# IMPROVING RESEARCH WITH BIG DATA VISUALIZATION: A LOOK AT FIREARM DEATHS IN THE UNITED STATES

by

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A THESIS

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Finding the right questions to conduct research on can be challenging. Even after discovering the cause of a problem, effectively communicating findings based off of statistical information to the American public proves to be yet another common hurdle. Visualizing big data can help find the right questions to ask, and it provides a way to graphically represent the information for the general public.

Big data is becoming more common, so we should adapt the way we approach research. Starting with the data itself, instead of a hypothesis, can be beneficial. By visualizing big data, patterns can be discovered that could have gone unnoticed when confined to answering a specific question. Starting with graphical information also allows studies to easily include images in reports, making them more digestible for the average consumer. It also allows an emphasis to be put on visual consistency, which is necessary to compare compilations of images. To exemplify the benefits of starting with visualized big data, maps depicting twenty years of data on deaths caused by firearms in the United States are produced. The process to produce more maps using data from the Centers for Disease Control and Prevention is included.

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# Introduction

Technological advancements in the twenty-first century have given us an immense amount of information sitting at our fingertips, just waiting to be used. At times, there seems to be an excessive amount of information to digest, a surplus of data. It can be overwhelming, but it does not need to be. The ways in which we record and access information have developed, and the ways in which we can use it have changed too. Now it is a matter of developing new techniques and adjusting standard research methods to further benefit from the growth of big data—large, comprehensive sets of information.

Looking for different ways to use big data as it becomes more common is incredibly important, even if it means approaching research in a different manner than we are accustomed to. We are living in an age where we have more data available to use than ever before because of digitization and datafication.[1] Using this immense amount of data, we can look for patterns and determine correlations we might not have been able to discern before.[2]

There are several ways to go about finding patterns in data. Perhaps you are able to find a pattern simply by looking at numbers in a table. When looking at numbers in a table is unhelpful, you might translate the data into a graph. If the dataset contains locational data, you can create a map of the information. Then there are times when visualization is not enough to find a pattern, and you might turn to machine learning, letting artificial intelligence tell you what the pattern is. Until the fields of artificial

[1] Viktor Mayer-Schönberger and Kenneth Cukier, *Big Data: A Revolution That Will Transform How We Live, Work, and Think* (HMH Books, 2013), 8, 15.
[2] Ibid, 14.

intelligence and machine learning become more developed and commonplace, the general way to find a pattern is by visualizing the data.

Visualizing big data can be used to find patterns that we did not know existed until we looked at a large or comprehensive dataset. Recognizing patterns is one of the first steps to researching a topic. If no one is aware of a trend taking place, then it is impossible to ask why the trend is occurring. Big data is more useful for discovering *what* is happening instead of *why* something is happening, so rather than only looking towards the data after coming up with a hypothesis, we should be visualizing big data to help us find new questions to ask.[3]

Creating visuals using big data before a hypothesis is even formed should be normalized. Not only can this process lead to new discoveries, but it also means researchers have visuals at their disposal when it comes time to write up their findings. Including graphics in reports improves the audience's understanding of the material. The inclusion of images is especially important when trying to convey complex information to a general audience. Just as visualizing the data can help a researcher find patterns, having visuals can help a reader understand the topic better.

Graphically representing big data is not without its challenges though. The sheer amount of data can make it difficult to look at all of it and still discern enough details to find the trends. Graphs, for instance, can only have so many points before the detail is lost, and if you focus in on a certain subset of data you could lose trends that can only be seen with the larger set. Sometimes it is best to make a compilation of visuals that, when all together, will allow you to see patterns without comprising the level of detail.

[3] Ibid.

However, when you use several separate images to get an understanding of the bigger picture, you need to make sure there is consistency amongst the images to avoid skewing the way your brain interprets the information.

Creating visuals using big data has two major benefits—finding trends to ask the right questions and conveying complex information. To show how creating visuals prior to developing a hypothesis can be beneficial, we will look at data provided by the Centers for Disease Control and Prevention on deaths caused by firearms. This data will be translated into maps and the process for doing so will be covered.

Technology has evolved allowing us to create more data, store big data, access it easily, and quickly visualize it. Adapting our research methods to life in the information and digital age is a must. Comprehensive studies that visualize big data are indispensable. They can pose new questions, help find solutions to seemingly unrelenting problems, and present complex information in a way that the general public can understand.

# Background

## What is Big Data?

The term "big data" relates to the amount of information available on a topic. Typically for a dataset to be considered under the umbrella of big data, the amount of information it contains is incredibly large; however, a dataset does not necessarily need to be large, rather it needs to be a comprehensive set of information relative to the topic.[4] For a study to "use big data", it must utilize as much of the entire dataset as possible—not just a subset of the information.[5] One way to recognize whether a study uses big data or not is to determine if the research is finding new insights using a large scale of data that could not otherwise be found using a smaller scale.[6]

Big data exists for a wide array of topics and can be used in a variety of ways. Google has an extensive collection of search terms people use, and it has been known to correlate searches with real world affairs, such as how the flu spreads.[7] In this case, an immense amount of data is already stored together, ready to be used. Another way to use big data is by compiling different sources together to get the full scope of a situation. Oren Etzioni, who created Farecast, found a way to compile airplane ticket prices from different airlines, for various flights, over a span of time and used the information to predict the value of a ticket at any given time (e.g. is the ticket cheap or expensive at the time you are looking to purchase).[8] Whether there is one large database

[4] Ibid, 28-9.
[5] Ibid, 28.
[6] Ibid, 6.
[7] Ibid, 1.
[8] Ibid, 3-5.

of information or bits of information from a mass of different sources, as long as the data comes together to form a comprehensive look at a topic, it is big data.

*Prior to Big Data*

Before the technology existed that has allowed us to use big data, the majority of the world's information was stored on paper, film, vinyl records, and other similar formats.[9] To collect and analyze data in such formats was not only time-consuming but also incredibly costly.[10] When researchers would come up with new questions, they often had to recollect data and start their analysis from the beginning.[11] Before we had vast amounts of data readily accessible, researchers were often limited in how many hypotheses they could pursue.[12]

Due to the limits of collecting and processing data, researchers frequently used sampling. For studies that ask a binary question, such as those with yes/no answers, statisticians showed that random sampling with 1,100 observations can accurately represent the whole.[13] Since gathering and examining just 1,100 data points is often precise enough, sampling is a common practice. Yet, random sampling does not work well when you need to break down the data and look at subcategories or ask additional questions that differ from the initial ones.[14] When we lacked the technology to process large amounts of data, sampling became a common practice, but its use now is no longer out of necessity.[15] Samples fail to catch the level of detail needed to find certain

[9] Ibid, 8.
[10] Ibid, 15.
[11] Ibid.
[12] Ibid, 14.
[13] Ibid, 22.
[14] Ibid, 24.
[15] Ibid, 26.

patterns, but prior to big data, sampling was the most realistic way to capture data when faced with a large scale study.[16]

*Digitization and Datafication*

In the early 2000s, there was a major shift from analog storage to digital storage of information.[17] The majority of recorded information existed non-digitally in the year 2000, coming in at roughly three-quarters.[18] By 2007, however, over ninety percent of all stored information was digital.[19] The improvements in computer related systems allowed us to store more information easily and cheaply, bringing about the desire for digitization.[20] Simply converting the existing physical information into a digital format that a computer can process did not create this shift of data storage on its own though.[21] New and increased usage of electronics meant more and more data was also being accumulated.[22]

In addition to digitization, datafication has led to an abundance of digital information. When information has been datafied, it has been put in a format that can be tabulated and analyzed.[23] Mayer-Schönberger and Cukier write datafication "refers to taking information about all things under the sun—including ones we never used to think of as information at all, such as a person's location, the vibrations of an engine, or the stress on a bridge—and transforming it into a data format to make it quantified".[24]

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[16] Ibid.
[17] Ibid, 8.
[18] Ibid.
[19] Ibid.
[20] Ibid, 15.
[21] Ibid, 83.
[22] Ibid, 6.
[23] Ibid, 78.
[24] Ibid, 15.

Since the technology to digitally store copious amounts of data exists now, the amount of data getting recorded is increasing. By knowing everyone's Google searches, having people's tweets and other social media posts, recording the locations of items such as cellphones and packages, being able to keep every random note or document we create, and more, the digital age has given us easier access to more information than we ever had before. This transformation has led to the creation and use of big data.

*Big Data Today*

In addition to having more data, the same set of data can frequently be used for several purposes now. Data's usefulness does not end after being used for its original collection purpose.[25] For example, having ticket prices is not only helpful to compare prices in the moment but various analyses can be run on the historical data. Similarly, Google can continue to use search terms for several different studies. The usefulness does not end the second a ticket price comparison is complete or a search is processed. Today, data itself has economic value and can be considered as a raw material of business.[26] The data can be used for its initial purpose then used again for other projects, within the same company or by a third party.

By using big data, new insights can be found that would have been challenging or impossible to find prior to big data.[27] Today's digital devices and systems have provided far more data to analyze than ever before. The constraints that led to using sampling are largely in the past, and our ability to analyze subcategories and submarkets

[25] Ibid, 5.
[26] Ibid.
[27] Ibid, 6.

has increased.[28] We can find anomalies in big data that would have otherwise been missed by sampling.[29] There are still areas where there is a lack of information and obtaining it could still be costly, but by moving on from the analog era, the cost to collect the data and the ability to analyze it has greatly improved. When we have big data, we can let it speak for itself, offering new insights into information we previously struggled to fully understand.[30]

**How Do We Use Visuals?**

Visuals come in many forms. Photographs inundate our everyday lives. Other common types of visuals are graphs, tables, charts, diagrams, and maps. Whether it is a photo in a social media post, a map for directions, or a graph depicting scientific data, visuals can provide us information. Visual communication predates written language.[31] Our conventions when it comes to using visuals have "been invented and reinvented across cultures and by children" indicating that visuals align with our natural ways of thinking.[32] People frequently use sketches to share information that is either literally or metaphorically spatial, such as the design of an object or a family tree, respectively.[33] While visualizations are commonplace, visualizing information that is imperceptible to the naked eye can be particularly challenging. Visual representations in STEM (science,

[28] Ibid, 12.
[29] Ibid, 28.
[30] Ibid, 14, 19.
[31] Angela Kessell and Barbara Tversky, "Visualizing Space, Time, and Agents: Production, Performance, and Preference," *Cognitive Processing* 12, no. 1 (2010): 43-52, doi:10.1007/s10339-010-0379-3.
[32] Jeff Zacks and Barbara Tversky, "Bars and Lines: A Study of Graphic Communication," *Memory & Cognition* 27, no. 6 (1999): 1073-079, doi:10.3758/bf03201236.
[33] Barbara Tversky and Masaki Suwa, "Thinking with Sketches," *Tools for Innovation* (2009): 75-84, doi:10.1093/acprof:oso/9780195381634.003.0004.

technology, engineering, and math) have been able to evolve over the years because of new technologies—drawings can now be advanced digital images or three-dimensional models which can easily be replicated and shared.[34] As digitization and datafication took place in the 2000s, creating visualizations of data started to become even more common.[35]

*Discovery Through Visuals*

Creating visual representations of data allows us to think spatially and discover new information. Visualizations can help group and simplify data, translating it into a form that is easier for people to make spatial comparisons and inferences.[36] Seeing elements and relations in a visual helps us make connections between the data and the real world because of the way our brains naturally think spatially.[37] Spatial thinking "involves objects, their size, location, shape, their relation to one another, and how and where they move through space".[38] Being a good spatial thinker is valuable when it comes to understanding concepts in STEM because interpreting visuals relies on spatial thinking.[39] Visual representations have been used for years because STEM frequently deals with complex phenomena and in order to observe important evidence visualizations are needed.[40] Sometimes a visual is primary data, such as an image from

[34] Maria Evagorou, Sibel Erduran, and Terhi Mäntylä, "The Role of Visual Representations in Scientific Practices: From Conceptual Understanding and Knowledge Generation to 'seeing' How Science Works," *International Journal of STEM Education* 2, no. 1 (2015), doi:10.1186/s40594-015-0024-x.
[35] Kessell and Tversky, "Visualizing Space, Time, and Agents: Production, Performance, and Preference," 43-52.
[36] Ibid.
[37] Tversky and Suwa, "Thinking with Sketches," 75-84.
[38] Eliza Bobek and Barbara Tversky, "Creating Visual Explanations Improves Learning," *Cognitive Research: Principles and Implications* 1, no. 1 (2016), doi:10.1186/s41235-016-0031-6.
[39] Ibid.
[40] Evagorou, Erduran, and Mäntylä, "The Role of Visual Representations in Scientific Practices: From Conceptual Understanding and Knowledge Generation to 'seeing' How Science Works."

a microscope, and sometimes it aids in understanding primary data by making the abstract more concrete, like graphs of sound waves.[41] To develop, clarify, and transmit knowledge, visual representations are an important part of the scientific process.[42]

*Explaining with Visuals*

Similar to how visuals can help researchers understand their data to make new discoveries, visualizations can help the general public understand complex information presented to them better. Since certain visual elements are widely used, such as arrows, the average person should be able to understand a good visual quicker than if the content was conveyed purely in word form, which depending on the complexity of the information could get confusing very quickly.[43] People often have a harder time understanding information when the phenomena they are learning about is macroscopic, sub-microscopic, or abstract.[44] Comprehending a visual is typically easier because words can only describe spatial properties, forcing the audience to create their own mental representations which takes more effort and is more error prone than simply being presented with a visual.[45] When trying to get the public to comprehend scientific research, the less effort they have to put into making a confusing subject understandable, the better. People are used to looking at and interpreting images, so having visuals included in a report make learning about the subject easier and more appealing.

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[41] Ibid.
[42] Ibid.
[43] Bobek and Tversky, "Creating Visual Explanations Improves Learning."
[44] Ibid.
[45] Ibid.

## Visualizing Big Data for Research

### Discovery

Visualizing big data in the beginning of the research process can help solve unrelenting problems. In order to find out why something is happening, we need to understand what is happening. By looking at the data graphically, new trends can be found which can lead to figuring out the cause of a phenomenon. Also, starting with hypotheses can result in biased research that fails to find the necessary information to solve an issue, so by letting the data lead the researchers, certain biases are reduced and new information might be found that would not have been learned otherwise. Adapting the beginning of the research process to leverage big data is beneficial.

#### *New Questions*

Correlations lead to new questions. Correlations show a relationship between two or more things, but it does not necessarily mean one caused the other. While correlations do not directly explain *why* something is happening, they can reveal *what* is happening.[46] Once what is happening is discovered, then an investigation as to why it is happening can take place.[47] While correlations do not always show a causal relationship, looking at correlations can steer researchers towards new knowledge.[48] The insights gained from correlations allow researchers to ask questions that may solve elusive problems.

[46] Mayer-Schönberger and Cukier, *Big Data: A Revolution That Will Transform How We Live, Work, and Think*, 14.
[47] Ibid, 59.
[48] Ibid, 66, 191.

Finding correlations is easier with big data. The immense amount of information provided with big data reveals otherwise hidden associations.[49] The statistical methods often applied to data to find correlations require large amounts of data to properly process it and find patterns.[50] Despite needing to process a lot of data, today's technology makes finding correlations quick and easy compared to costly and time-consuming experiments.[51] Since non-causal analyses do not require as many resources, several can be run. Despite how not all correlations find a causal relationship, the cost of running several correlation analyses can be less than the cost of doing causal analyses. The more data there is, the easier it is to find correlations, so big data lends itself well to correlations. As Mayer-Schönberger and Cukier write, "Predictions based on correlations lie at the heart of big data".[52]

Visualizing big data assists researchers looking for correlations. While mathematical and statistical methods can find and analyze correlations, there are times when people need to look at the data to find a connection between sets of information first. The enormity of big data can make it hard for people to find patterns by looking at the raw data, but by visualizing big data, our brains are better at comprehending the information. The visualizations allow our brains to think spatially which in turn helps us make connections within the data. Since big data encompasses both the overall view of a situation and a more granular view, these visualizations of big data can be more helpful than images produced from smaller datasets or sampling.[53] While smaller

[49] Ibid, 61.
[50] Ibid.
[51] Ibid, 54, 66.
[52] Ibid, 55.
[53] Ibid, 12.

datasets are needed to create graphics by hand, computers are able to quickly produce graphics using large datasets, or multiple datasets. Looking at visualizations of big data at the beginning of the research process allows researchers to quickly identify patterns, or correlate information, before posing new research questions to investigate the causal relationship and hopefully present a solution to a problem.

*Reducing Bias*

Starting with a hypothesis can result in a bias that skews research results. When starting the research process with a hypothesis, the data is looked at through a lens that expects a certain outcome. This can affect the results in at least two ways. Since a certain result is already anticipated, the choice of data used for analysis could be inadvertently tailored to be more likely to produce the expected outcome. Additionally, starting with a proposed explanation can alter the way the data is interpreted by the researchers because of a subconscious desire for the hypothesis to be correct. Without a hypothesis, there is less bias that could manipulate what data is used and how it is interpreted.

To mitigate the bias caused by hypotheses, big data can be used to find trends before a hypothesis is even posed. Prior to big data, it was normal for both causal investigations and correlation analyses to begin with a hypothesis and "both were equally susceptible to prejudice and erroneous intuition".[54] Today's technology makes finding correlations using big data quick and easy. It should no longer be necessary to start with a hypothesis for correlational analysis because collecting and processing data

[54] Ibid, 61.

does not require as many resources anymore.[55] By letting the data show correlations, without the bias caused by hypotheses, more connections can be made that may have gone unnoticed before.[56] The research process could benefit from being "driven more by the abundance of data rather than by hypotheses".[57] Big data helps us find new correlations, to pose new questions, to get answers that could solve problems where biases stand in the way of finding a solution.

## Publication

Conveying complex information, especially to the general public, can be challenging, but getting people to understand complex topics is easier with the normalization of using visuals. If visuals are routinely produced at the beginning of the research process and included in reports, then standards can be established which help develop a consistency amongst visualizations. These standards could help prevent images from misleading our brains, causing incorrect interpretations. Additionally, the consistency and increased usage of visuals would make it easier for people to quickly comprehend the graphical information. The research process should include making visualizations at the beginning of the process to improve our ability to communicate complex information.

### *Consistency*

When graphics pertaining to the same subject look similar but use different methods to display the data, there is a risk people will not notice the change in

[55] Ibid.
[56] Ibid, 14.
[57] Ibid, 70.

construction and misinterpret patterns instead. Changes in scale, color, classification, and inclusion or exclusion of data can all lead to misinterpretations. For example, if you have two maps, from different years, depicting the number of people who died in each area during that year, it is common to want to compare the images. Perhaps both maps show the number of deaths by having the area with the lowest number as a light red and the color gradually gets darker until the area with the highest number is a dark red. These maps would look very similar, so our brains would naturally start to draw comparisons and identify patterns based on how dark the shade of red is. However, if the maps do not share the same scale or classification, then the lightest red and darkest red may not correspond to the same number of deaths in both maps. This could cause a person to notice patterns that might not actually exist in the data. If the shade of red for an area is different between the two maps, our brains will assume the number of deaths was different—even if the number of deaths was the same and the color key was simply the only difference. To prevent confusion, there needs to be a consistency in creating graphics so there is uniformity amongst images that display data on the same topic.

Developing a standard practice for the creation of big data visuals will establish a consistency that will reduce the chances of misinterpretation. Big data is frequently represented by a compilation of images. Creating a compilation of images that can be quickly, and correctly, interpreted is particularly tricky given the need for uniformity. Since visuals rely on our spatial thinking skills, it is important to keep our methods to create big data visuals consistent. If the methods used to visualize data remain uniform, then the resulting images are less likely to skew the way we interpret patterns in the data. When the data has not been processed yet, there is less desire to make artistic

choices which could affect the way the data is seen. Adhering to a standard would be easier if the visuals are created at the beginning of the research process because researchers are not looking for images that have been enhanced or altered for artistic reasoning. This does not mean the visuals are poor quality. In fact, these visuals can, and should, be included in the report. Then when future researchers create new visuals, using the same standards, they will simply be adding to the existing compilation of images. To reduce the chances of misinterpreting big data visuals, a standard needs to be established.

*Understanding*

Visuals make understanding complex information easier, so they should be used when communicating research results. Our ability to understand a visual relies on our familiarity of the symbols used within the graphic. Part of the benefits of graphically representing data is that it uses our spatial thinking skills. Spatial thinking relies on understanding the markings and symbols. When we are used to seeing a symbol, such as an arrow, we can quickly interpret its meaning. Establishing a consistency amongst the images we see will allow for a normalization and recognition of symbols used to depict complex information. If researchers visualize their data at the beginning of the process, and follow a standardized method to create them, then these original images can easily be included in the report. There is no need to go and create images simply to convey the research because the images will have already been created. Additionally, using the original images will prevent “enhancements” to the visuals that may ultimately cause readers to misunderstand the information. If there are several reports that use visuals depicting information on the same topic, then these images can be compiled and used to

find new patterns—but only if the images have a base uniformity. The general public, as well as other researchers, will be able to comprehend complex reports better if they include visuals. If more reports include visuals, then the easier it will become to interpret the visuals as our ability to understand them improves the more we see them. Reports should include visuals from the research process because good research can be rendered useless if others cannot understand it or use the results.

# Deaths Caused by Firearms – An Example

## Background

Mass shootings appeared in the news more and more frequently in the United States during the 2010s. This caused more people to get involved in the gun control debate. Devastating mass shootings often garner nationwide media attention. The general public tends to use these tragedies as a doorway into firearm discussions. When someone partakes in discussions of controlling firearms because of mass shootings, they often focus on the way a particular method of gun control will affect the occurrence of mass shootings. While preventing mass shootings may be an advocate's main concern, the decisions affecting access to firearms and ammunition not only have a possibility of impacting the number of mass shootings but also impacts the number of deaths caused by firearms as a whole—not just mass shooting casualties. This means the gun control debate needs to analyze the full scope of firearm death rates, not just mass shooting statistics.

## Definitions

My definitions for two phrases I use stem from the Centers for Disease Control and Prevention (CDC) and the way they handle their vast database of death information. My use of the phrase "deaths caused by firearms" refers to everyone who's underlying cause of death was from being shot. This means someone who died from exsanguination, because they were shot, died from a firearm. I use the phrase "full scope of firearm death rates" to refer to the big data on firearm death rates. This includes every year the CDC has published on firearm death rates and also includes the

details for every single intent category: homicide, suicide, legal intervention, unintentional, and unknown. These categories are what the CDC uses to subcategorize the total number of people who died from firearms.

**Purpose**

When looking for information on the full scope of firearm death rates, there is a gap in the type of reports the average U.S. citizen can find. Current reports lack comprehensiveness with visuals. Comprehensiveness, in this case, refers to the span of time covered and the amount of detail provided for each subcategory within a report that covers the full scope. This example will show the importance of visualizing big data, especially in relation to topics the average American is a consumer of. It will also fill a gap that currently exists in firearm death rates research.

**Production**

The data utilized in this example comes mainly from the CDC's Wide-ranging ONline Data for Epidemiologic Research (WONDER) Database. From the Multiple Cause of Death data in the WONDER database, information on deaths caused by firearms can be retrieved. Currently, there is data for the years 1999 through 2018, and when submitting a data request, the statistics can be grouped by year or month. Because of the scope of this study, the data is grouped by year. The data can be further grouped by location. For the purposes of this study, the data is gathered at the state level because at the county level, data suppression occurs to protect the identity of people contained in the request results. To get the information pertaining only to firearm deaths, the Underlying Cause of Death is selected by the Injury Intent and Mechanism. The

mechanism is a firearm, and six separate requests are made to get a detailed look at the data based on intent—all injury intent, suicide, homicide, legal intervention, unintentional, and unknown. For the purposes of this study, the results are not filtered using demographics, weekday of death, autopsy status, place of death, or additional causes of death.

Some additional data is utilized to create the maps depicting firearm death rates. The New York University's Spatial Data Repository contains the necessary files to produce the base map. The United States Census Bureau provides the files needed to show state borders. The data from the CDC is connected to the state information from the United States Census Bureau which then overlays the country outlines from New York University's Spatial Data Repository.

A mixture of ArcMap 10.5 and Python 2.7.12 is used to produce the maps. The Python scripts rely on the use of ArcPy which is provided by the ArcGIS suite. ArcMap 10.5 is used directly to create the document and symbology templates. From there, Python scripts produce all of the maps using the data downloaded from the CDC. I have published the code on GitHub for others to use. Step by step instructions can be found in the README markdown in the GitHub repository.

**Compilation of Images**

The following images are produced from big data on deaths caused by firearms. The first section is an overview of all the deaths. The following five sections correspond to the intent classification—suicide, homicide, legal intervention, unintentional, and undetermined. At the beginning of each section is a set of three graphics. The first bar graph of each section shows the raw number of deaths per year for that category. The

second bar graph normalizes the data from the first one, displaying the deaths per 100,000 people. The third image in each section is a box and whisker plot. These plots help determine the color key for each set of maps. The box and whisker plots make it easier to determine minimum, maximum, and extraneous values. Finally, each section has twenty maps, one for each year, depicting firearm death rates per state.

The last section, Small Multiples, compiles the 120 maps into twelve images. In this format, ten of the twenty maps for each category can be viewed at one time. However, due to the size of each map, some states can be harder to see. Because of this, each map is given half a page in their respective sections.

*Deaths Caused by Firearms – All Causes*

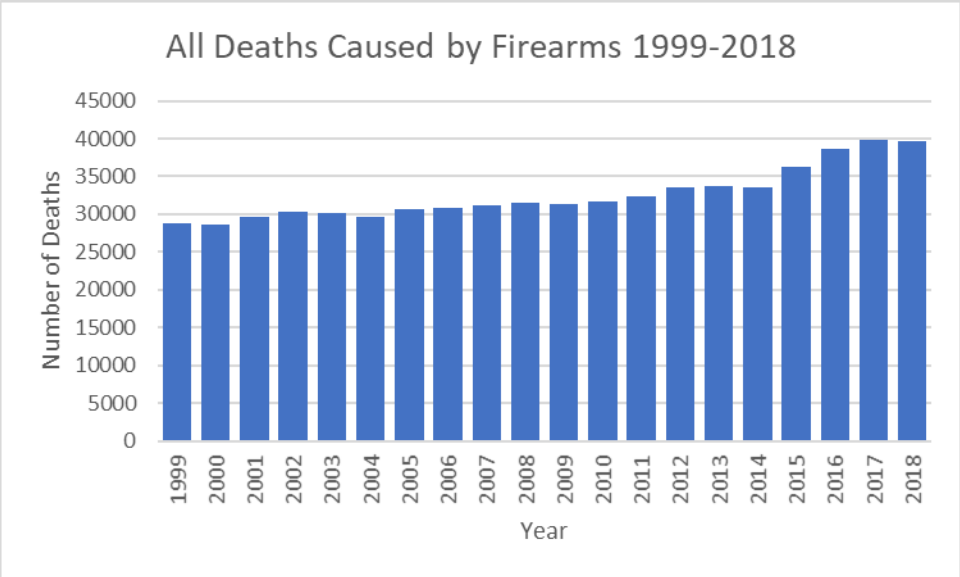


Figure 1: All Deaths Caused by Firearms 1999–2018 Graph

This bar graph shows the total number of people who died from a firearm, regardless of intent, from 1999 to 2018.

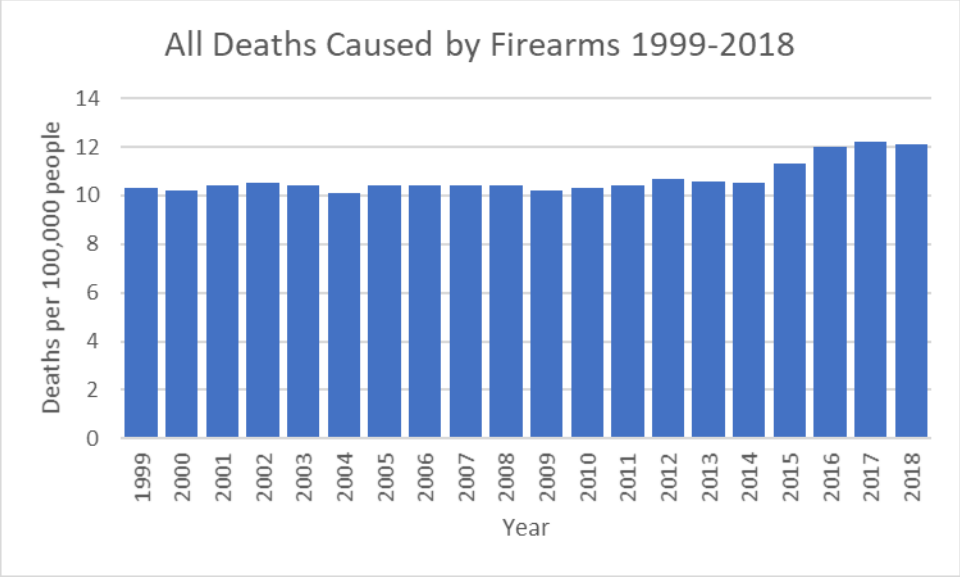


Figure 2: All Deaths Caused by Firearms 1999–2018 Crude Rate Graph

This bar graph shows the number of people who died from a firearm, regardless of intent, per 100,000 people from 1999 to 2018. By calculating the crude rate using the population in each year, the effects of population growth are reduced.

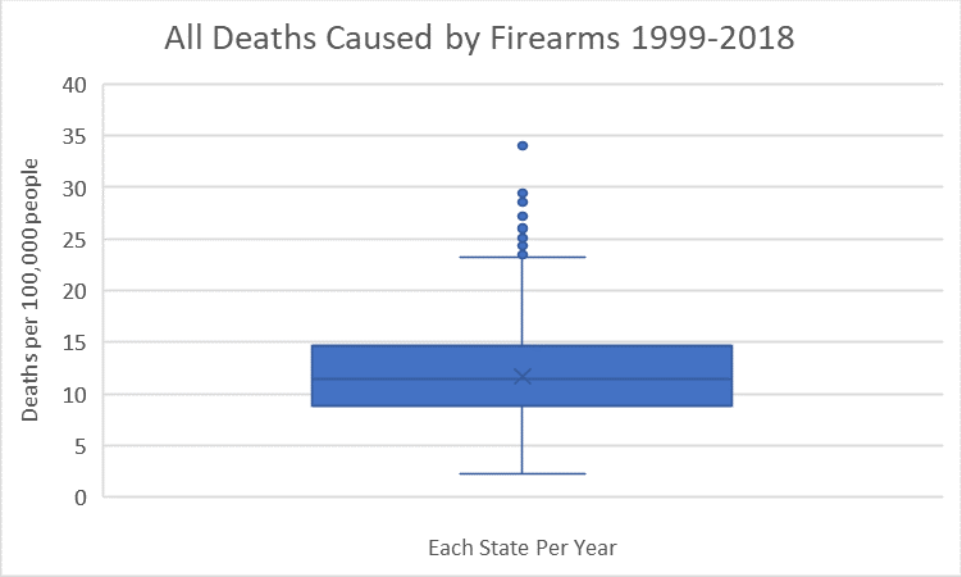


Figure 3: All Deaths Caused by Firearms 1999–2018 Boxplot

This box and whisker plot shows the statistics on the crude rate of all firearm deaths, regardless of intent, in each state from 1999 to 2018.

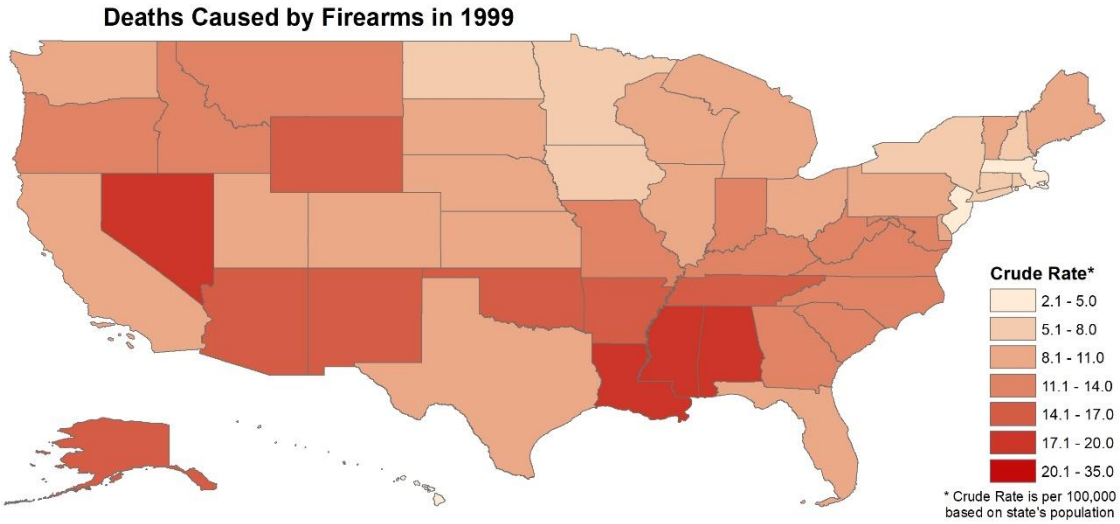


Figure 4: All Deaths Caused by Firearms in 1999 Map

This choropleth map shows how many people died by a firearm, regardless of intent, per 100,000 people in each state during 1999.

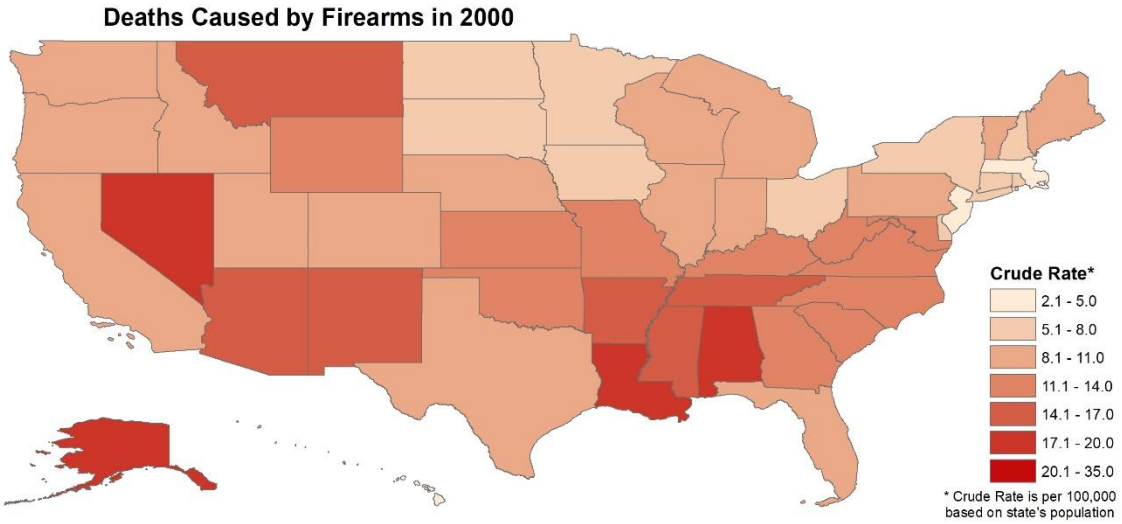


Figure 5: All Deaths Caused by Firearms in 2000 Map

This choropleth map shows how many people died by a firearm, regardless of intent, per 100,000 people in each state during 2000.

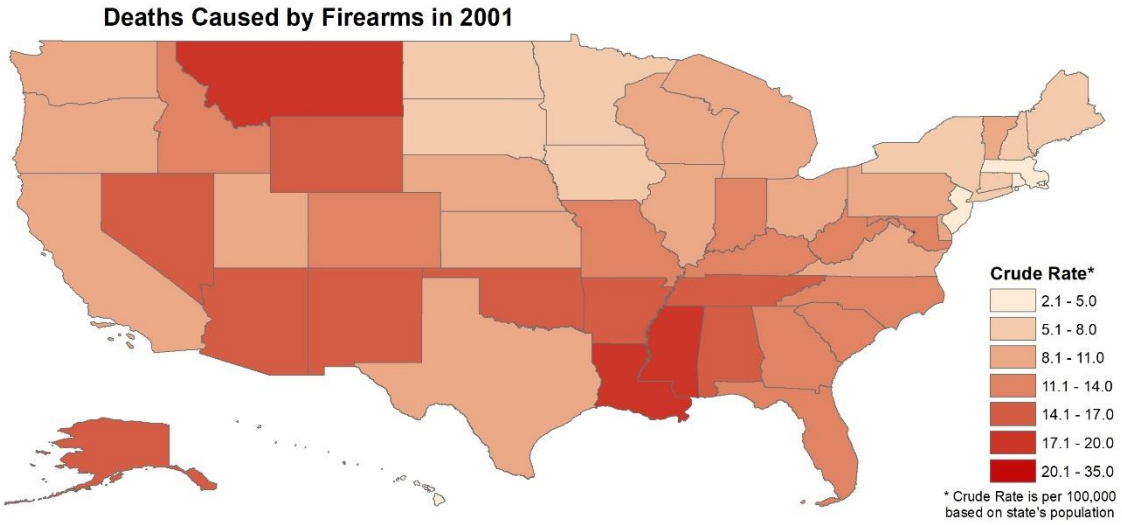


Figure 6: All Deaths Caused by Firearms in 2001 Map

This choropleth map shows how many people died by a firearm, regardless of intent, per 100,000 people in each state during 2001.

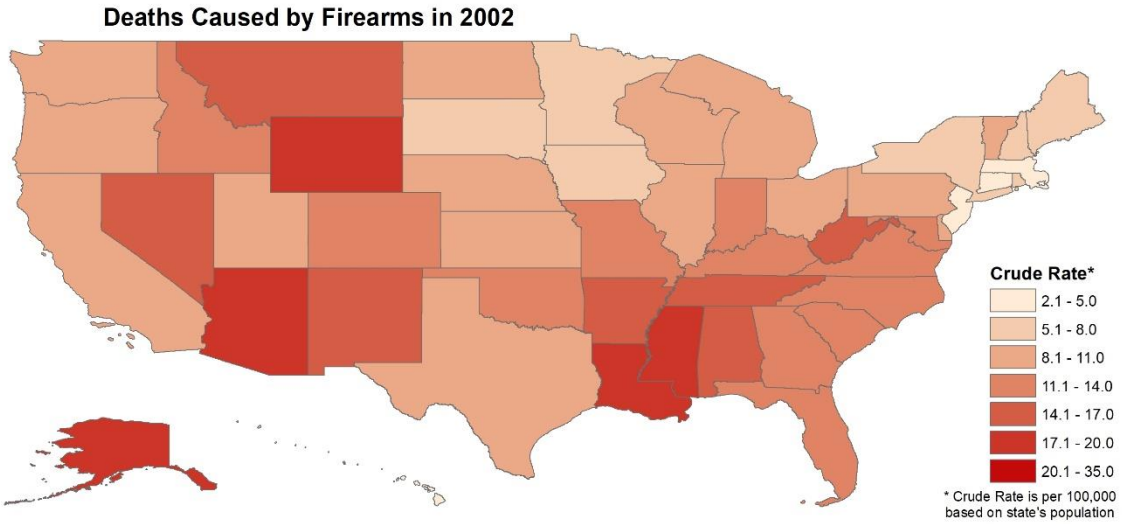


Figure 7: All Deaths Caused by Firearms in 2002 Map

This choropleth map shows how many people died by a firearm, regardless of intent, per 100,000 people in each state during 2002.

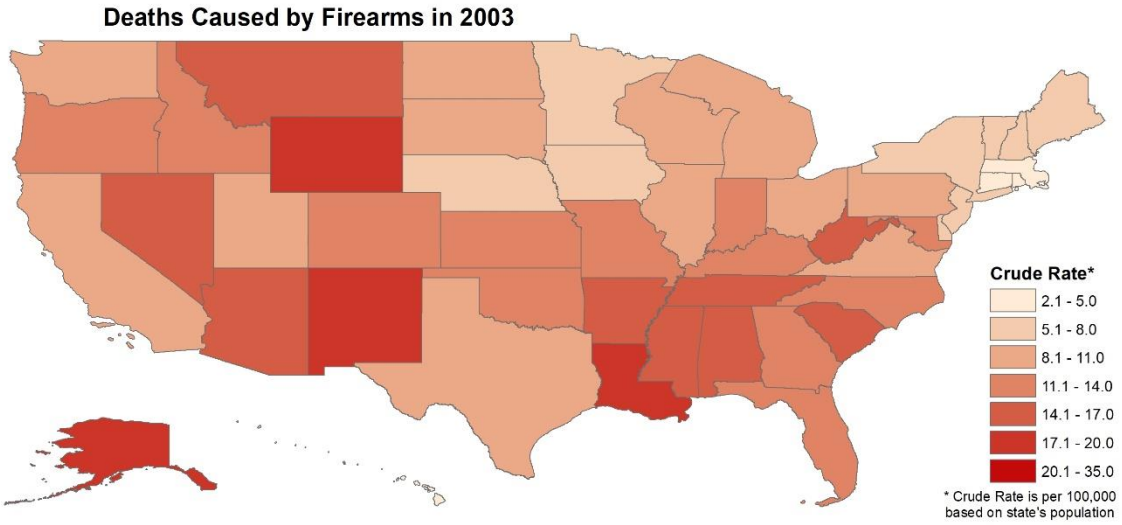


Figure 8: All Deaths Caused by Firearms in 2003 Map

This choropleth map shows how many people died by a firearm, regardless of intent, per 100,000 people in each state during 2003.

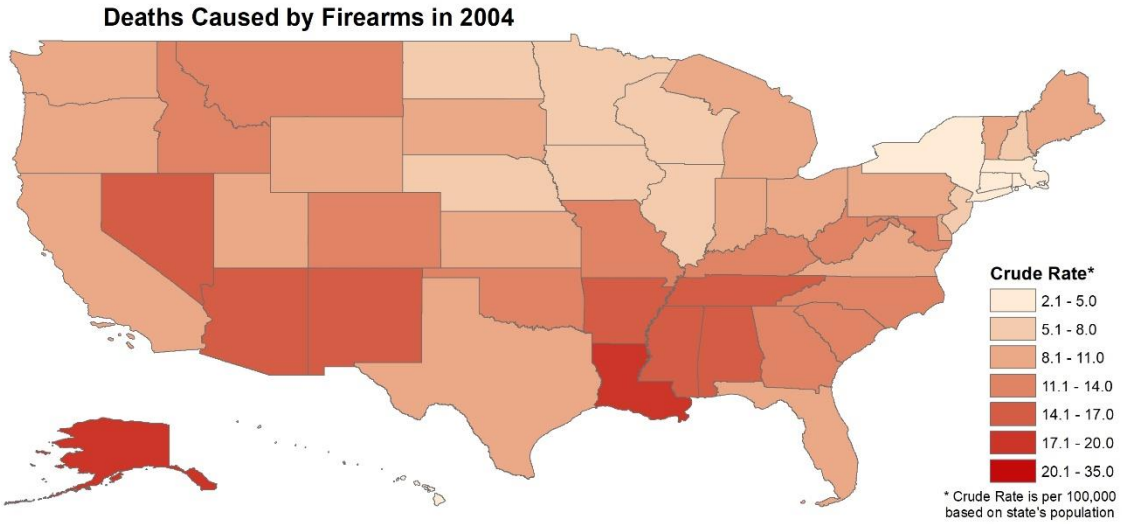


Figure 9: All Deaths Caused by Firearms in 2004 Map

This choropleth map shows how many people died by a firearm, regardless of intent, per 100,000 people in each state during 2004.

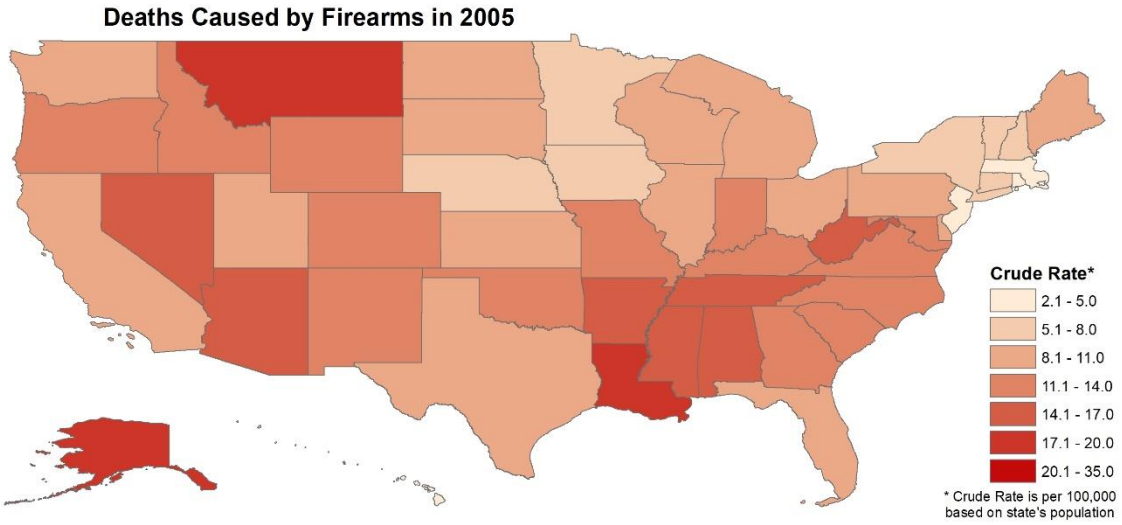


Figure 10: All Deaths Caused by Firearms in 2005 Map

This choropleth map shows how many people died by a firearm, regardless of intent, per 100,000 people in each state during 2005.

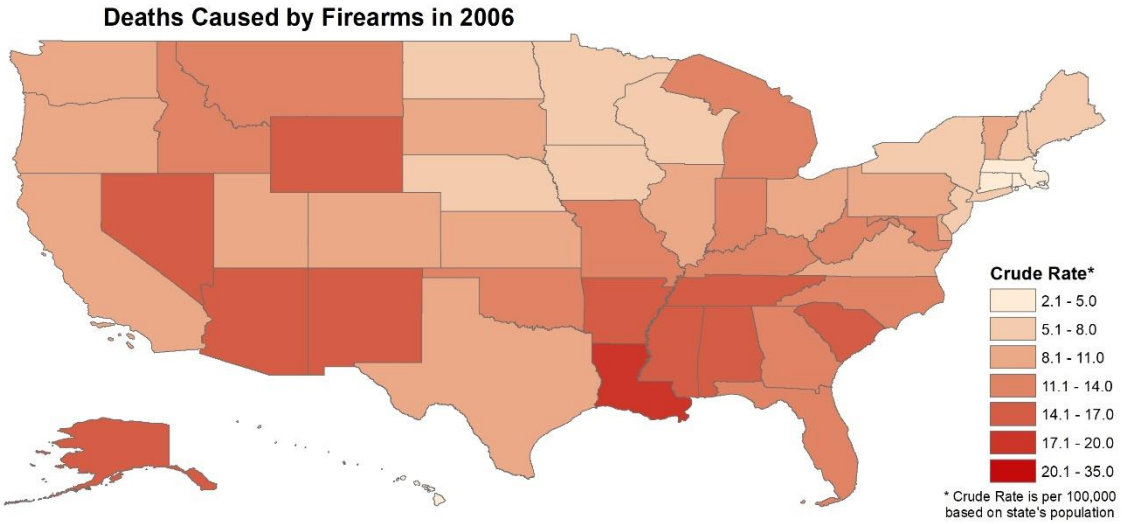


Figure 11: All Deaths Caused by Firearms in 2006 Map

This choropleth map shows how many people died by a firearm, regardless of intent, per 100,000 people in each state during 2006.

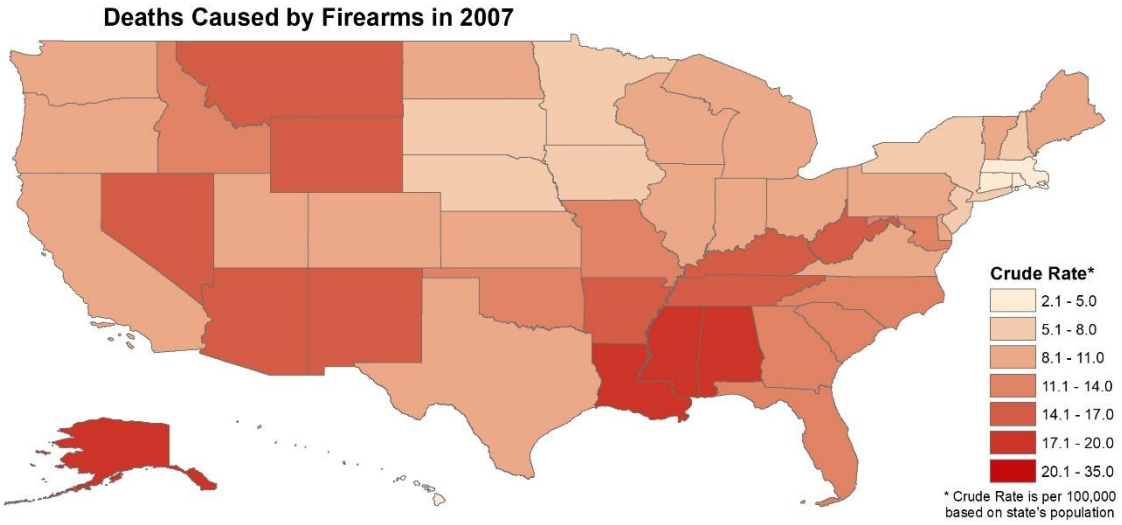


Figure 12: All Deaths Caused by Firearms in 2007 Map

This choropleth map shows how many people died by a firearm, regardless of intent, per 100,000 people in each state during 2007.

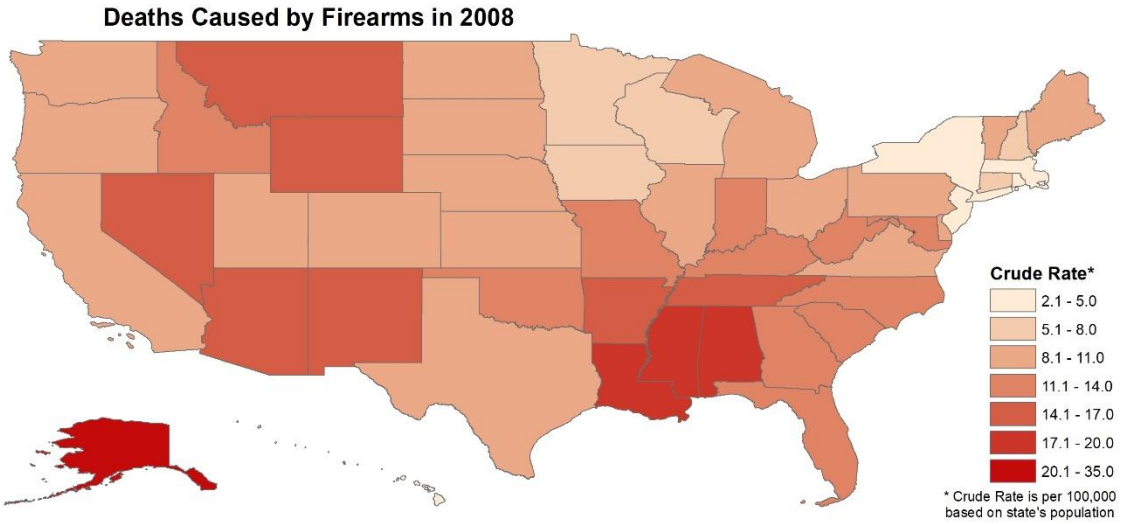


Figure 13: All Deaths Caused by Firearms in 2008 Map

This choropleth map shows how many people died by a firearm, regardless of intent, per 100,000 people in each state during 2008.

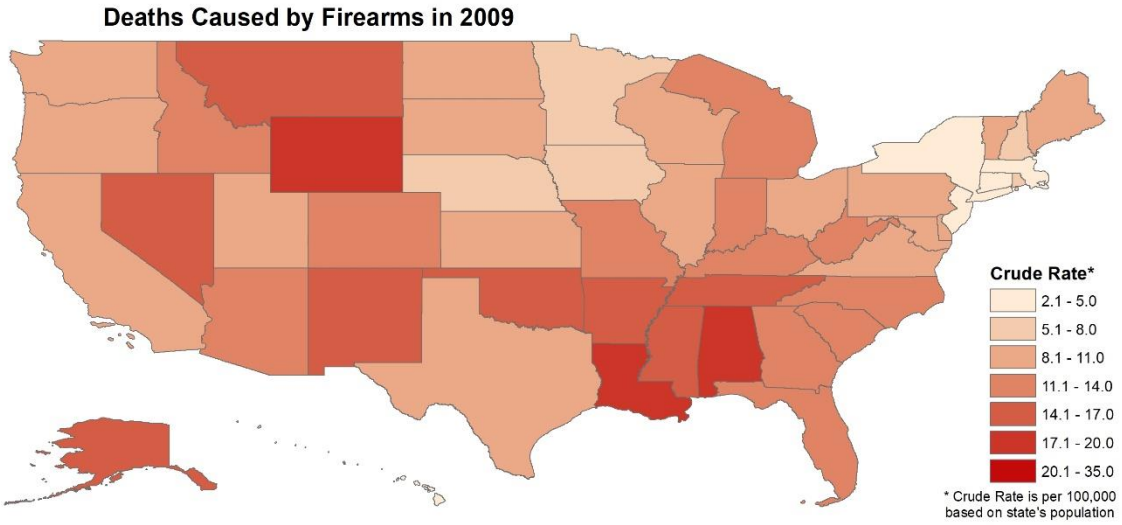


Figure 14: All Deaths Caused by Firearms in 2009 Map

This choropleth map shows how many people died by a firearm, regardless of intent, per 100,000 people in each state during 2009.

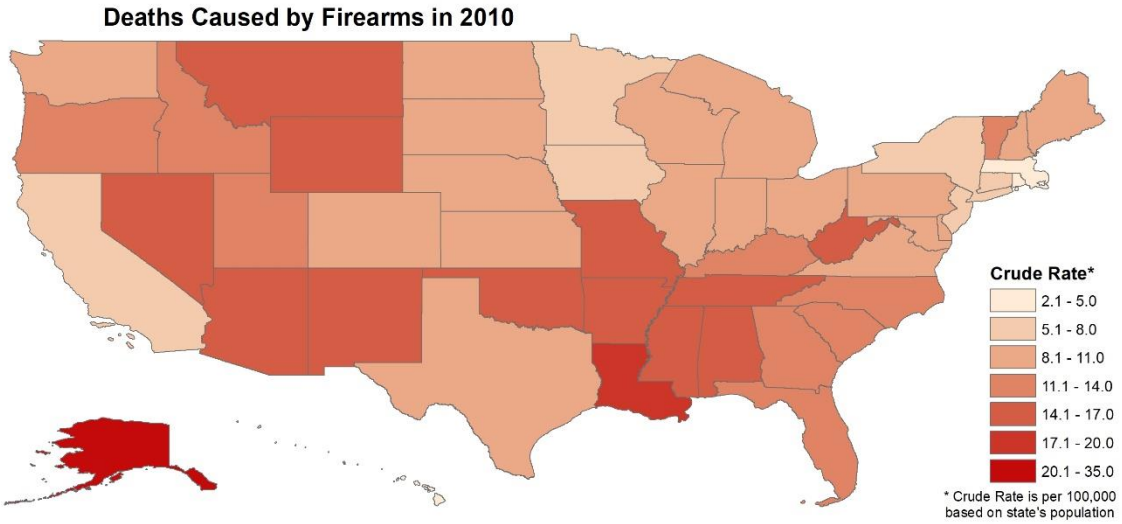


Figure 15: All Deaths Caused by Firearms in 2010 Map

This choropleth map shows how many people died by a firearm, regardless of intent, per 100,000 people in each state during 2010.

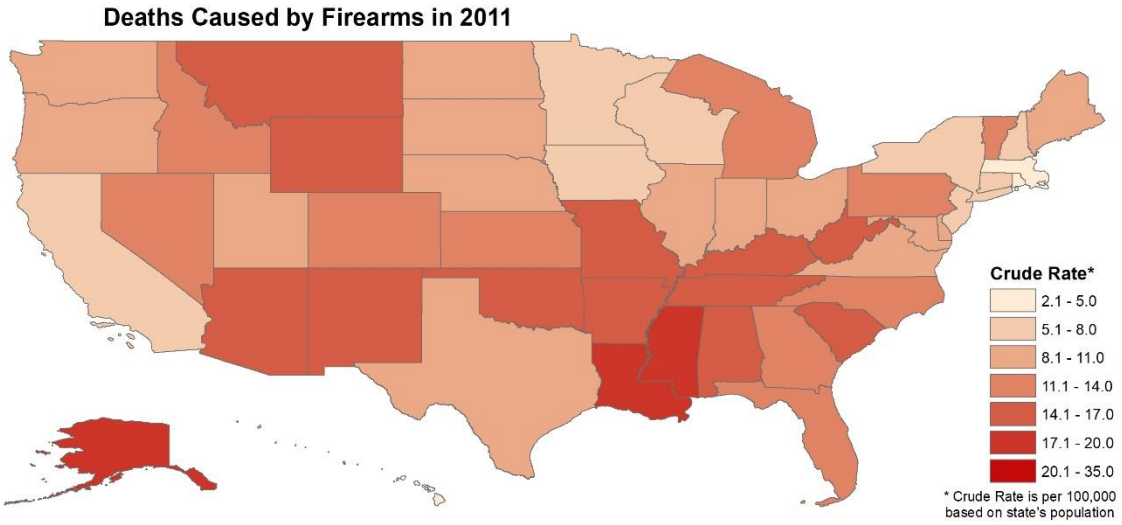


Figure 16: All Deaths Caused by Firearms in 2011 Map

This choropleth map shows how many people died by a firearm, regardless of intent, per 100,000 people in each state during 2011.

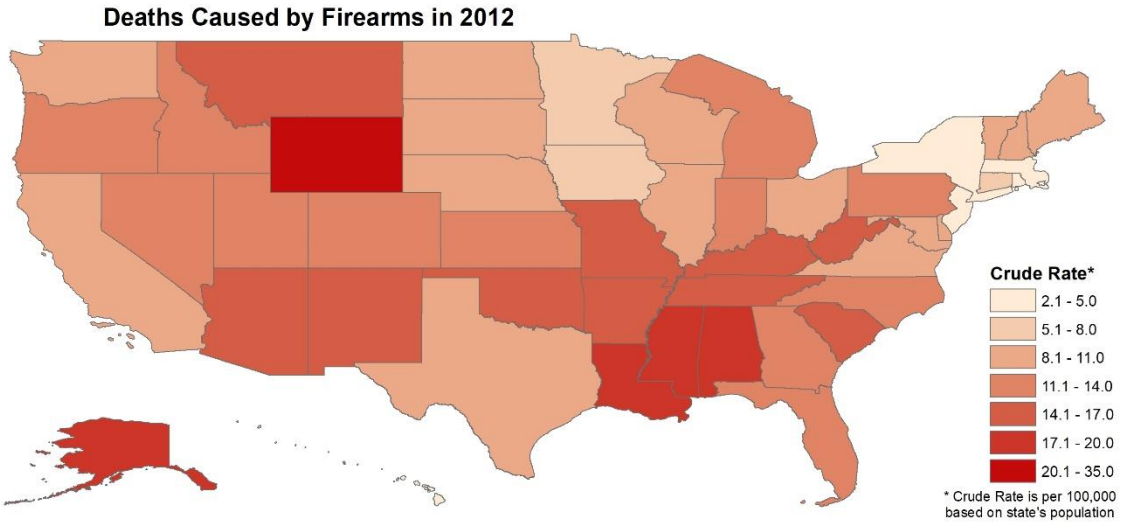


Figure 17: All Deaths Caused by Firearms in 2012 Map

This choropleth map shows how many people died by a firearm, regardless of intent, per 100,000 people in each state during 2012.

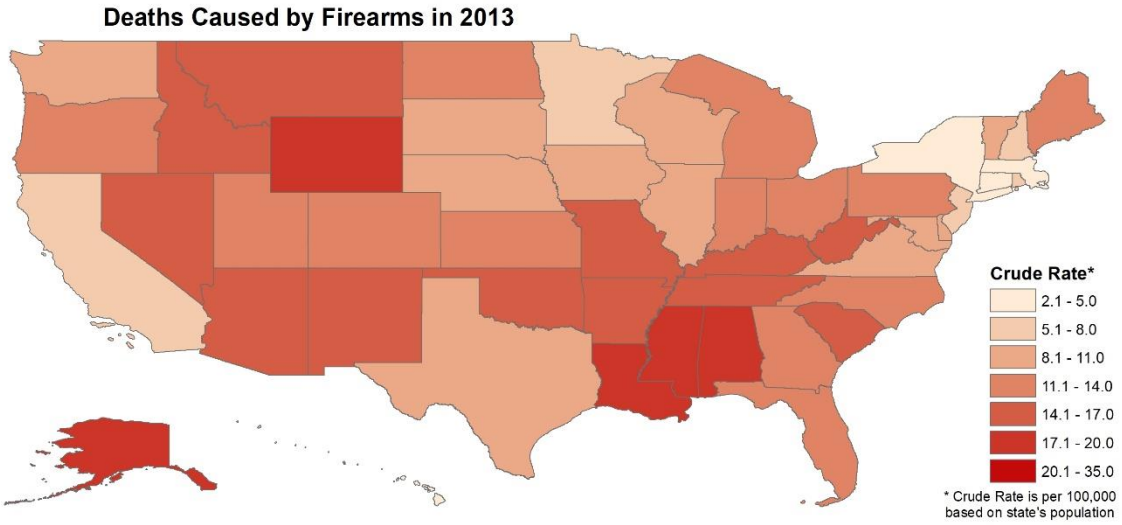


Figure 18: All Deaths Caused by Firearms in 2013 Map

This choropleth map shows how many people died by a firearm, regardless of intent, per 100,000 people in each state during 2013.

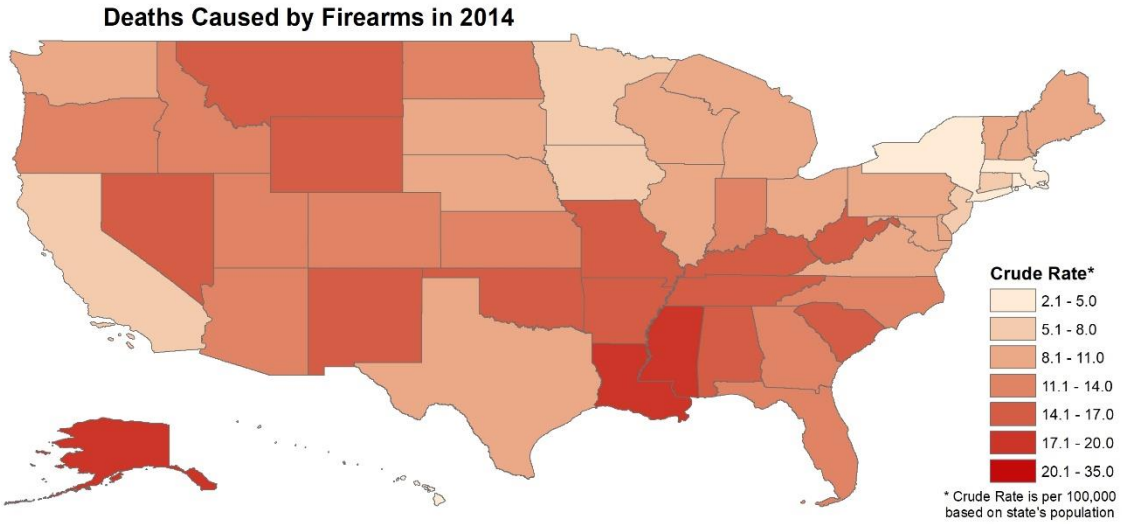


Figure 19: All Deaths Caused by Firearms in 2014 Map

This choropleth map shows how many people died by a firearm, regardless of intent, per 100,000 people in each state during 2014.

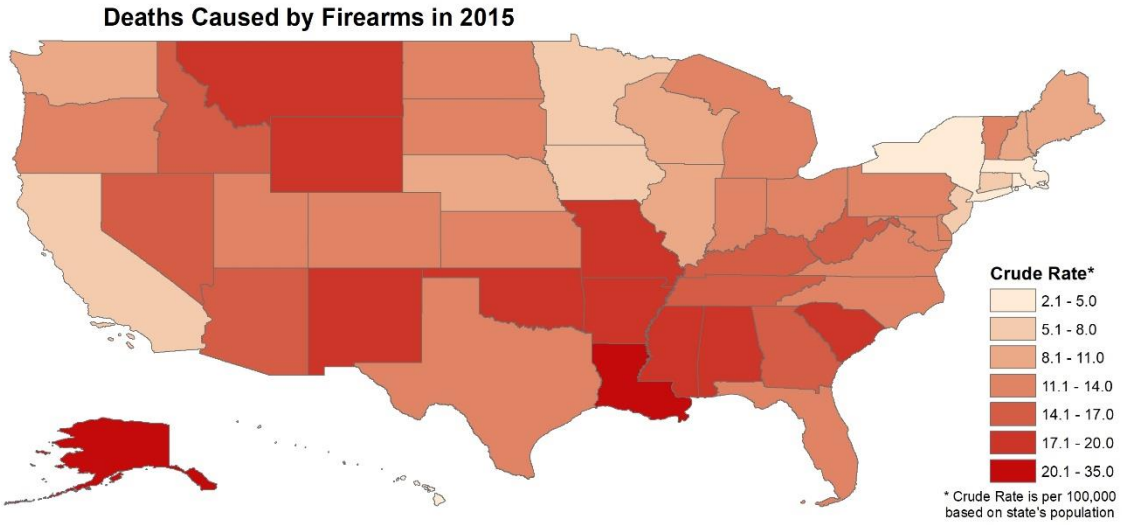


Figure 20: All Deaths Caused by Firearms in 2015 Map

This choropleth map shows how many people died by a firearm, regardless of intent, per 100,000 people in each state during 2015.

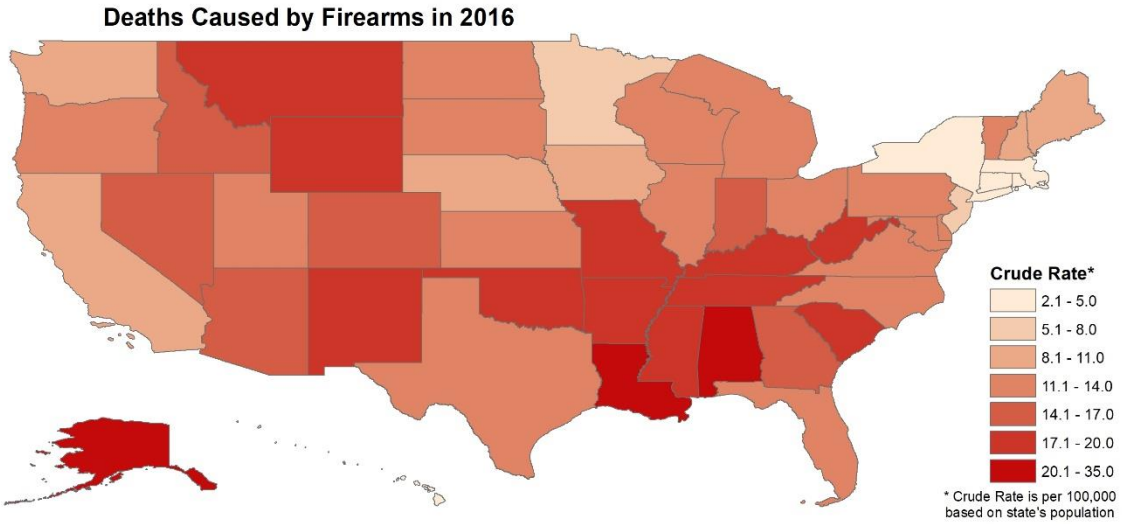


Figure 21: All Deaths Caused by Firearms in 2016 Map

This choropleth map shows how many people died by a firearm, regardless of intent, per 100,000 people in each state during 2016.

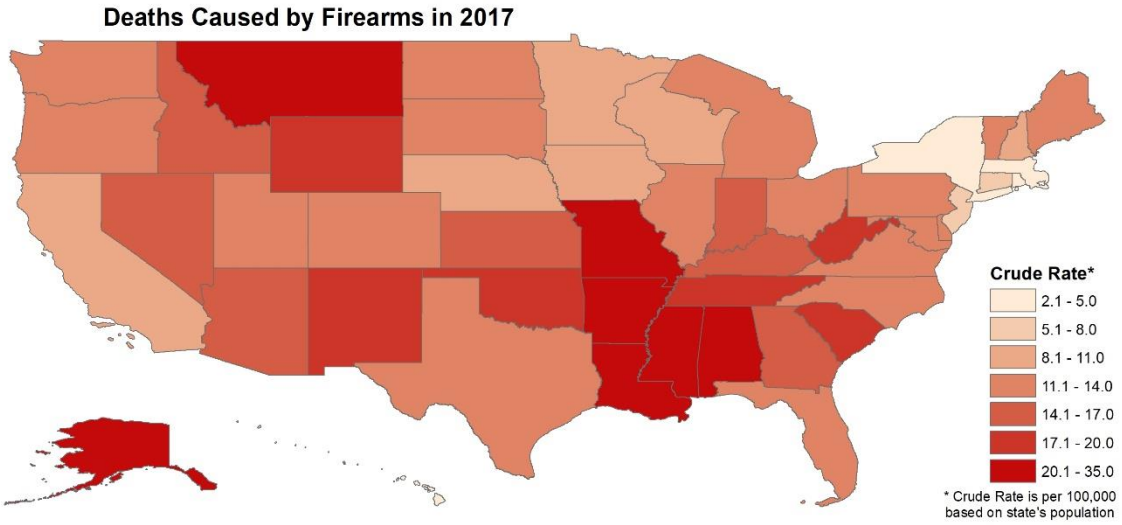


Figure 22: All Deaths Caused by Firearms in 2017 Map

This choropleth map shows how many people died by a firearm, regardless of intent, per 100,000 people in each state during 2017.

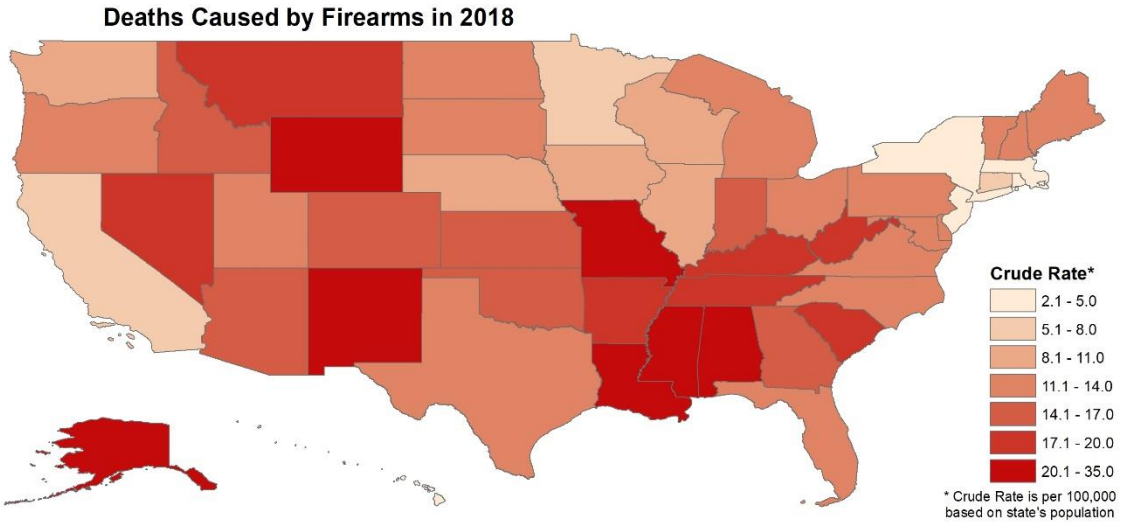


Figure 23: All Deaths Caused by Firearms in 2018 Map

This choropleth map shows how many people died by a firearm, regardless of intent, per 100,000 people in each state during 2018.

*Deaths Caused by Firearms – Suicide*

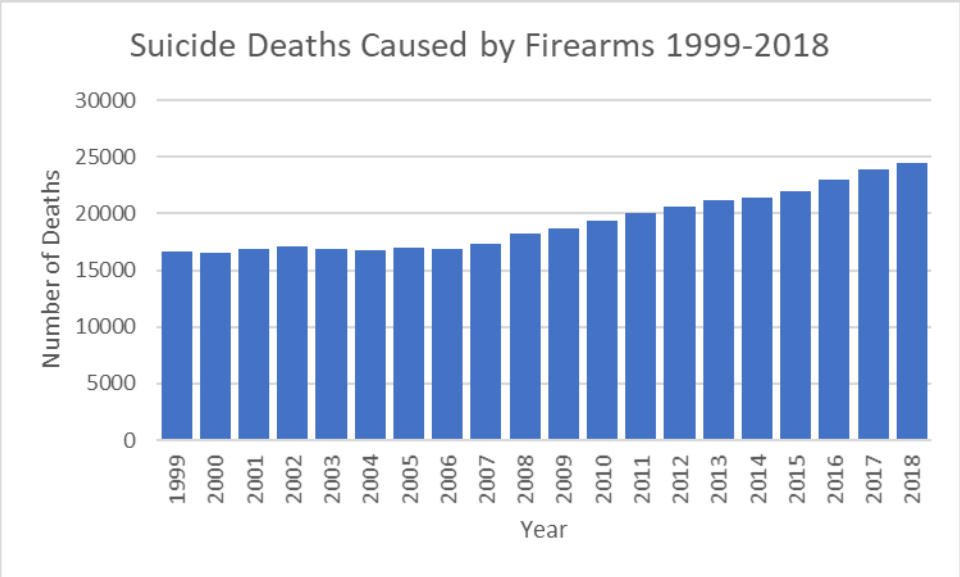


Figure 24: Suicide Deaths Caused by Firearms 1999–2018 Graph

This bar graph shows the total number of people who committed suicide with a firearm from 1999 to 2018.

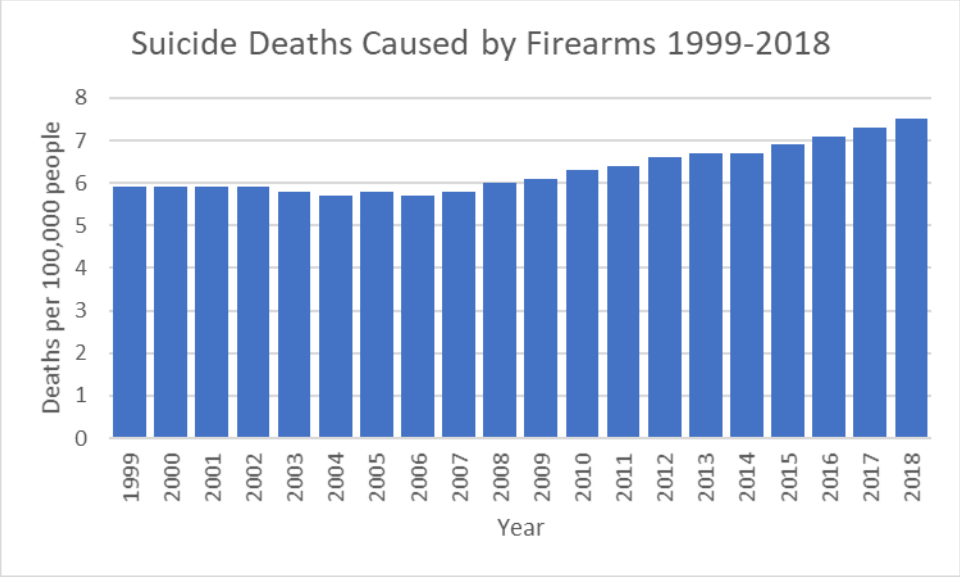


Figure 25: Suicide Deaths Caused by Firearms 1999–2018 Crude Rate Graph

This bar graph shows the number of people who committed suicide with a firearm per 100,000 people from 1999 to 2018. By calculating the crude rate using the population in each year, the effects of population growth are reduced.

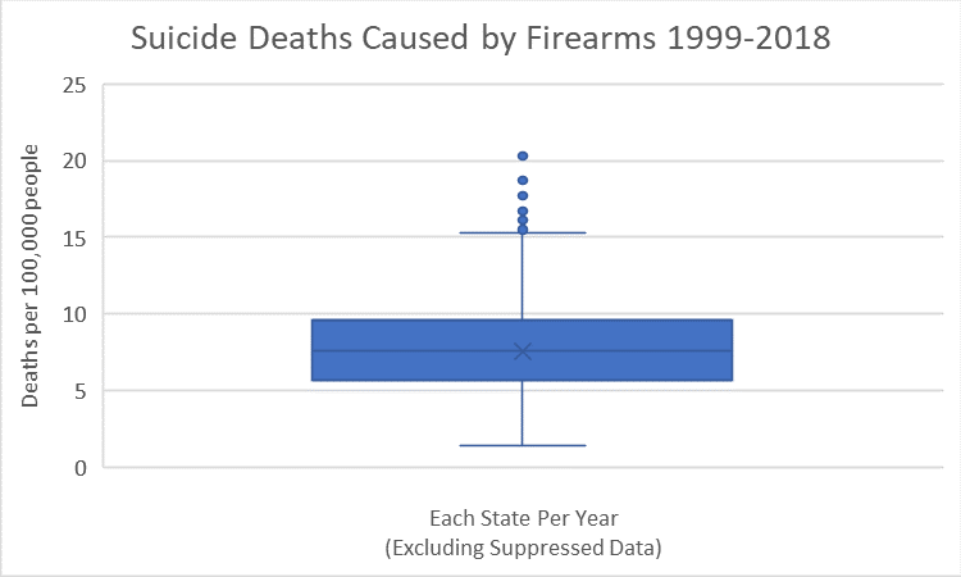


Figure 26: Suicide Deaths Caused by Firearms 1999–2018 Boxplot

This box and whisker plot shows the statistics on the crude rate of suicides involving a firearm in each state from 1999 to 2018.

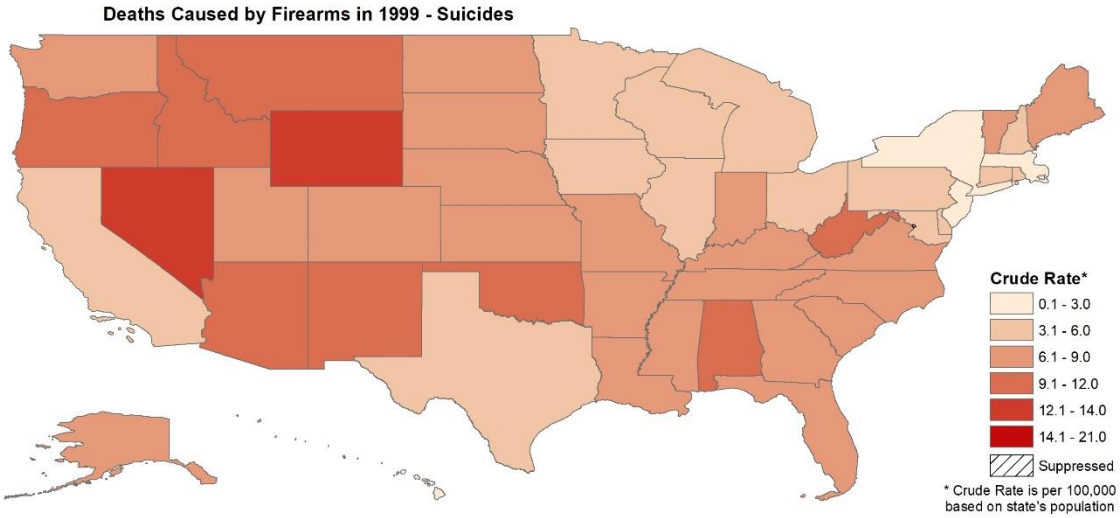


Figure 27: Suicide Deaths Caused by Firearms in 1999 Map

This choropleth map shows how many people committed suicide with a firearm per 100,000 people in each state during 1999.

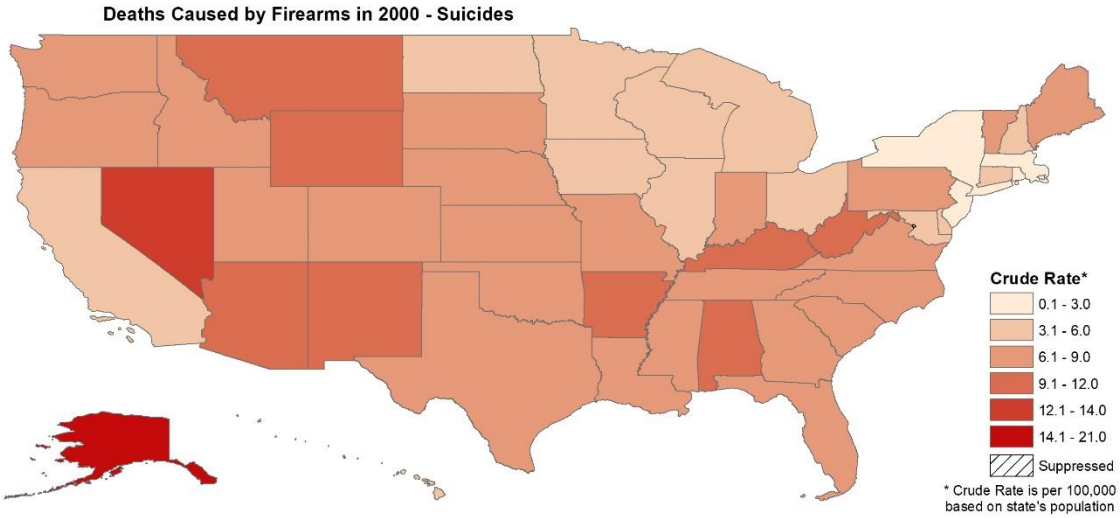


Figure 28: Suicide Deaths Caused by Firearms in 2000 Map

This choropleth map shows how many people committed suicide with a firearm per 100,000 people in each state during 2000.

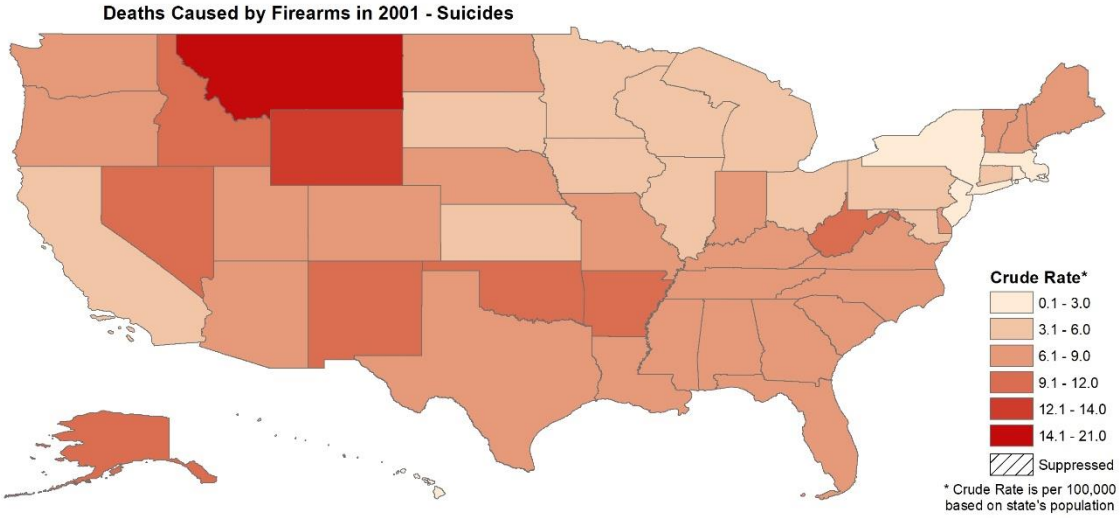


Figure 29: Suicide Deaths Caused by Firearms in 2001 Map

This choropleth map shows how many people committed suicide with a firearm per 100,000 people in each state during 2001.

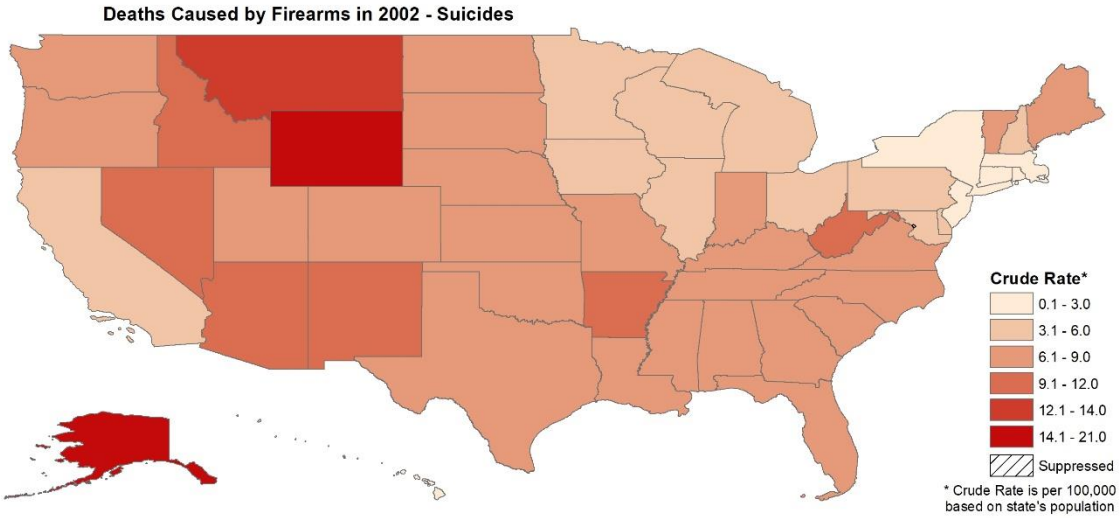


Figure 30: Suicide Deaths Caused by Firearms in 2002 Map

This choropleth map shows how many people committed suicide with a firearm per 100,000 people in each state during 2002.

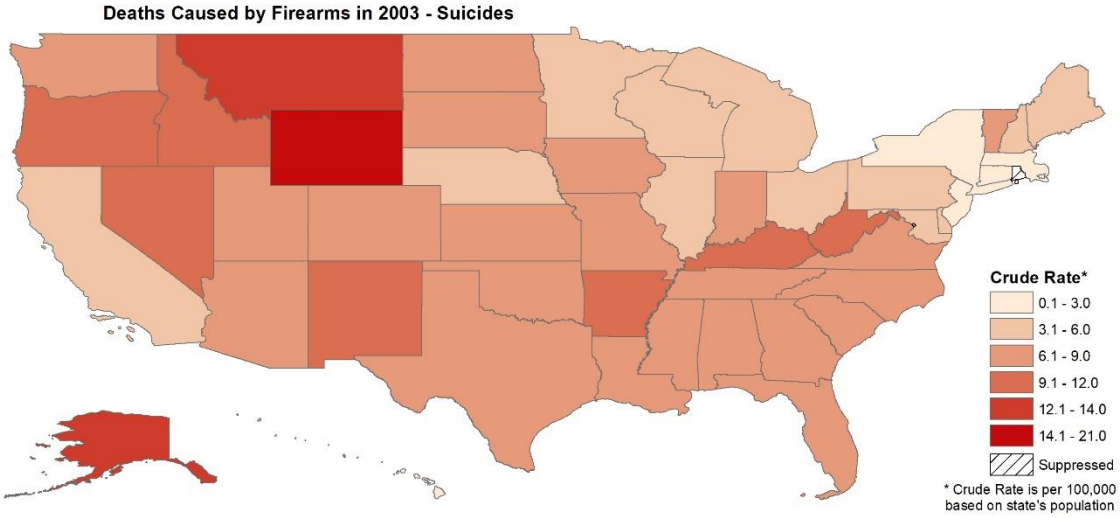


Figure 31: Suicide Deaths Caused by Firearms in 2003 Map

This choropleth map shows how many people committed suicide with a firearm per 100,000 people in each state during 2003.

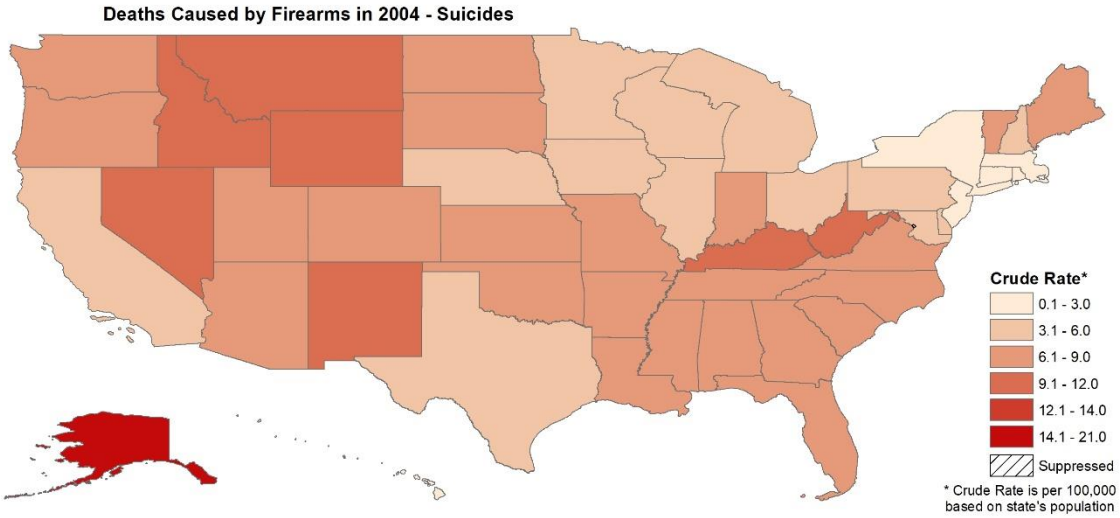


Figure 32: Suicide Deaths Caused by Firearms in 2004 Map

This choropleth map shows how many people committed suicide with a firearm per 100,000 people in each state during 2004.

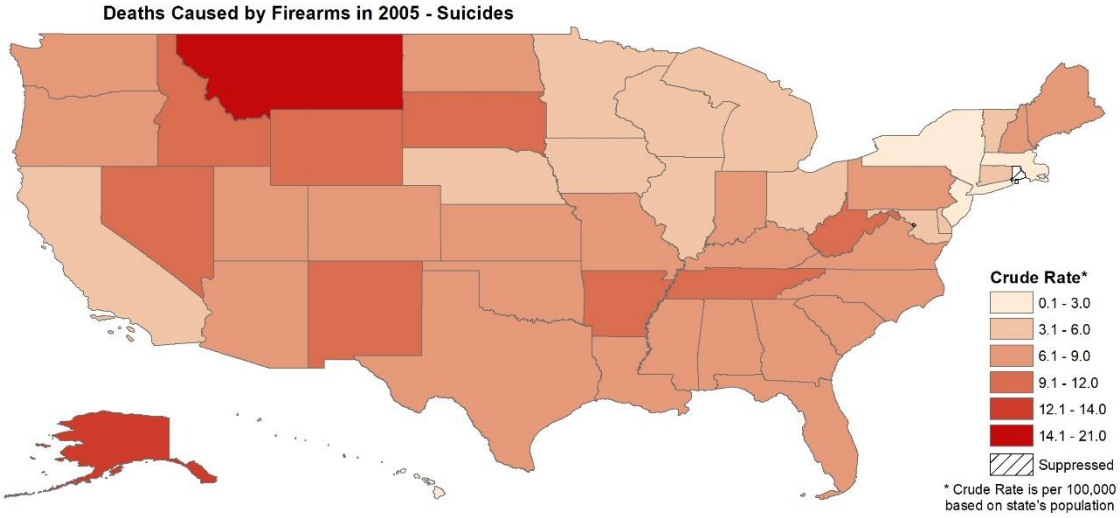


Figure 33: Suicide Deaths Caused by Firearms in 2005 Map

This choropleth map shows how many people committed suicide with a firearm per 100,000 people in each state during 2005.

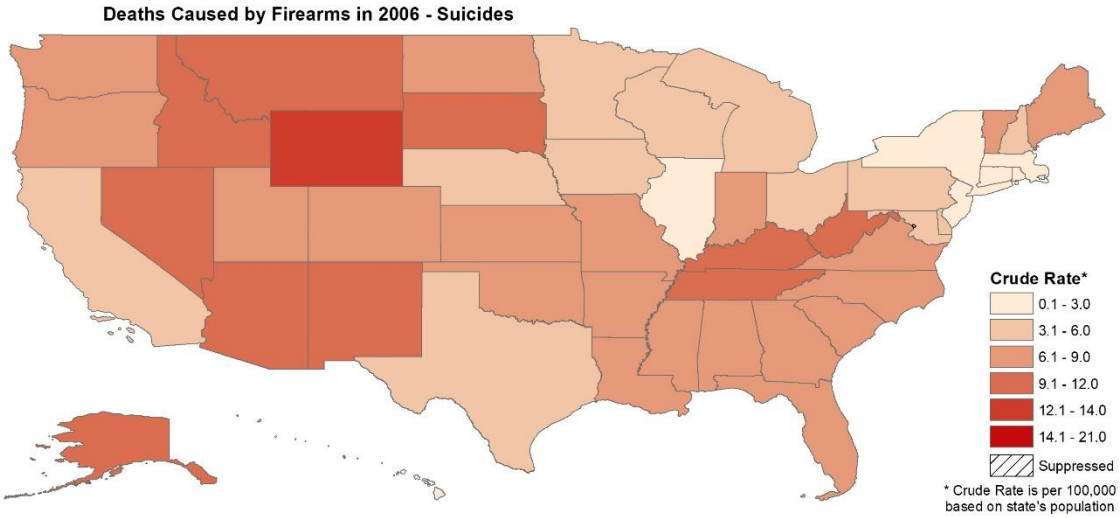


Figure 34: Suicide Deaths Caused by Firearms in 2006 Map

This choropleth map shows how many people committed suicide with a firearm per 100,000 people in each state during 2006.

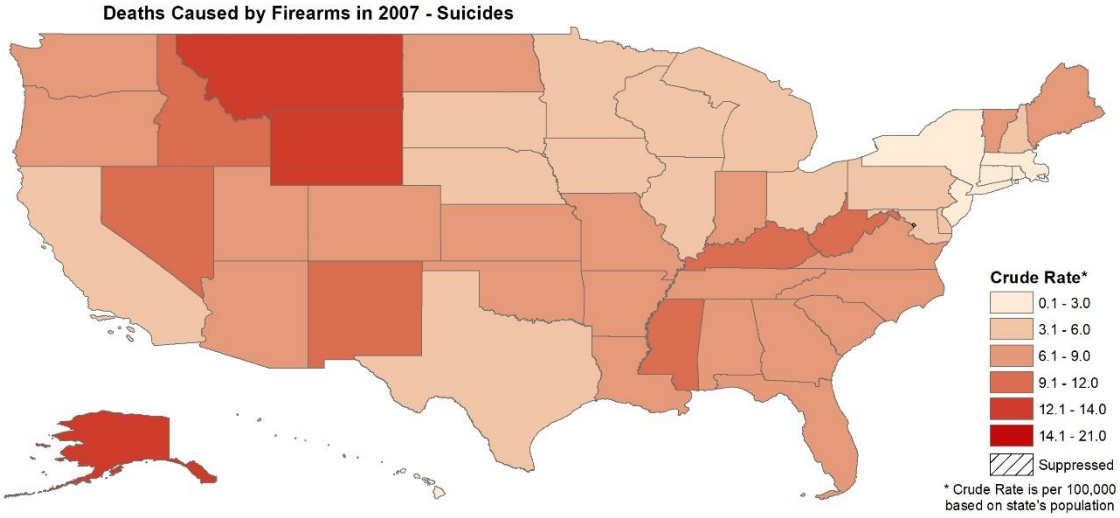


Figure 35: Suicide Deaths Caused by Firearms in 2007 Map

This choropleth map shows how many people committed suicide with a firearm per 100,000 people in each state during 2007.

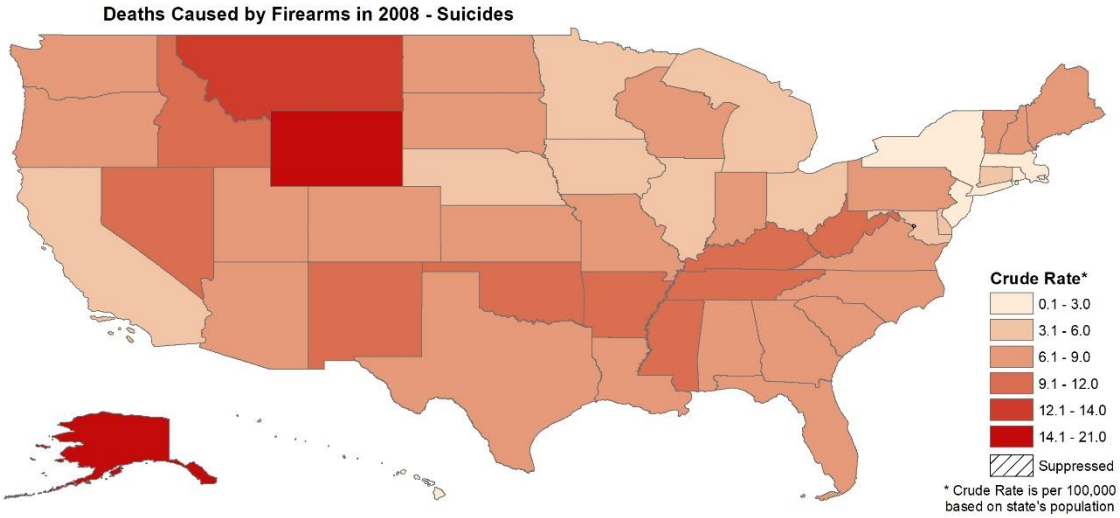


Figure 36: Suicide Deaths Caused by Firearms in 2008 Map

This choropleth map shows how many people committed suicide with a firearm per 100,000 people in each state during 2008.

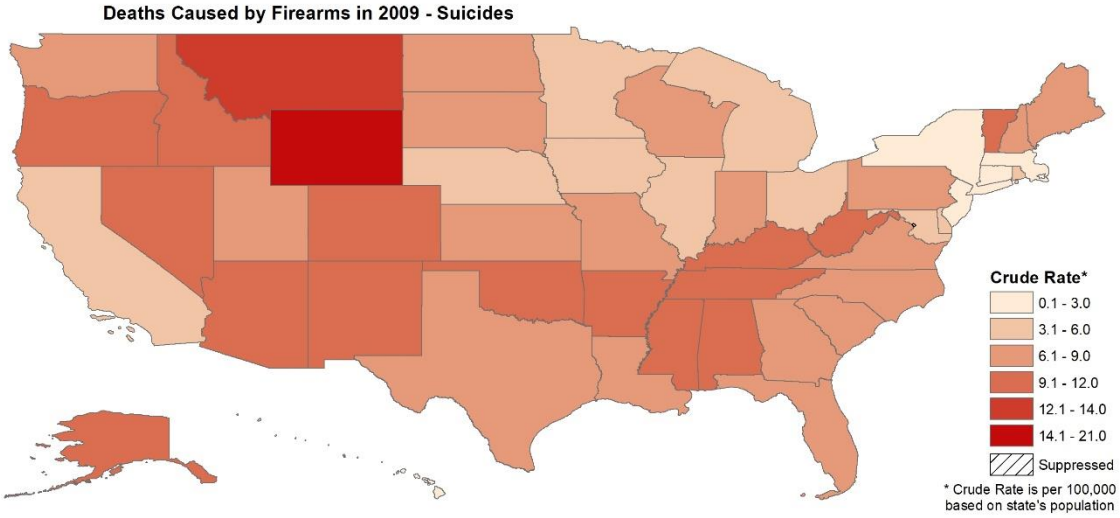


Figure 37: Suicide Deaths Caused by Firearms in 2009 Map

This choropleth map shows how many people committed suicide with a firearm per 100,000 people in each state during 2009.

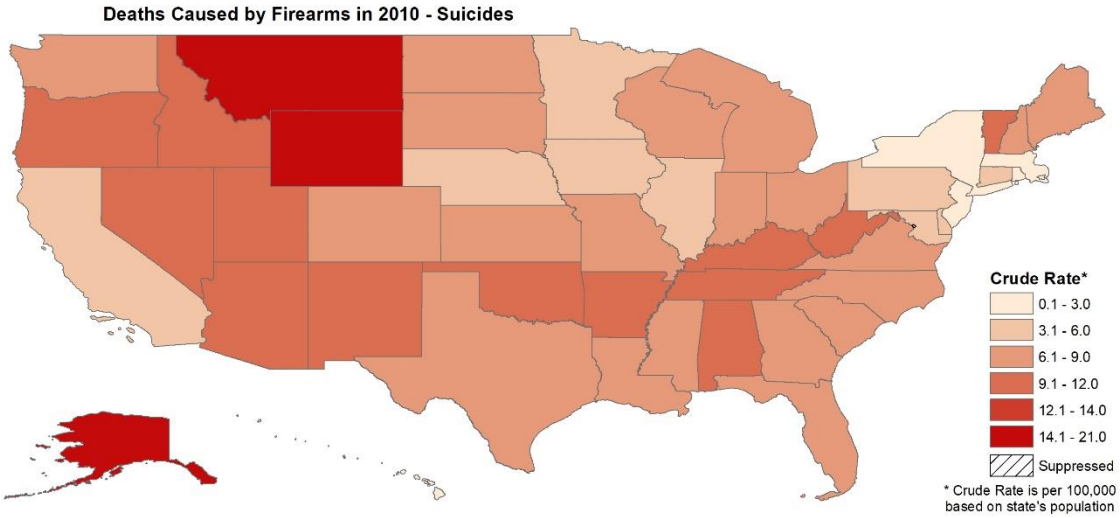


Figure 38: Suicide Deaths Caused by Firearms in 2010 Map

This choropleth map shows how many people committed suicide with a firearm per 100,000 people in each state during 2010.

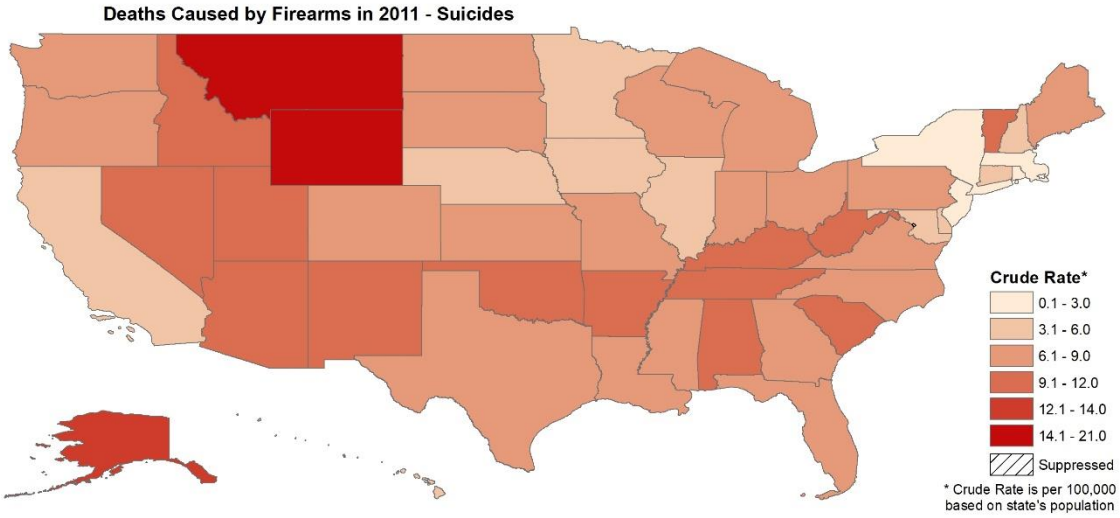


Figure 39: Suicide Deaths Caused by Firearms in 2011 Map

This choropleth map shows how many people committed suicide with a firearm per 100,000 people in each state during 2011.

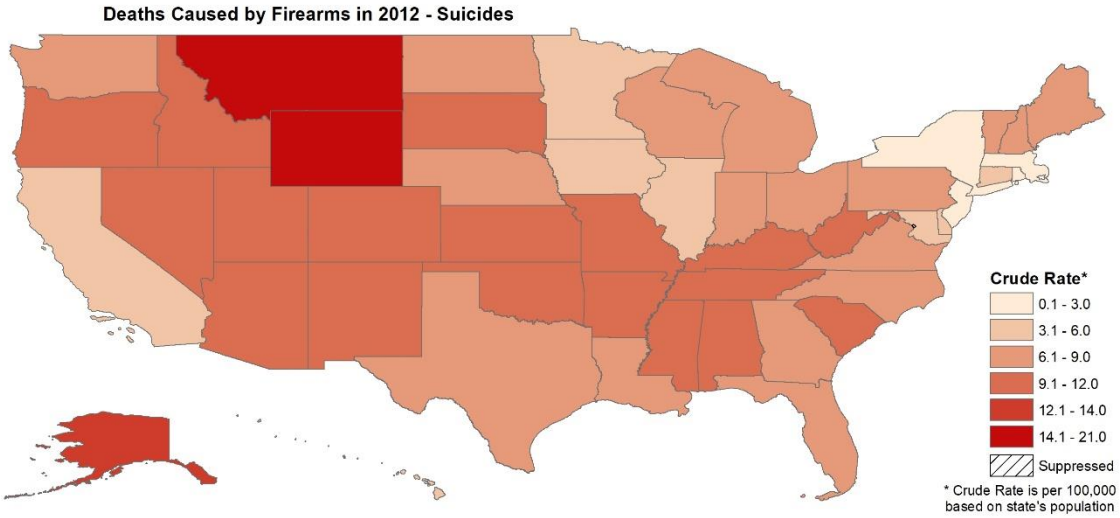


Figure 40: Suicide Deaths Caused by Firearms in 2012 Map

This choropleth map shows how many people committed suicide with a firearm per 100,000 people in each state during 2012.

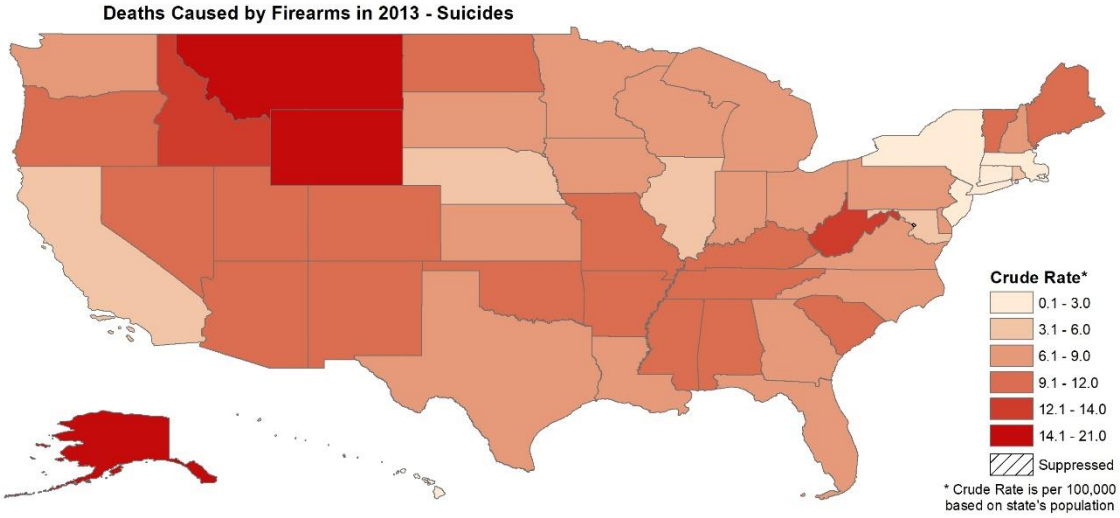


Figure 41: Suicide Deaths Caused by Firearms in 2013 Map

This choropleth map shows how many people committed suicide with a firearm per 100,000 people in each state during 2013.

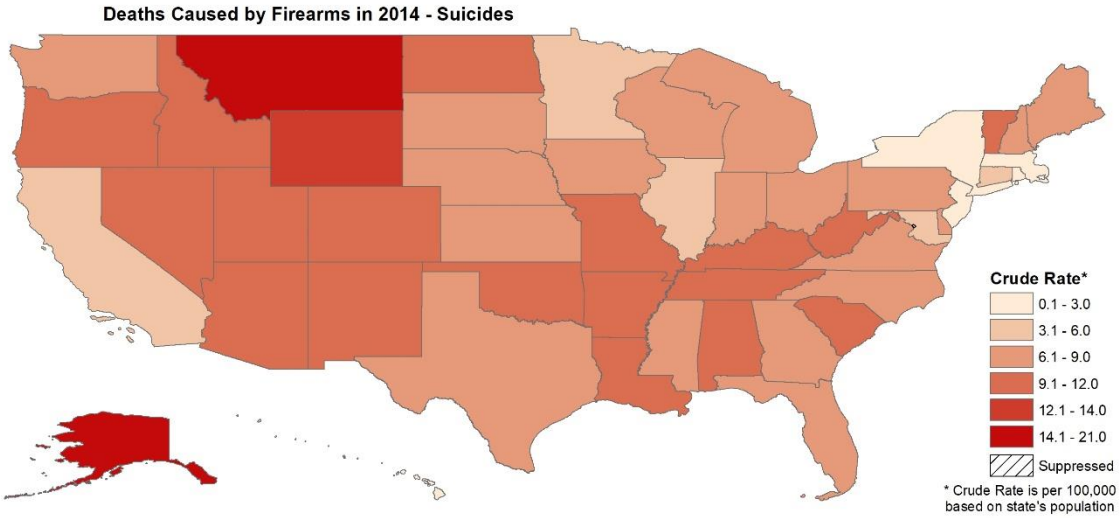


Figure 42: Suicide Deaths Caused by Firearms in 2014 Map

This choropleth map shows how many people committed suicide with a firearm per 100,000 people in each state during 2014.

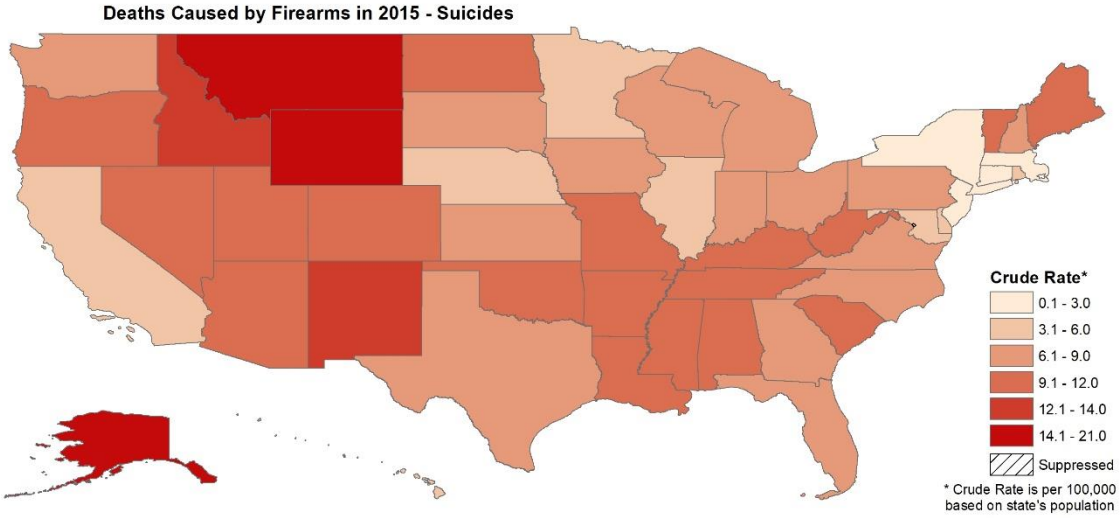


Figure 43: Suicide Deaths Caused by Firearms in 2015 Map

This choropleth map shows how many people committed suicide with a firearm per 100,000 people in each state during 2015.

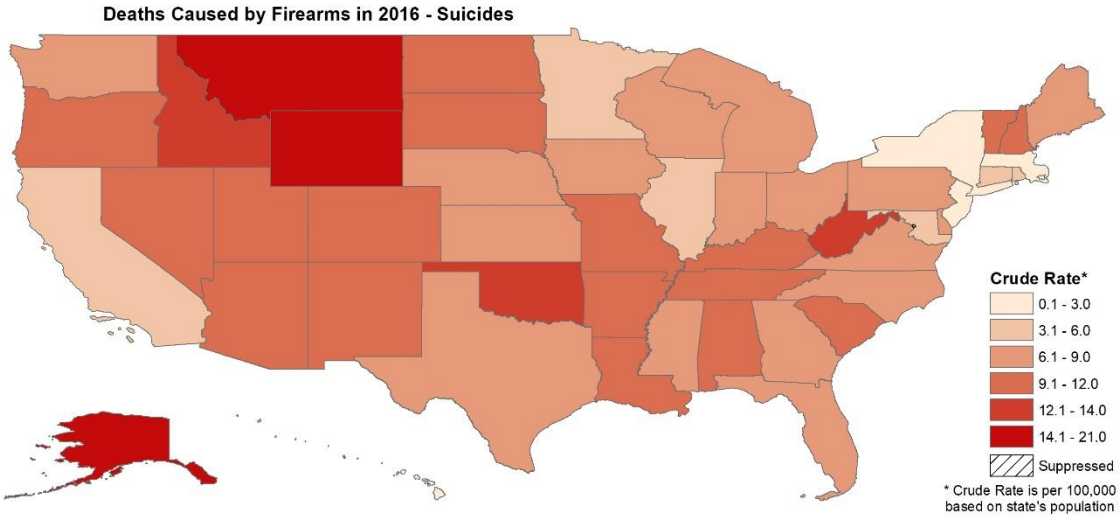


Figure 44: Suicide Deaths Caused by Firearms in 2016 Map

This choropleth map shows how many people committed suicide with a firearm per 100,000 people in each state during 2016.

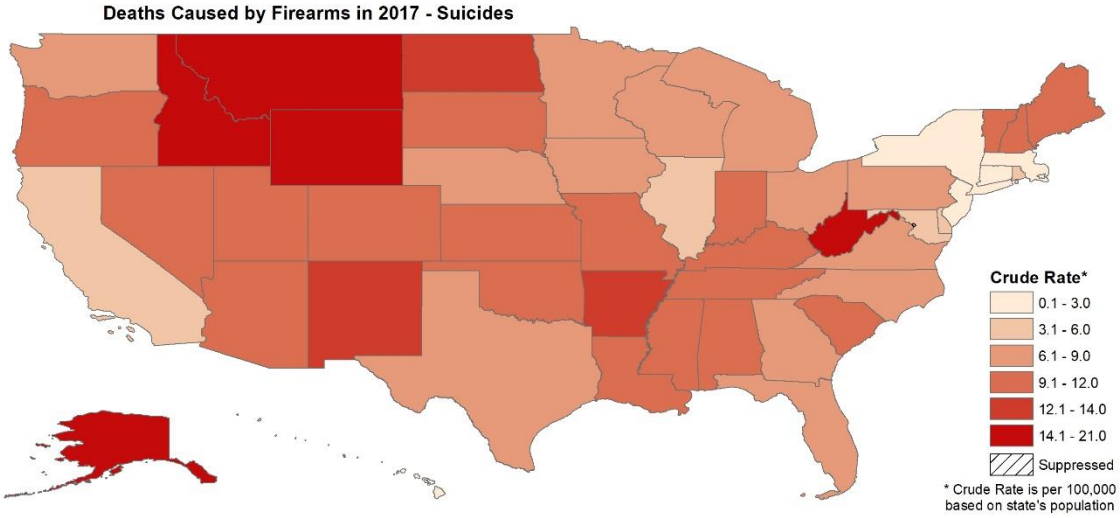


Figure 45: Suicide Deaths Caused by Firearms in 2017 Map

This choropleth map shows how many people committed suicide with a firearm per 100,000 people in each state during 2017.

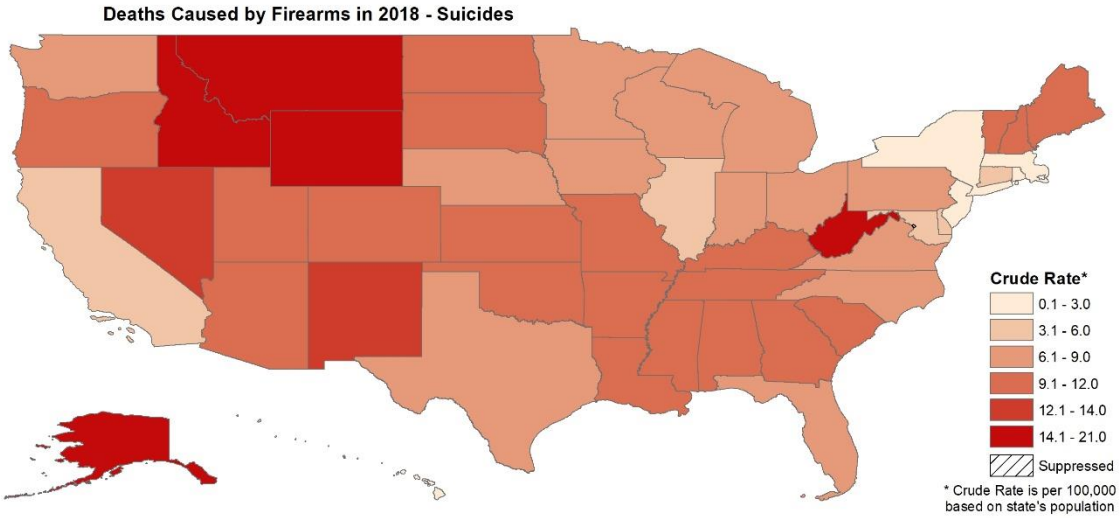


Figure 46: Suicide Deaths Caused by Firearms in 2018 Map

This choropleth map shows how many people committed suicide with a firearm per 100,000 people in each state during 2018.

*Deaths Caused by Firearms – Homicide*

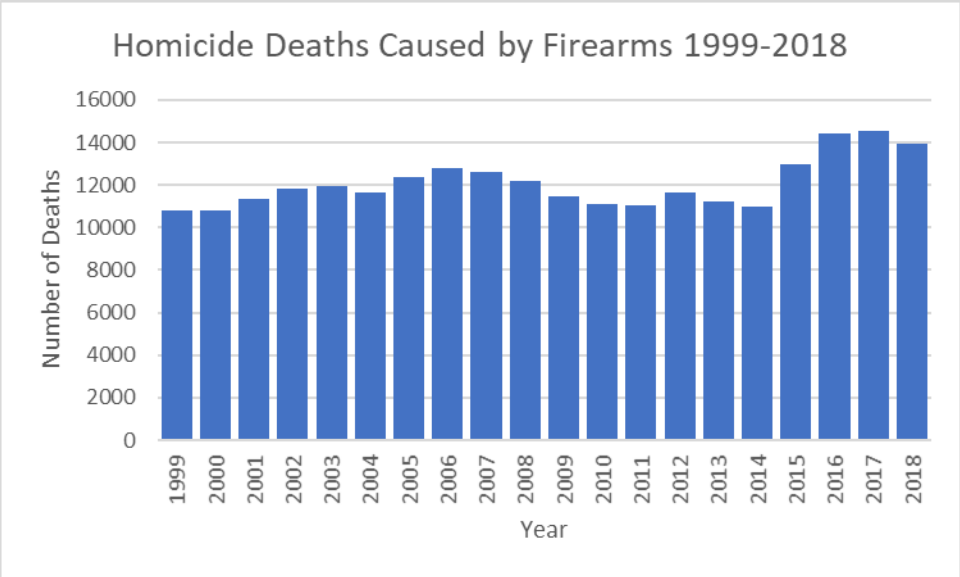


Figure 47: Homicide Deaths Caused by Firearms 1999–2018 Graph

This bar graph shows the total number of homicidal deaths involving a firearm from 1999 to 2018.

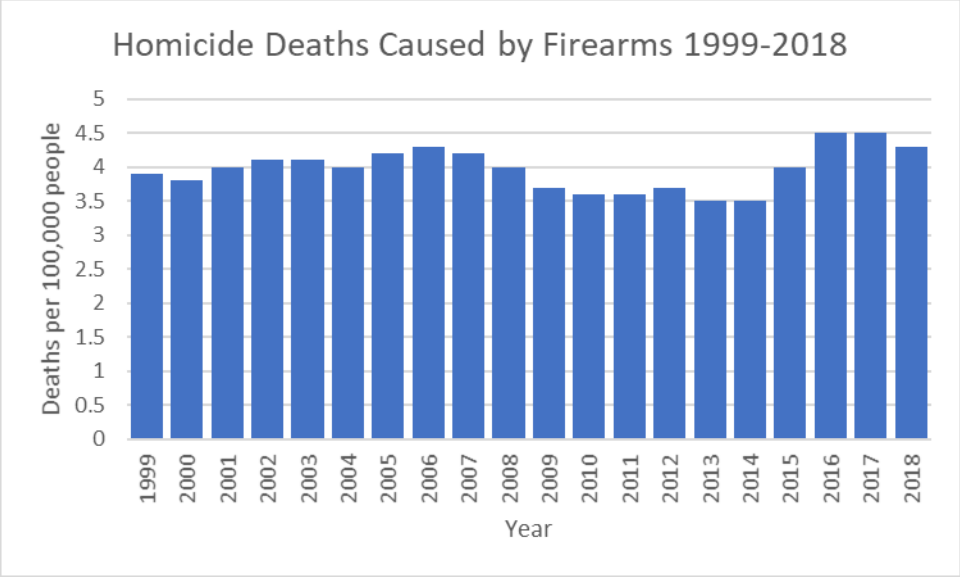


Figure 48: Homicide Deaths Caused by Firearms 1999–2018 Crude Rate Graph

This bar graph shows the number of homicidal deaths involving a firearm per 100,000 people from 1999 to 2018. By calculating the crude rate using the population in each year, the effects of population growth are reduced.

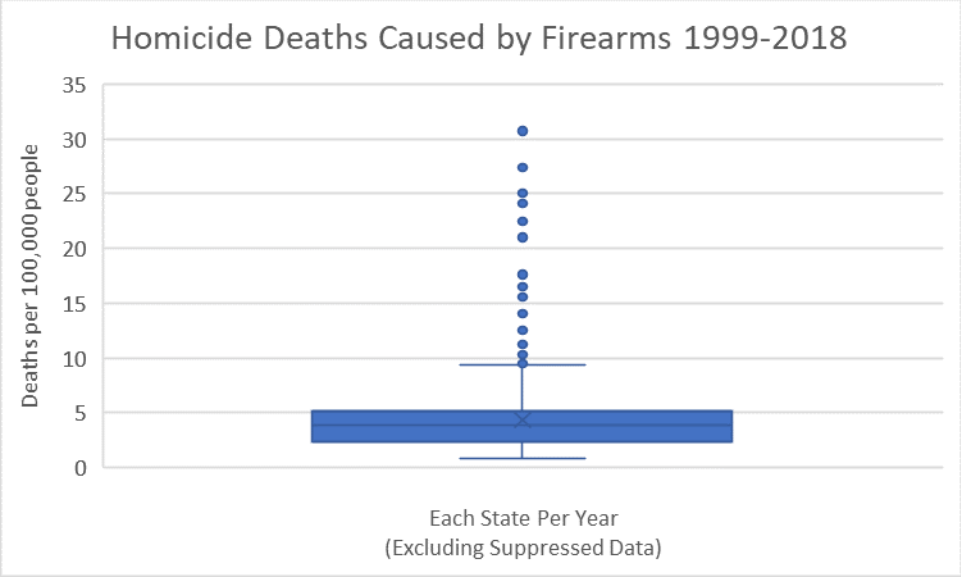


Figure 49: Homicide Deaths Caused by Firearms 1999–2018 Boxplot

This box and whisker plot shows the statistics on the crude rate of homicidal deaths involving a firearm in each state from 1999 to 2018.

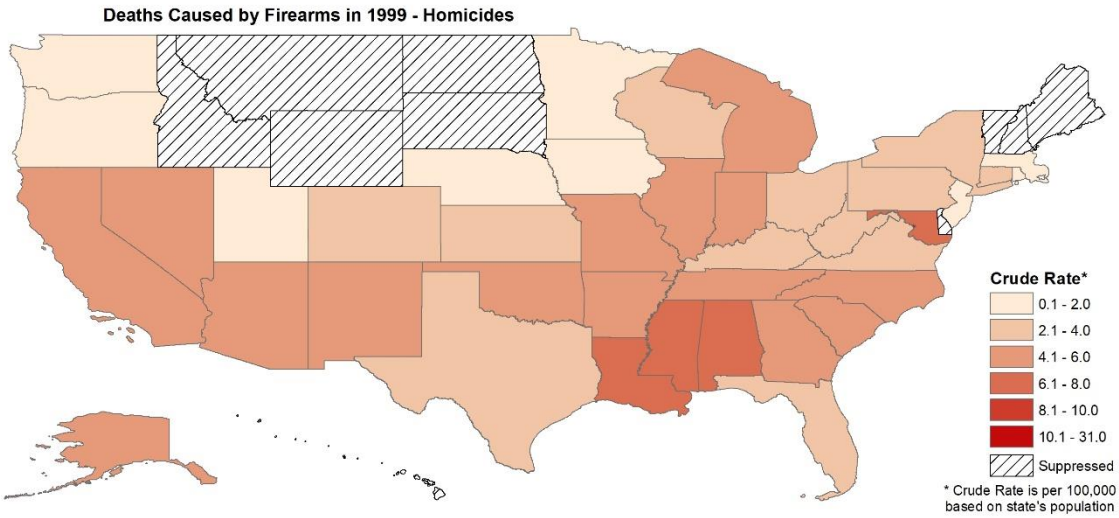


Figure 50: Homicide Deaths Caused by Firearms in 1999 Map

This choropleth map shows how many people died in a homicide by a firearm per 100,000 people in each state during 1999.

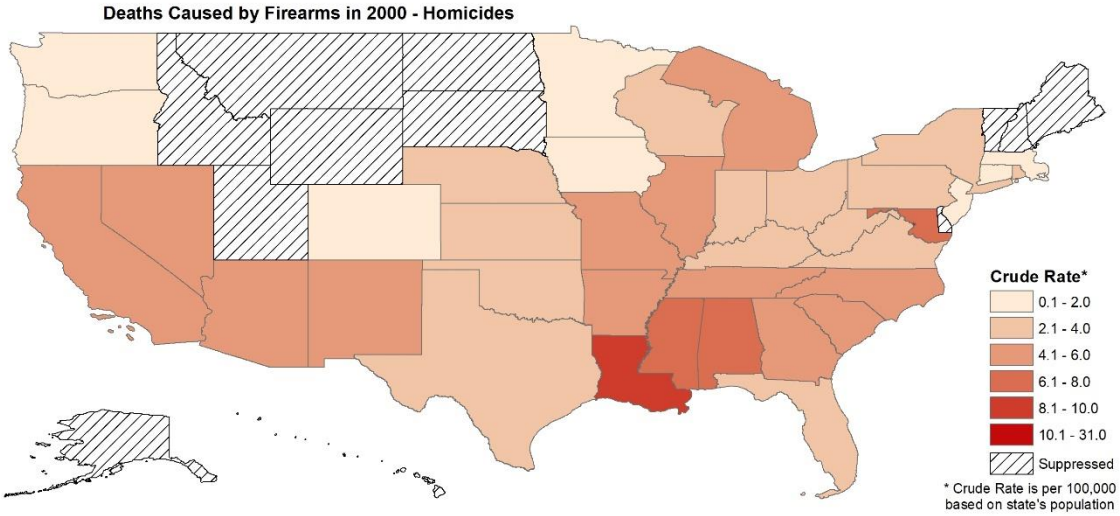


Figure 51: Homicide Deaths Caused by Firearms in 2000 Map

This choropleth map shows how many people died in a homicide by a firearm per 100,000 people in each state during 2000.

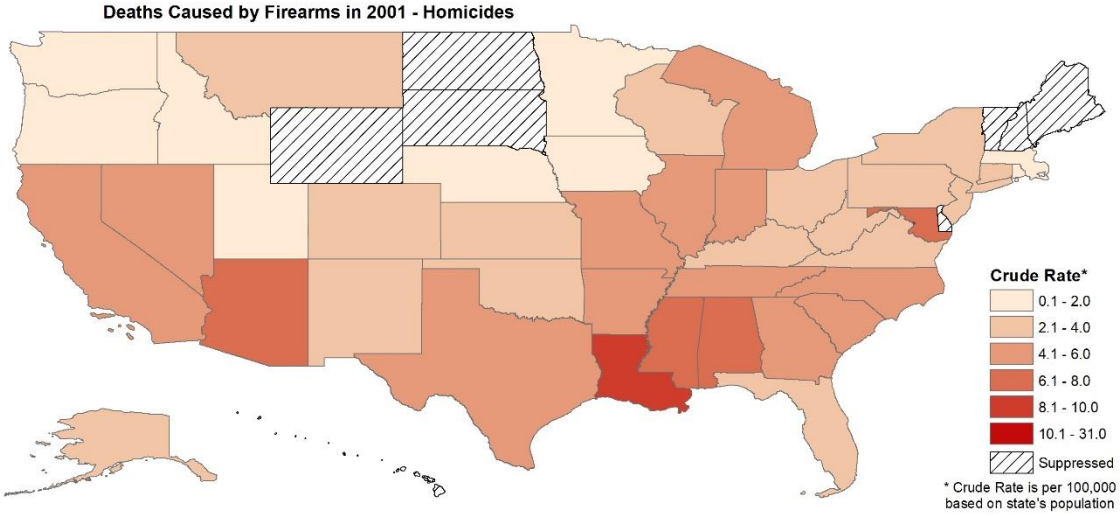


Figure 52: Homicide Deaths Caused by Firearms in 2001 Map

This choropleth map shows how many people died in a homicide by a firearm per 100,000 people in each state during 2001.

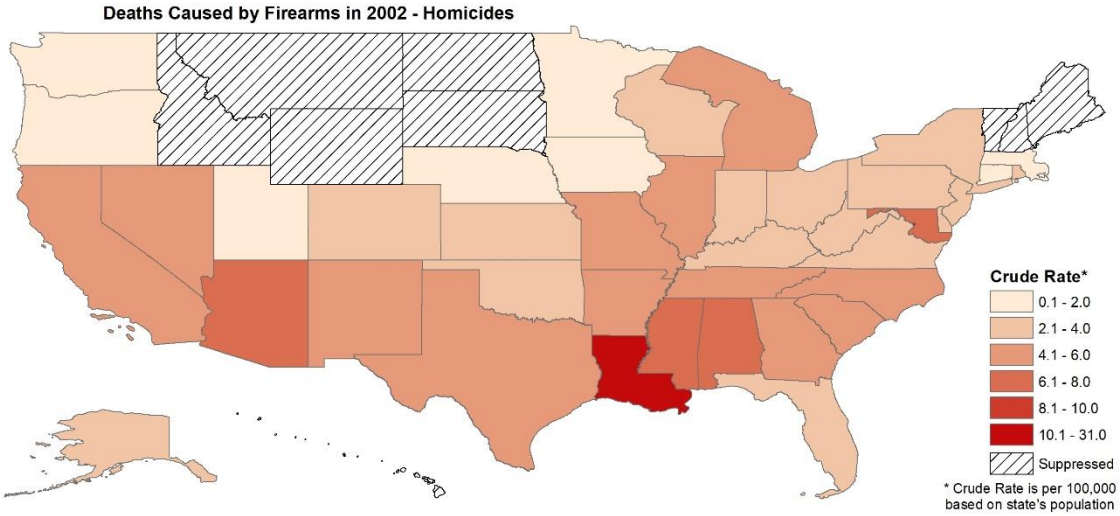


Figure 53: Homicide Deaths Caused by Firearms in 2002 Map

This choropleth map shows how many people died in a homicide by a firearm per 100,000 people in each state during 2002.

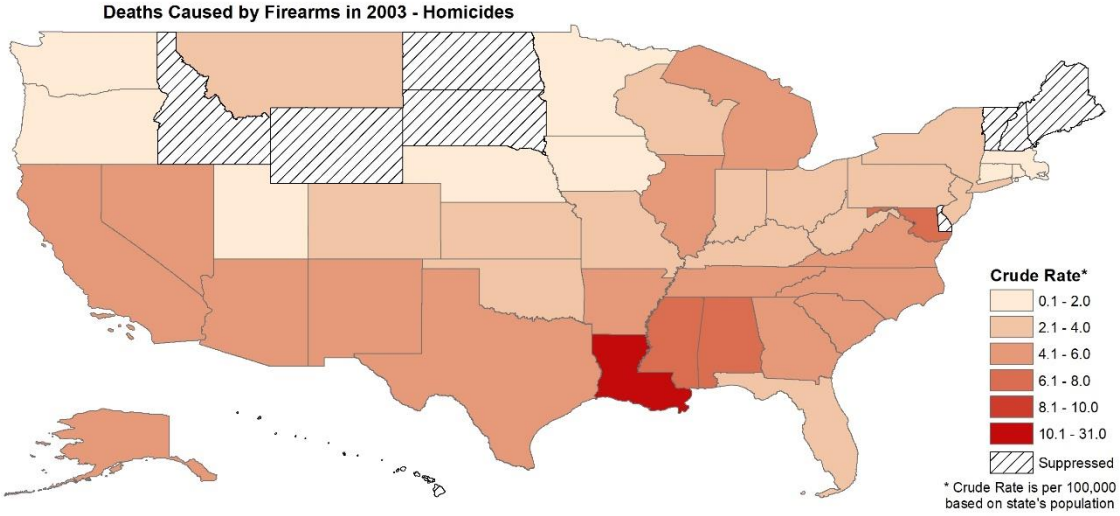


Figure 54: Homicide Deaths Caused by Firearms in 2003 Map

This choropleth map shows how many people died in a homicide by a firearm per 100,000 people in each state during 2003.

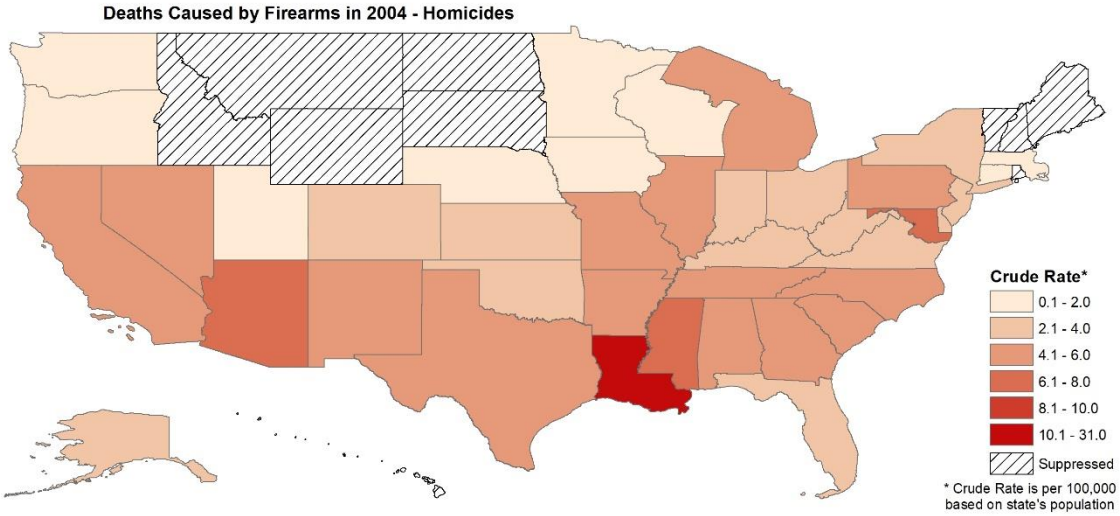


Figure 55: Homicide Deaths Caused by Firearms in 2004 Map

This choropleth map shows how many people died in a homicide by a firearm per 100,000 people in each state during 2004.

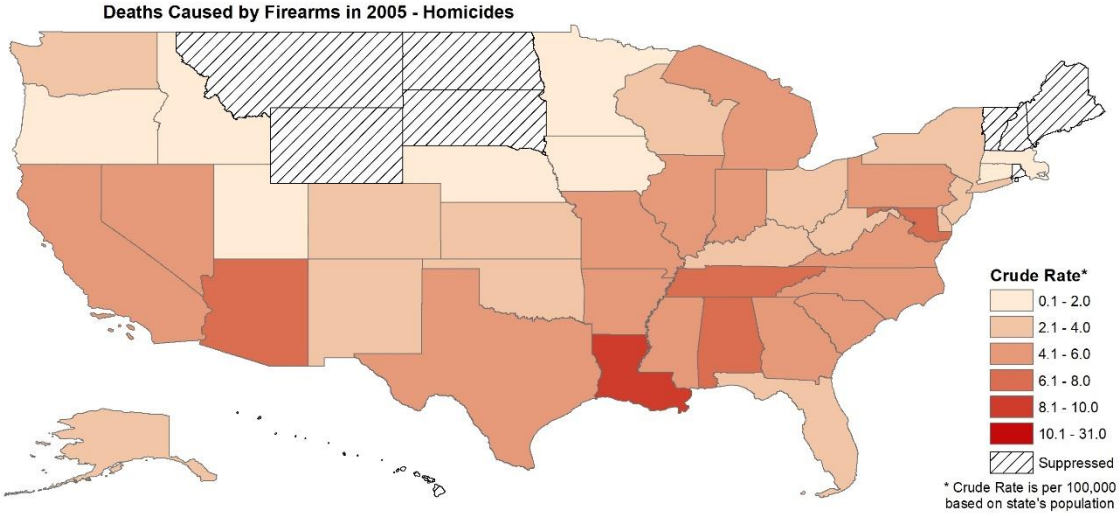


Figure 56: Homicide Deaths Caused by Firearms in 2005 Map

This choropleth map shows how many people died in a homicide by a firearm per 100,000 people in each state during 2005.

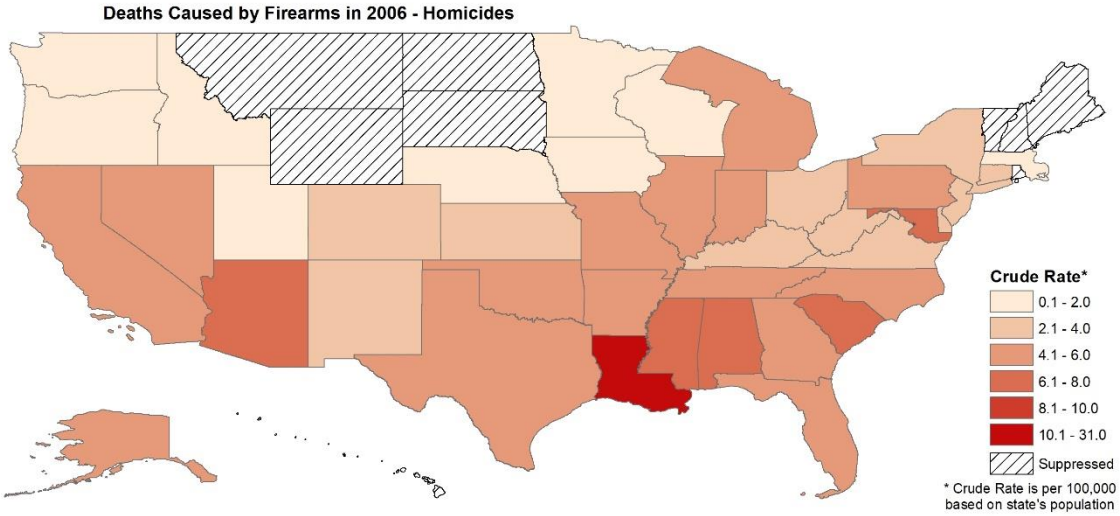


Figure 57: Homicide Deaths Caused by Firearms in 2006 Map

This choropleth map shows how many people died in a homicide by a firearm per 100,000 people in each state during 2006.

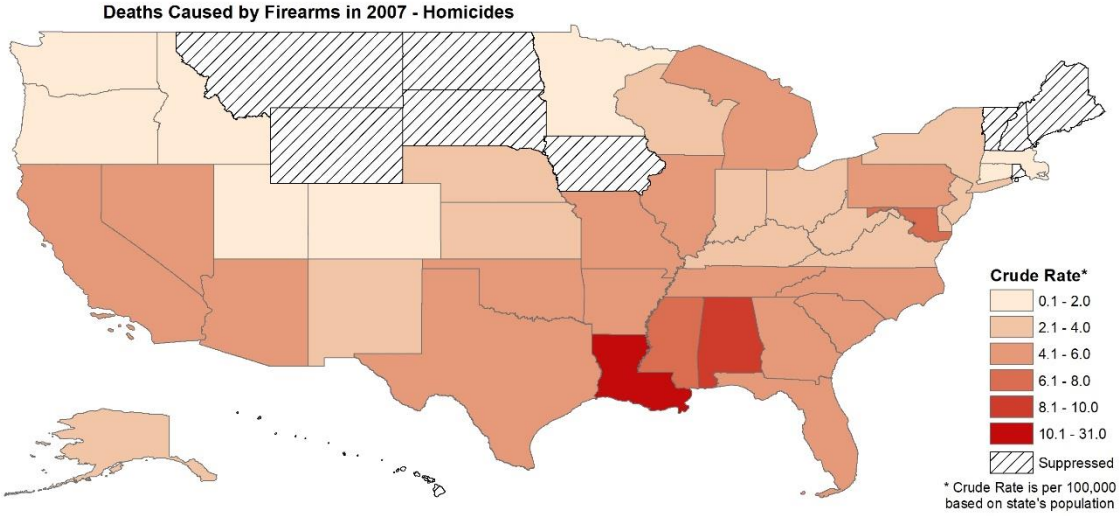


Figure 58: Homicide Deaths Caused by Firearms in 2007 Map

This choropleth map shows how many people died in a homicide by a firearm per 100,000 people in each state during 2007.

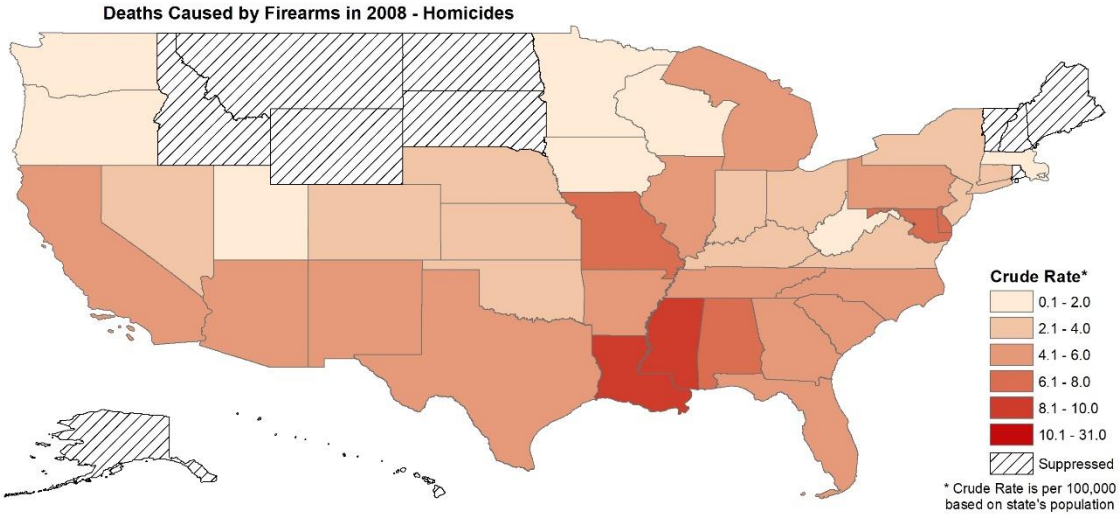


Figure 59: Homicide Deaths Caused by Firearms in 2008 Map

This choropleth map shows how many people died in a homicide by a firearm per 100,000 people in each state during 2008.

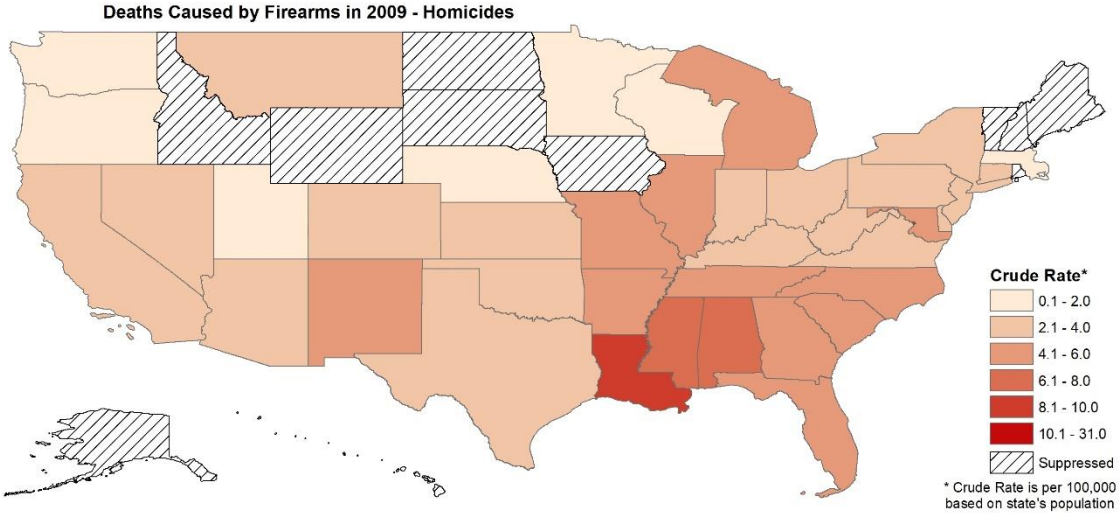


Figure 60: Homicide Deaths Caused by Firearms in 2009 Map

This choropleth map shows how many people died in a homicide by a firearm per 100,000 people in each state during 2009.

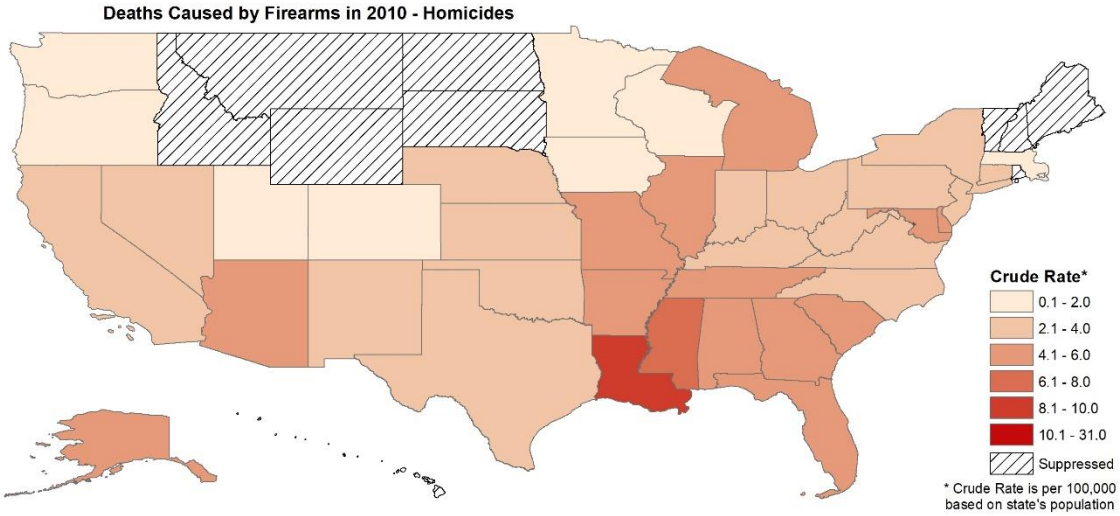


Figure 61: Homicide Deaths Caused by Firearms in 2010 Map

This choropleth map shows how many people died in a homicide by a firearm per 100,000 people in each state during 2010.

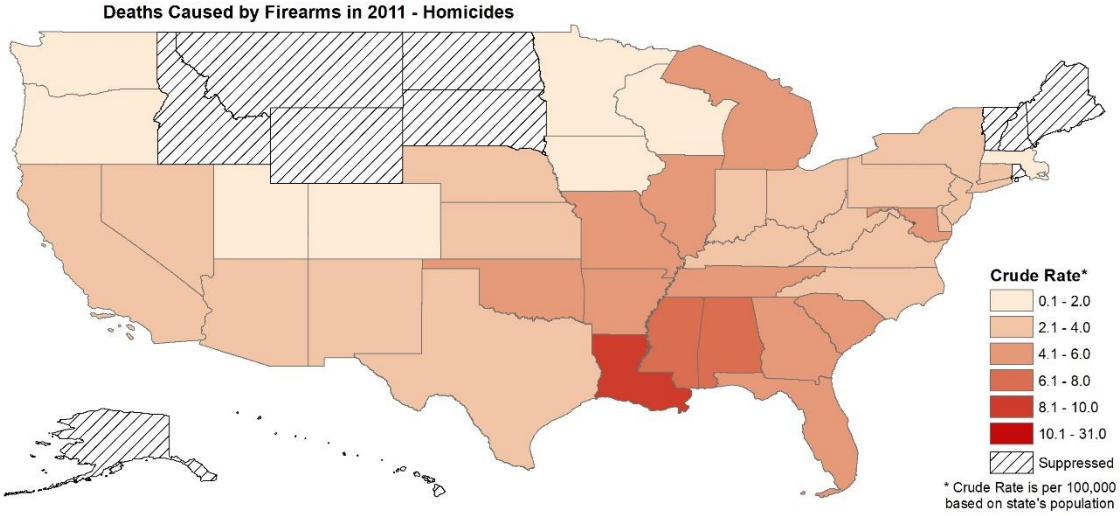


Figure 62: Homicide Deaths Caused by Firearms in 2011 Map

This choropleth map shows how many people died in a homicide by a firearm per 100,000 people in each state during 2011.

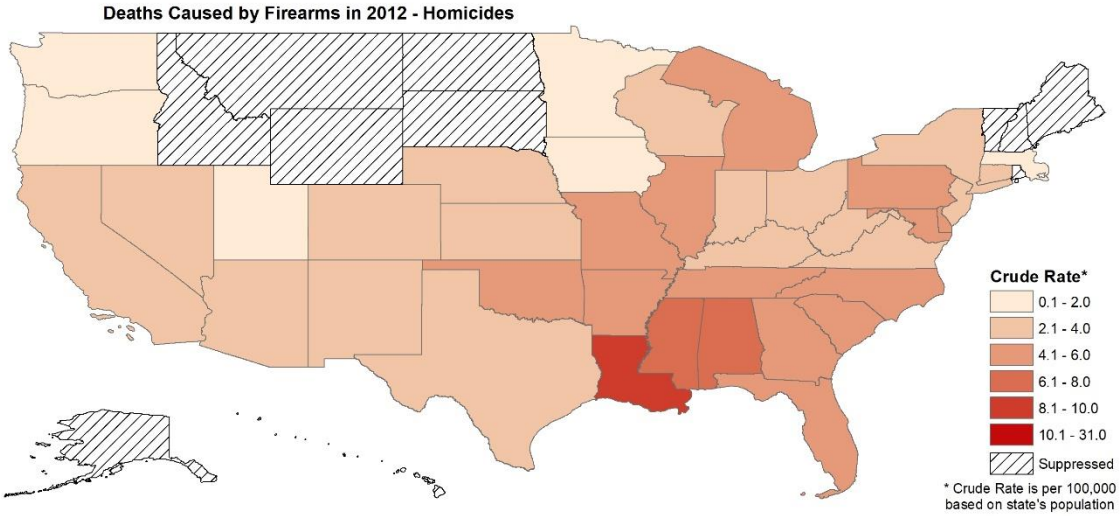


Figure 63: Homicide Deaths Caused by Firearms in 2012 Map

This choropleth map shows how many people died in a homicide by a firearm per 100,000 people in each state during 2012.

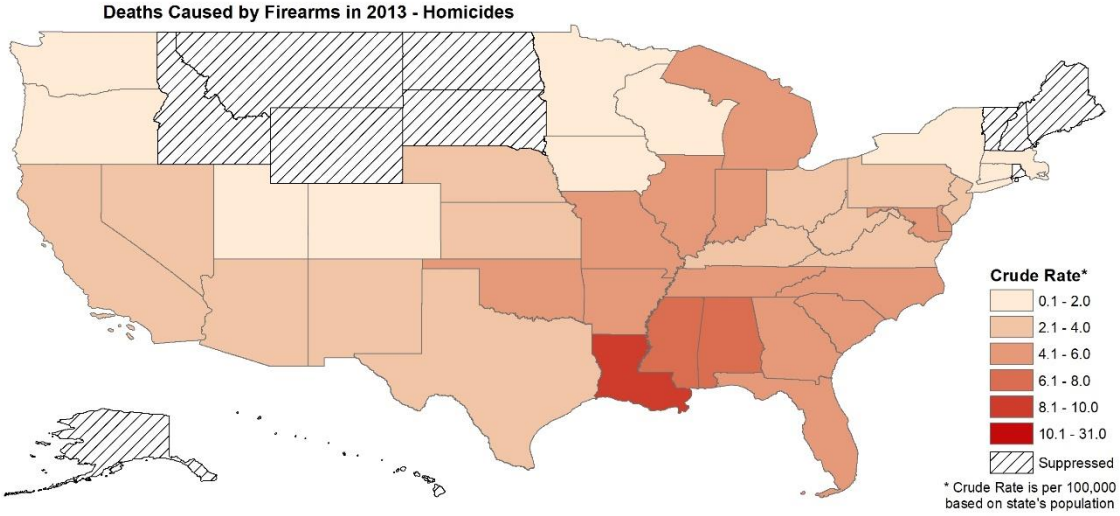


Figure 64: Homicide Deaths Caused by Firearms in 2013 Map

This choropleth map shows how many people died in a homicide by a firearm per 100,000 people in each state during 2013.

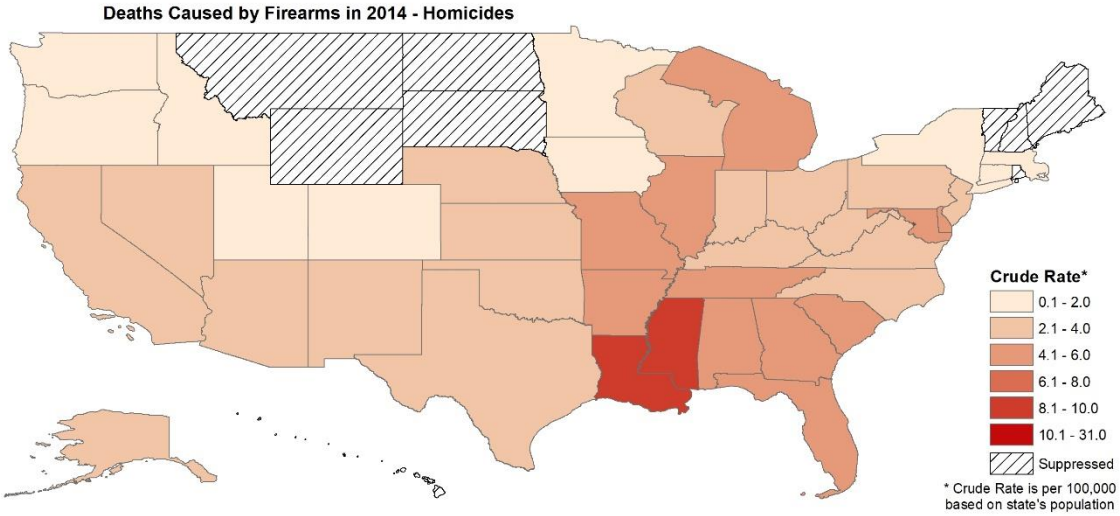


Figure 65: Homicide Deaths Caused by Firearms in 2014 Map

This choropleth map shows how many people died in a homicide by a firearm per 100,000 people in each state during 2014.

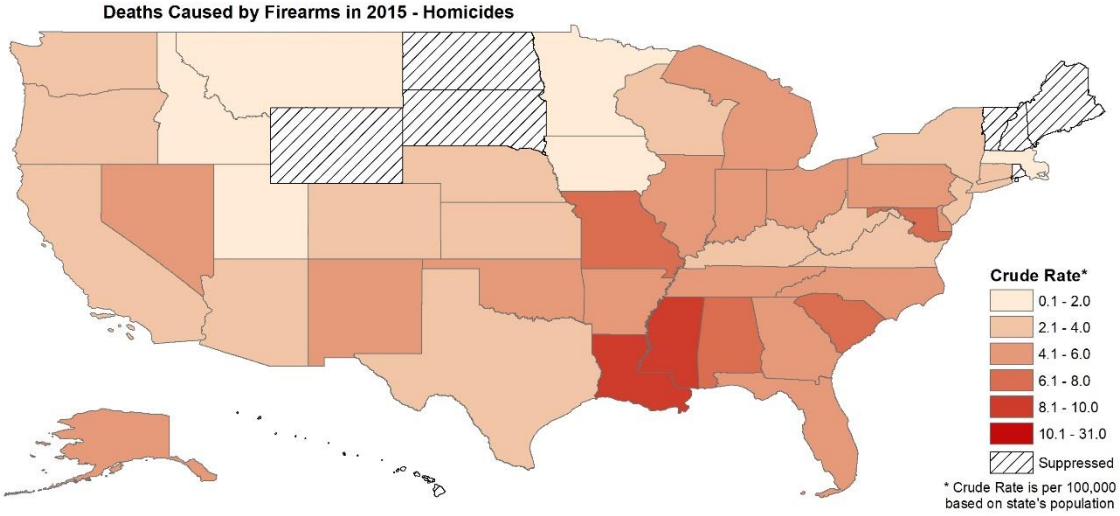


Figure 66: Homicide Deaths Caused by Firearms in 2015 Map

This choropleth map shows how many people died in a homicide by a firearm per 100,000 people in each state during 2015.

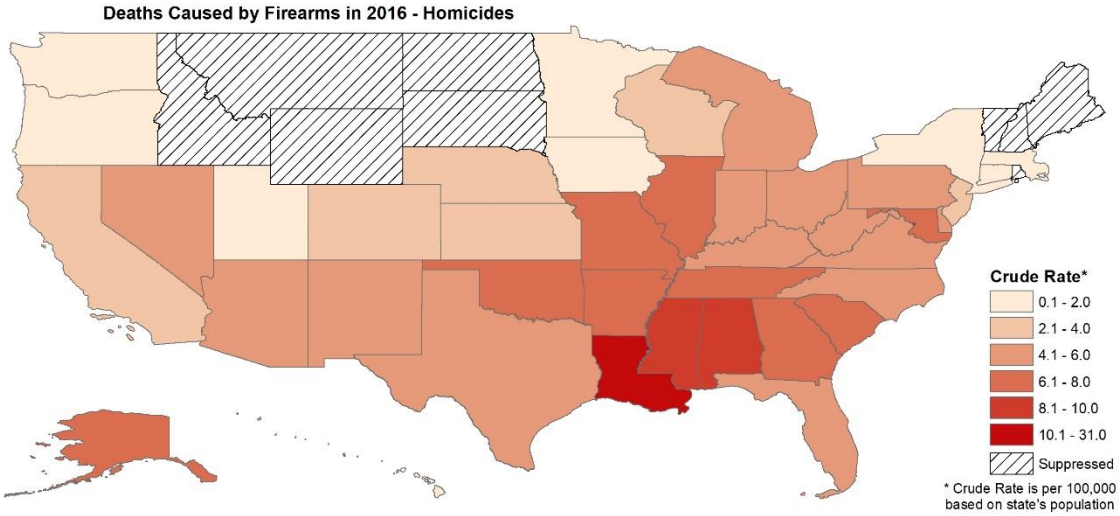


Figure 67: Homicide Deaths Caused by Firearms in 2016 Map

This choropleth map shows how many people died in a homicide by a firearm per 100,000 people in each state during 2016.

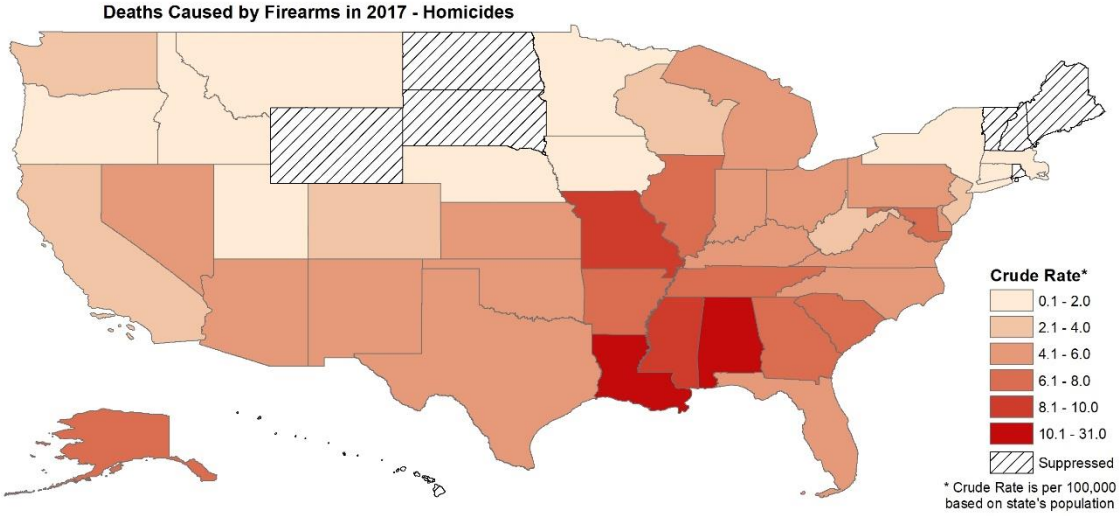


Figure 68: Homicide Deaths Caused by Firearms in 2017 Map

This choropleth map shows how many people died in a homicide by a firearm per 100,000 people in each state during 2017.

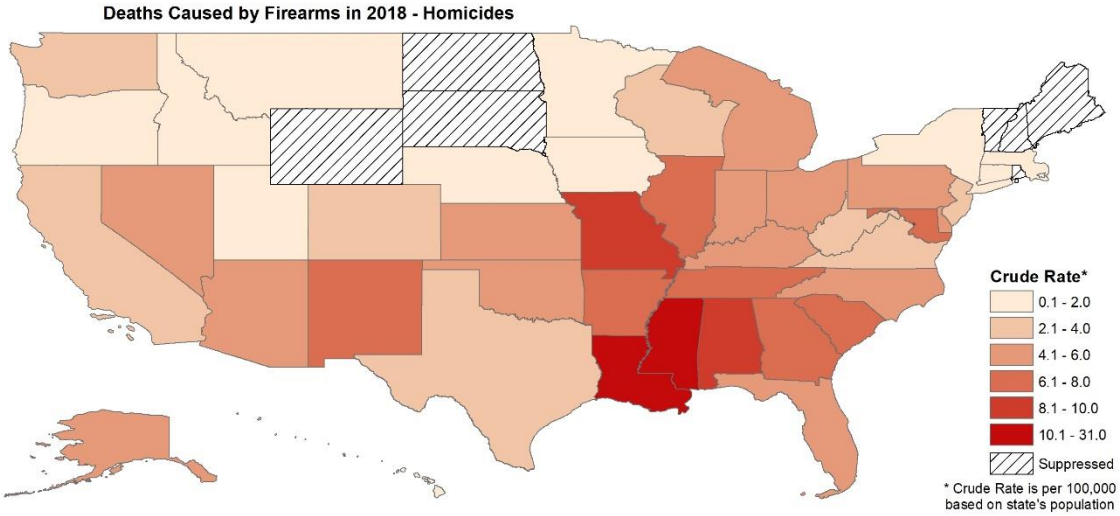


Figure 69: Homicide Deaths Caused by Firearms in 2018 Map

This choropleth map shows how many people died in a homicide by a firearm per 100,000 people in each state during 2018.

*Deaths Caused by Firearms – Legal Intervention*

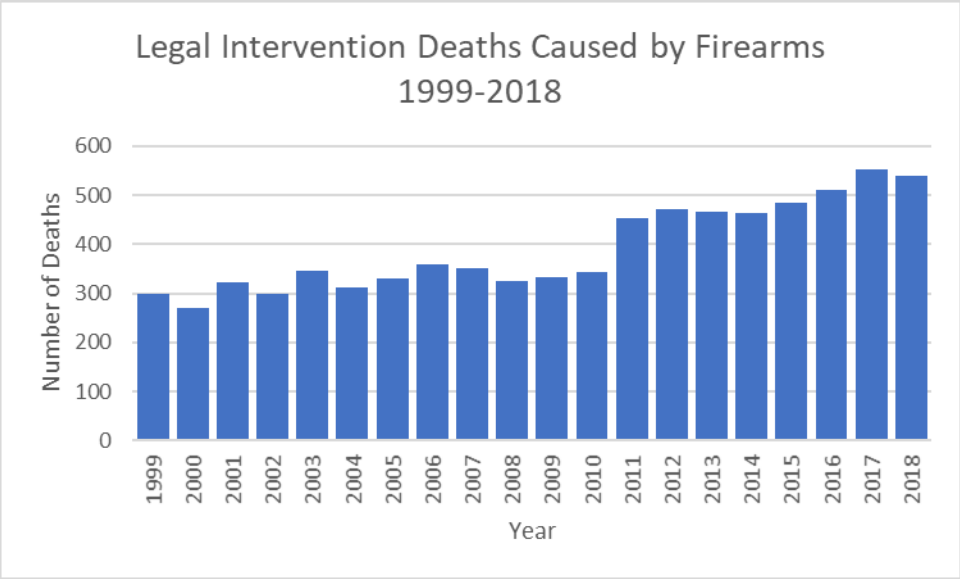


Figure 70: Legal Intervention Deaths Caused by Firearms 1999–2018 Graph

This bar graph shows the total number of people who died from legal intervention firearm use from 1999 to 2018.

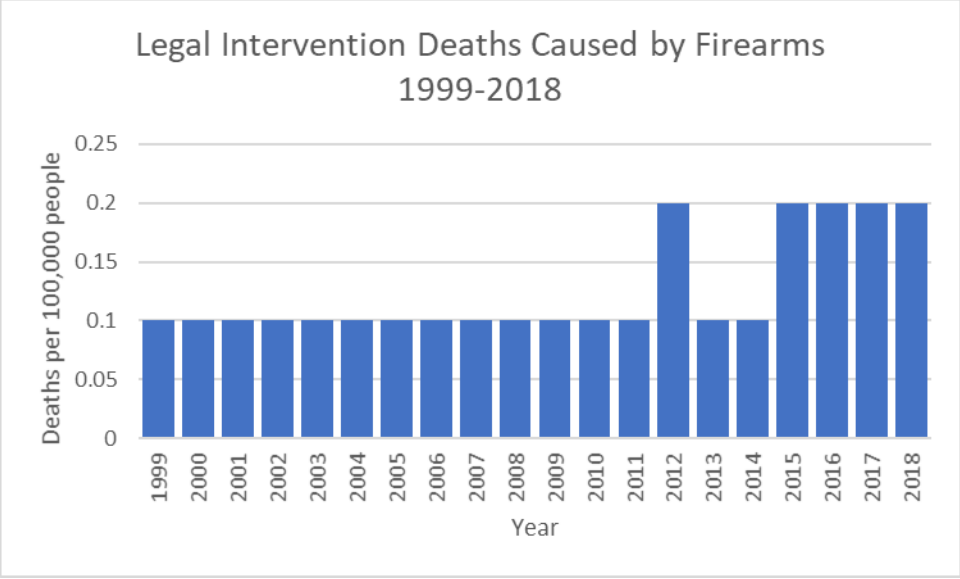


Figure 71: Legal Intervention Deaths Caused by Firearms 1999–2018 Crude Rate Graph

This bar graph shows the number of people who died from legal intervention firearm use per 100,000 people from 1999 to 2018. By calculating the crude rate using the population in each year, the effects of population growth are reduced.

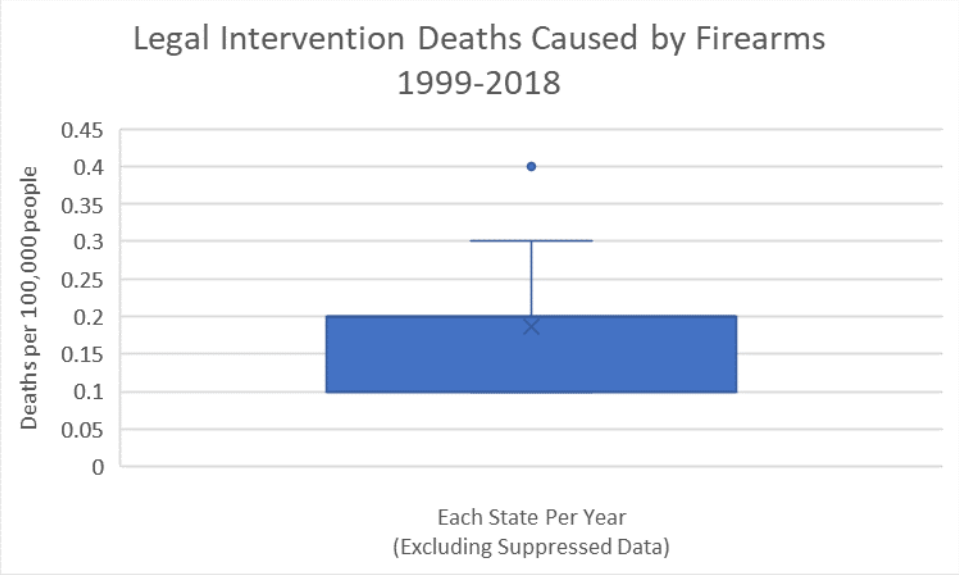


Figure 72: Legal Intervention Deaths Caused by Firearms 1999–2018 Boxplot

This box and whisker plot shows the statistics on the crude rate of deaths stemming from legal intervention firearm use in each state from 1999 to 2018.

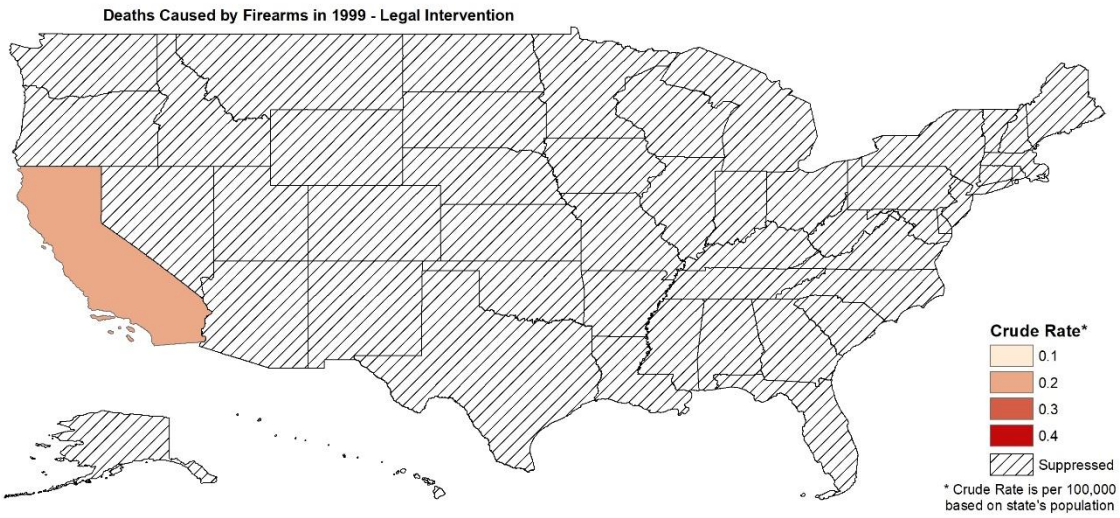


Figure 73: Legal Intervention Deaths Caused by Firearms in 1999 Map

This choropleth map shows how many people died from legal intervention firearm use per 100,000 people in each state during 1999.

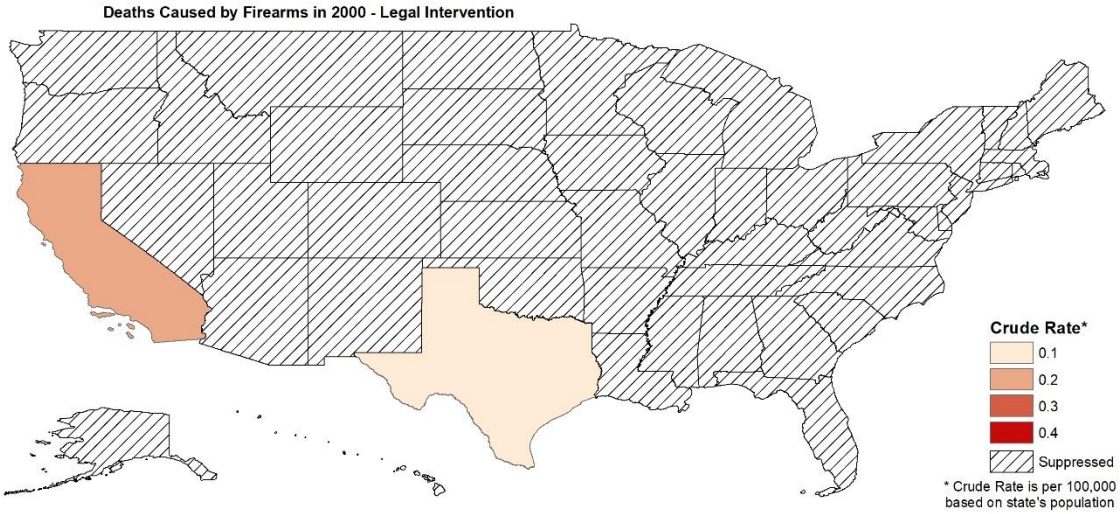


Figure 74: Legal Intervention Deaths Caused by Firearms in 2000 Map

This choropleth map shows how many people died from legal intervention firearm use per 100,000 people in each state during 2000.

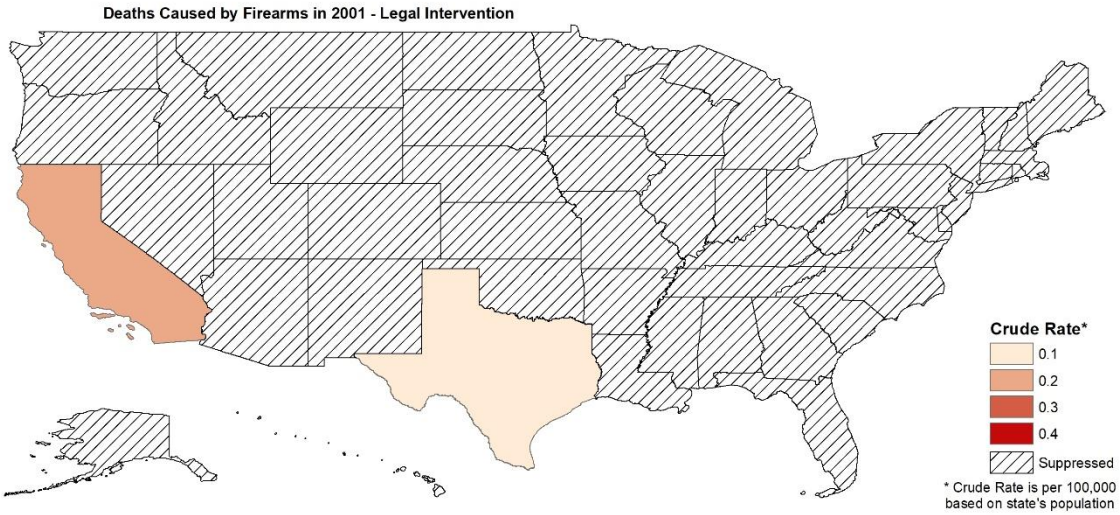


Figure 75: Legal Intervention Deaths Caused by Firearms in 2001 Map

This choropleth map shows how many people died from legal intervention firearm use per 100,000 people in each state during 2001.

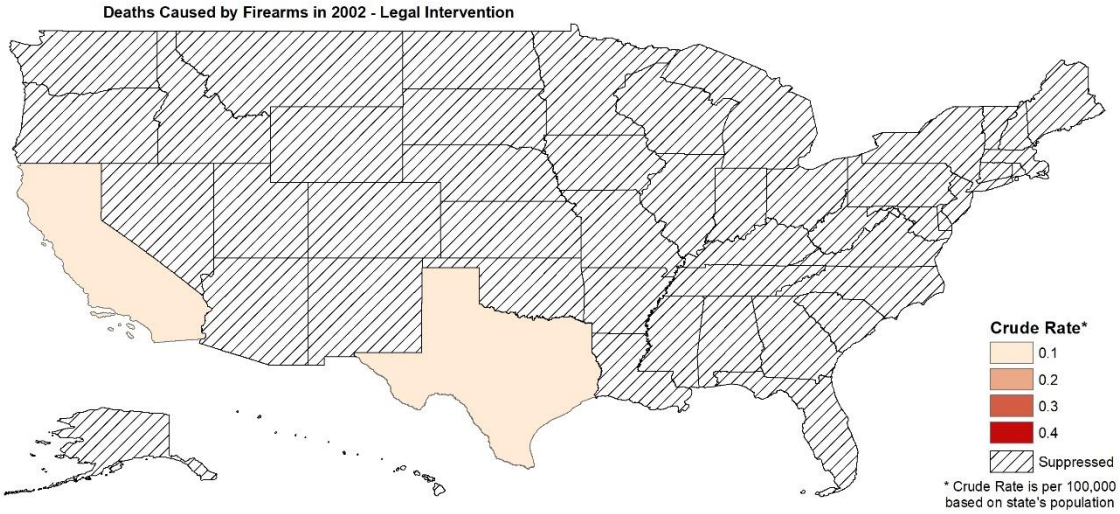


Figure 76: Legal Intervention Deaths Caused by Firearms in 2002 Map

This choropleth map shows how many people died from legal intervention firearm use per 100,000 people in each state during 2002.

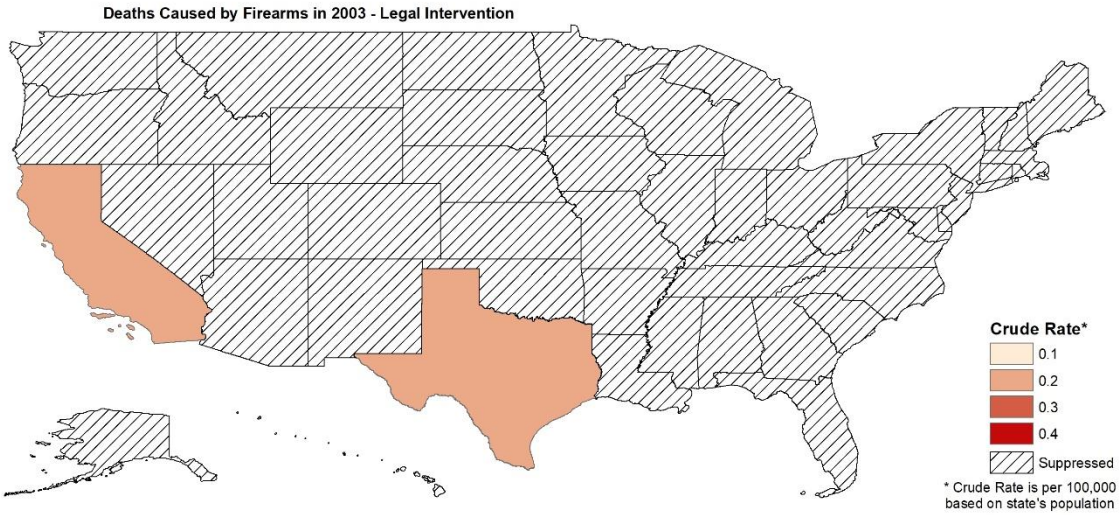


Figure 77: Legal Intervention Deaths Caused by Firearms in 2003 Map

This choropleth map shows how many people died from legal intervention firearm use per 100,000 people in each state during 2003.


Figure 78: Legal Intervention Deaths Caused by Firearms in 2004 Map

This choropleth map shows how many people died from legal intervention firearm use per 100,000 people in each state during 2004.

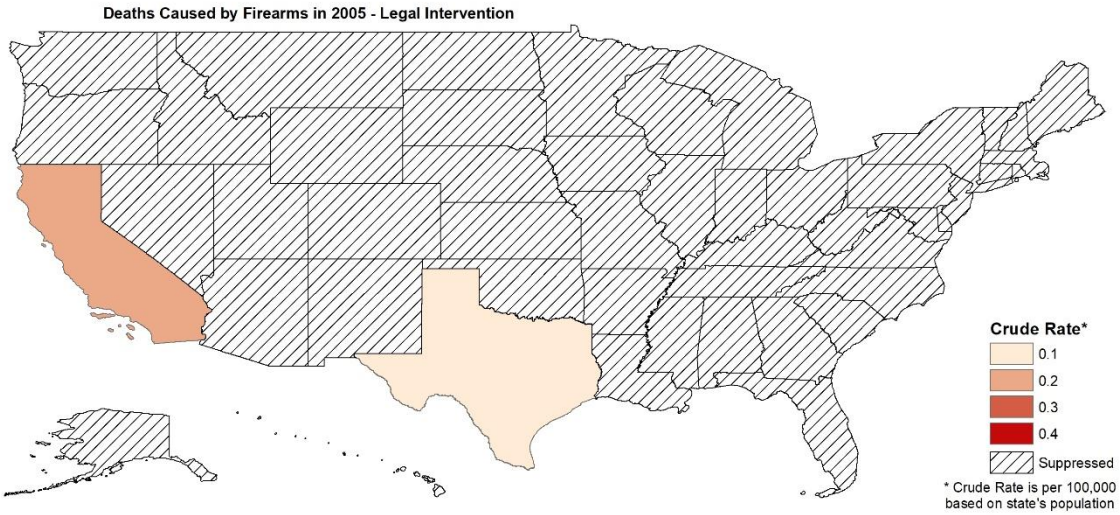


Figure 79: Legal Intervention Deaths Caused by Firearms in 2005 Map

This choropleth map shows how many people died from legal intervention firearm use per 100,000 people in each state during 2005.

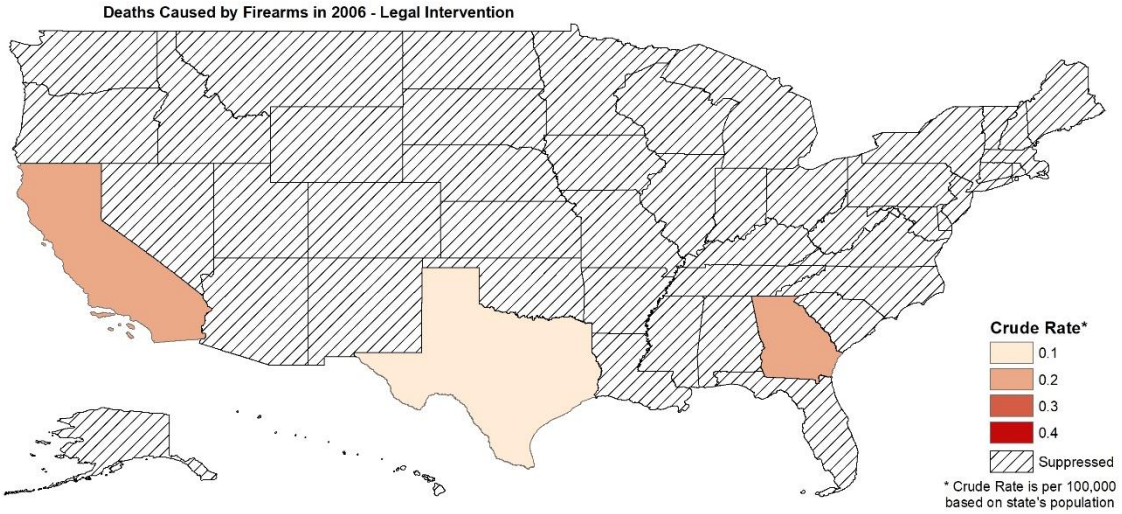


Figure 80: Legal Intervention Deaths Caused by Firearms in 2006 Map

This choropleth map shows how many people died from legal intervention firearm use per 100,000 people in each state during 2006.

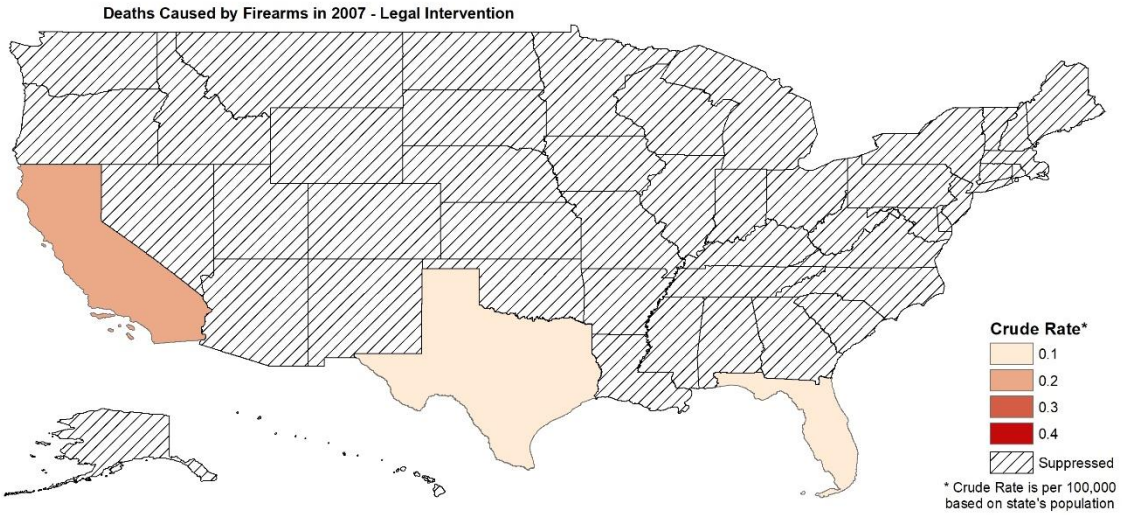


Figure 81: Legal Intervention Deaths Caused by Firearms in 2007 Map

This choropleth map shows how many people died from legal intervention firearm use per 100,000 people in each state during 2007.

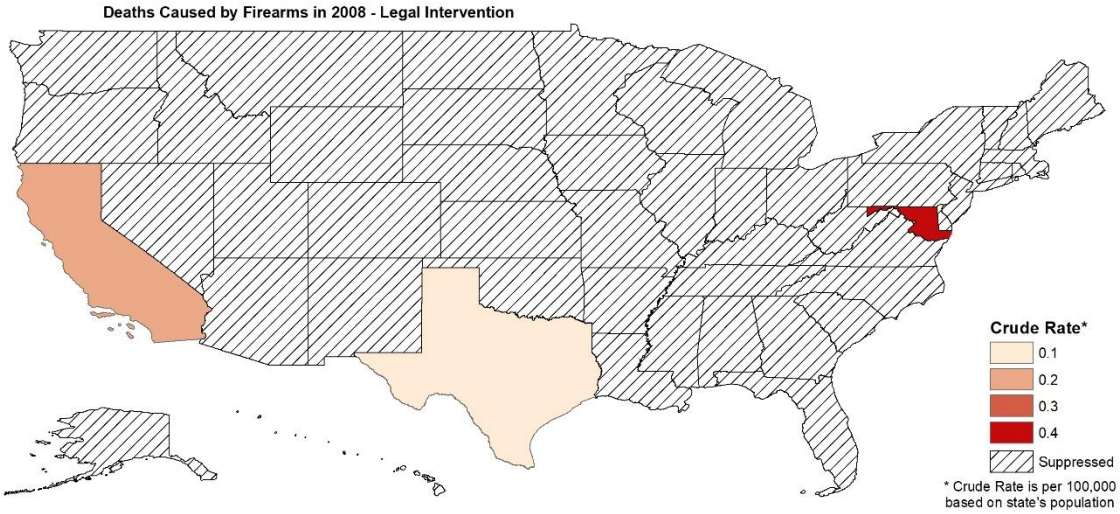


Figure 82: Legal Intervention Deaths Caused by Firearms in 2008 Map

This choropleth map shows how many people died from legal intervention firearm use per 100,000 people in each state during 2008.

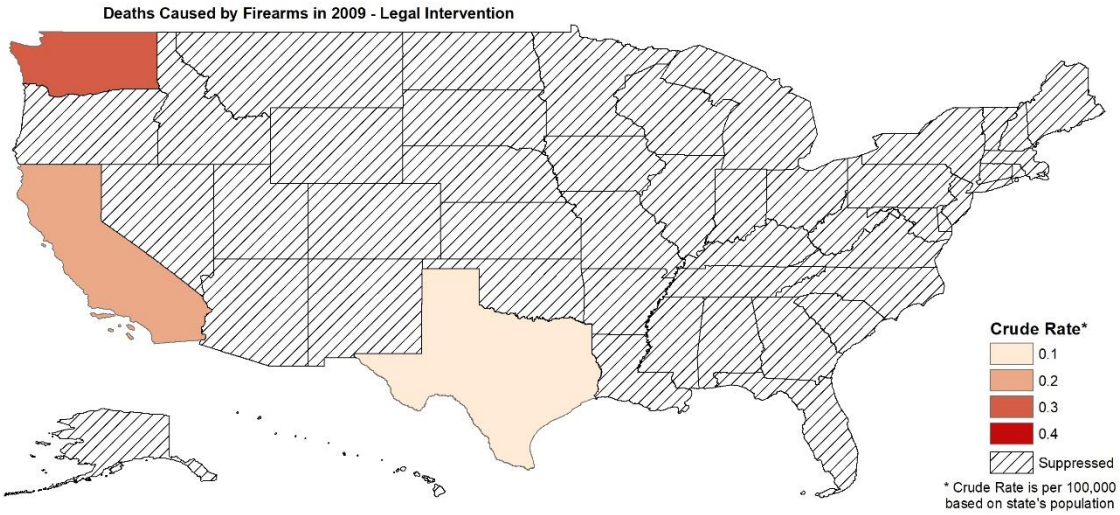


Figure 83: Legal Intervention Deaths Caused by Firearms in 2009 Map

This choropleth map shows how many people died from legal intervention firearm use per 100,000 people in each state during 2009.

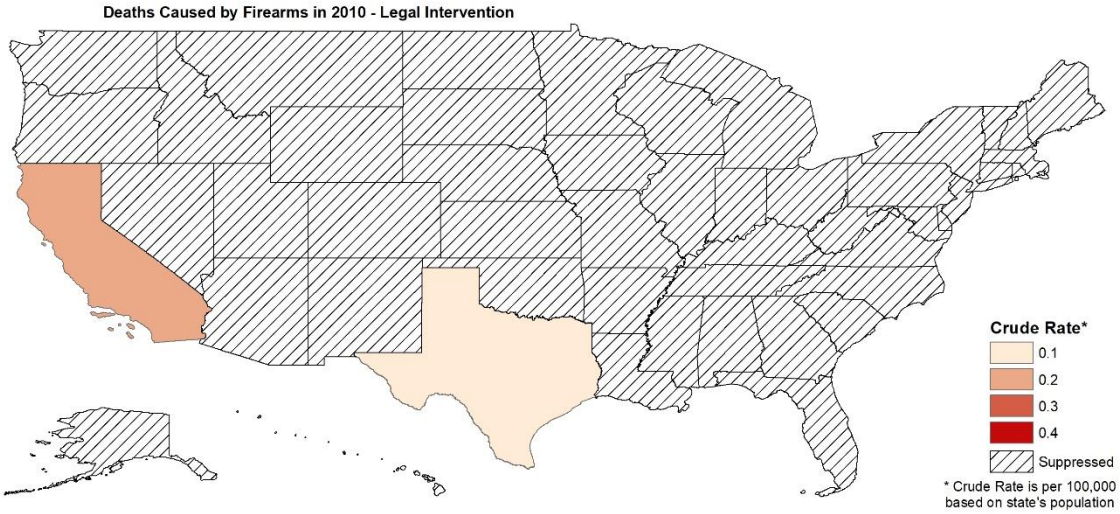


Figure 84: Legal Intervention Deaths Caused by Firearms in 2010 Map

This choropleth map shows how many people died from legal intervention firearm use per 100,000 people in each state during 2010.

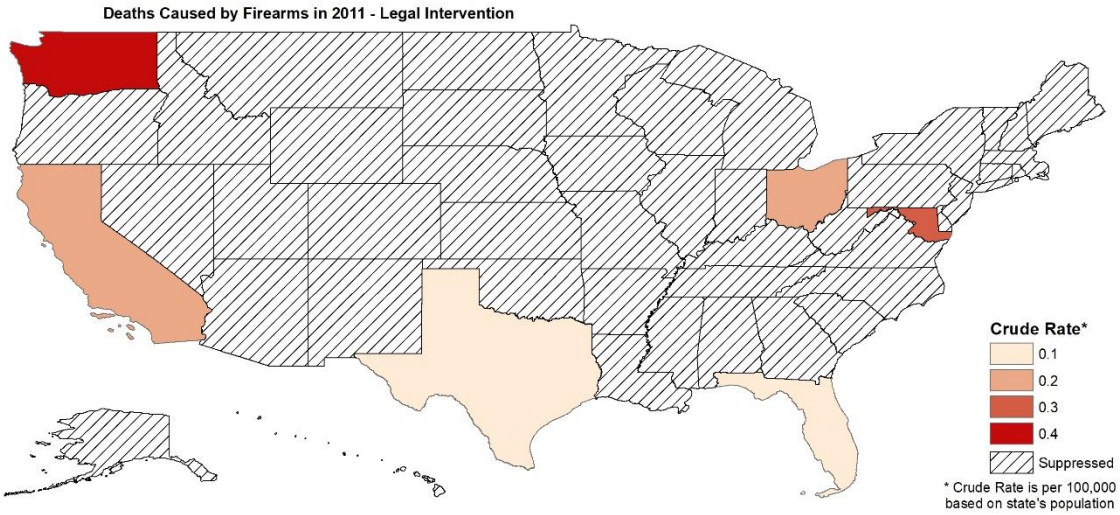


Figure 85: Legal Intervention Deaths Caused by Firearms in 2011 Map

This choropleth map shows how many people died from legal intervention firearm use per 100,000 people in each state during 2011.

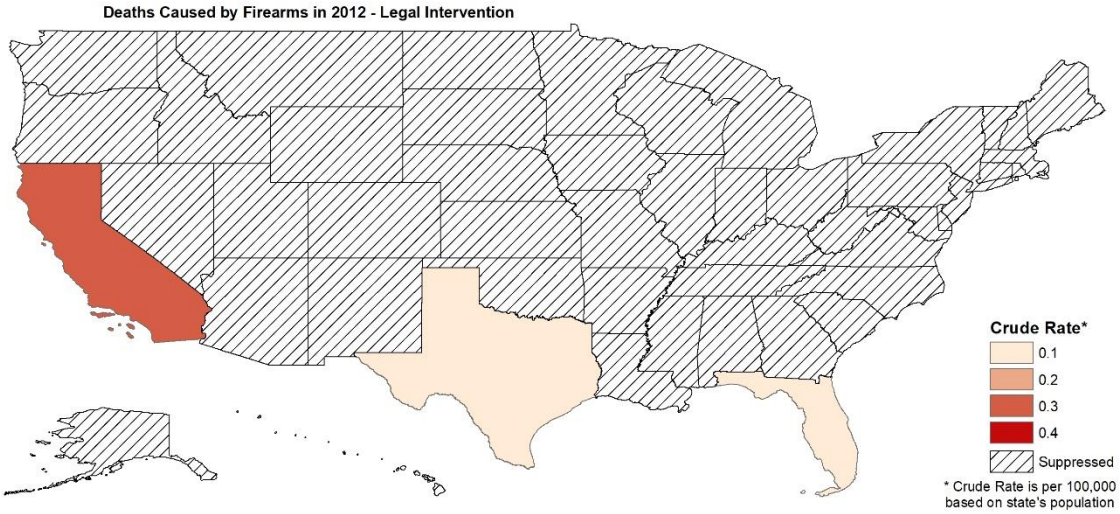


Figure 86: Legal Intervention Deaths Caused by Firearms in 2012 Map

This choropleth map shows how many people died from legal intervention firearm use per 100,000 people in each state during 2012.

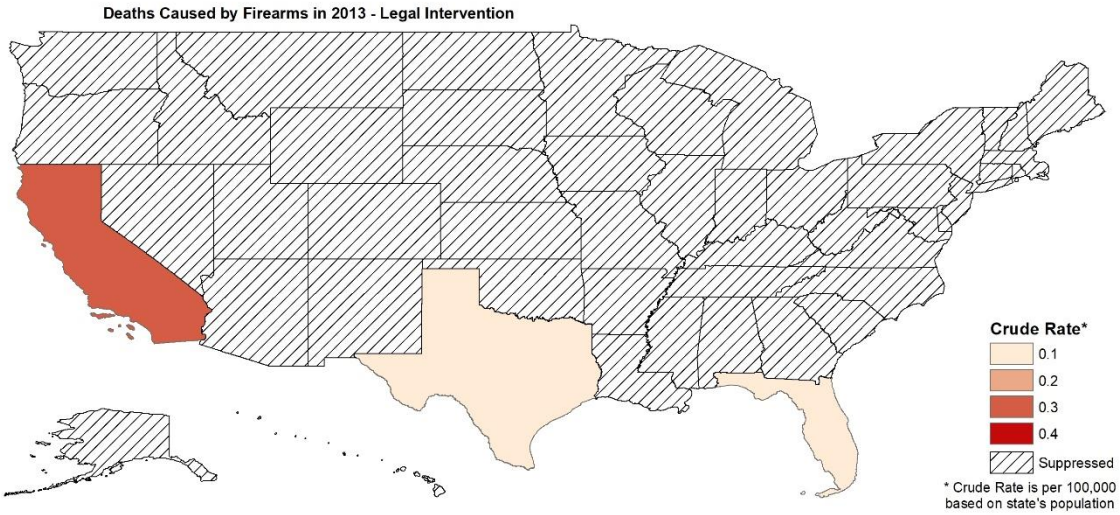


Figure 87: Legal Intervention Deaths Caused by Firearms in 2013 Map

This choropleth map shows how many people died from legal intervention firearm use per 100,000 people in each state during 2013.

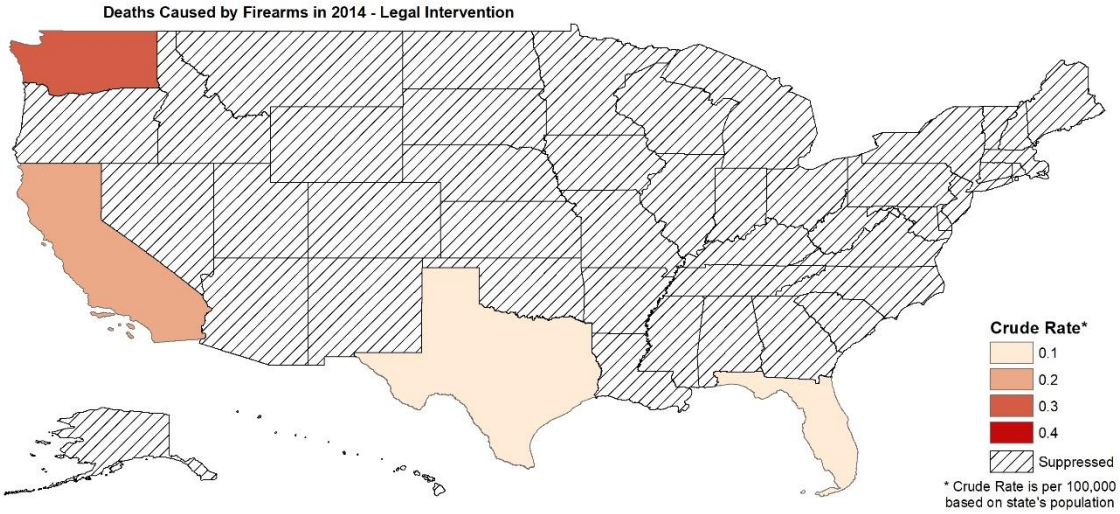


Figure 88: Legal Intervention Deaths Caused by Firearms in 2014 Map

This choropleth map shows how many people died from legal intervention firearm use per 100,000 people in each state during 2014.

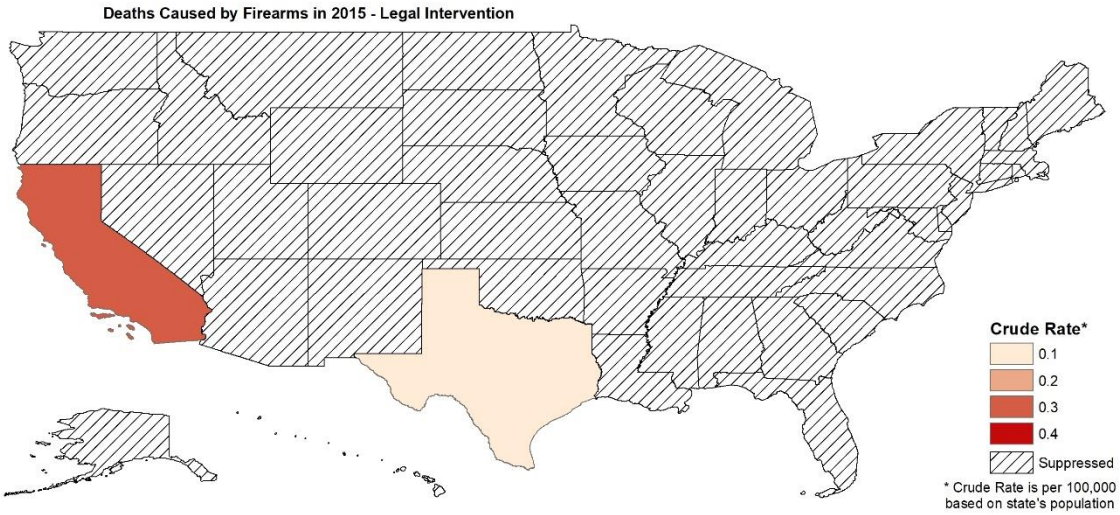


Figure 89: Legal Intervention Deaths Caused by Firearms in 2015 Map

This choropleth map shows how many people died from legal intervention firearm use per 100,000 people in each state during 2015.

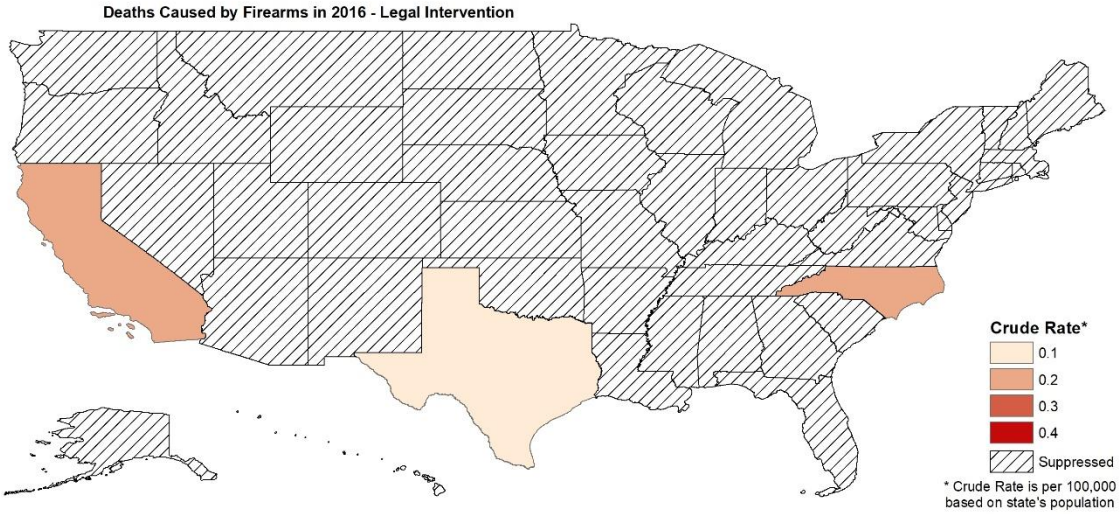


Figure 90: Legal Intervention Deaths Caused by Firearms in 2016 Map

This choropleth map shows how many people died from legal intervention firearm use per 100,000 people in each state during 2016.

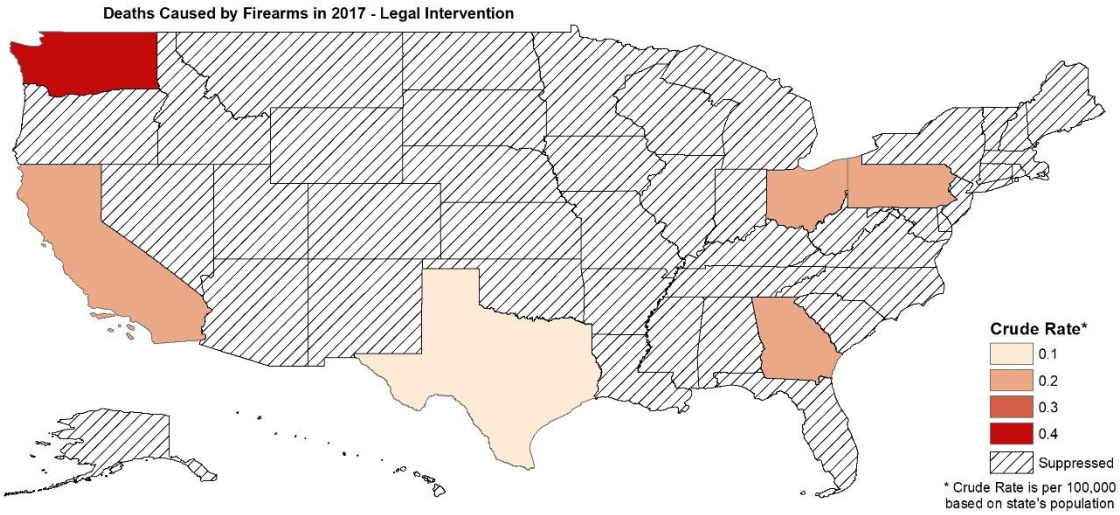


Figure 91: Legal Intervention Deaths Caused by Firearms in 2017 Map

This choropleth map shows how many people died from legal intervention firearm use per 100,000 people in each state during 2017.

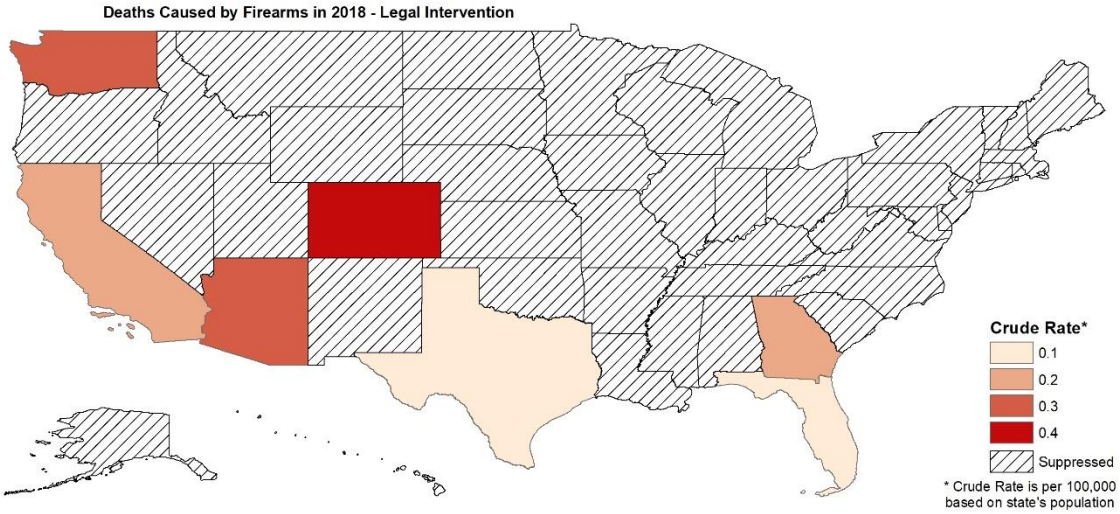


Figure 92: Legal Intervention Deaths Caused by Firearms in 2018 Map

This choropleth map shows how many people died from legal intervention firearm use per 100,000 people in each state during 2018.

*Deaths Caused by Firearms – Unintentional*

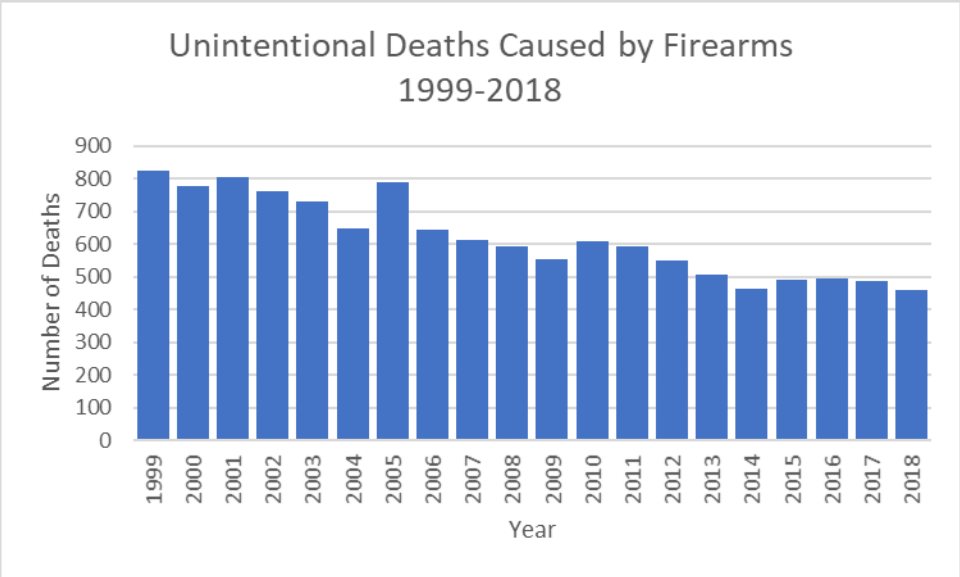


Figure 93: Unintentional Deaths Caused by Firearms 1999–2018 Graph

This bar graph shows the total number of people who unintentionally died from a firearm from 1999 to 2018.

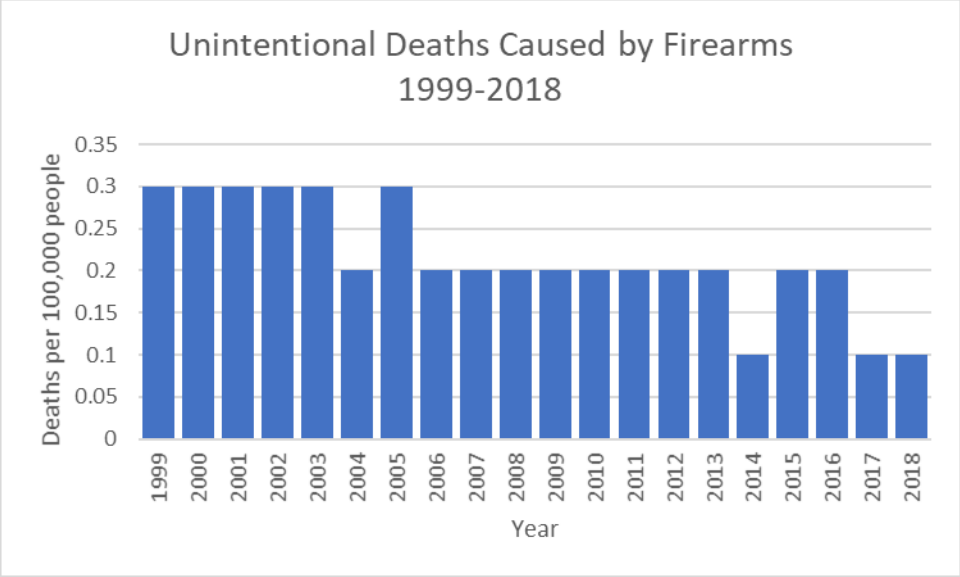


Figure 94: Unintentional Deaths Caused by Firearms 1999–2018 Crude Rate Graph

This bar graph shows the number of people who unintentionally died from a firearm per 100,000 people from 1999 to 2018. By calculating the crude rate using the population in each year, the effects of population growth are reduced.

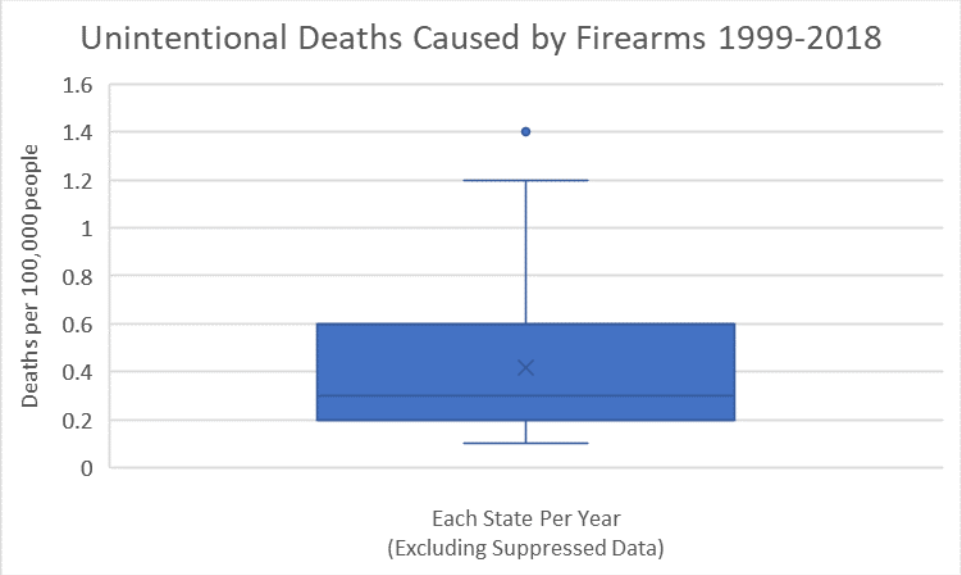


Figure 95: Unintentional Deaths Caused by Firearms 1999–2018 Boxplot

This box and whisker plot shows the statistics on the crude rate of unintentional firearm deaths in each state from 1999 to 2018.

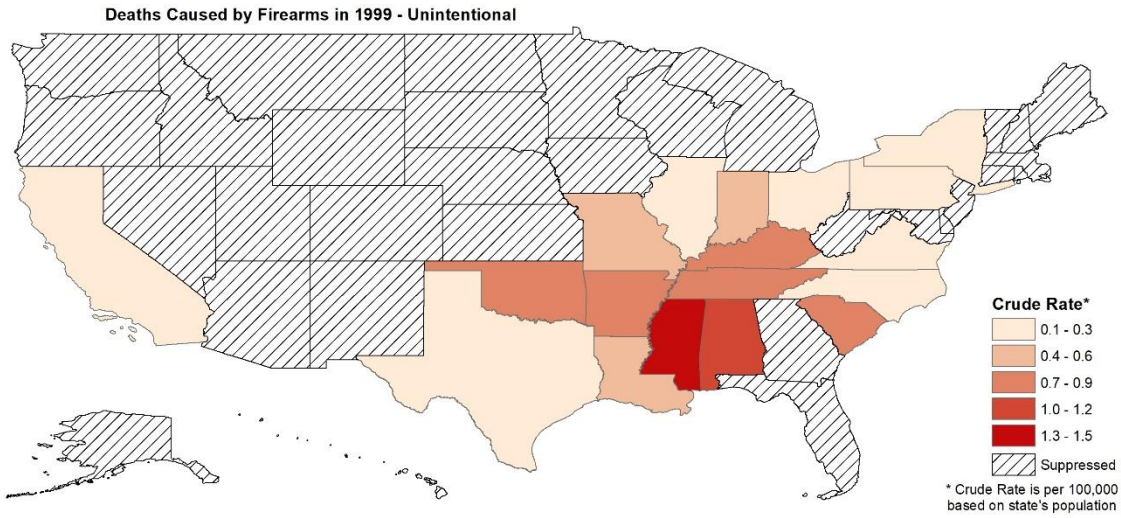


Figure 96: Unintentional Deaths Caused by Firearms in 1999 Map

This choropleth map shows how many people unintentionally died from a firearm per 100,000 people in each state during 1999.

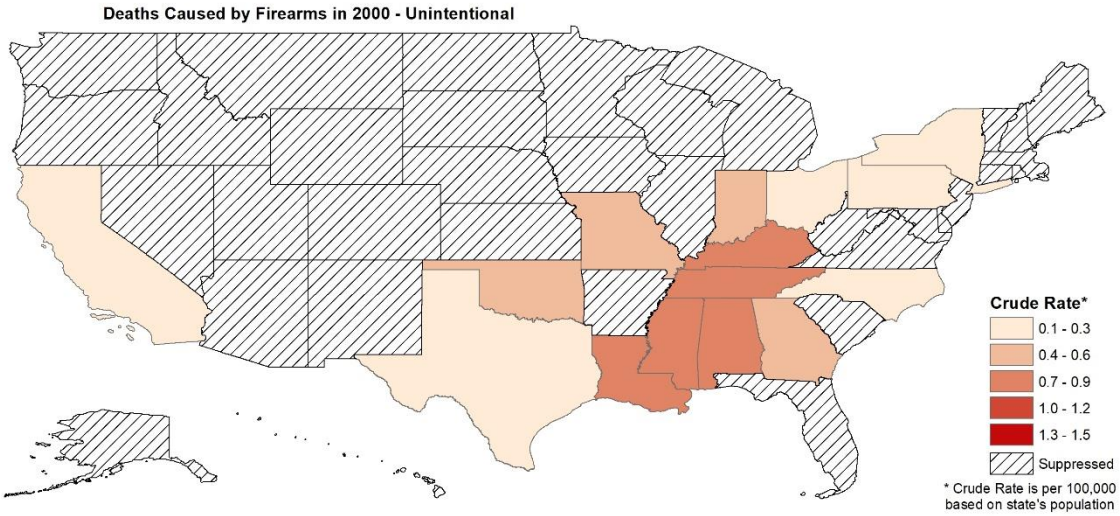


Figure 97: Unintentional Deaths Caused by Firearms in 2000 Map

This choropleth map shows how many people unintentionally died from a firearm per 100,000 people in each state during 2000.

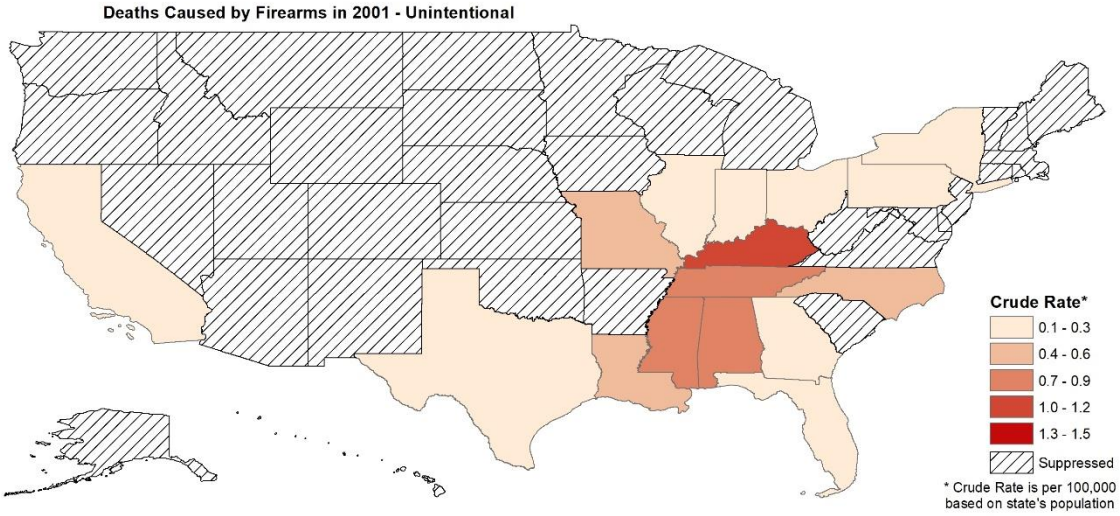


Figure 98: Unintentional Deaths Caused by Firearms in 2001 Map

This choropleth map shows how many people unintentionally died from a firearm per 100,000 people in each state during 2001.

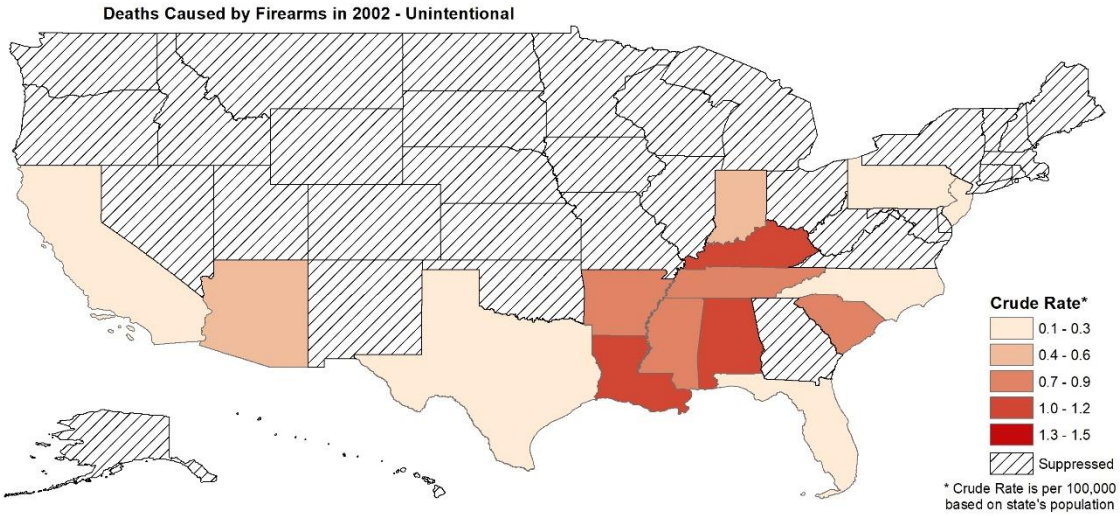


Figure 99: Unintentional Deaths Caused by Firearms in 2002 Map

This choropleth map shows how many people unintentionally died from a firearm per 100,000 people in each state during 2002.

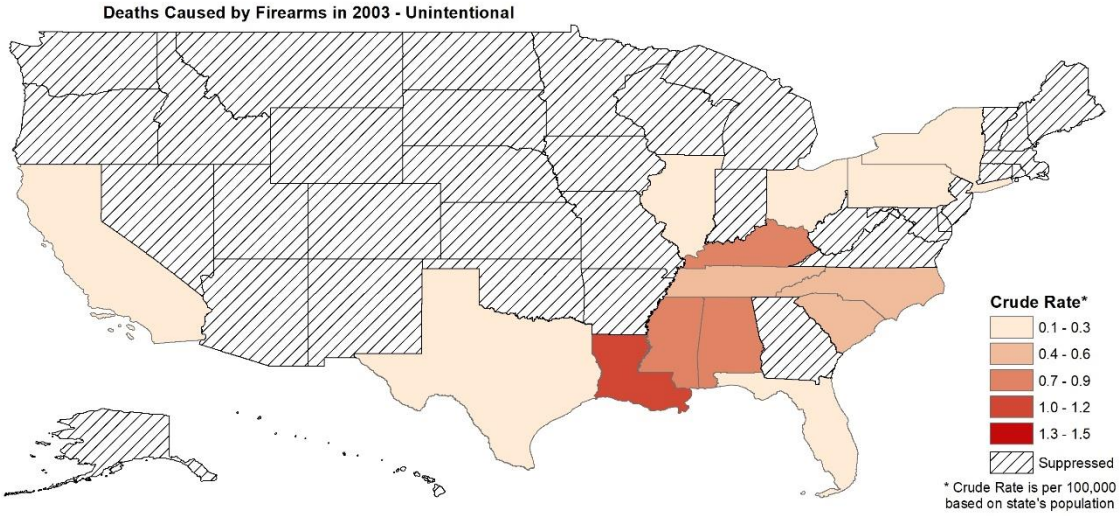


Figure 100: Unintentional Deaths Caused by Firearms in 2003 Map

This choropleth map shows how many people unintentionally died from a firearm per 100,000 people in each state during 2003.

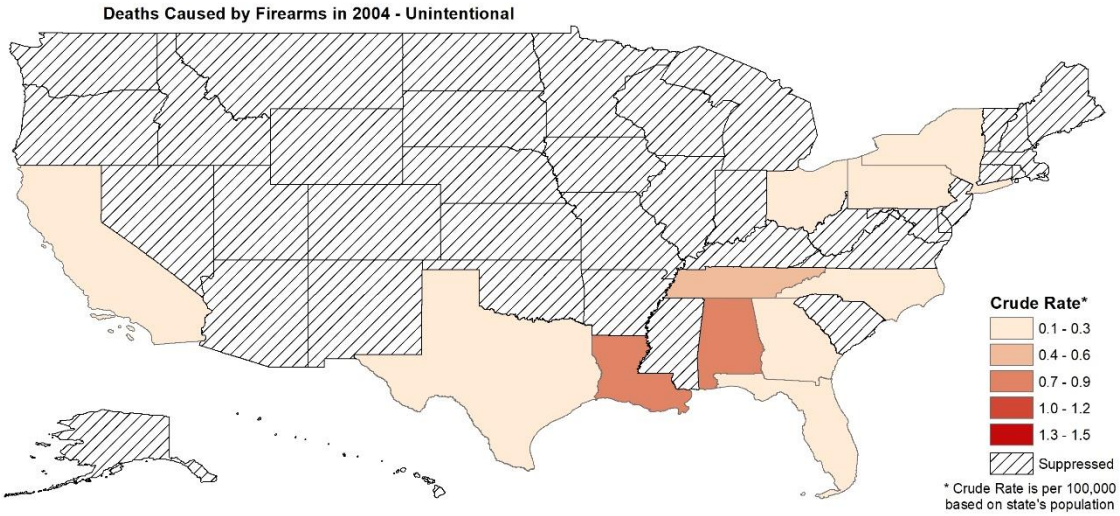


Figure 101: Unintentional Deaths Caused by Firearms in 2004 Map

This choropleth map shows how many people unintentionally died from a firearm per 100,000 people in each state during 2004.

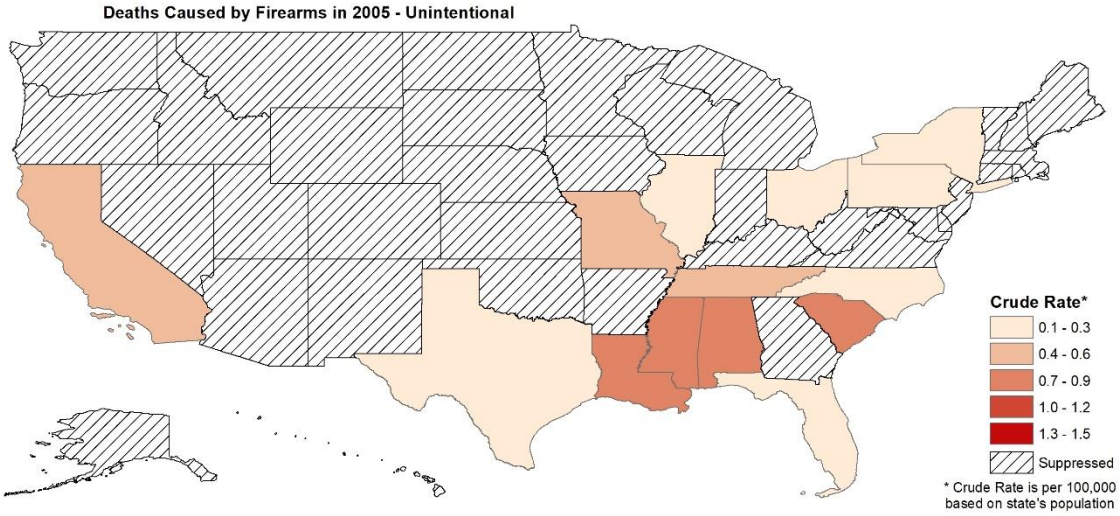


Figure 102: Unintentional Deaths Caused by Firearms in 2005 Map

This choropleth map shows how many people unintentionally died from a firearm per 100,000 people in each state during 2005.

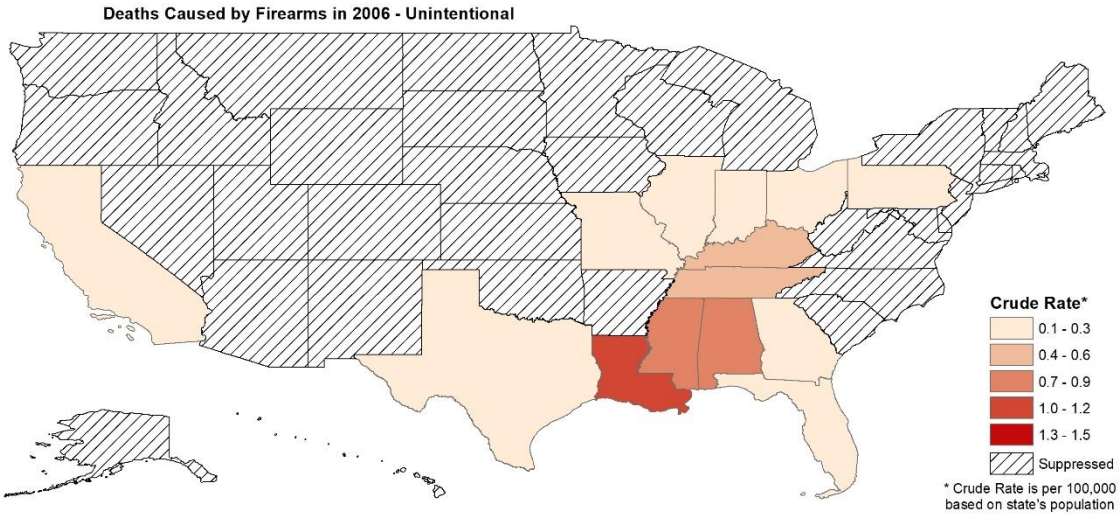


Figure 103: Unintentional Deaths Caused by Firearms in 2006 Map

This choropleth map shows how many people unintentionally died from a firearm per 100,000 people in each state during 2006.

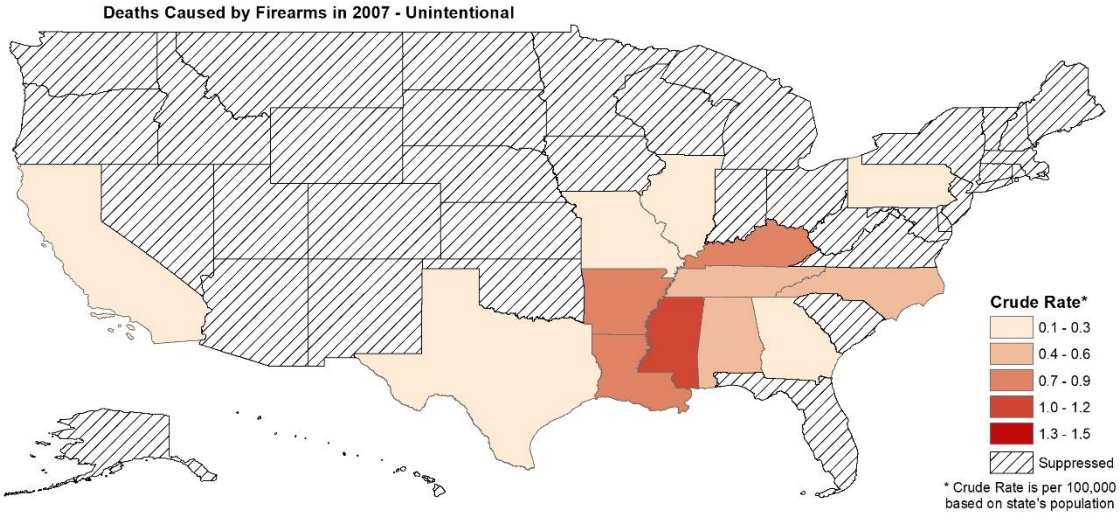


Figure 104: Unintentional Deaths Caused by Firearms in 2007 Map

This choropleth map shows how many people unintentionally died from a firearm per 100,000 people in each state during 2007.

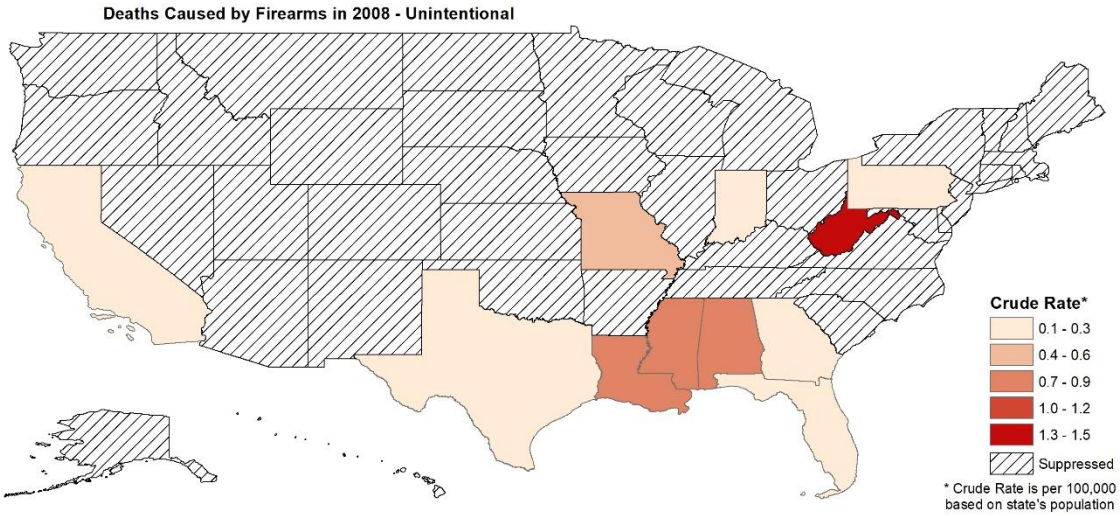


Figure 105: Unintentional Deaths Caused by Firearms in 2008 Map

This choropleth map shows how many people unintentionally died from a firearm per 100,000 people in each state during 2008.

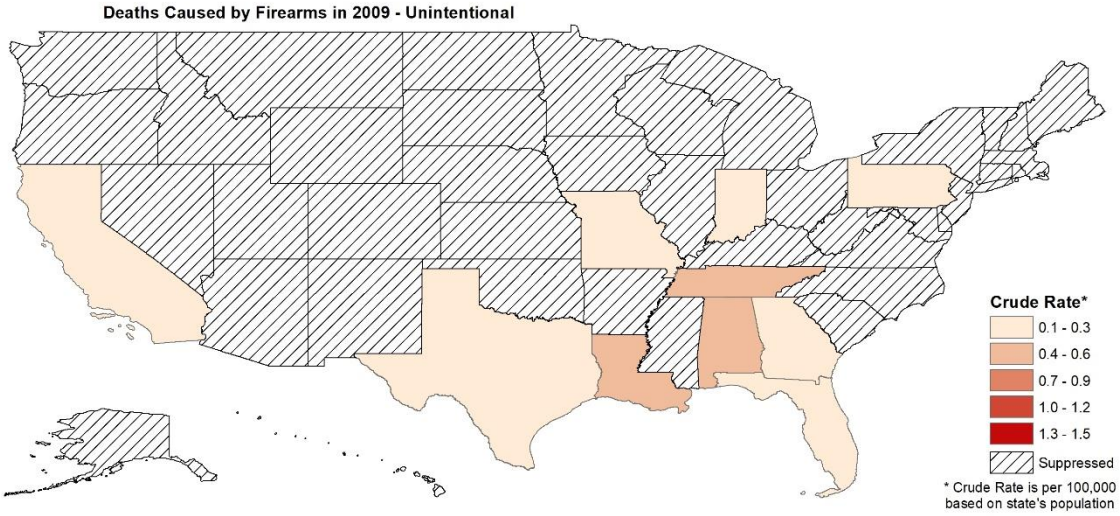


Figure 106: Unintentional Deaths Caused by Firearms in 2009 Map

This choropleth map shows how many people unintentionally died from a firearm per 100,000 people in each state during 2009.

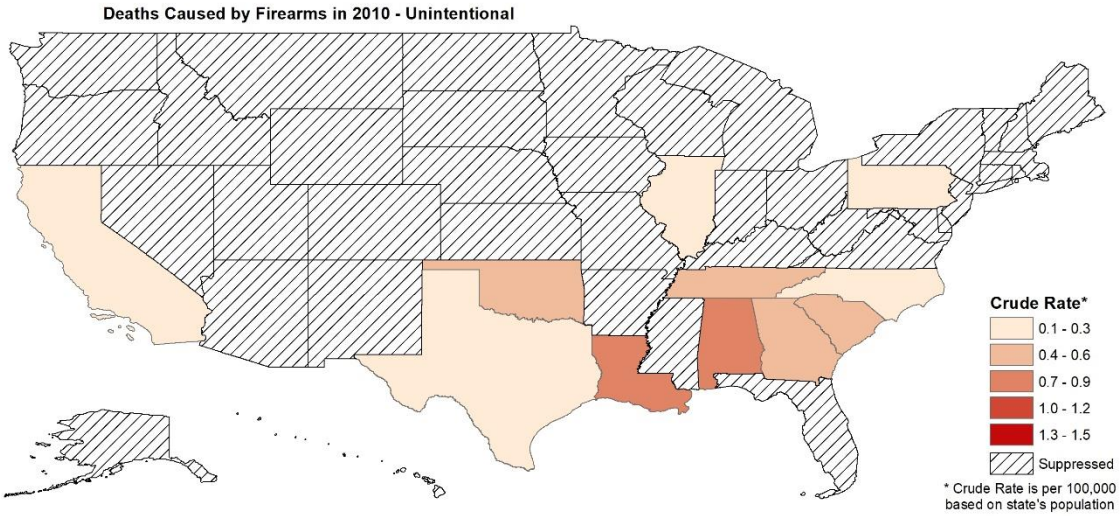


Figure 107: Unintentional Deaths Caused by Firearms in 2010 Map

This choropleth map shows how many people unintentionally died from a firearm per 100,000 people in each state during 2010.

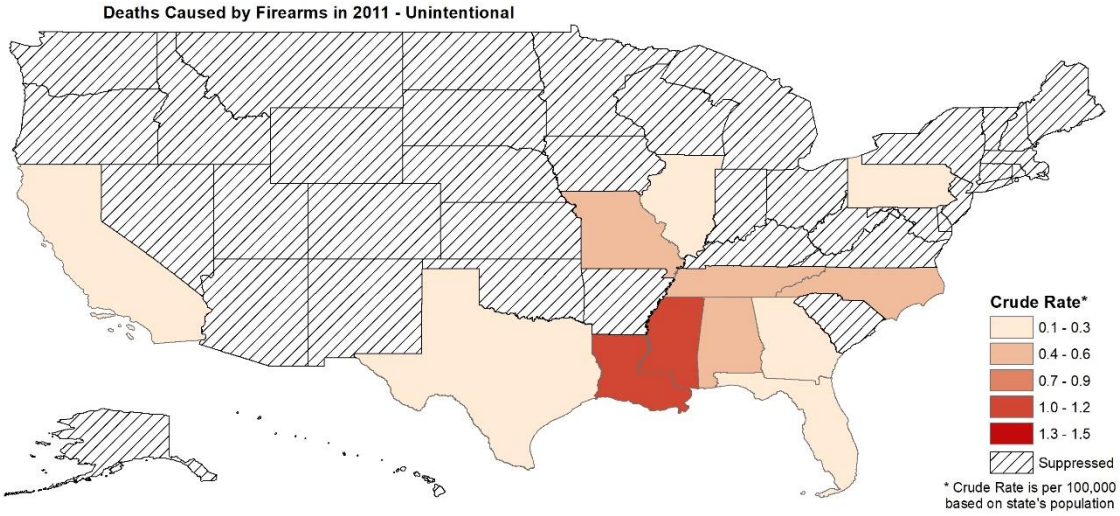


Figure 108: Unintentional Deaths Caused by Firearms in 2011 Map

This choropleth map shows how many people unintentionally died from a firearm per 100,000 people in each state during 2011.

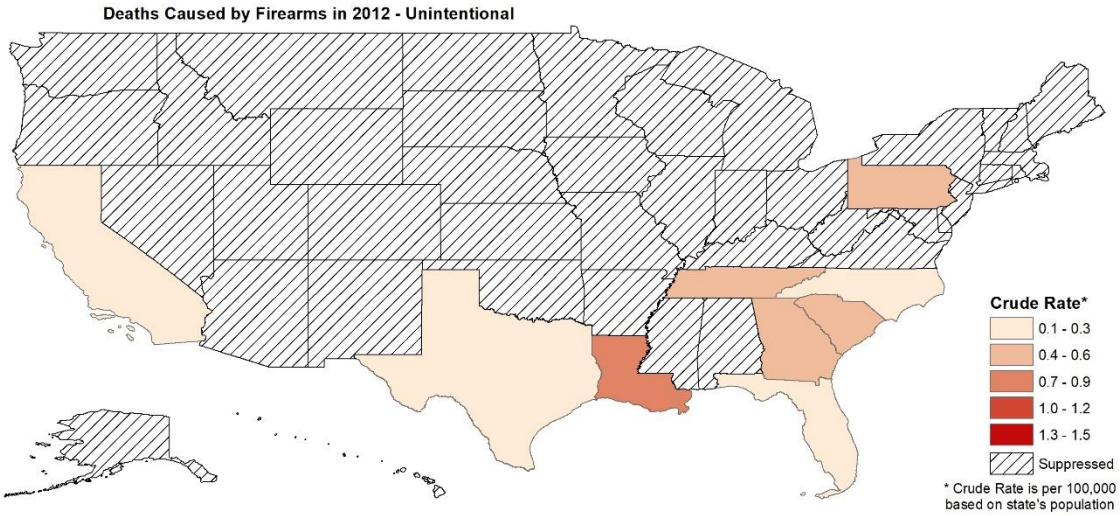


Figure 109: Unintentional Deaths Caused by Firearms in 2012 Map

This choropleth map shows how many people unintentionally died from a firearm per 100,000 people in each state during 2012.

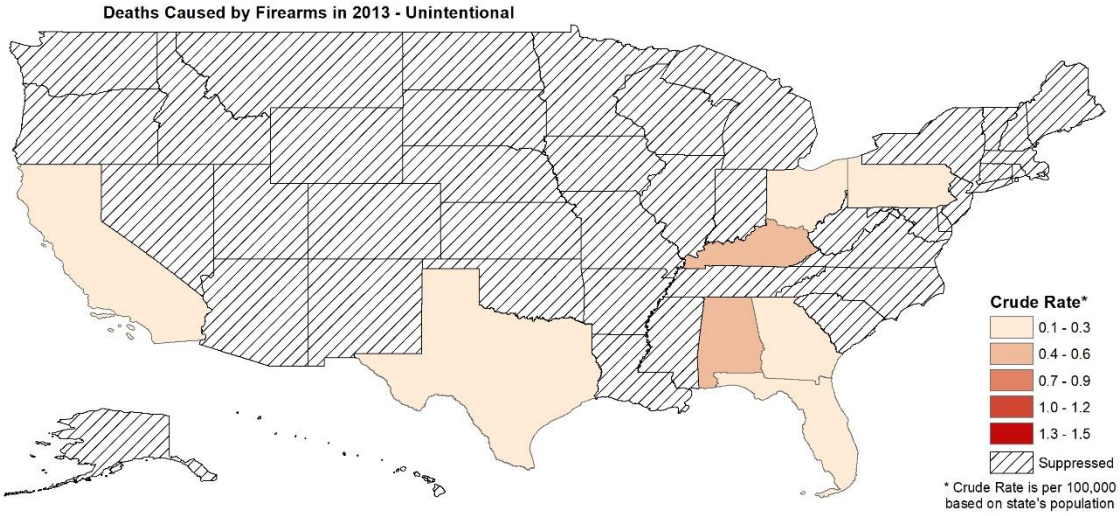


Figure 110: Unintentional Deaths Caused by Firearms in 2013 Map

This choropleth map shows how many people unintentionally died from a firearm per 100,000 people in each state during 2013.

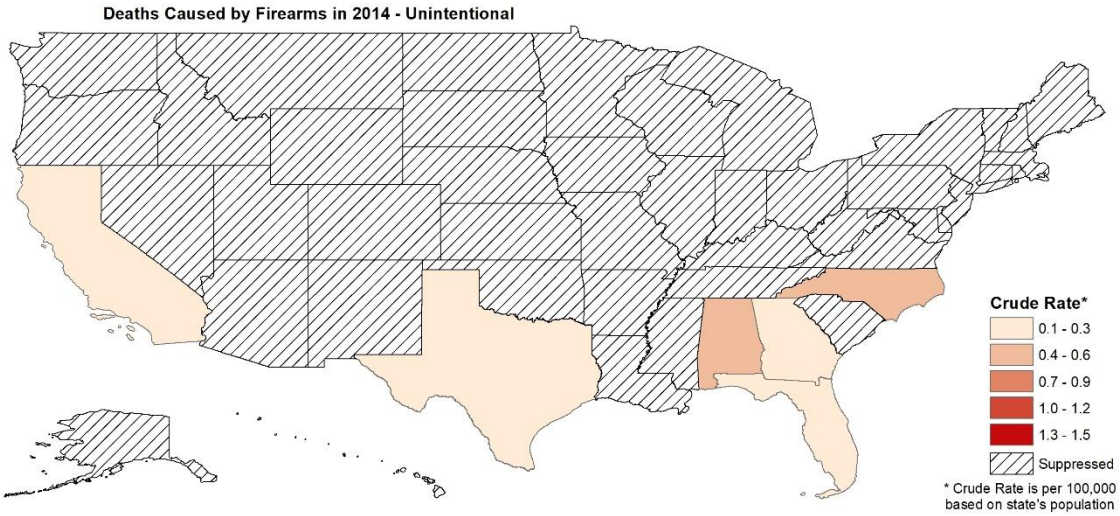


Figure 111: Unintentional Deaths Caused by Firearms in 2014 Map

This choropleth map shows how many people unintentionally died from a firearm per 100,000 people in each state during 2014.

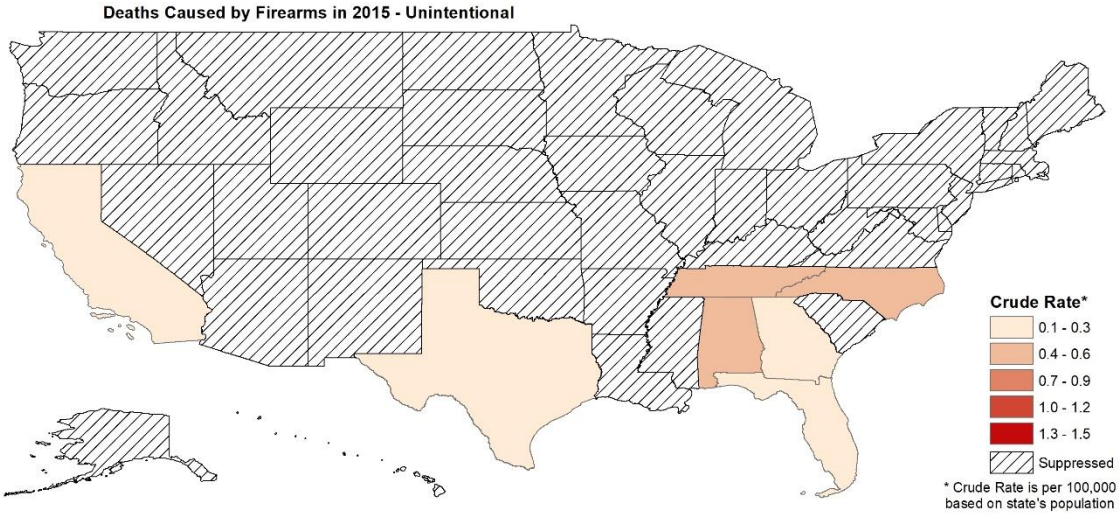


Figure 112: Unintentional Deaths Caused by Firearms in 2015 Map

This choropleth map shows how many people unintentionally died from a firearm per 100,000 people in each state during 2015.

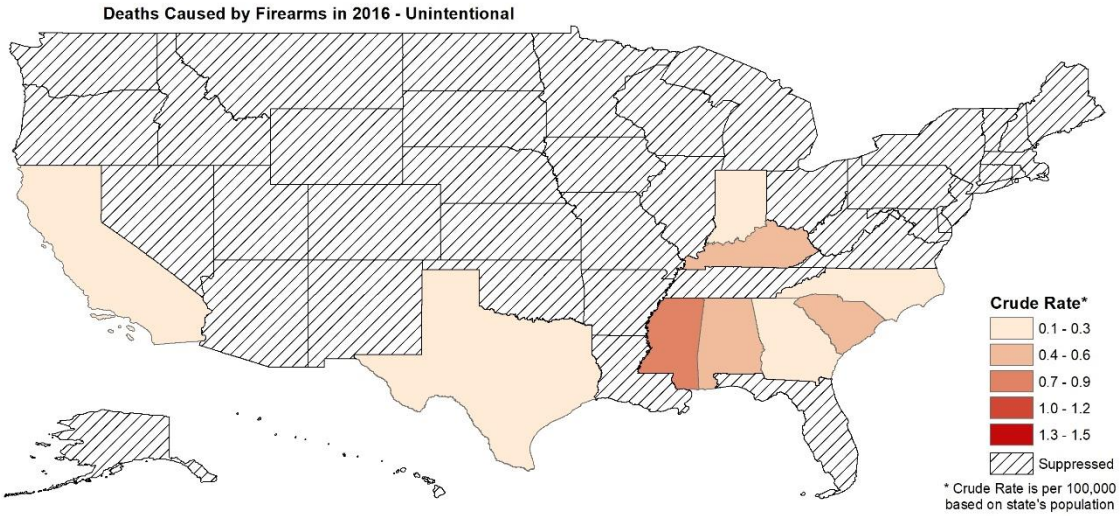


Figure 113: Unintentional Deaths Caused by Firearms in 2016 Map

This choropleth map shows how many people unintentionally died from a firearm per 100,000 people in each state during 2016.

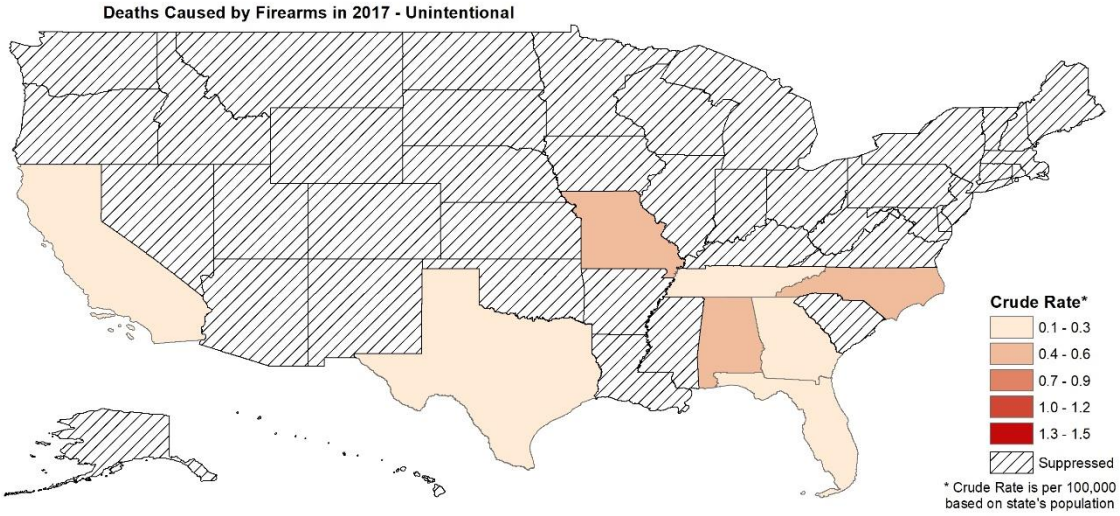


Figure 114: Unintentional Deaths Caused by Firearms in 2017 Map

This choropleth map shows how many people unintentionally died from a firearm per 100,000 people in each state during 2017.

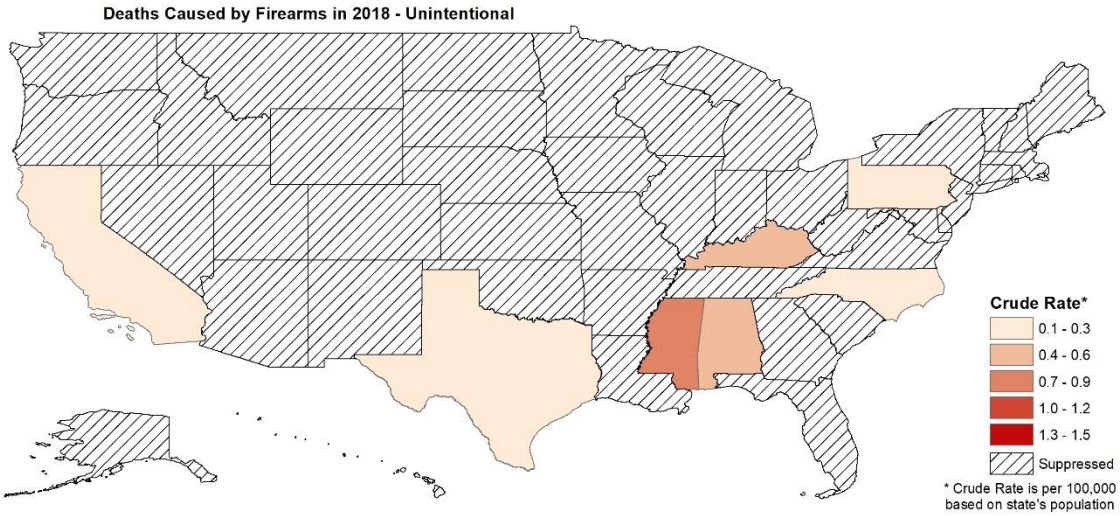


Figure 115: Unintentional Deaths Caused by Firearms in 2018 Map

This choropleth map shows how many people unintentionally died from a firearm per 100,000 people in each state during 2018.

*Deaths Caused by Firearms – Undetermined Intent*

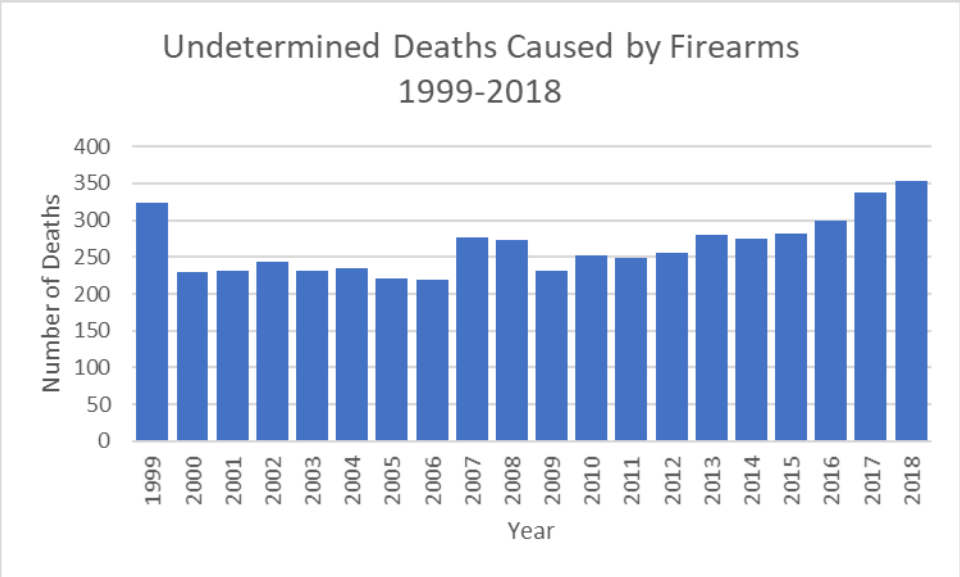


Figure 116: Undetermined Deaths Caused by Firearms 1999–2018 Graph

This bar graph shows the total number of people who died from a firearm with unknown intent from 1999 to 2018.

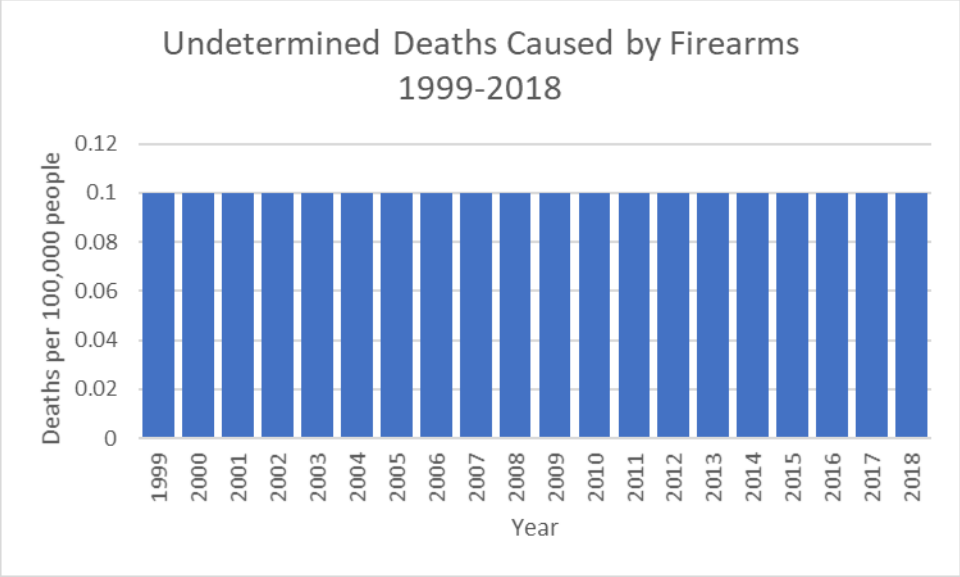


Figure 117: Undetermined Deaths Caused by Firearms 1999–2018 Crude Rate Graph

This bar graph shows the number of people who died from a firearm with unknown intent per 100,000 people from 1999 to 2018. By calculating the crude rate using the population in each year, the effects of population growth are reduced.

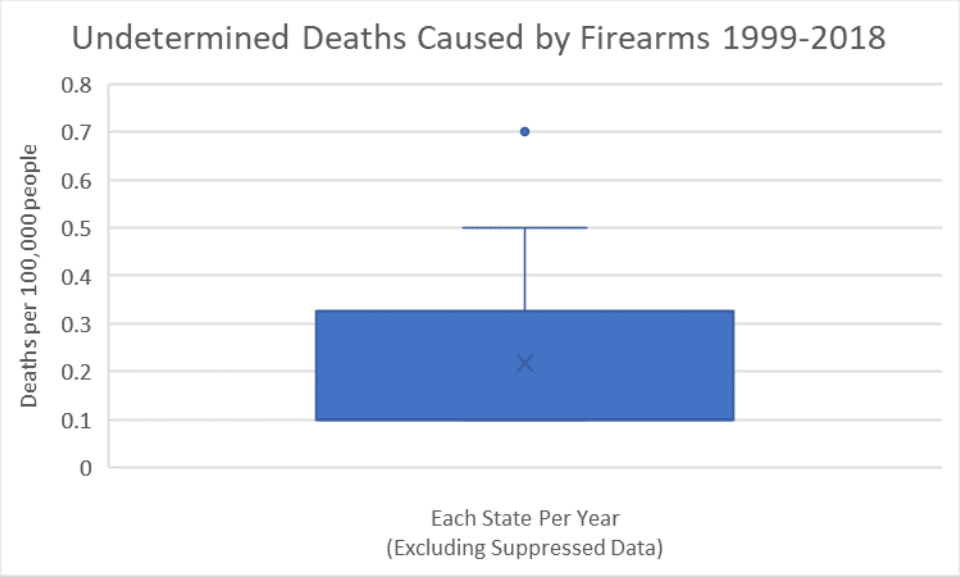


Figure 118: Undetermined Deaths Caused by Firearms 1999–2018 Boxplot

This box and whisker plot shows the statistics on the crude rate of firearm deaths with unknown intents in each state from 1999 to 2018.

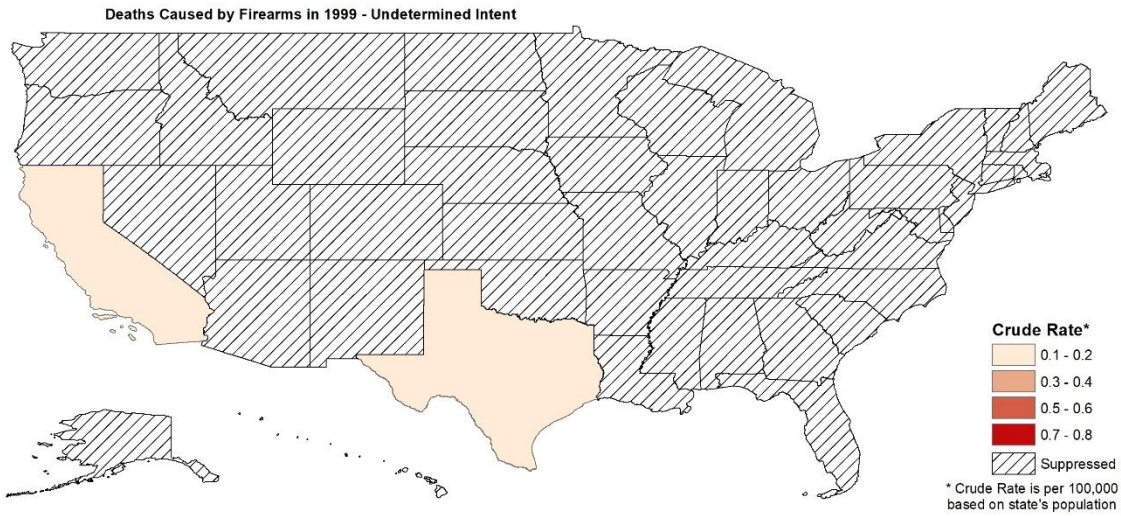


Figure 119: Undetermined Deaths Caused by Firearms in 1999 Map

This choropleth map shows how many people died from a firearm with unknown intent per 100,000 people in each state during 1999.

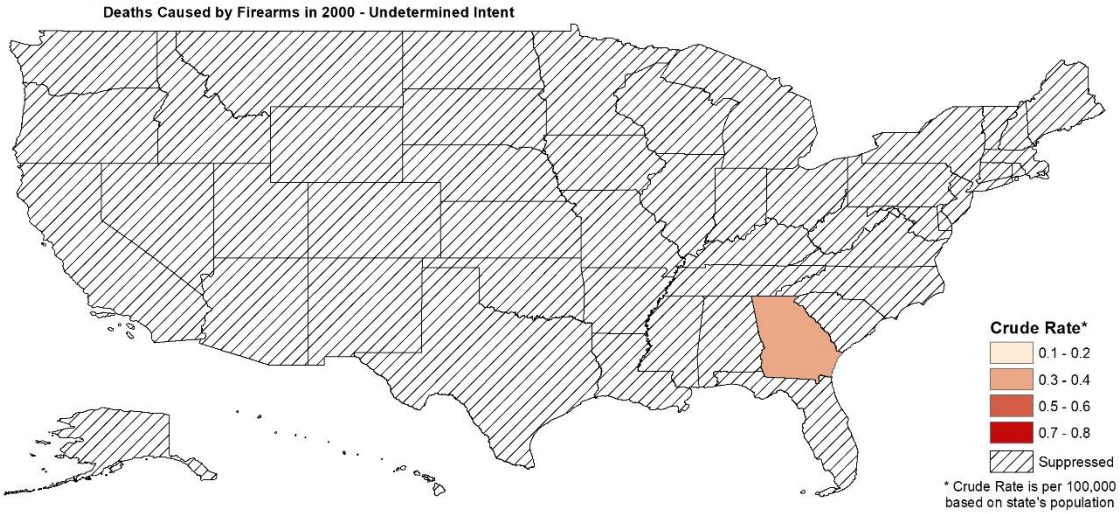


Figure 120: Undetermined Deaths Caused by Firearms in 2000 Map

This choropleth map shows how many people died from a firearm with unknown intent per 100,000 people in each state during 2000.

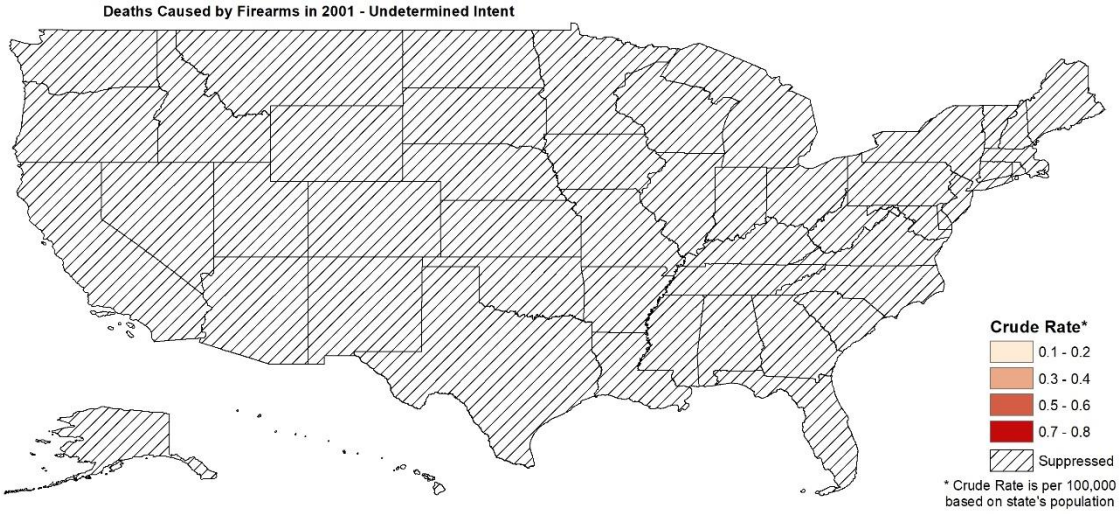


Figure 121: Undetermined Deaths Caused by Firearms in 2001 Map

This choropleth map shows how many people died from a firearm with unknown intent per 100,000 people in each state during 2001.

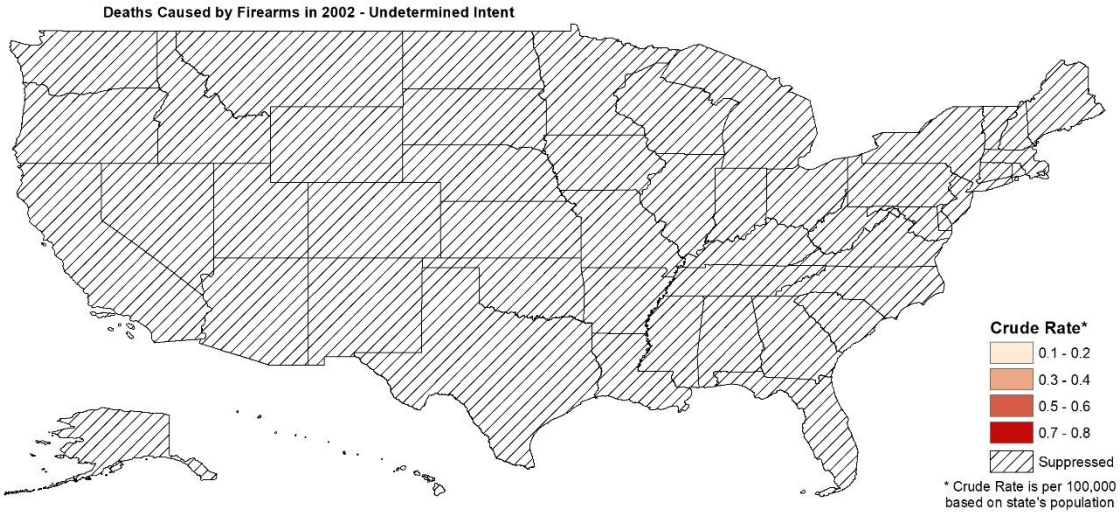


Figure 122: Undetermined Deaths Caused by Firearms in 2002 Map

This choropleth map shows how many people died from a firearm with unknown intent per 100,000 people in each state during 2002.

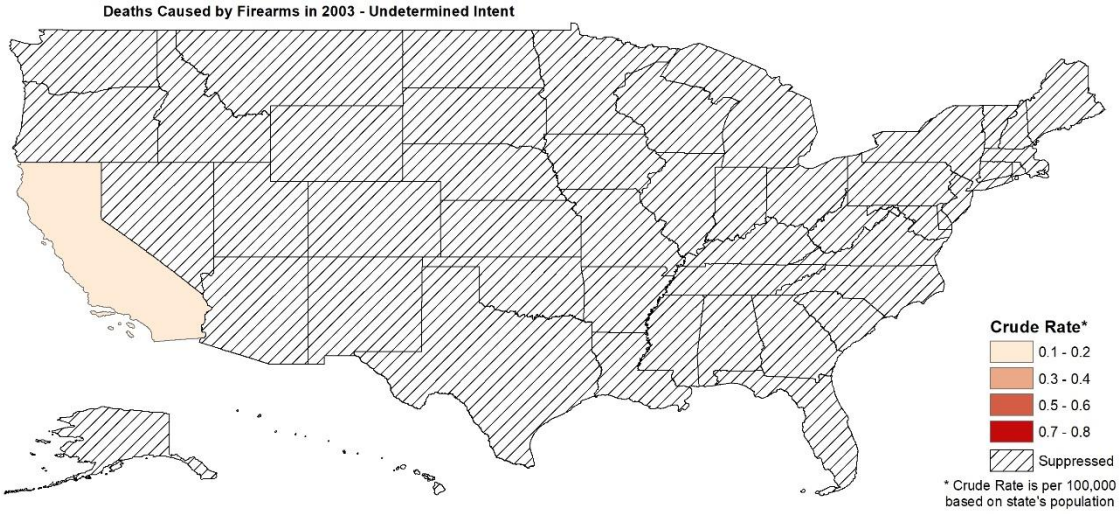


Figure 123: Undetermined Deaths Caused by Firearms in 2003 Map

This choropleth map shows how many people died from a firearm with unknown intent per 100,000 people in each state during 2003.

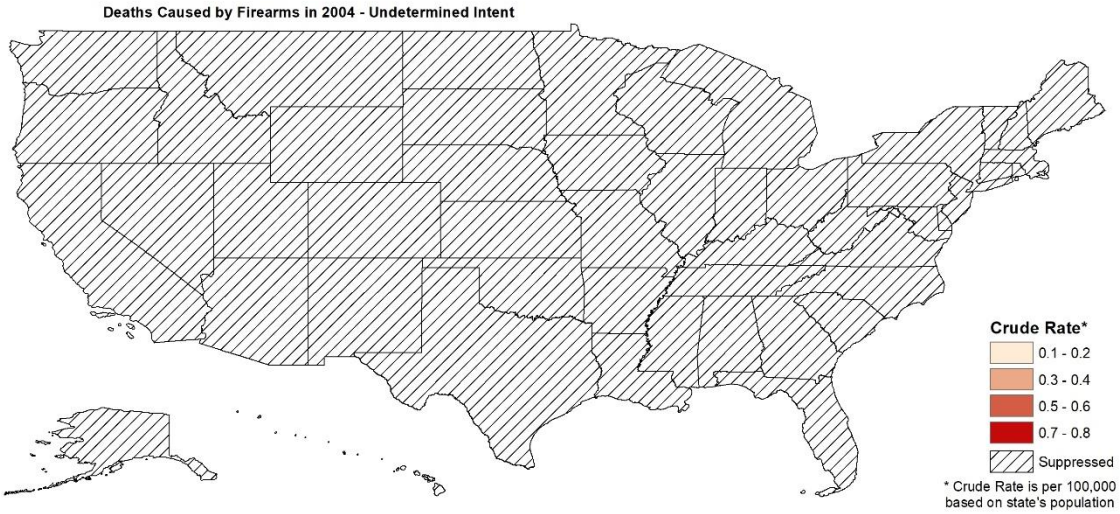


Figure 124: Undetermined Deaths Caused by Firearms in 2004 Map

This choropleth map shows how many people died from a firearm with unknown intent per 100,000 people in each state during 2004.

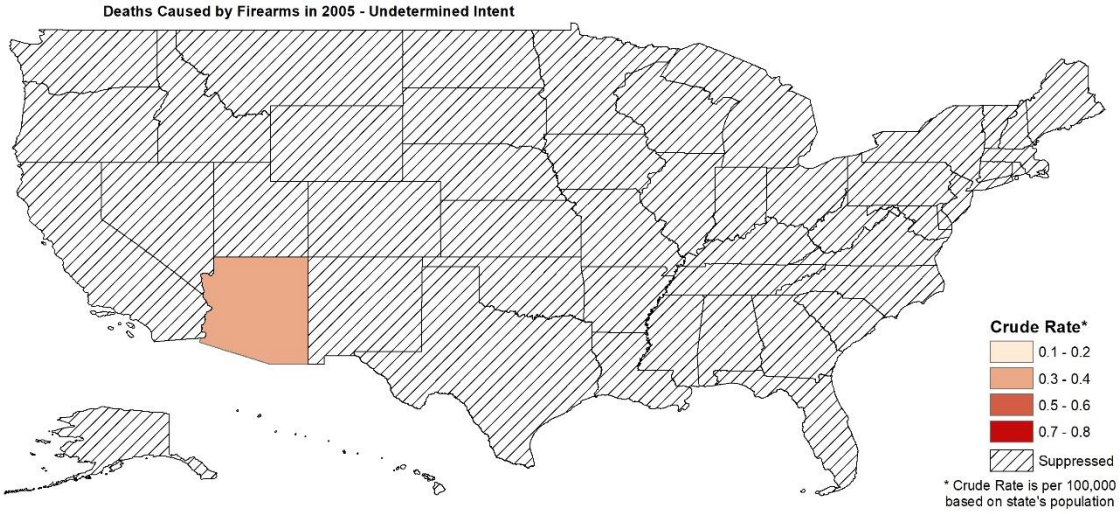


Figure 125: Undetermined Deaths Caused by Firearms in 2005 Map

This choropleth map shows how many people died from a firearm with unknown intent per 100,000 people in each state during 2005.

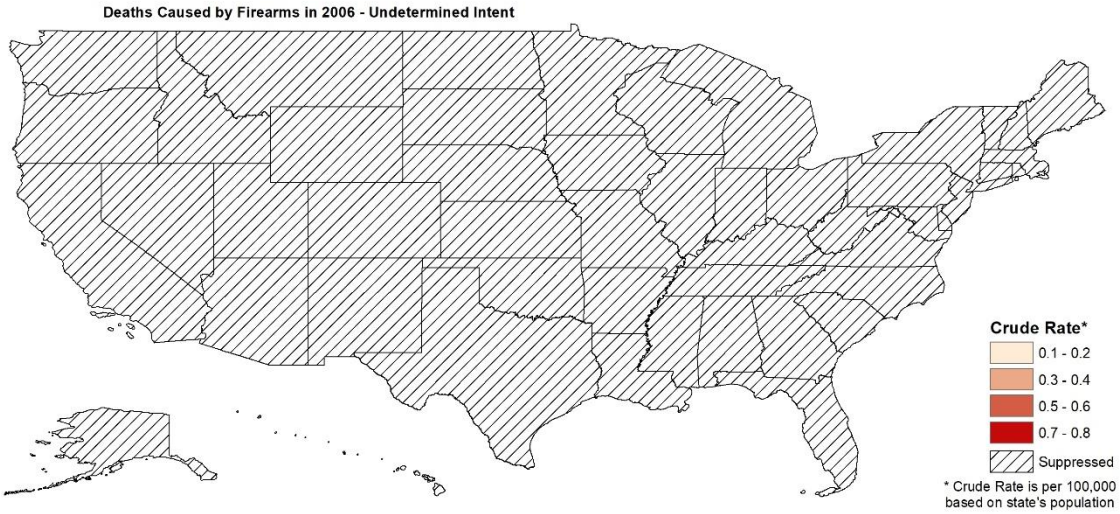


Figure 126: Undetermined Deaths Caused by Firearms in 2006 Map

This choropleth map shows how many people died from a firearm with unknown intent per 100,000 people in each state during 2006.

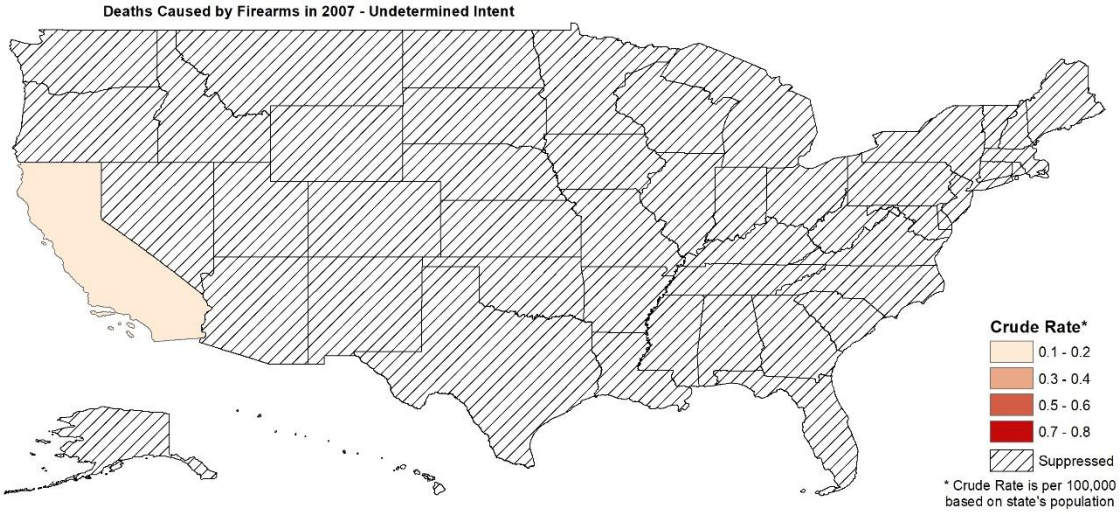


Figure 127: Undetermined Deaths Caused by Firearms in 2007 Map

This choropleth map shows how many people died from a firearm with unknown intent per 100,000 people in each state during 2007.

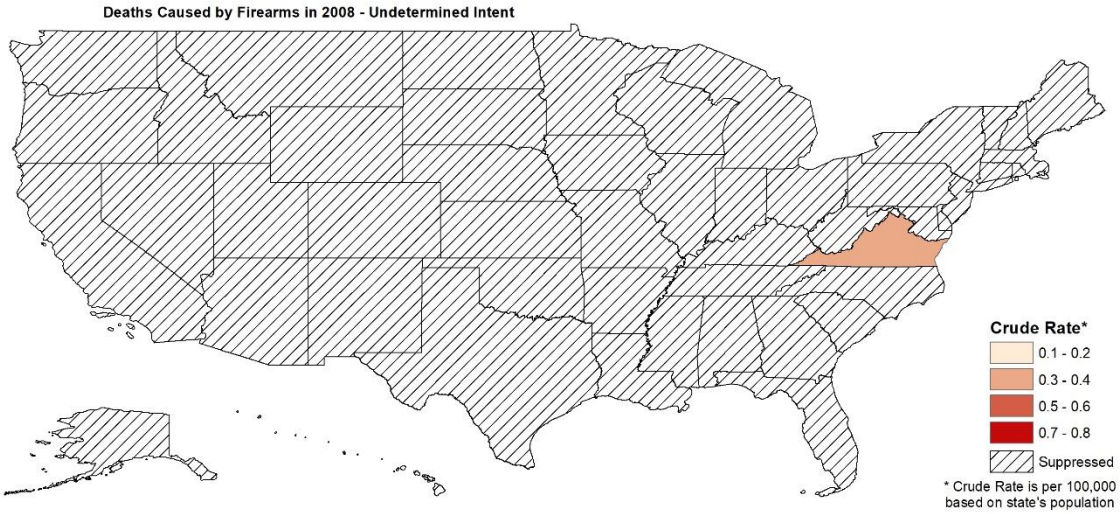


Figure 128: Undetermined Deaths Caused by Firearms in 2008 Map

This choropleth map shows how many people died from a firearm with unknown intent per 100,000 people in each state during 2008.

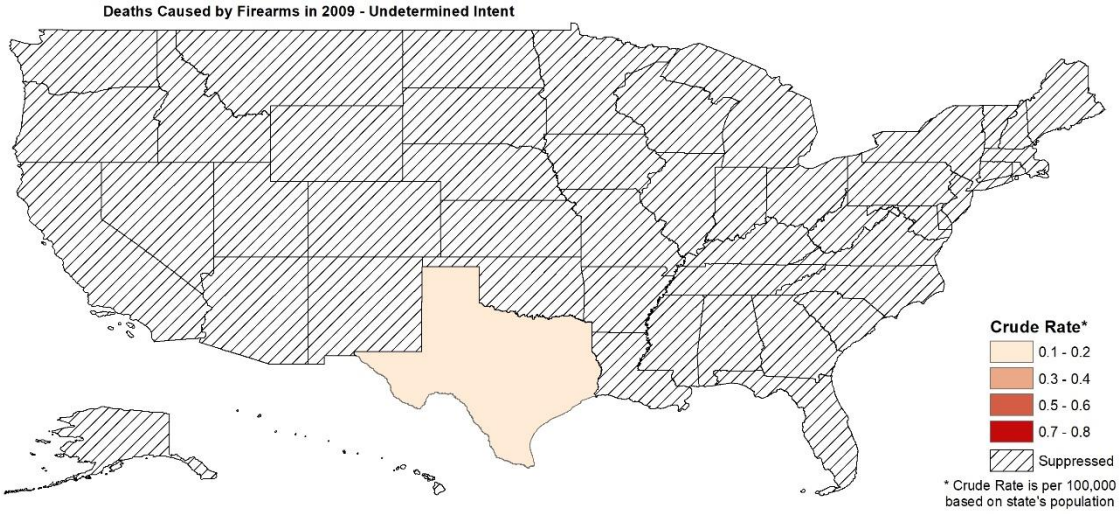


Figure 129: Undetermined Deaths Caused by Firearms in 2009 Map

This choropleth map shows how many people died from a firearm with unknown intent per 100,000 people in each state during 2009.

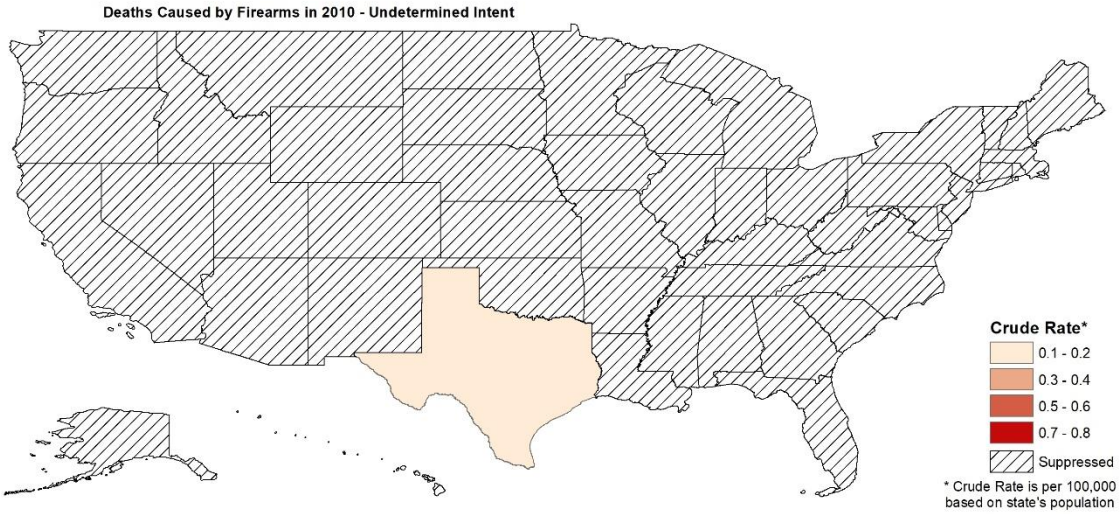


Figure 130: Undetermined Deaths Caused by Firearms in 2010 Map

This choropleth map shows how many people died from a firearm with unknown intent per 100,000 people in each state during 2010.

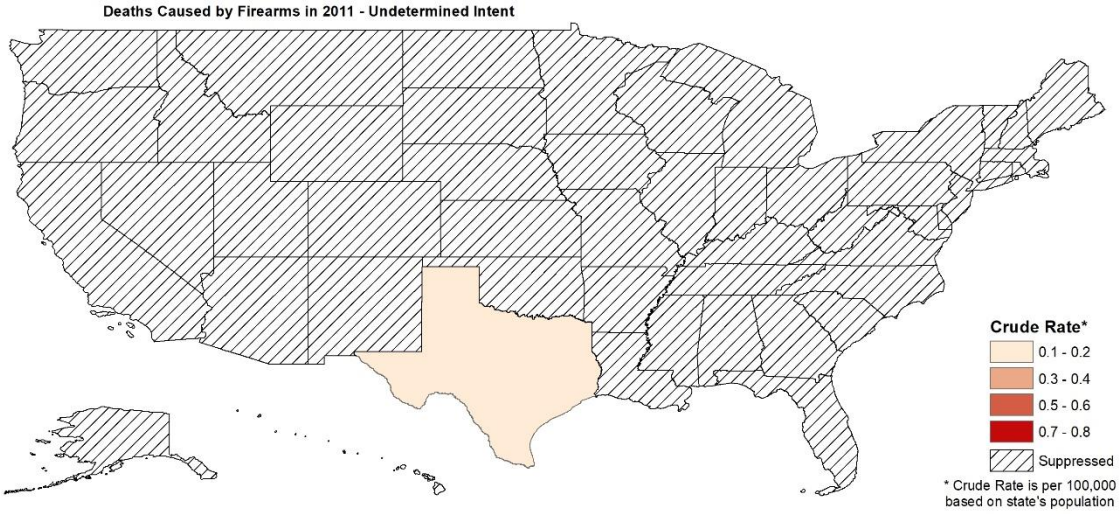


Figure 131: Undetermined Deaths Caused by Firearms in 2011 Map

This choropleth map shows how many people died from a firearm with unknown intent per 100,000 people in each state during 2011.

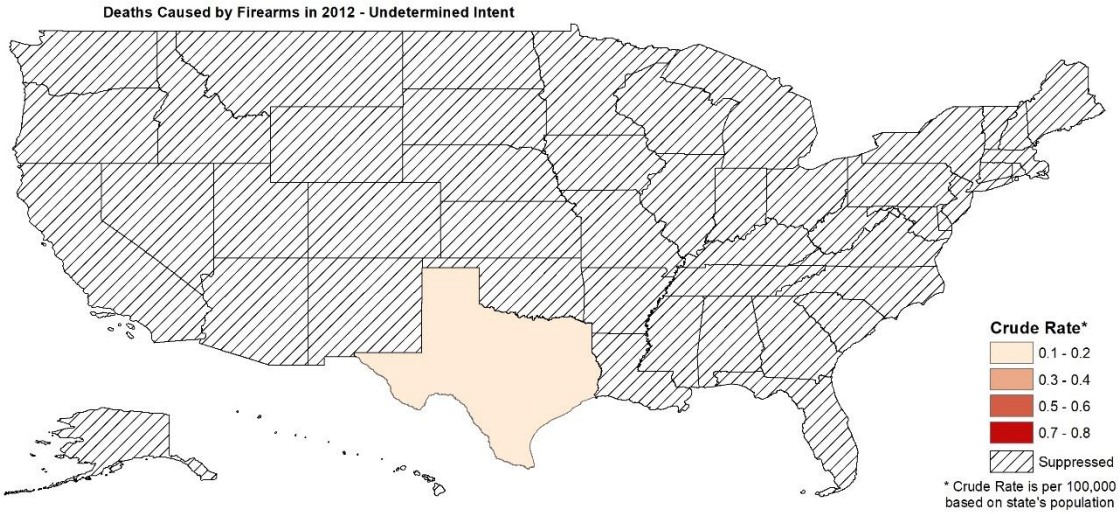


Figure 132: Undetermined Deaths Caused by Firearms in 2012 Map

This choropleth map shows how many people died from a firearm with unknown intent per 100,000 people in each state during 2012.

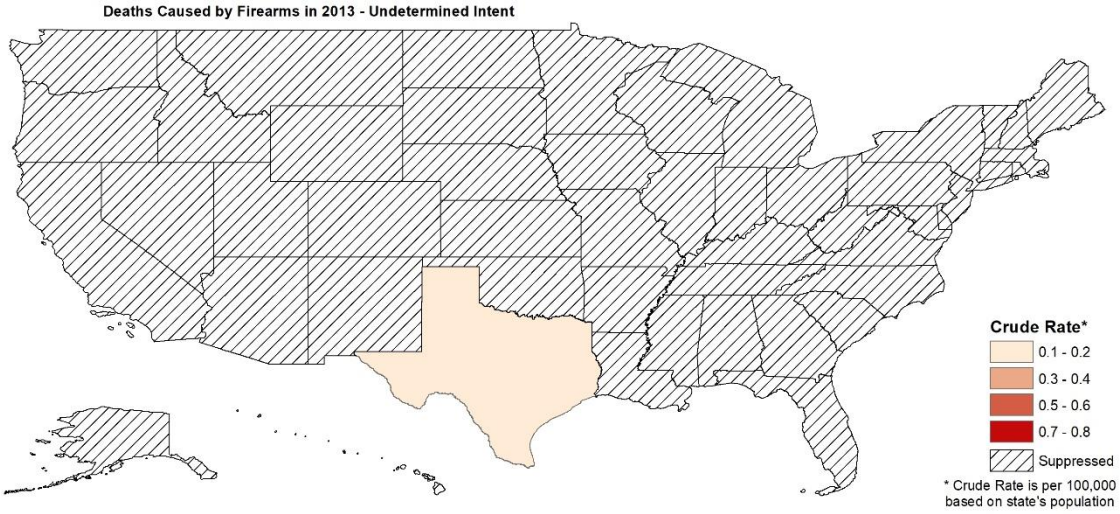


Figure 133: Undetermined Deaths Caused by Firearms in 2013 Map

This choropleth map shows how many people died from a firearm with unknown intent per 100,000 people in each state during 2013.

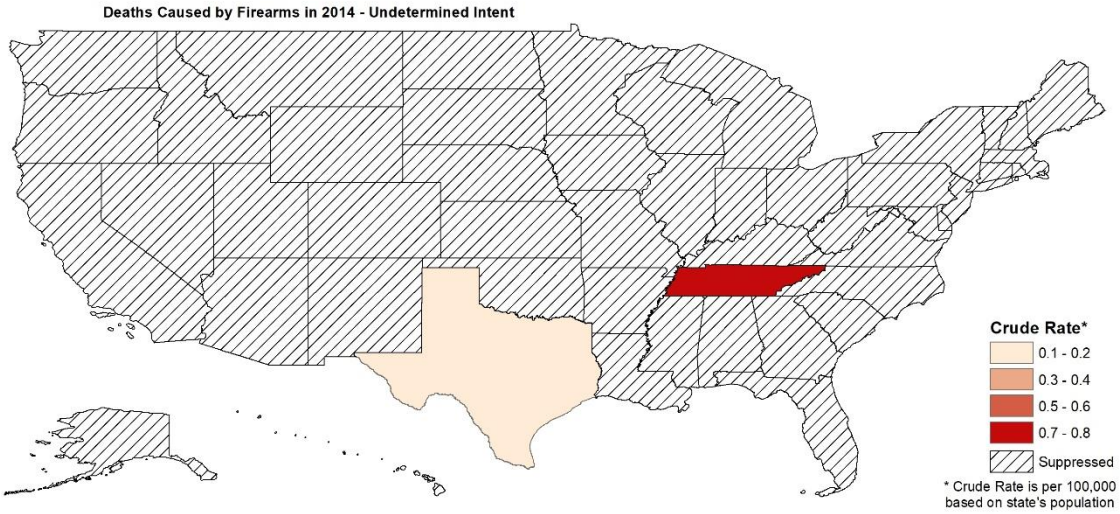


Figure 134: Undetermined Deaths Caused by Firearms in 2014 Map

This choropleth map shows how many people died from a firearm with unknown intent per 100,000 people in each state during 2014.

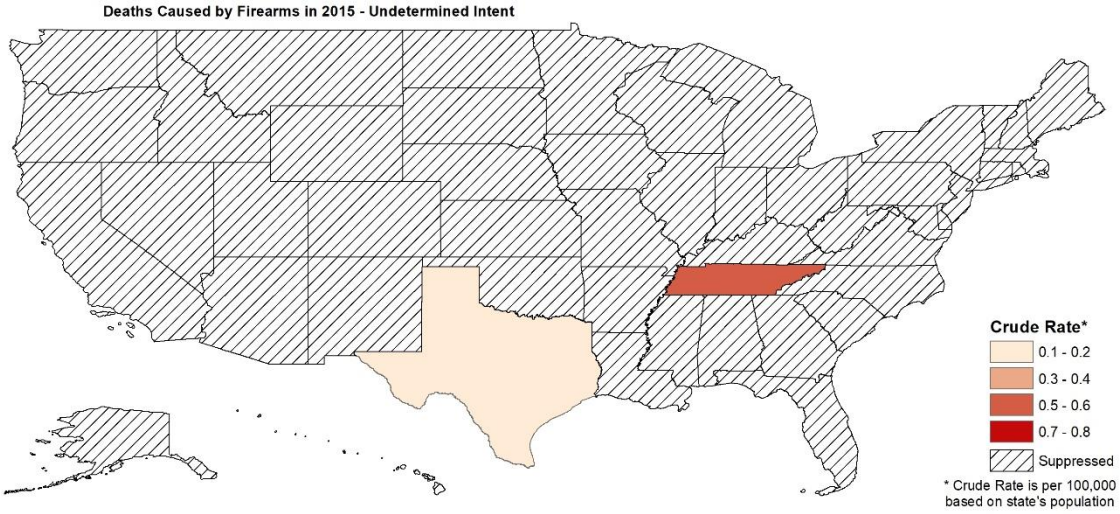


Figure 135: Undetermined Deaths Caused by Firearms in 2015 Map

This choropleth map shows how many people died from a firearm with unknown intent per 100,000 people in each state during 2015.

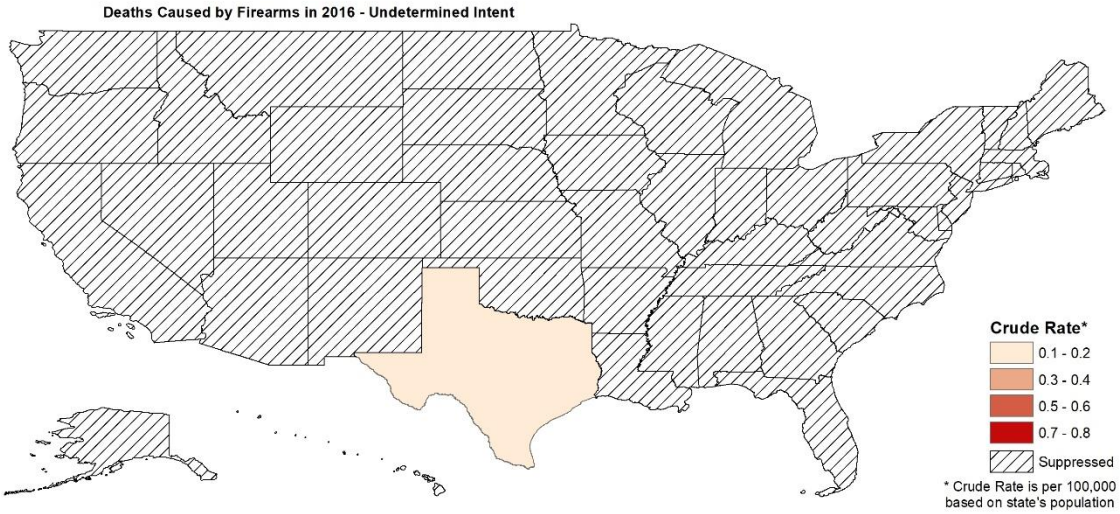


Figure 136: Undetermined Deaths Caused by Firearms in 2016 Map

This choropleth map shows how many people died from a firearm with unknown intent per 100,000 people in each state during 2016.

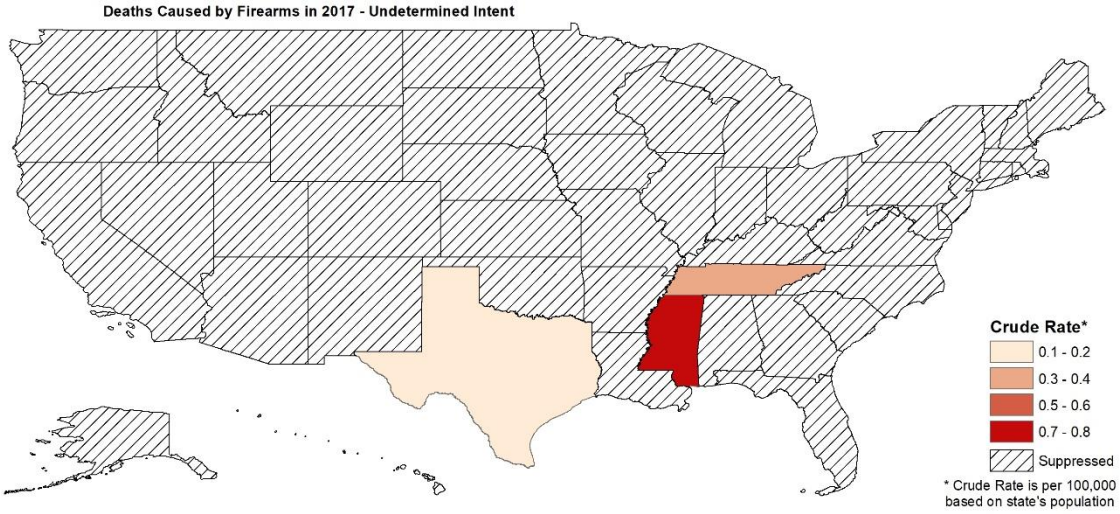


Figure 137: Undetermined Deaths Caused by Firearms in 2017 Map

This choropleth map shows how many people died from a firearm with unknown intent per 100,000 people in each state during 2017.

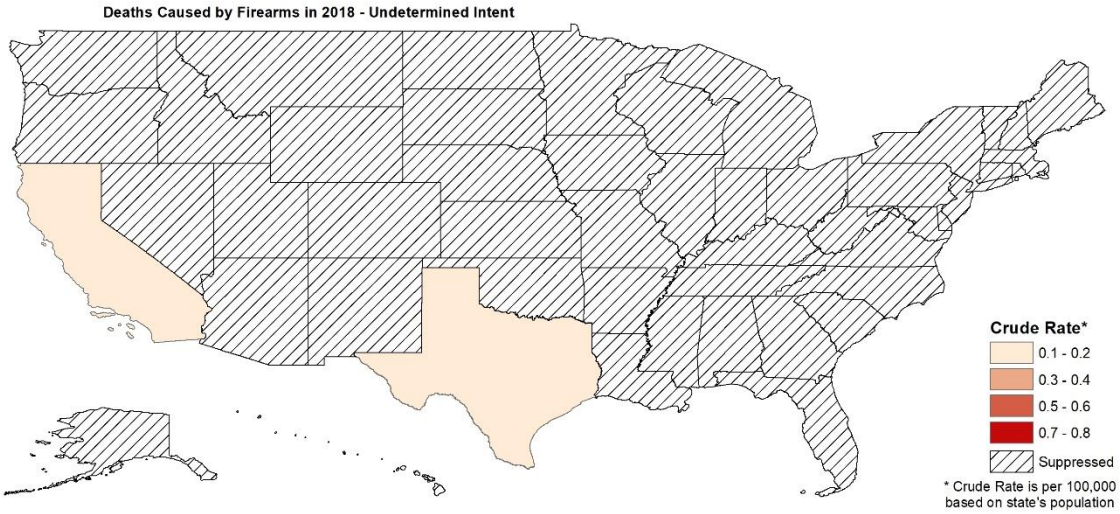


Figure 138: Undetermined Deaths Caused by Firearms in 2018 Map

This choropleth map shows how many people died from a firearm with unknown intent per 100,000 people in each state during 2018.

*Small Multiples*

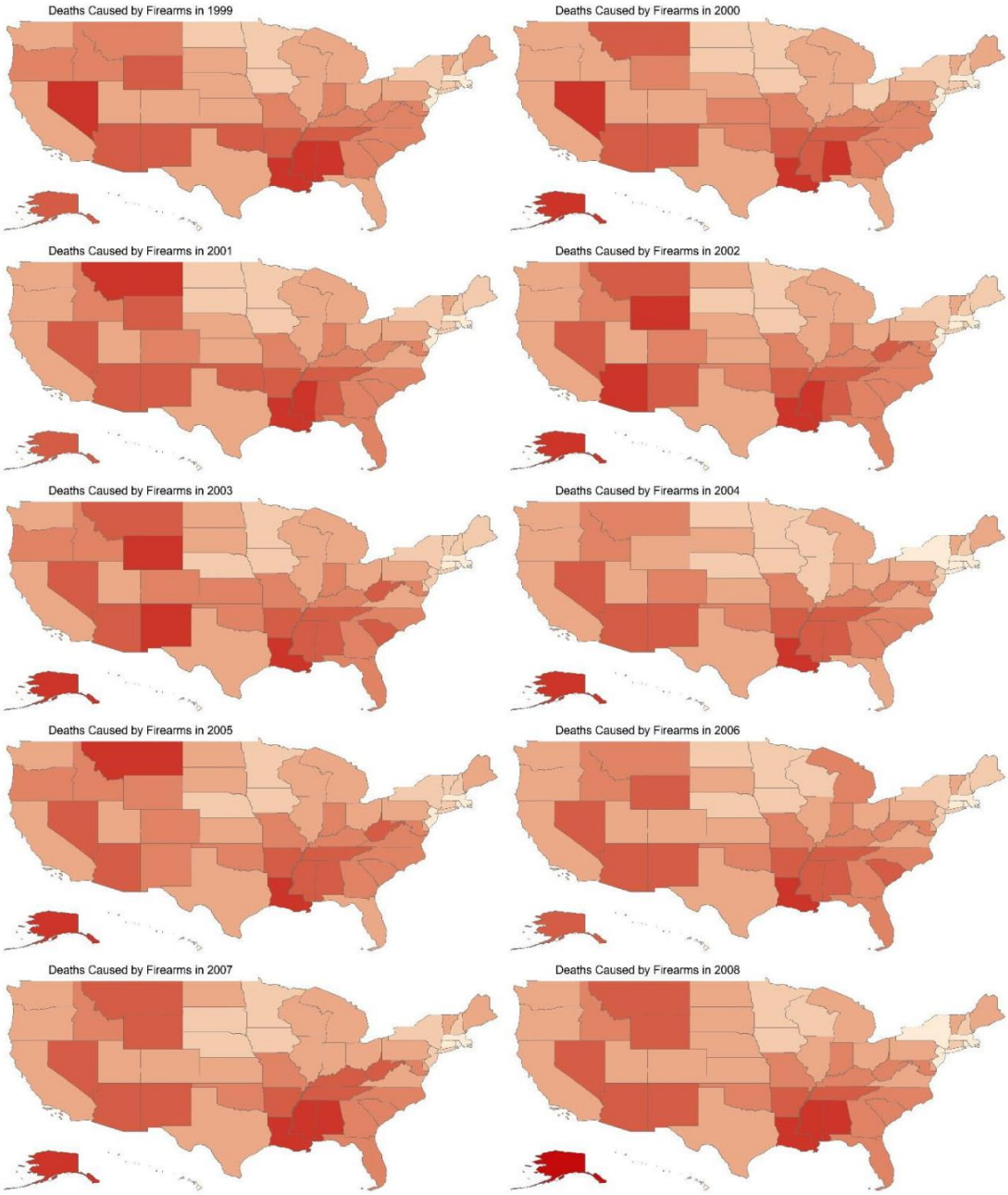


Figure 139: Small Multiples – All Deaths Caused by Firearms 1999-2008

These choropleth maps show how many people died by a firearm, regardless of intent, per 100,000 people in each state during the given year.

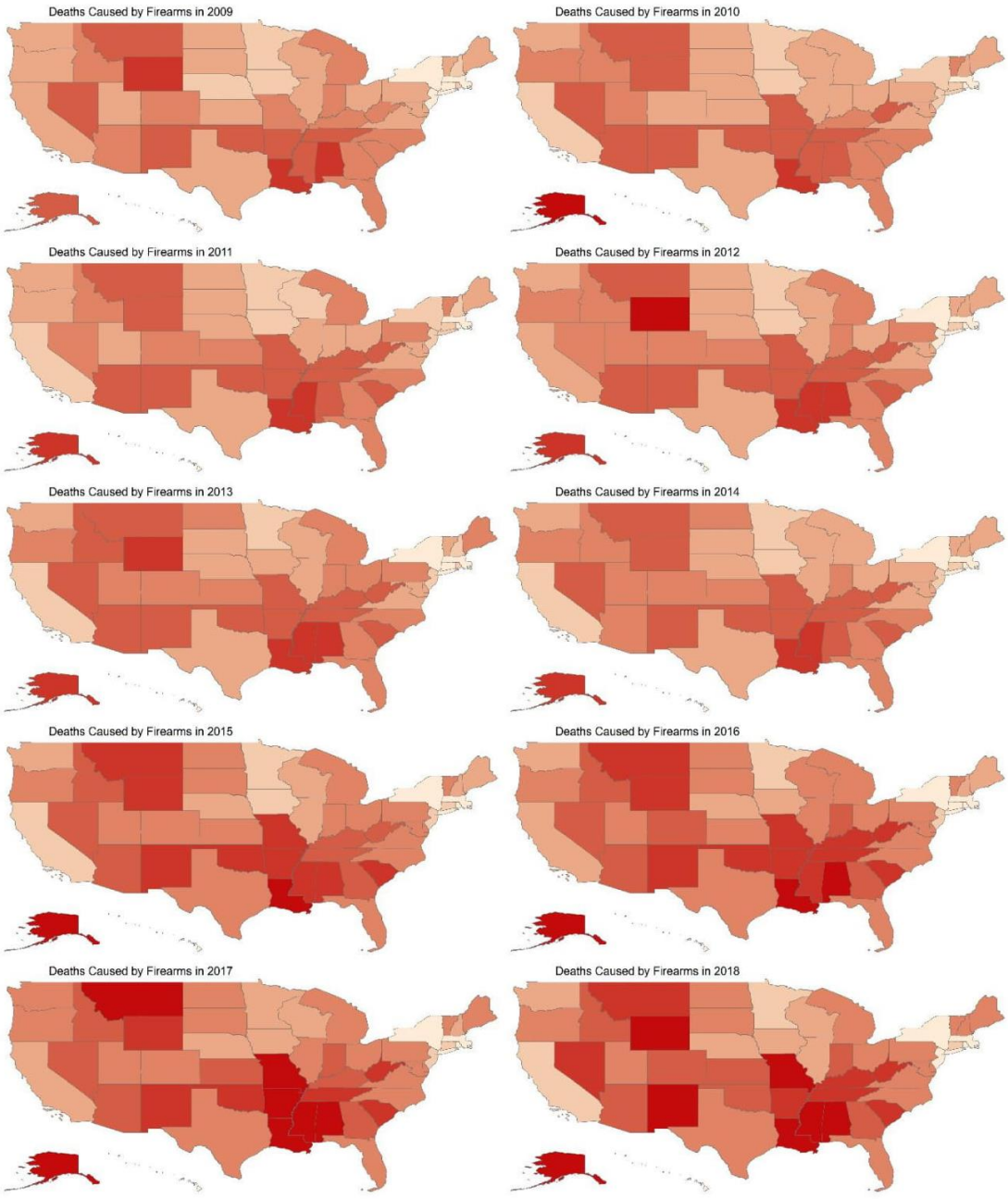


Figure 140: Small Multiples – All Deaths Caused by Firearms 2009-2018

These choropleth maps show how many people died by a firearm, regardless of intent, per 100,000 people in each state during the given year.

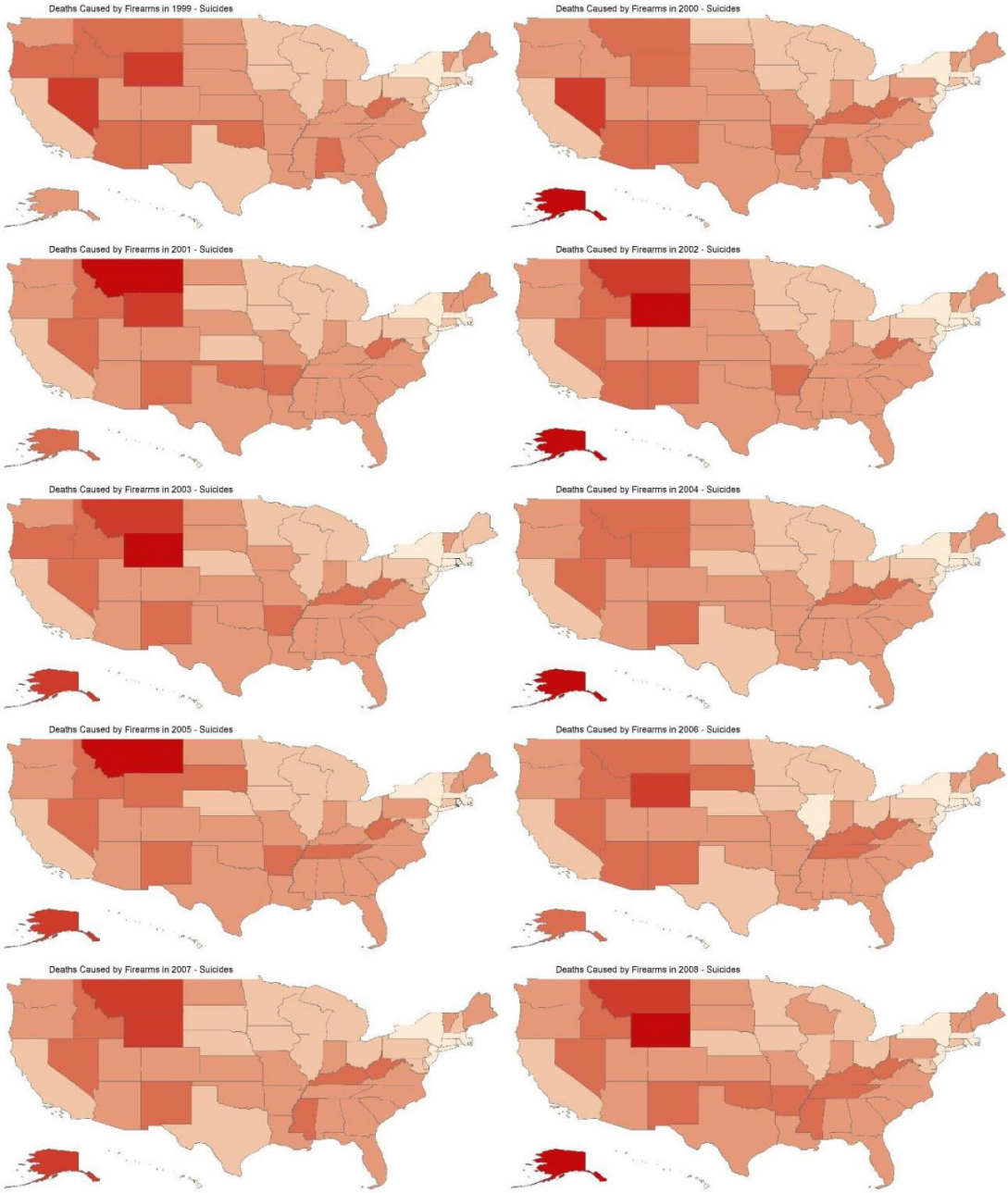


Figure 141: Small Multiples – Suicide Deaths Caused by Firearms 1999-2008

These choropleth maps show how many people committed suicide with a firearm per 100,000 people in each state during the given year.

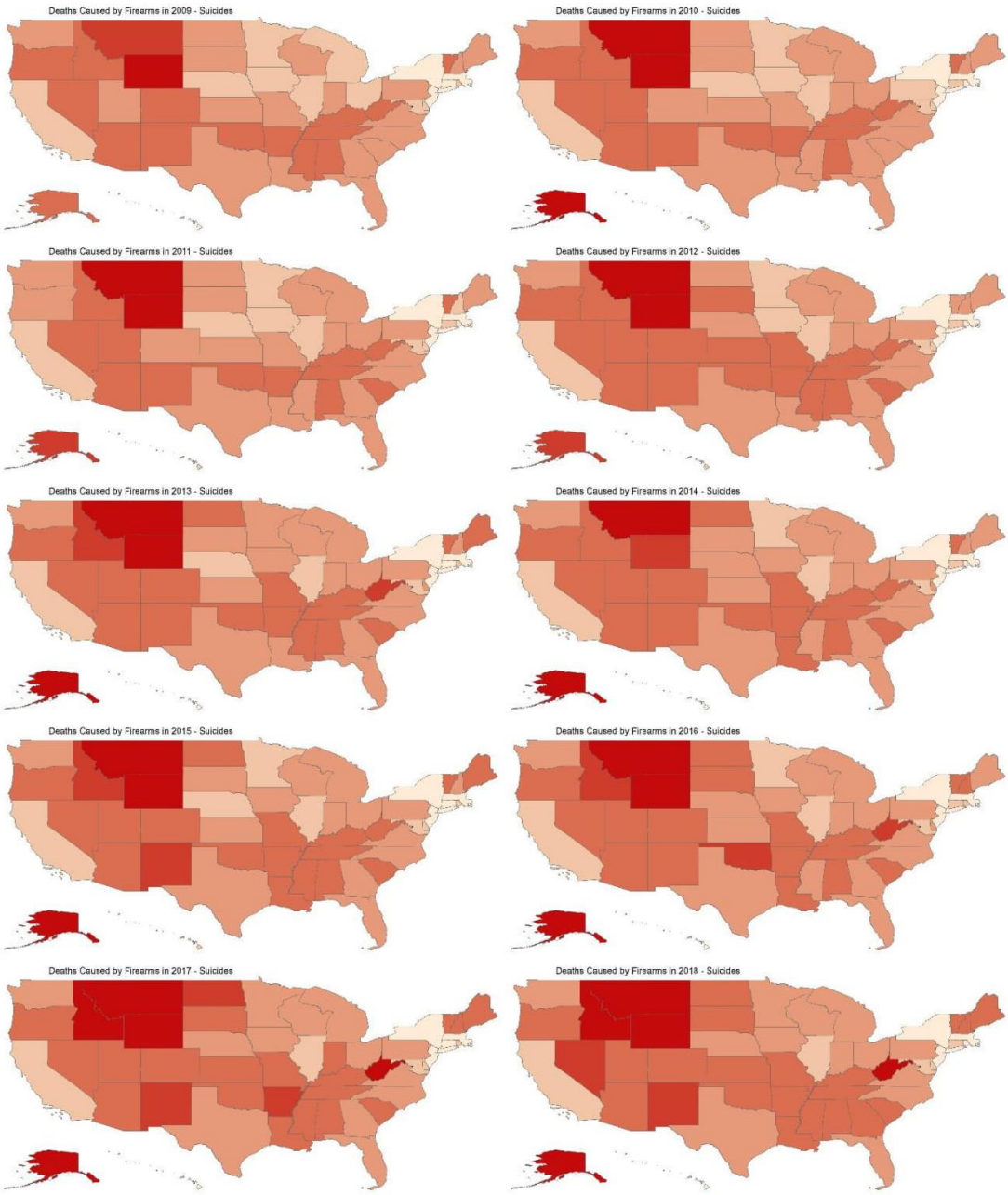


Figure 142: Small Multiples – Suicide Deaths Caused by Firearms 2009-2018

These choropleth maps show how many people committed suicide with a firearm per 100,000 people in each state during the given year.

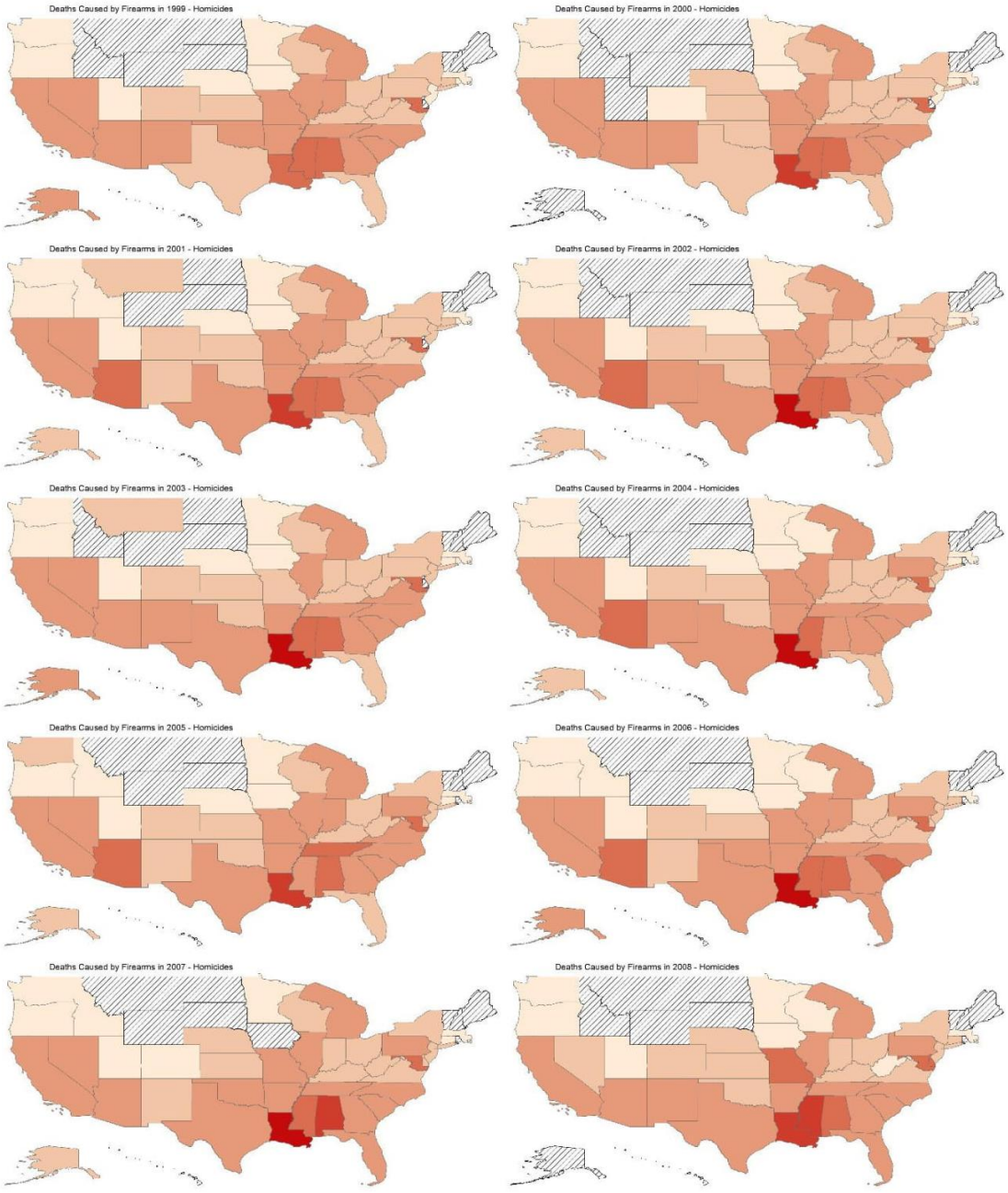


Figure 143: Small Multiples – Homicide Deaths Caused by Firearms 1999-2008

These choropleth maps show how many people died in a homicide by a firearm per 100,000 people in each state during the given year.

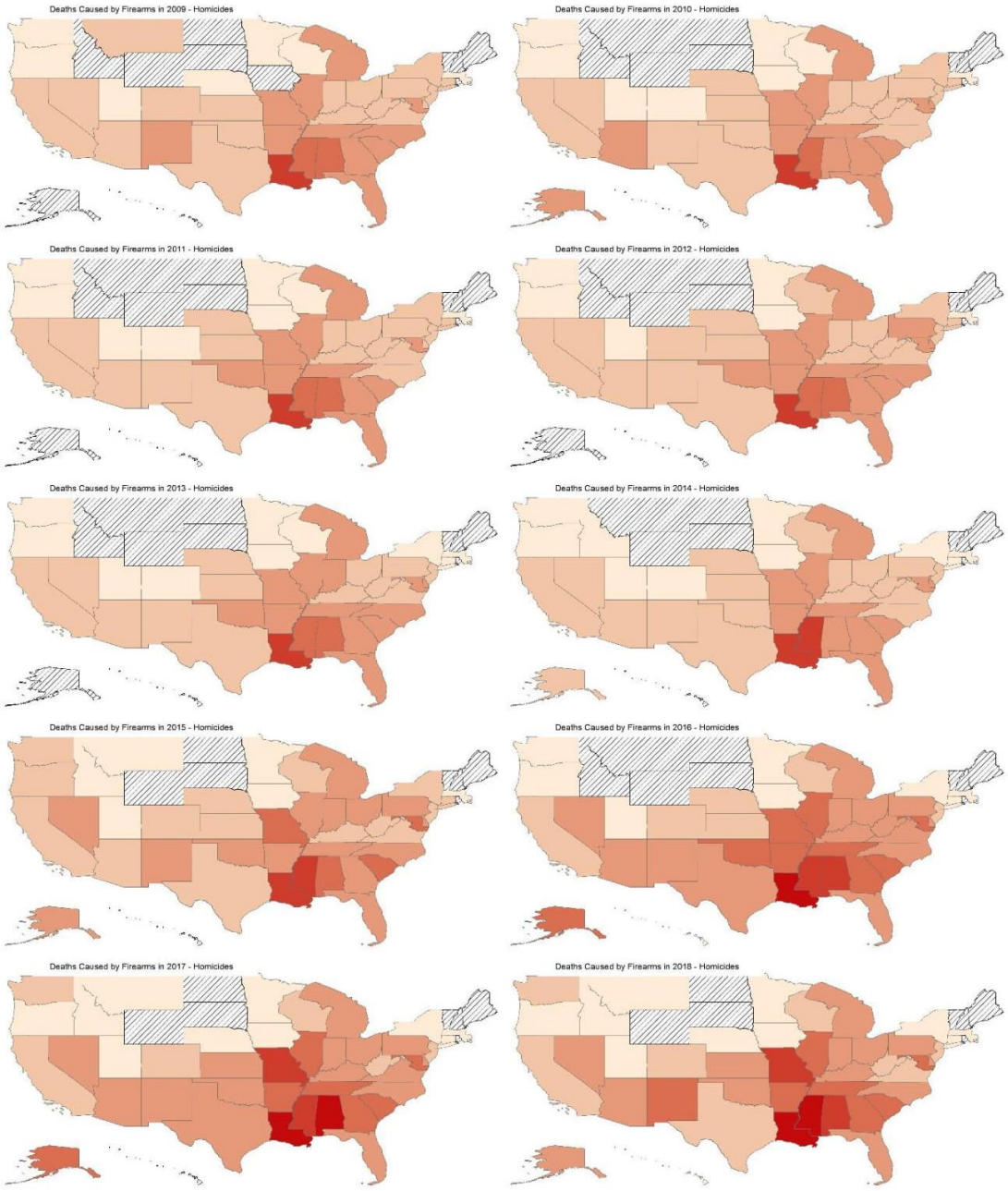


Figure 144: Small Multiples – Homicide Deaths Caused by Firearms 2009-2018

These choropleth maps show how many people died in a homicide by a firearm per 100,000 people in each state during the given year.

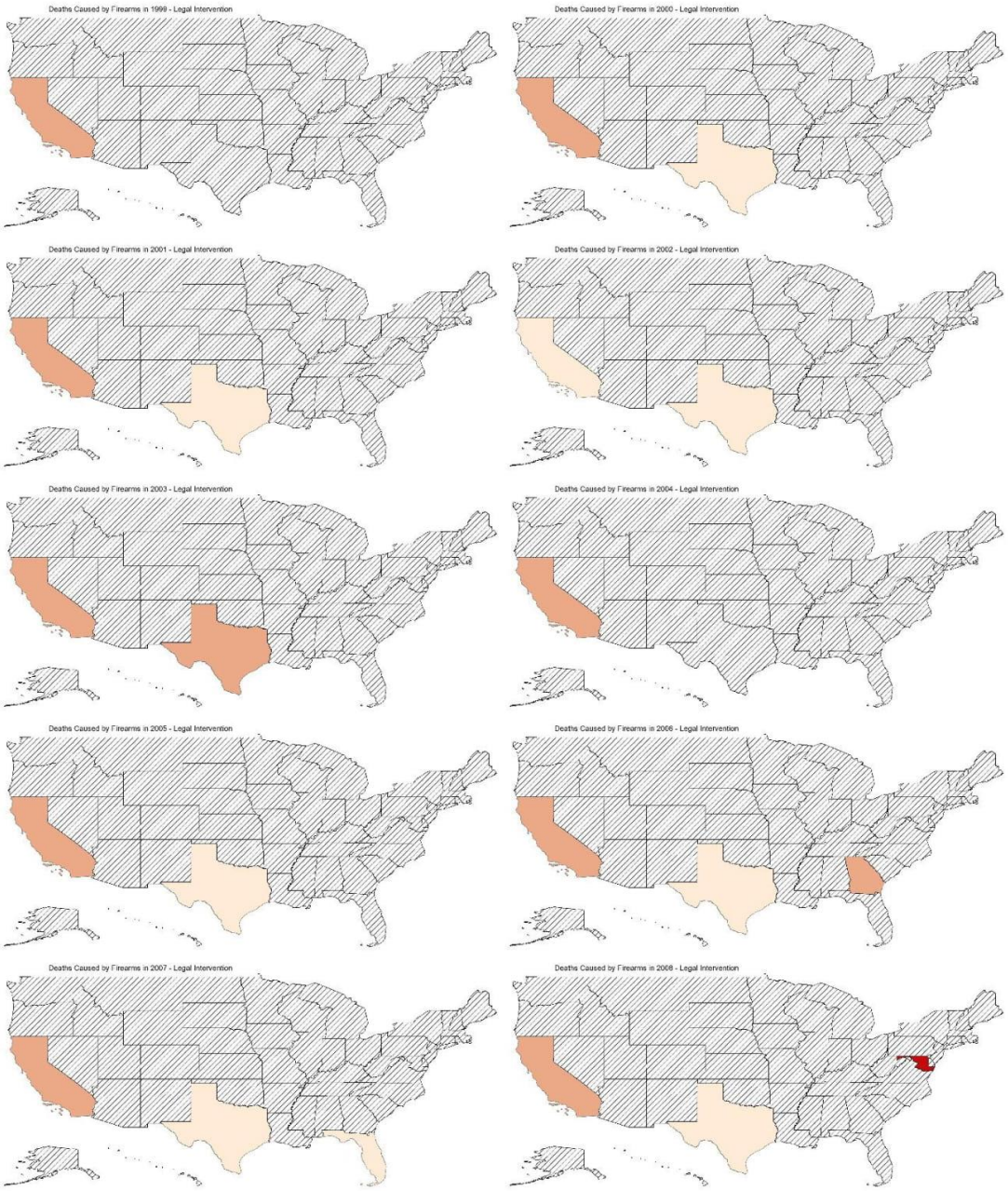


Figure 145: Small Multiples–Legal Intervention Deaths Caused by Firearms 1999-2008

These choropleth maps show how many people died from legal intervention firearm use per 100,000 people in each state during the given year.

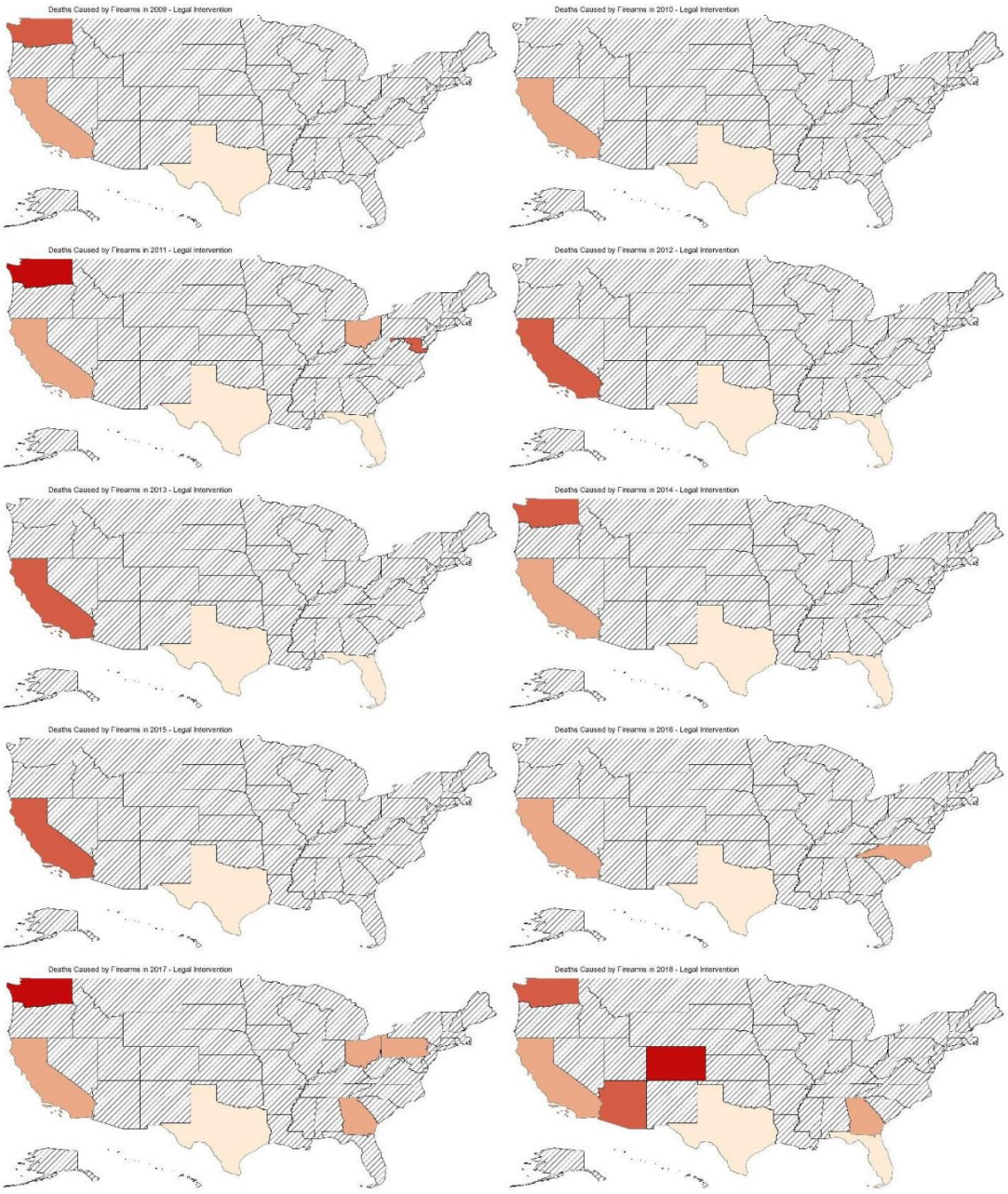


Figure 146: Small Multiples–Legal Intervention Deaths Caused by Firearms 2009-2018

These choropleth maps show how many people died from legal intervention firearm use per 100,000 people in each state during the given year.

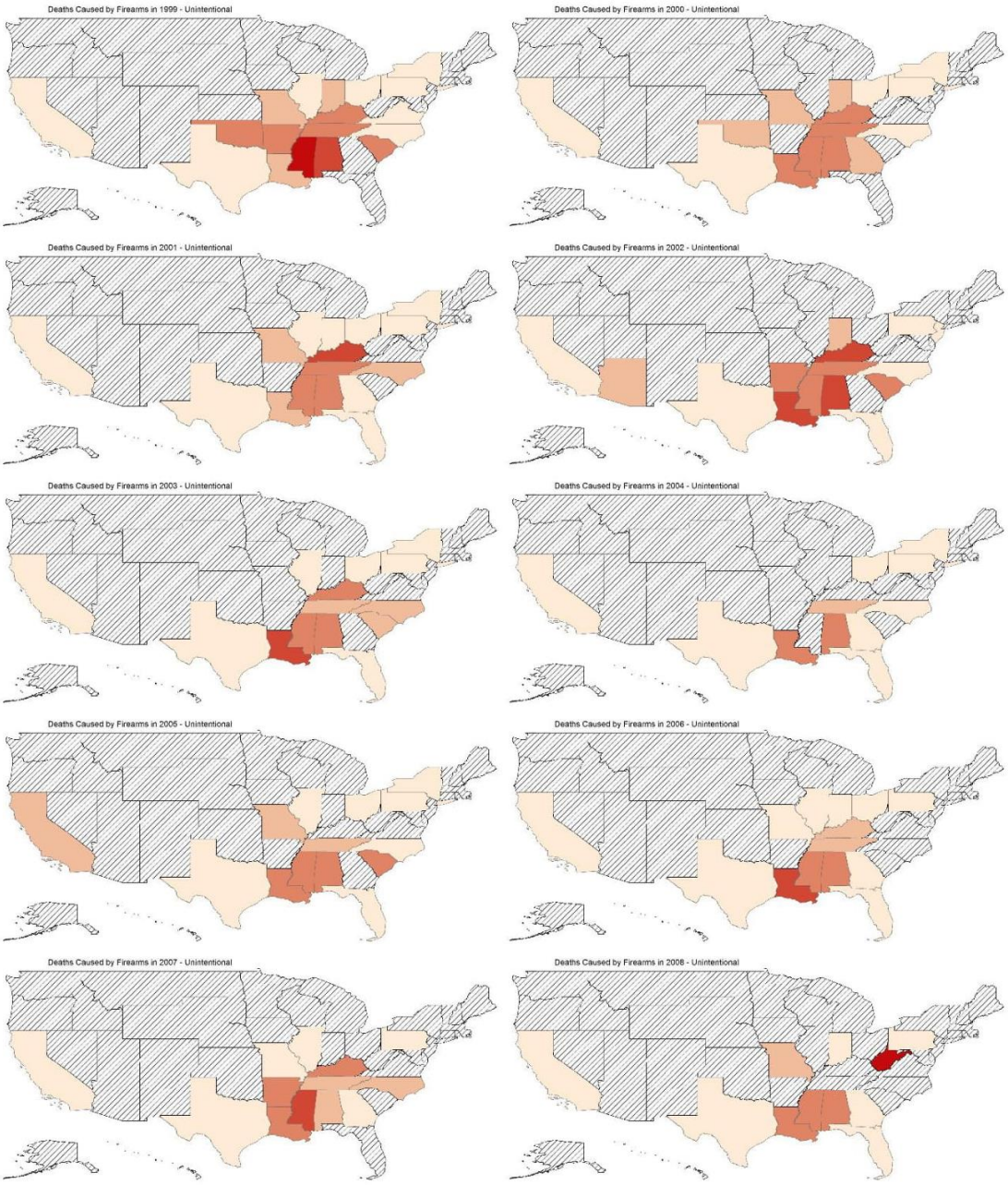


Figure 147: Small Multiples – Unintentional Deaths Caused by Firearms 1999-2008

These choropleth maps show how many people unintentionally died from a firearm per 100,000 people in each state during the given year.

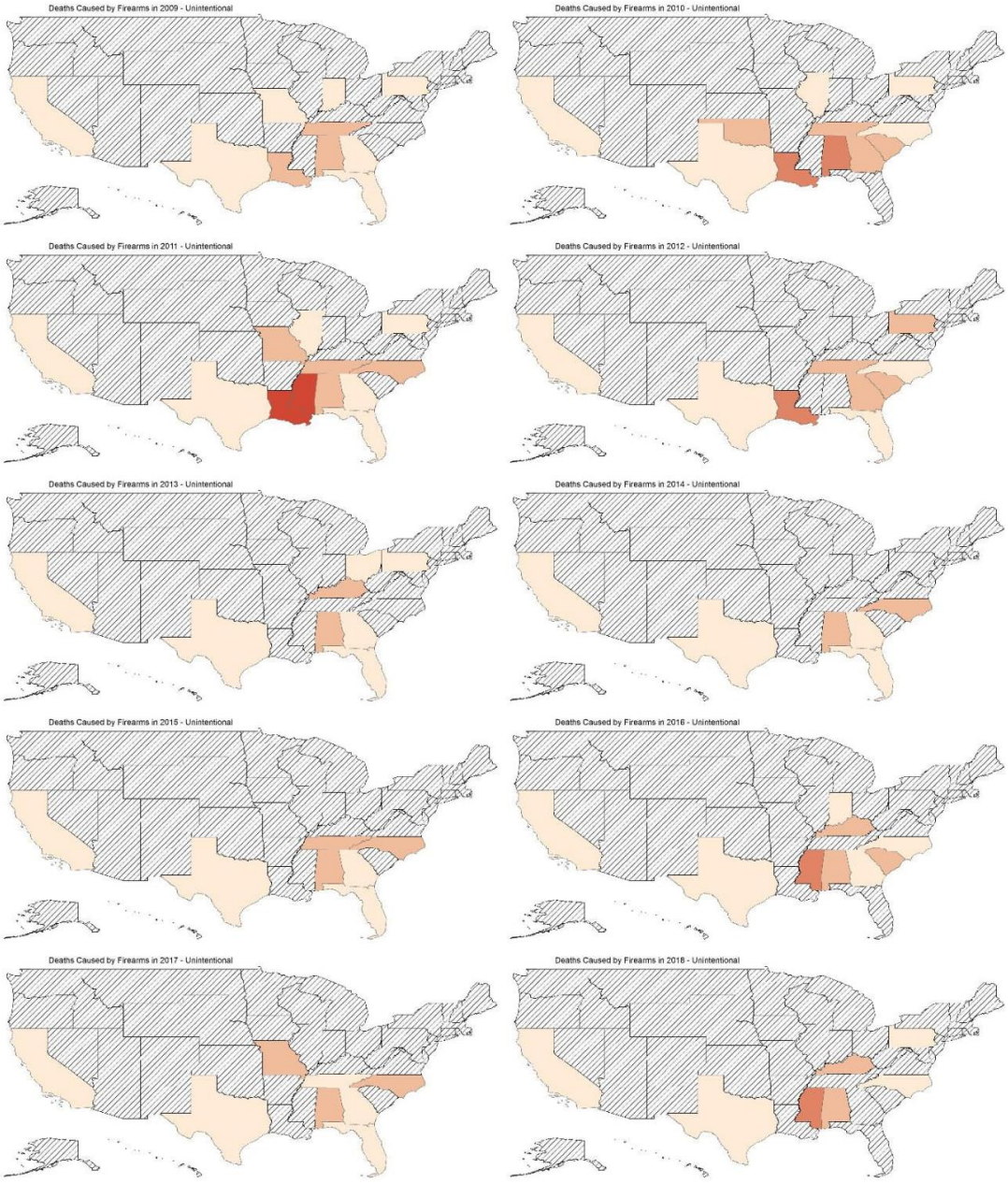


Figure 148: Small Multiples – Unintentional Deaths Caused by Firearms 2009-2018

These choropleth maps show how many people unintentionally died from a firearm per 100,000 people in each state during the given year.

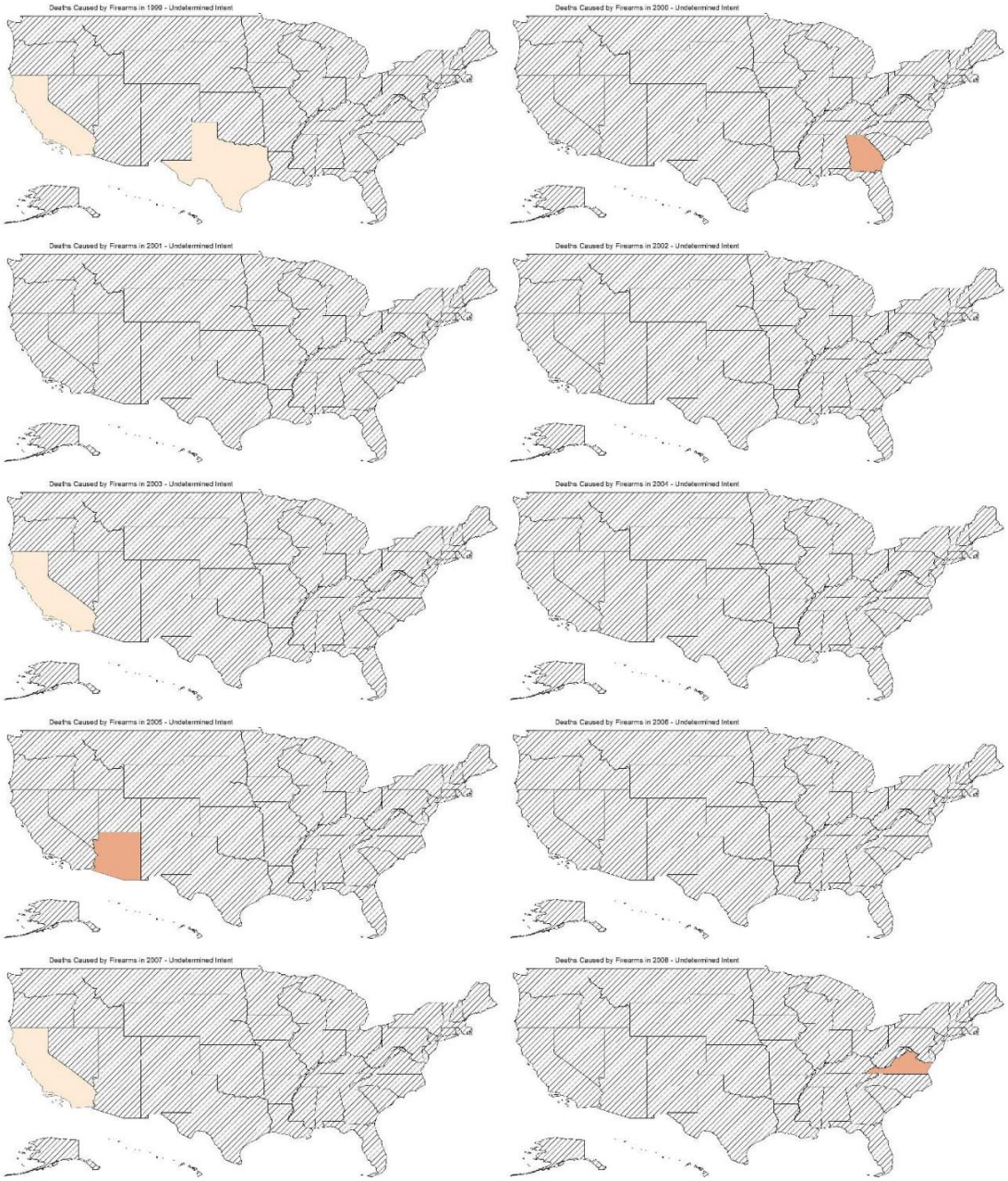


Figure 149: Small Multiples – Undetermined Deaths Caused by Firearms 1999-2008

These choropleth maps show how many people died from a firearm with unknown intent per 100,000 people in each state during the given year.

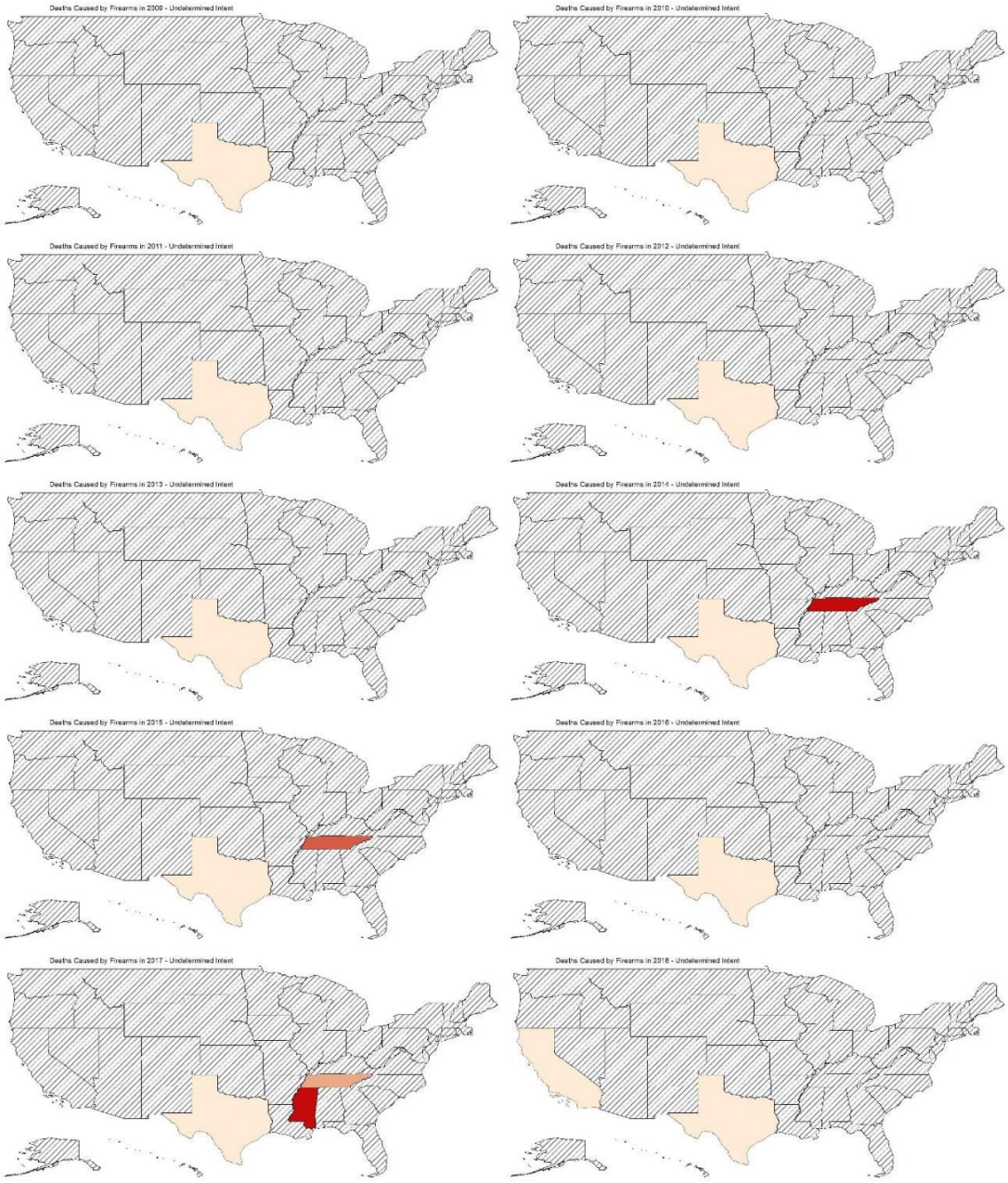


Figure 150: Small Multiples – Undetermined Deaths Caused by Firearms 2009-2018

These choropleth maps show how many people died from a firearm with unknown intent per 100,000 people in each state during the given year.

**Discussion**

The above images showcase the value of visualizing big data at the beginning of the research process. There was no need for a hypothesis prior to creating these visuals. By looking at these visuals before forming a hypothesis, a researcher could lessen the impact their biases have on the focus of their research. These visuals can also help researchers identify patterns that have not been previously acknowledged. Although these images were not made for the sole use to support research findings in a report, they are still high-quality visuals that can be included in the final report. Comparing the two bar graphs at the beginning of each section shows how not accounting for fluctuation in population size can skew our interpretation of trends occurring. Like the bar graphs, the maps could trick our brains into seeing nonexistent patterns if they were not normalized or did not use a consistent color key. These visuals provide us with a way to quickly find patterns in U.S. firearm death rates.

Viewing these images in the standalone portfolio makes it even easier to view the maps and notice trends. While using the small multiples technique allows us to see multiple maps all at once, it can become harder to see what color each state is. In the portfolio, there is one map per page. Each page represents a different year. A user can quickly flip through each page and the color of the states will change. When viewing on a computer, the outline of the states can remain in one place and it truly looks like only the colors are updating (instead of the whole page).

Digital, interactive maps are also great at conveying this information. The maps in the six sections above could be combined into a single map for each section. With a timeline across the bottom, the user can slowly scroll through the years, watching the

death rates change overtime. This makes it easy to see how the data changes as time progress. It also allows the user to click on a particular state in a given year and see the details. Digital, interactive maps are ideal, but they are not a feasible when visuals need to be included in print reports.

# Conclusion

The rise of big data allows us to approach research differently than we have in the past. To further benefit from the extensive amount of data accessible today, we need to adjust standard research methods to utilize big data better. Visualizing big data has two major benefits: finding new patterns to ask new questions and conveying complex information effectively. The benefits of visualizing big data are even better when it occurs in the beginning of the research process. The normalization of digitization and datafication in the digital age gives us the opportunity to improve research methods.

There are several advantages of visualizing big data early in the research process. Looking at big data before a hypothesis is formed can reduce biases. Letting the data speak for itself can lead to new research questions. Investigations into these new questions could solve unrelenting problems. Finding the patterns in this data is easier through visualization, and by visualizing it at the beginning of the research process, standard techniques can be established. These same visuals produced at the beginning of the research process can then be reused in the report. Images also help the general public, and even well-versed researchers, comprehend complex information better. The more commonplace standardized graphics are, the easier it is to understand new information in similar graphics. The more we produce standardized visuals, the better we get at understanding them, which makes using them even more beneficial. By routinely visualizing big data early in the research process we can establish a new research method.

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