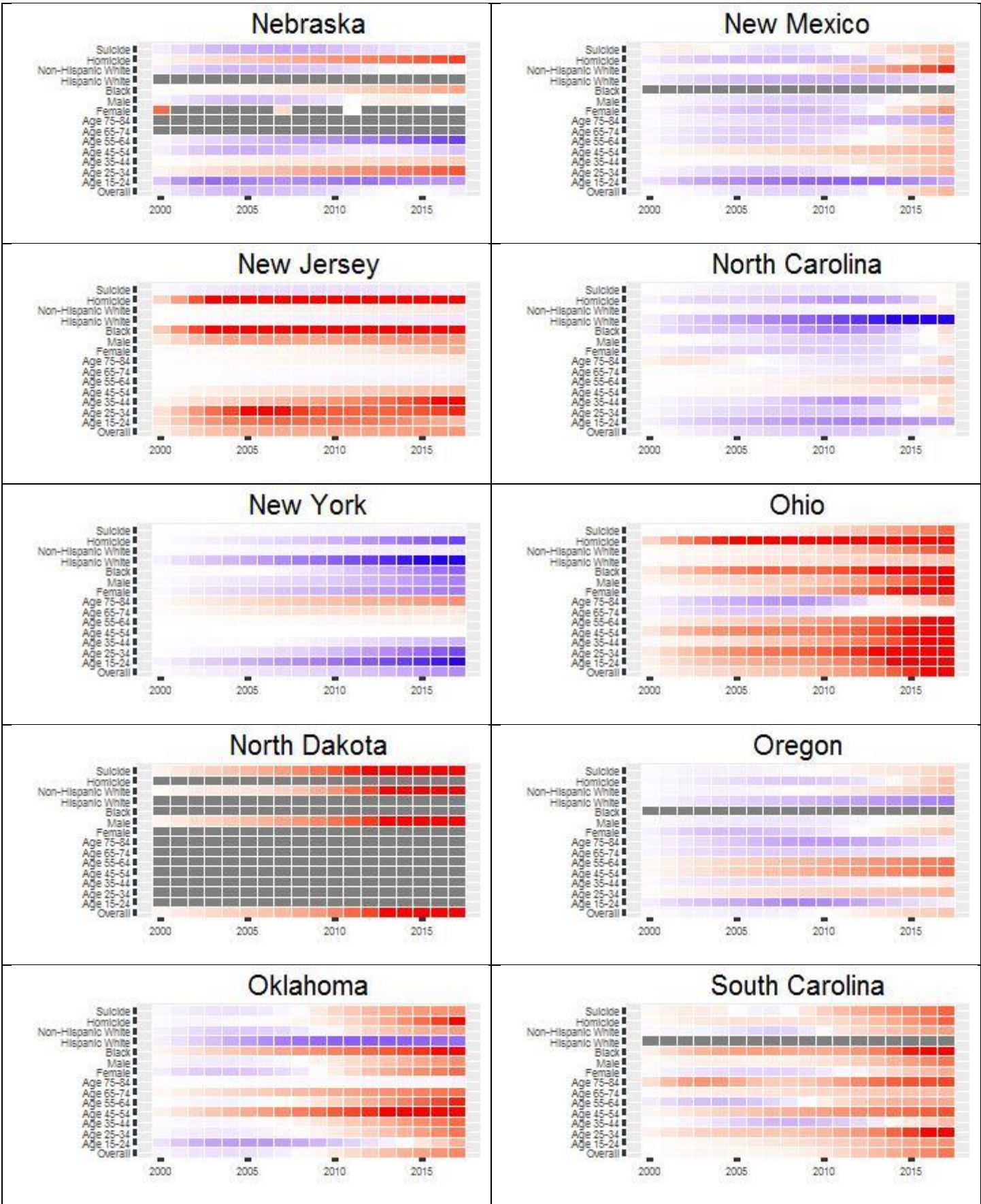
Note: The p-values reported correspond to a test of whether or not the trajectory is constant (i.e. a horizontal line); in column 4 (1999-2014) this test is restricted only to that time interval and in column 5 (1999-2017) the test uses the full time window from 1999 to 2017; these tests are both displayed to show changes in significance when restricting to the time period before the recent national increases in firearm mortality.

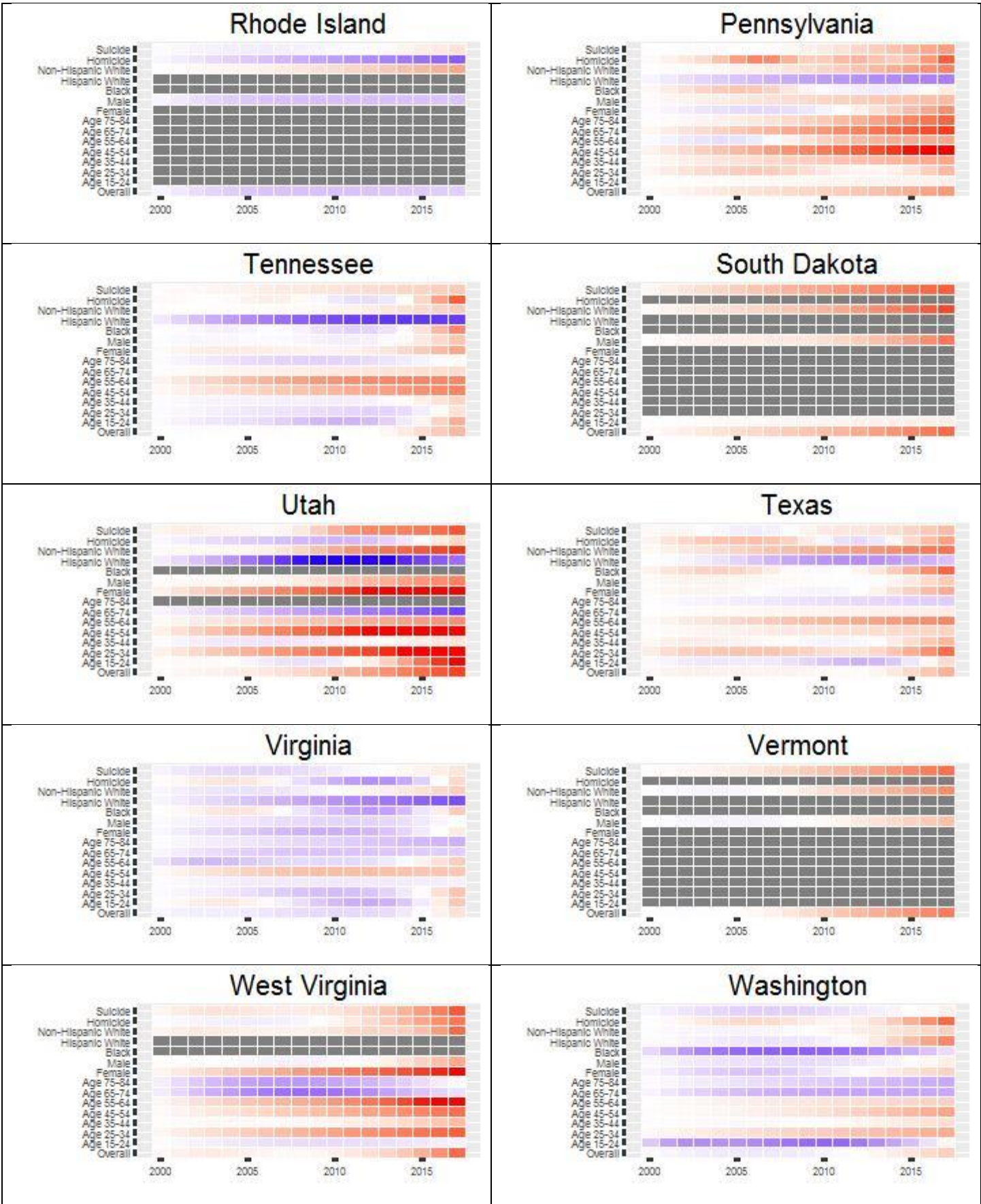
Appendix Exhibit 11: State-by-state trajectories of firearm mortality within sub-populations expressed in terms of percent change relative to the baseline value (1999).

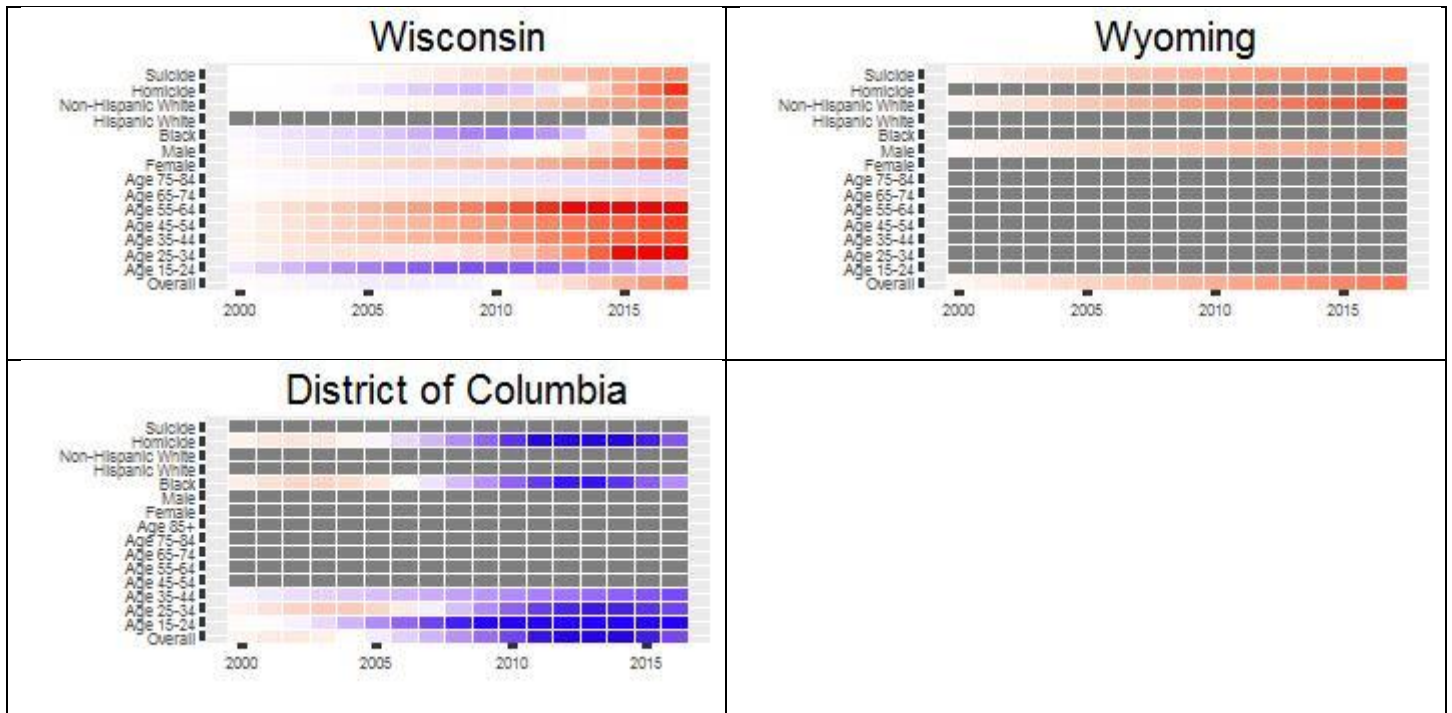












Note: Gray cells indicate suppressed counts

Note 2: Within each demographic sub-population, and sub-type of firearm mortality, we characterized the trajectories using generalized additive models. However, if over half of the trajectory was suppressed, then linear regression was used instead, to avoid overfitting. If fewer than four time points were unsuppressed, no modeling was performed.