

Incidence of Firearm Suicide in US Congressional Districts Estimated from County-Level Underlying Cause of Death Reports

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Abstract

Background: Suicide is the most common form of violent death in the US and firearms are the most common means of suicide, contributing to half of all suicide deaths. The focus of this research is calculating suicide and firearm suicide counts and rates for each congressional district in order to highlight the types of legislation and local programs that can address this public health crisis in each district.

Methods: Counts of suicides and firearm suicides for the congressional districts were calculated by weighting county counts as reported by the Centers for Disease Control and Prevention for the five-year period 2014 to 2018 by the proportion of the county population allocated to the congressional district for that population group as available from the Census Bureau's Summary File for the 116th Congress. The weighted counts were then summed over the counties in the congressional district.

Results: There are 52 firearm suicides on average per congressional district each year, yet there is tremendous district-level variation across the country and even within states. Seventeen districts—in Massachusetts, New Jersey, New York and Washington, DC—have 10 or fewer firearm suicides each year. On the other hand, 11 districts—in Alaska, Arizona, Colorado, Idaho, Montana, Oklahoma, Oregon, and Tennessee—have over 100 gun suicides each year. 88 percent of the difference in congressional district-level suicide rates is explained by differences in firearm suicide. The proportion of suicides by firearm out of all suicides ranges from 6% to 73% across districts. Rates of suicide by other means were similar across rural and urban districts, while rates of firearm suicide were on average 5 times higher in rural districts (1.77 in urban compared to 10.60 per 100,000 population in rural).

Conclusions: Understanding the incidence of firearm suicide in US congressional districts can provide tools for holding elected officials accountable for taking steps— including research funding, key policies, storage practices, public education initiatives – to protect the lives of their constituents by preventing firearm suicide.

Background

Suicide is the most common form of violent death in the US and firearms are the most common means of suicide, contributing to half of all suicide deaths.(1) On average over the period 2014 to 2018, there are approximately 23,000 firearm suicide deaths each year in the United States—a rate of 6.7 per 100,000 people. (1) While these statistics paint a distressing picture, suicide is preventable and reducing firearm suicide in particular could save thousands of lives each year.

As with any public health crisis of this magnitude, the “cure” requires data and science to figure out the causes of the problem and the interventions that work to prevent it. However, a public health approach to preventing suicide is hampered by a lack of up-to-date data with regards to vulnerable groups and meaningful geographic areas.

The objective of this analysis was to estimate suicide and firearm suicide counts and rates for each congressional district of the 435 United States congressional districts as well as the non-voting district of the District of Columbia (DC) using publicly available county-level counts and rates from the Centers for Disease

Control and Prevention (CDC). This is essential for pointing to the types of federal and local legislation, policies, and programs that can address this public health crisis in each district. The importance of presenting mortality by congressional district is not unique to firearm deaths. Analysis of congressional district mortality has similarly been calculated for other causes of death, including cancer, coronavirus, opioid use, and multiple causes of mortality.(2–5) Congressional districts are a valuable geographic unit for data analysis because they all have roughly the same population size, approximately 740,000 residents for the 116th Congress (2019 to 2020).(6) Firearm suicide data for congressional districts can help voters and elected representatives pinpoint the scope and location of the problem, help identify underlying factors present in different places, and mobilize communities to take action to save lives.

Results

There are 52 firearm suicides on average per congressional district each year, yet there is tremendous district-level variation across the country and even within states (see Fig. 1). Seventeen districts—in Massachusetts, New Jersey, New York and Washington, DC—have 10 or fewer firearm suicides each year. On the other hand, 11 districts—in Alaska, Arizona, Colorado, Idaho, Montana, Oklahoma, Oregon, and Tennessee—have over 100 gun suicides each year. Results for every district are available as a supplemental file [LINK].

The 20 congressional districts with the lowest rates of firearm suicide are confined to only three states: Massachusetts, New Jersey, and New York, plus the non-voting District of Columbia (see Table 1). In most of these districts, there were fewer than 10 firearm suicides per year (counts below 10 are suppressed to protect the privacy of individuals in those places). Rates of firearm suicide in these districts are below 2 per 100,000 people. On average, firearm suicides comprise 15 percent of all suicides in these districts, far lower than the national average of 50 percent.

Table 1
Congressional districts with lowest firearm suicide rate

State, District	Firearm Suicides per Year	Firearm Suicide Rate per 100,000	All Suicides per Year	Suicide Rate per 100,000	Firearm Suicides as percent of Suicides	Population
New York-13	< 10	<1.5	47	6.12	< 25%	774,528
New York-05	< 10	<1.5	41	5.36	< 25%	772,342
New York-15	< 10	<1.5	38	5.15	< 25%	744,647
New York-08	< 10	<1.5	37	4.77	< 25%	771,343
New York-07	< 10	<1.5	42	5.75	< 25%	734,208
New York-09	< 10	<1.5	38	5.15	< 25%	733,271
New York-12	< 10	<1.5	63	8.82	< 25%	719,072
New York-10	< 10	<1.5	59	8.01	< 25%	730,760
New York-14	< 10	<1.5	47	6.68	< 25%	705,681
New York-06	< 10	<1.5	51	6.94	< 25%	732,433
Massachusetts-07	< 10	<1.5	50	6.26	< 25%	795,850
New York-16	< 10	<1.5	48	6.41	< 25%	741,586
New Jersey-10	< 10	<1.5	42	5.61	< 25%	749,828
New York-11	< 10	<1.5	50	6.83	< 25%	730,634
Massachusetts-05	10	1.29	68	8.86	< 25%	766,241
New Jersey-08	10	1.32	49	6.43	< 25%	760,952
District of Columbia-At large	< 10	<1.5	45	6.63	< 25%	684,498
New Jersey-09	11	1.46	50	6.66	< 25%	751,755
New Jersey-06	11	1.53	59	8.03	< 25%	736,045
Massachusetts-08	12	1.53	64	8.41	18%	764,581

Table 1: Congressional districts were defined using the 116th Congress. Population is the average estimate from the American Community Survey 5-year file for 2014 to 2018. The CDC requires that cell counts less than 10 are suppressed for subnational geographies as well as related totals in the same row; in this case rates and the percent of firearm suicides out of all suicides.

The 20 congressional districts with the highest rate of firearm suicide are found across 16 states (see Table 2), all in the Western and Southern US. In stark contrast to the districts with the lowest rates of firearm suicide, these districts have, on average, 106 firearm suicides per year. The rate of firearm suicide in the 20 districts with the highest rates of firearm suicide is more than 10 times higher than that of the 20 districts with the lowest rates of firearm suicide. Rates of firearm suicide in these districts are all above 13 per 100,000 people. Firearm suicides account for 61% of all suicides in these districts.

Table 2
Congressional districts with highest firearm suicide rate per 100,000

State, District	Firearm Suicides per Year	Firearm Suicide Rate per 100,000	Suicides per Year	Suicide Rate per 100,000	Firearm Suicides as percent of Suicides	Population
Arizona-04	139	18.04	219	28.51	63%	768,077
Montana-At large	172	16.47	273	26.19	63%	1,041,732
Wyoming-At large	93	16.05	145	24.92	64%	581,836
Alaska-At large	115	15.63	189	25.59	61%	738,516
Colorado-03	109	14.73	195	26.34	56%	739,107
Nevada-02	99	14.03	175	24.69	57%	708,357
Oregon-02	112	13.92	193	23.99	58%	805,737
West Virginia-03	81	13.68	126	21.23	64%	591,379
Kentucky-05	95	13.59	131	18.65	73%	702,070
Colorado-05	106	13.48	207	26.35	51%	786,912
Tennessee-06	102	13.46	157	20.63	65%	759,176
Arkansas-01	97	13.38	149	20.59	65%	722,915
West Virginia-02	83	13.35	129	20.70	64%	623,350
Oregon-04	106	13.30	190	23.88	56%	794,776
New Mexico-02	92	13.18	158	22.53	59%	700,177
Georgia-09	97	13.18	145	19.68	67%	735,832
Idaho-02	108	13.17	184	22.51	59%	818,249
Idaho-01	114	13.12	186	21.43	61%	869,560
Oklahoma-02	98	13.11	171	22.91	57%	748,286
Oklahoma-03	101	12.96	157	20.23	64%	776,845

Table 2: Counts are average per year for the 2014 to 2018 period. Congressional districts were defined using the 116th Congress. Population is the average estimate from the American Community Survey 5-year file for 2014 to 2018.

Among the 43 states with more than one congressional district, ten have differences in average annual incidence of firearm suicide of more than 50 per year (see Table 3). The largest variation in the number of firearm suicides was seen in Arizona between the 4th district (139/year) and the 7th district (50/year). In terms of rate per 100,000 the largest variation within a state was between California's 1st district (11.87/100,000) and the 40th district (1.88/100,000).

Table 3
States with largest district-level range in firearm suicide deaths

State	District	Firearm Suicides per Year	Firearm Suicide Rate per 100,000	Suicides per Year	Suicide Rate per 100,000	Firearm Suicides as percent of Suicides	Population	
Arizona	High	4	139	18.04	219	28.51	63%	768,077
	Low	7	50	6.30	95	11.8	53%	801,173
California	High	1	84	11.87	155	21.99	54%	706,822
	Low	40	13	1.88	47	6.56	29%	711,793
Florida	High	11	94	12.40	154	20.44	61%	754,649
	Low	24	30	4.04	71	9.43	43%	750,906
Tennessee	High	6	102	13.46	157	20.63	65%	759,176
	Low	9	38	5.37	60	8.51	63%	705,233
Georgia	High	9	97	13.18	145	19.68	67%	735,832
	Low	5	39	5.14	73	9.66	53%	759,756
Virginia	High	6	84	11.18	137	18.28	61%	750,774
	Low	8	27	3.39	67	8.49	40%	792,945
North Carolina	High	11	89	11.85	153	20.34	58%	752,316
	Low	4	34	4.10	77	9.18	45%	840,168
Texas	High	4	85	11.55	136	18.46	63%	738,929
	Low	15	31	3.95	62	8.01	49%	776,971
Oregon	High	2	112	13.92	193	23.99	58%	805,737
	Low	3	59	7.14	141	16.99	42%	830,995
Pennsylvania	High	15	75	11.01	123	17.89	62%	685,714
	Low	3	23	3.19	68	9.46	34%	722,979

Table 3: Counts are average per year for the 2014 to 2018 period. Congressional districts were defined using the 116th Congress. Population is the average estimate from the American Community Survey 5-year file for 2014 to 2018.

Firearm suicide as a proportion of all suicide

Nationally, on average from 2014 to 2018, nearly half of suicides involve a firearm, however the range is from a low of 6% to a high of 73%. There are 34 districts across 6 states and the District of Columbia where suicide with a firearm makes up less than 25% of all suicide deaths. This stands in contrast to 21 districts across 7 states where firearm suicides account for 65% or more of all suicide deaths. Focusing only on males, which account for 86% of all firearm suicides, the proportion of firearm suicides out of all suicides ranges from a low of 8% to a high of 77% (with firearm suicide rates of 0.40/100,000 and 13.59/100,000, respectively).

District-level rates confirm that differences in firearm suicide across the US drive differences in suicide: 88% of the difference in congressional district-level suicide rates is explained by differences in firearm suicide (see Fig. 2). While there was a ten-fold difference in rates of firearm suicide for the highest and lowest districts, the 20 districts with the highest suicide rates have an average rate four times higher than the 20 districts with the lowest suicide rates (24.03/100,000 and 5.66/100,000, respectively).

Rural firearm suicide

One clear pattern that emerges from this analysis was the relationship between population density and firearm suicide which exists at the county level was confirmed at the congressional district level (see Fig. 3). Across levels of urbanization, there is little difference in the non-firearm suicide rate: entirely rural districts (70 districts across 34 states) have rates of suicide by means other than firearm 1.3 times higher than entirely urban districts (5.66/100,000 and 7.43/100,000, respectively).(8) In the case of firearm suicide, however, entirely rural districts have a firearm suicide rate 5 times higher than pure urban districts (10.60/100,000 and 1.77/100,000, respectively).

Discussion

This analysis of firearm suicide by congressional district using publicly available county-level mortality reporting here showed that, despite similar population size and equal political representation, there is wide variation in the number and rate of firearm suicides across US congressional districts. On average, the 20 districts with the highest suicide rates have rates four times higher than the lowest 20 districts; the 20 districts with the highest firearm suicide rates have rates ten times higher than the lowest 20 districts. Prior research has shown that suicide rates for all methods, including firearms, differ widely among the 50 states and that those differences are driven by the disparities in firearm suicides.(9)

Understanding what is driving the difference in firearm suicide rates – factors such as firearm ownership and laws, race, sex, age, and rurality – can help improve local and federal legislation, policies, and programs towards preventing all suicide. The finding that differences in firearm suicide rates are so key to understanding differences in all suicide is in part because of the lethality of firearms compared to other methods or mechanisms for suicide. Nearly all other methods (such as hanging, poisoning, or drug overdose) are less lethal. For example, 90% of suicide attempts using a gun result in death. By comparison, only 4% of suicide attempts by other means are fatal.(10) There is growing evidence that access to a gun increases the risk of death by suicide.(11, 12) There is also growing evidence that laws such as extreme risk protection orders and programs at gun shops, shooting ranges, and law enforcement for temporary storage that provide opportunities to temporarily remove access to firearms when people are at risk can prevent firearm suicide.

Firearm suicide as a proportion of all suicide is often used in research and evaluation as a proxy for firearm ownership either on its own or alongside surveys or other proxies.(13, 14) The range of 6–73% for all persons and for 8–77% for males strongly suggests that firearm ownership varies significantly at geographic units below the state level. Further research is needed to understand differences below the state level for firearm ownership and how this may affect or be affected by local policies, programs, and regulations.

Limitations

The estimates are limited according to available data from the CDC and Census as well as simplifying assumptions. Using county-level counts and rates for the populations does assume that differences in suicide rates by counties, possibly because of local support programs, unemployment rates, occupation, or other social factors, matter. Research shows that differences at a state-level matter, for example in access to firearms (whether because of differences in state laws or culture)(9, 12, 15), access to healthcare and mental healthcare services(16), socio-economic differences and access to economic assistance.(17–19) It also assumes that the difference in congressional district borders by sex and race, where parts of a county were allocated to one or a different congressional district, are more significant than differences across congressional borders because of the county-level age structure which were not considered.

Another simplifying assumption made was that 5-year totals and averages could be used despite an increasing trend in firearm suicides over the period. Additionally, the deaths and rates are allocated to current (116th) Congress even though the deaths occurred during the 113th (2013–2014) – 115th (2017–2018). The Census uses 2010 population counts for its congressional district summary files, so while the census tracts are assigned according to their 2018 county and congressional district borders, the population demographics may have changed from their 2010 relative levels.

Of the 428 districts analyzed (excluding the known at-large districts), 263 congressional districts included at least one county that was wholly within the geographic boundaries of the district. This means that deaths reported for these counties was wholly included in the congressional district totals, limiting the number of deaths that had to be apportioned partially because of county and congressional district borders overlapping. Conversely, there are counties that wholly include multiple congressional districts. For example, Los Angeles county includes 18 districts, 11 of which are completely within the county borders and 7 that overlap with other counties. Differences across these within-county congressional districts would be unmeasured in this use of county-level rates.

The importance of presenting mortality by congressional district is not unique to firearm violent deaths and the limitations presented here are similar for many other attempts at allocating deaths to this level.(2, 4, 5) Ideally, the CDC would add congressional district data to its public reporting from the National Vital Statistics System reporting. Short of this, additional validation of these congressional estimates could be done with more detailed datasets that have restricted availability such as the National Violent Death Reporting System.

Conclusions

The fact that 23,000 American lives are claimed each year by a preventable cause is tragic. This analysis helps to provide the data necessary to understand what drives 10-fold differences in the number and rate of firearm suicides across US congressional districts. Increasing understanding of the types of life-saving policies, interventions, and behavioral changes needed to prevent suicide and firearm suicide in particular is essential to a public health approach as well as a tool for holding elected officials accountable for taking steps to protect the lives of their constituents.

Methods

Data source for counts of firearm suicides and all suicides

County counts of firearm suicide and all suicide by sex and race and Hispanic origin were obtained from CDC WONDER. Five years of data, from 2014–2018, were used to minimize suppression of data and stabilize rates. Because of small counts and frequent suppression, race and ethnic populations were grouped according to similar rates. Four sets of county-level counts were obtained: 1. Male, all races, all Hispanic origins; 2. Male, non-Hispanic white and Native American and Alaskan Native races; 3. Female, all races, all Hispanic origins; and Female, non-Hispanic white and Native American and Alaskan Native races. Male and female, non-Hispanic Black and African American, non-Hispanic Asian American and Pacific Islander, and Hispanics county-level counts were then calculated as the difference between the overall category and the specified races.

Counts of deaths were as reported using the International Classification of Disease Codes, 10th revision (ICD-10) firearm suicide: X72 (Intentional self-harm by handgun discharge); X73 (Intentional self-harm by rifle, shotgun and larger firearm discharge); X74 (Intentional self-harm by other and unspecified firearm discharge) or all suicide mechanisms including firearm suicide X60-X84 (Intentional self-harm). The ICD-10 code for the sequelae of intentional self-harm, Y87.0 was excluded from the definition of all suicide because the firearm and non-firearm mechanisms could not be disentangled from this combined category. From 2014–2018, across the United States, there were 240 male deaths and 65 female deaths where Y87.0 (Sequelae of intentional self-harm) was the underlying cause of death; therefore estimates for all suicide may be less than analyses which included this cause. No deaths were reported by CDC for the period as intentional self-harm by terrorism (U03.0 or U03.9).

Allocation of county deaths to congressional districts

County-level reporting is the most granular geographic unit available publicly. Congressional district borders can be a portion of one county or encompass parts or all of multiple counties. Many US counties straddle two or more districts; many districts include parts of two or more counties. If the distribution of gun suicides was relatively even within a county, one could then simply divide county-level suicides by the proportion of the population of a county that is contained within that district. But neither overall suicide nor firearm suicide are distributed evenly across the population; rather they vary by age, sex, and race.

To account for differences in how county populations are split across districts, Census tract populations for county and congressional district for the 116th Congress borders from the 2010 census counts by sex, race

and Hispanic origin were obtained from the Census summary file for the 116th Congress.(6) For the six sex, race, and Hispanic origin groups noted above, two sets of weights were created: the proportion of county population allocated to the congressional district and the proportion of the congressional district population from the county.

Allocation of counts from the county to the congressional district and calculation of rates for the congressional district was based upon the methods from the American Cancer Society(3) and published on the CDC website for calculation of congressional district cancer mortality.(5, 20) Counts of suicides and firearm suicides for the congressional districts were calculated by weighting county counts by the proportion of the county population allocated to the congressional district for that population group. The weighted counts were then summed over the counties in the congressional district. Crude rates were calculated using population data from 5-year estimates file of the American Community Survey.(21) Estimated rates and counts were replaced by actual state rates and counts for both firearm suicide and all suicide for the 8 at-large congressional districts that follow state or federal district boundaries: Alaska, Delaware, District of Columbia, Montana, North Dakota, South Dakota, Vermont, and Wyoming.

Imputation for suppressed data

The CDC suppresses data when counts of deaths for the requested disaggregation are less than 10. Across the 43 states that do not have an at-large congressional district for the 116th Congress, 10 states had more than 40% of their counties suppressed even as totaled across all sex, race, and ethnicity groups: Arkansas (31/75), Colorado (31/64), Iowa (70/99), Illinois (47/102), Kansas (77/105), Minnesota (47/87), Mississippi (34/82), Nebraska (82/93), Nevada (7/17), and Texas (126/254). Suppressed counts of deaths were imputed by multiplying the population of the county by the state-level crude rate of death for both suicide and firearm suicide. In cases where estimated deaths exceeded 9.5, they were replaced with 9.5 given that actual deaths in excess of 9 would not have been suppressed by the CDC. While there was a large number of suppressed counties, most firearm suicide deaths (90% overall) were known and not suppressed: 94% (92,698/98,656) of male firearm suicides were reported; 63% (10,060/15,972) of female firearm suicides were reported. Suppression was lower for all suicide, which included firearm suicide, and also bounded the suppressed data for firearm suicide (counts of suppressed firearm suicide could not exceed counts of all suicide).

Validation checks

As a validation, estimated firearm suicide deaths across congressional districts within a state were then summed together and checked against CDC state totals. On average across states, the total of congressional districts within the state was 99.5% of the CDC state-level counts for firearm suicide. This ranged from Nebraska total (95.5%) to Mississippi (102.2%), meaning that the firearm deaths for congressional districts in Nebraska are an underestimate of the total for the state by 4.5% and those in Mississippi are an overestimate by 2.2%. As expected, the states with the largest under and over counts were those with higher proportions of counties with suppressed county-level deaths. The validation was repeated for all suicides, and because of higher counts and fewer counties with suppressed data, the range was from a low of 99.2% of all suicides (Virginia) to a high of 103.75% (Mississippi).

Declarations

Ethics Approval

Not applicable. This was a quantitative analysis of publicly available summary data at the census tract or county level and therefore was not considered human subject research.

Consent for publication

Not applicable.

Availability of data and material

The datasets analyzed in the current study were obtained from publicly available sources.

Resulting generated analysis is either included in this published article, as supplemental file, or available on the Everytown for Gun Safety Support Fund Research website (www.everystat.org/#congressional).

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

SBS conceptualized the analysis, interpreted the results, wrote the discussion, and revised the manuscript. KS designed and performed the quantitative analysis, interpreted the results, and drafted the manuscript. Both authors read and approved the final manuscript.

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Figures

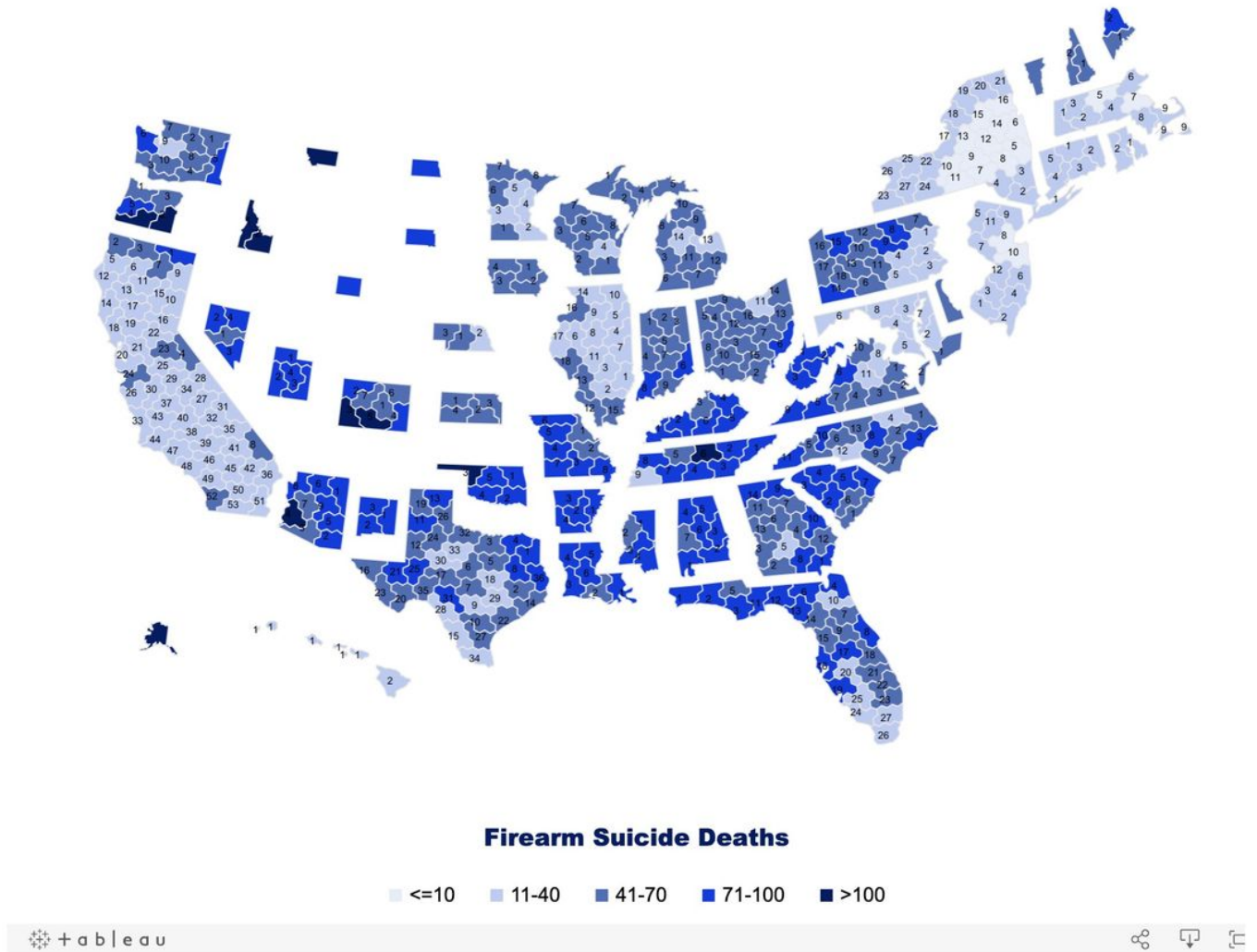


Figure 1

Cartogram choropleth showing average number of firearm suicides per year by US congressional district, 2014 to 2018. Congressional districts were defined using the 116th Congress. The cartogram(7) shows each of the 435 congressional districts as approximately the same size to represent their equal political power and similar population size despite their enormous variation in square mileage and shape. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city

or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

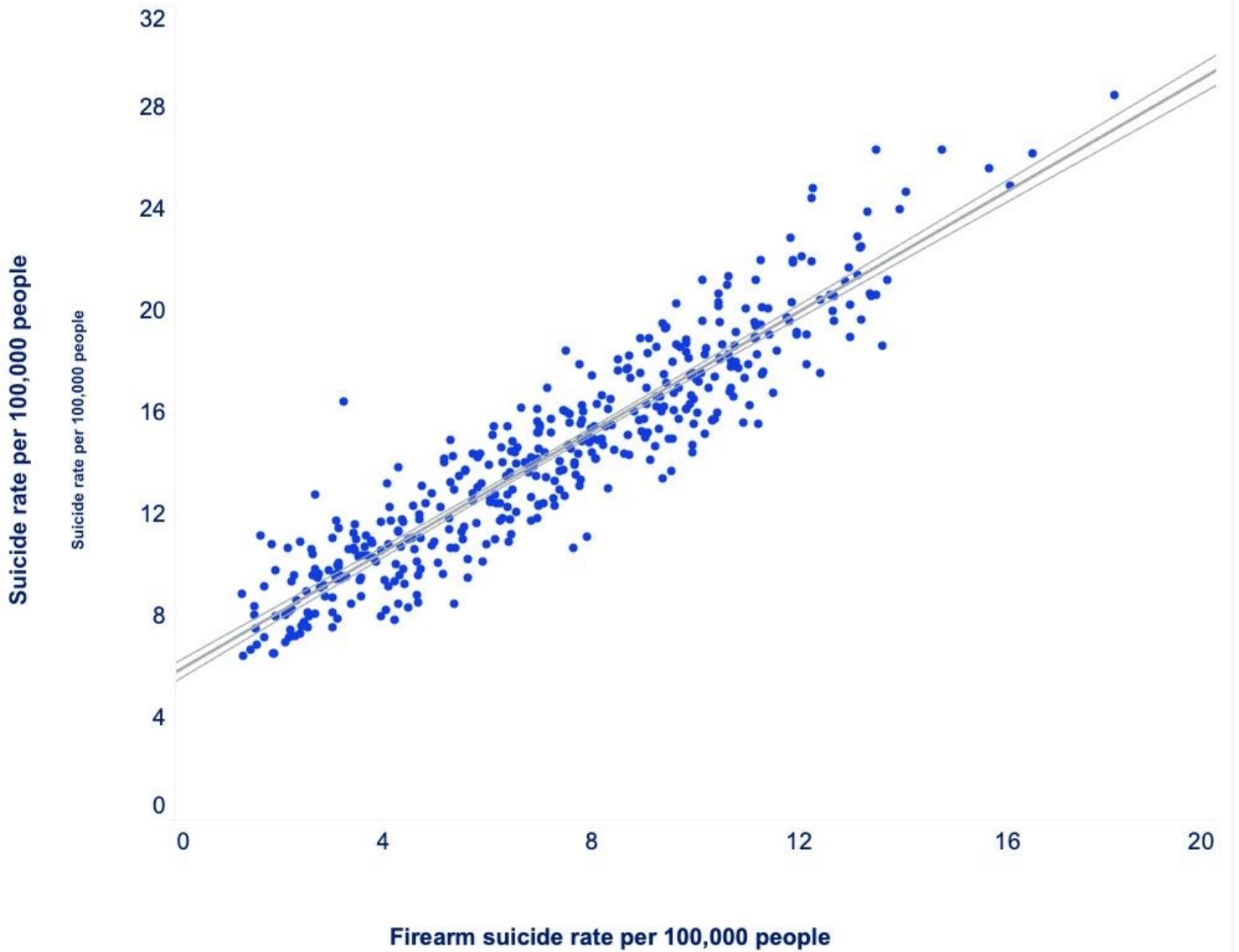


Figure 2

Association of firearm suicide rate and all suicide rate. Crude rates per 100,000 calculated as an average for the 2014-2018 period. Line of best fit, with 95% confidence interval bands. R-squared=0.86, $p < 0.0001$.

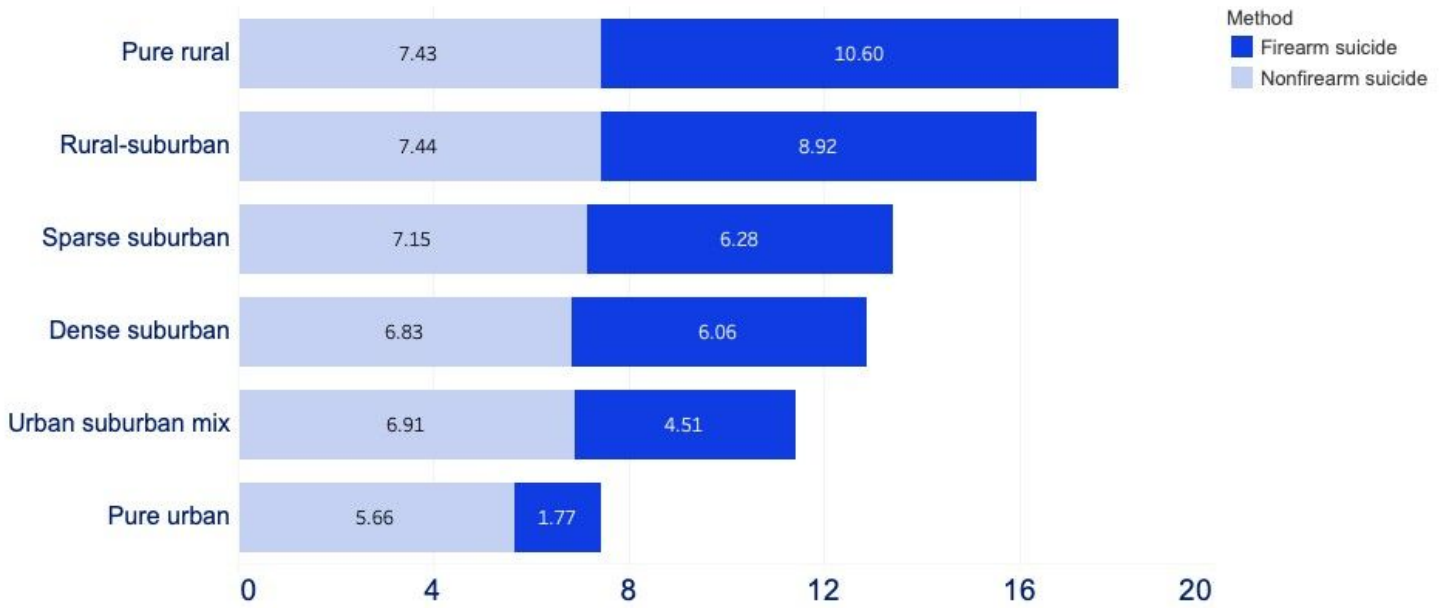


Figure 3

Firearm and non-firearm suicide rates per 100,000 persons for 2014 to 2014 by level of rurality and urbanization. Crude rates per 100,000 calculated as an average for the 2014-2018 period. Non-firearm suicide calculated by subtracting firearm suicide from total suicide. Rurality or urbanization as defined by CityLab Congressional Density Index.(8)

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [SupplementalFileCongressionalFirearmSuicide.xlsx](#)