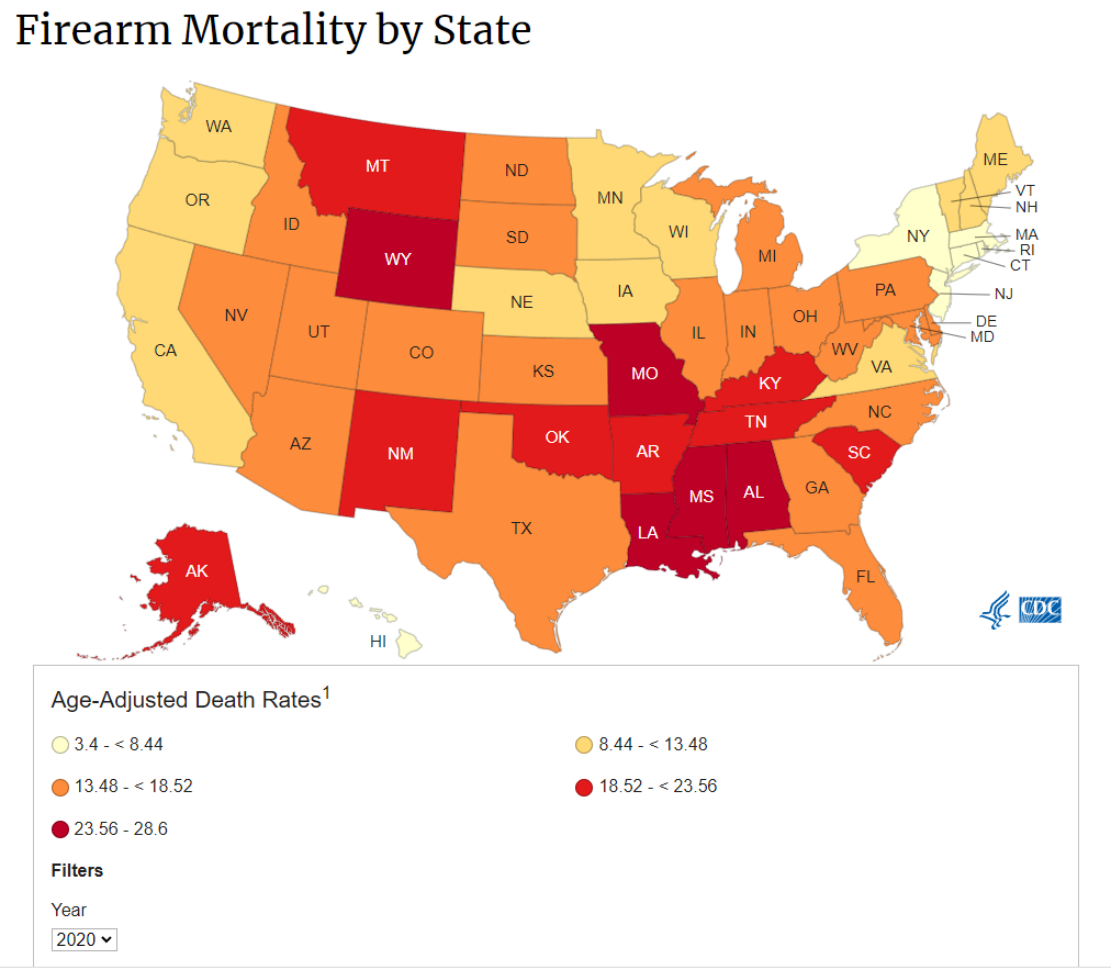
FACTORS AFFECTING GUN VIOLENCE: A STATISTICAL STUDY

SUMMARY

- Gun violence in the United States results in tens of thousands of deaths and injuries annually. In 2018, the Centers for Disease Control and Prevention's (CDC's) National Center for Health Statistics reports 38,390 deaths by firearm, of which 24,432 were by suicide.
- Mass shootings are incidents involving multiple victims of firearm-related violence. As for the definition of it, the precise inclusion criteria are disputed, and there is no broadly accepted definition.
- In 2019 alone, 13% of Americans surveyed purchased a weapon to protect themselves against mass shootings, with an additional 16% seriously considering the option (Brenan, 2019).



Source: https://www.cdc.gov/

PROBLEM DEFINITION & SIGNIFICANCE

This study focuses on the gun violence by handguns, including homicide and mass shooting.

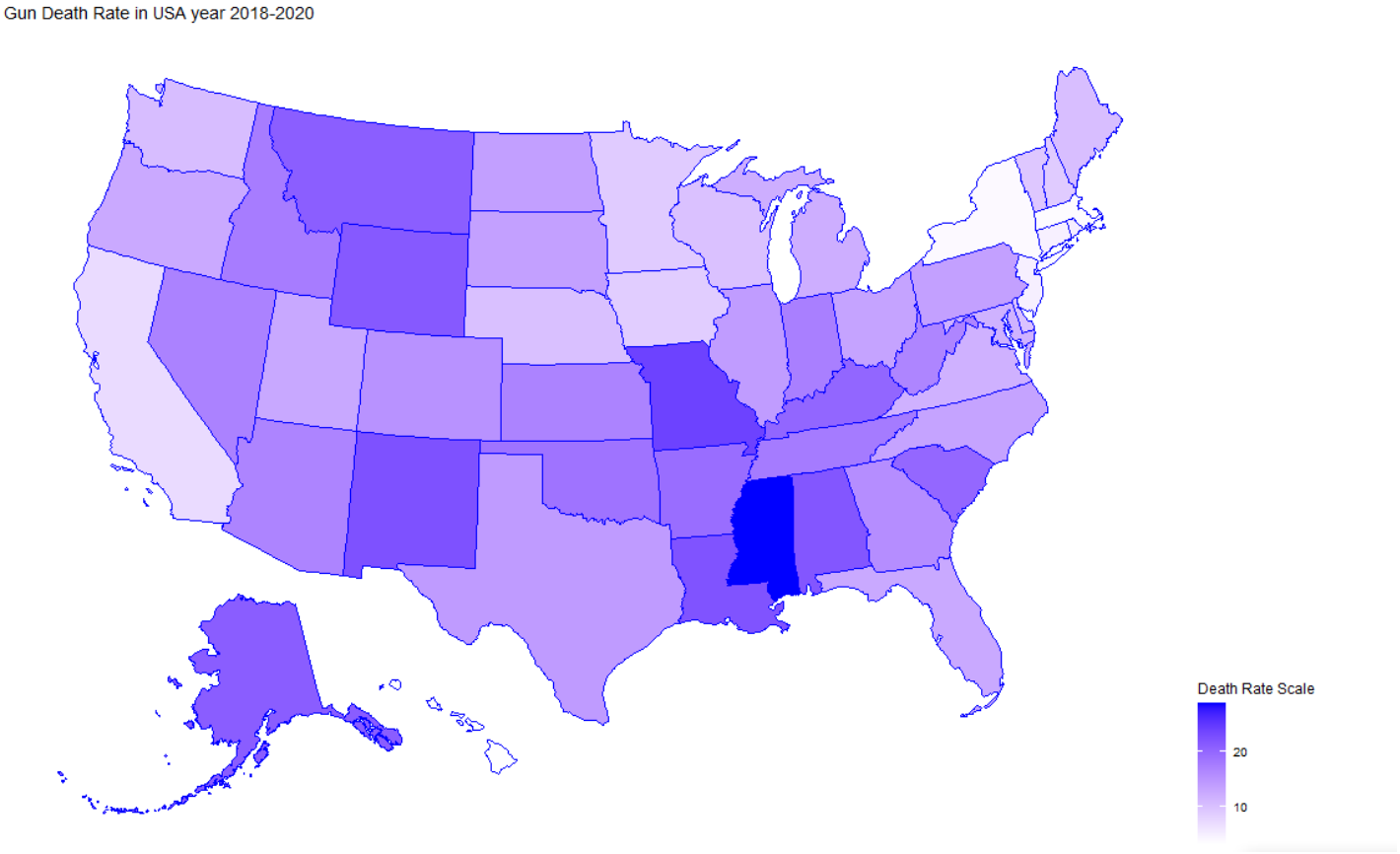
US gun violence incidents have been increasing over the years. As US lawmakers continue to pass laws reducing access to guns. Has there been an impact? Does completely locking down owning guns such as the United Kingdom or responsible carry laws as seen in several states reduce the number of incidents? Which approach is more effective at lessening gun violence or are there other factors such as mental illness or unemployment that are more influential and should be a focus on any upcoming gun laws?

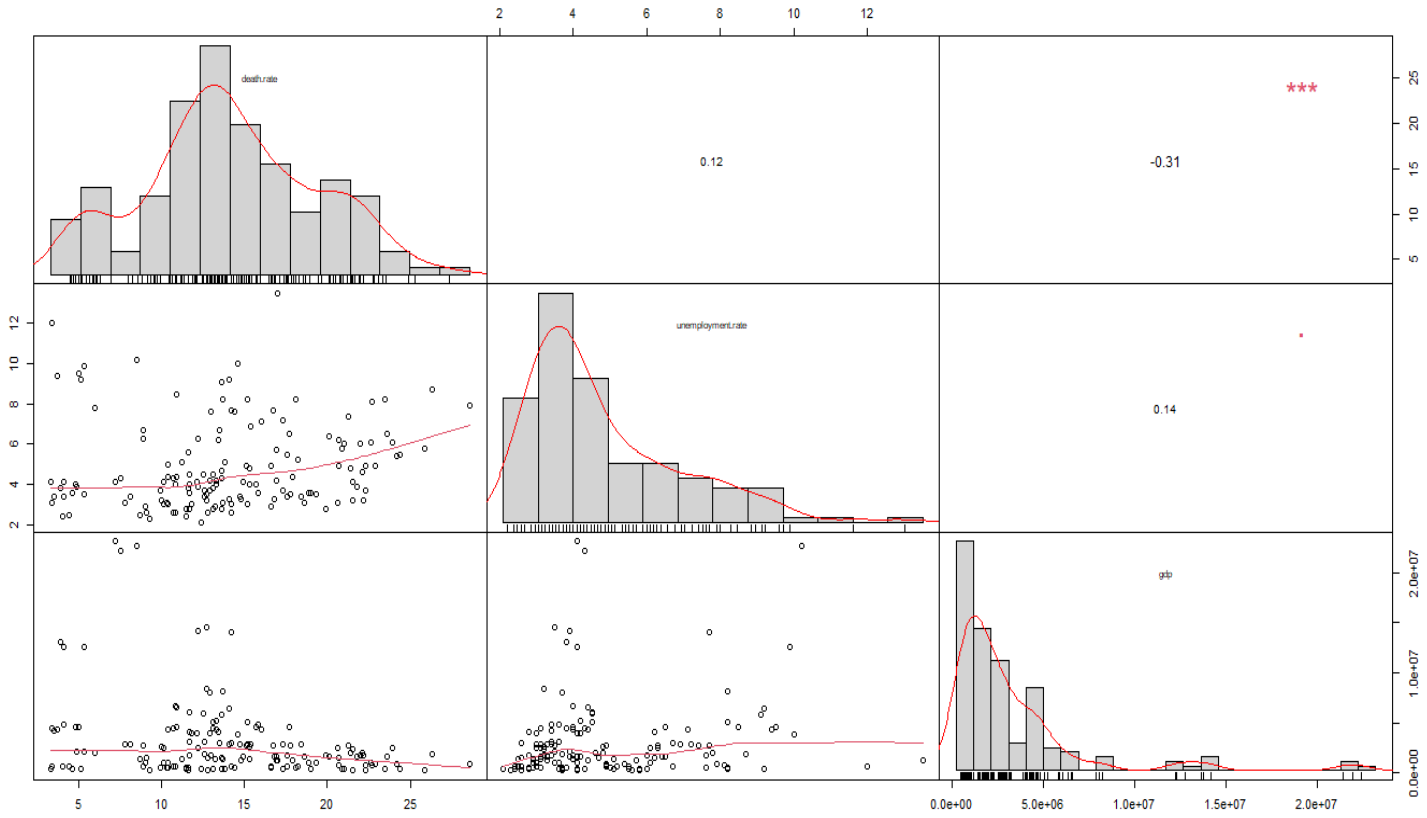
Are stricter gun laws making an impact on the rising number of gun violence incidents within the US? Does restricting access to guns lessen the total number of gun violence incidents? Or does the ability of an individual to protect themselves reduce the total number of gun violence incidents? Are there other factors such as mental illness or unemployment that are a stronger influence on the number of gun violence incidents in the US?

VARIABLE SELECTION

Predictor	Effect	Rationale
DV: death.rate and death		
permit.purchase	-	Additional restrictions causing less impulsive gun purchase, lower predicted death.rate and death
permit.concealed	-	Additional restrictions causing less impulsive gun purchase, lower predicted death.rate and death
permit	-	Additional restrictions causing less impulsive gun purchase, lower predicted death.rate and death
open.carry.handgun	-	Additional restrictions causing less impulsive gun purchase, lower predicted death.rate and death
mentalhealth.background	-	Additional restrictions causing less impulsive gun purchase, lower predicted death.rate and death
amm.background	-	Additional restrictions causing less impulsive gun purchase, lower predicted death.rate and death
cc.background	-	Additional restrictions causing less impulsive gun purchase, lower predicted death.rate and death
cc.background.nics	-	Additional restrictions causing less impulsive gun purchase, lower predicted death.rate and death
registration	-	Additional restrictions causing less impulsive gun purchase, lower predicted death.rate and death
covid	+	Covid resulting in negative psychological impact, higher predicted death.rate and death
unemployment.rate	+	Higher unemployment, more stress, higher predicted death.rate and death
GDP	+	Higher GDP, better economy, lower predicted death.rate and death
gdp.rate		
gov.party	+	Since 0 = Democrat, 1= Republican, and because Democrats are pro- gun laws, the death rate might be higher if Republican
Excluded: NA		

EXPLORATORY DATA ANALYSIS & VISUALIZATIONS




deathrate
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-0.31
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unemploymentrate
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gdp
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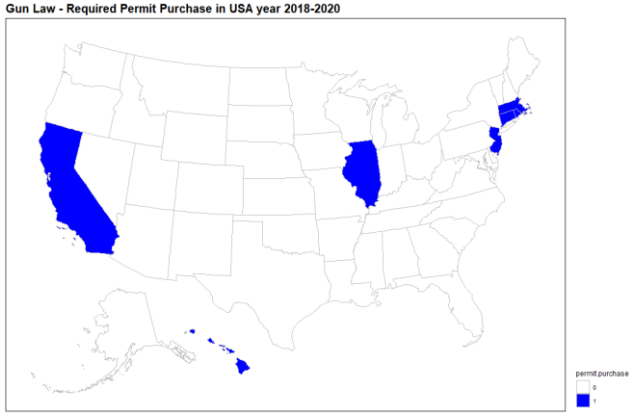
1.0e+07
1.5e+07
2.0e+07


Gun Law - Required Permit Purchase in USA year 2018-2020
permit.purchase
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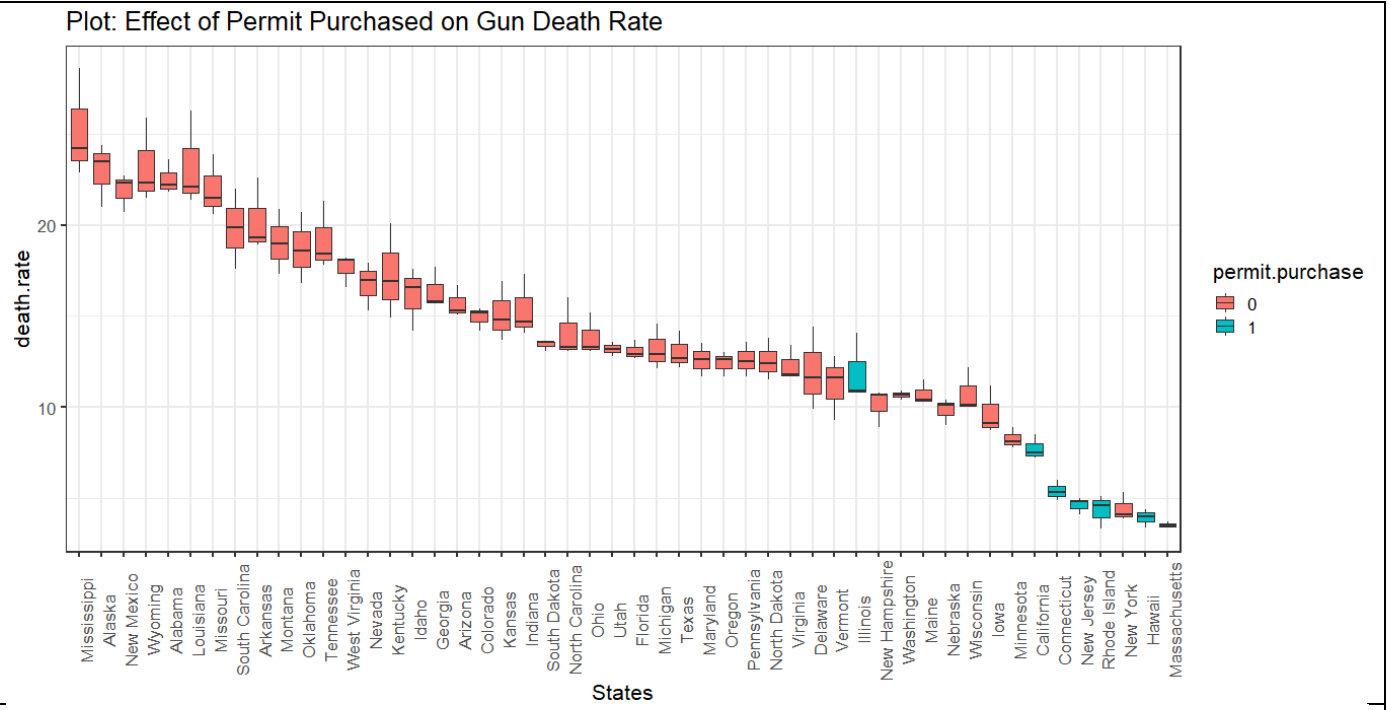
Plot: Effect of Permit Purchased on Gun Death Rate
death.rate
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Illinois
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Washington
Maine
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permit.purchase
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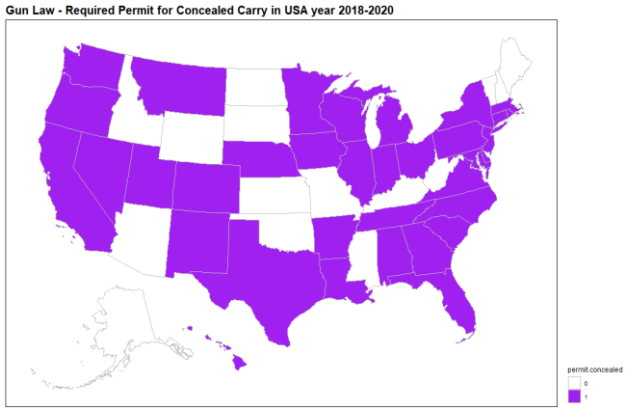
Gun Law - Required Permit for Concealed Carry in USA year 2018-2020
permit.concealed
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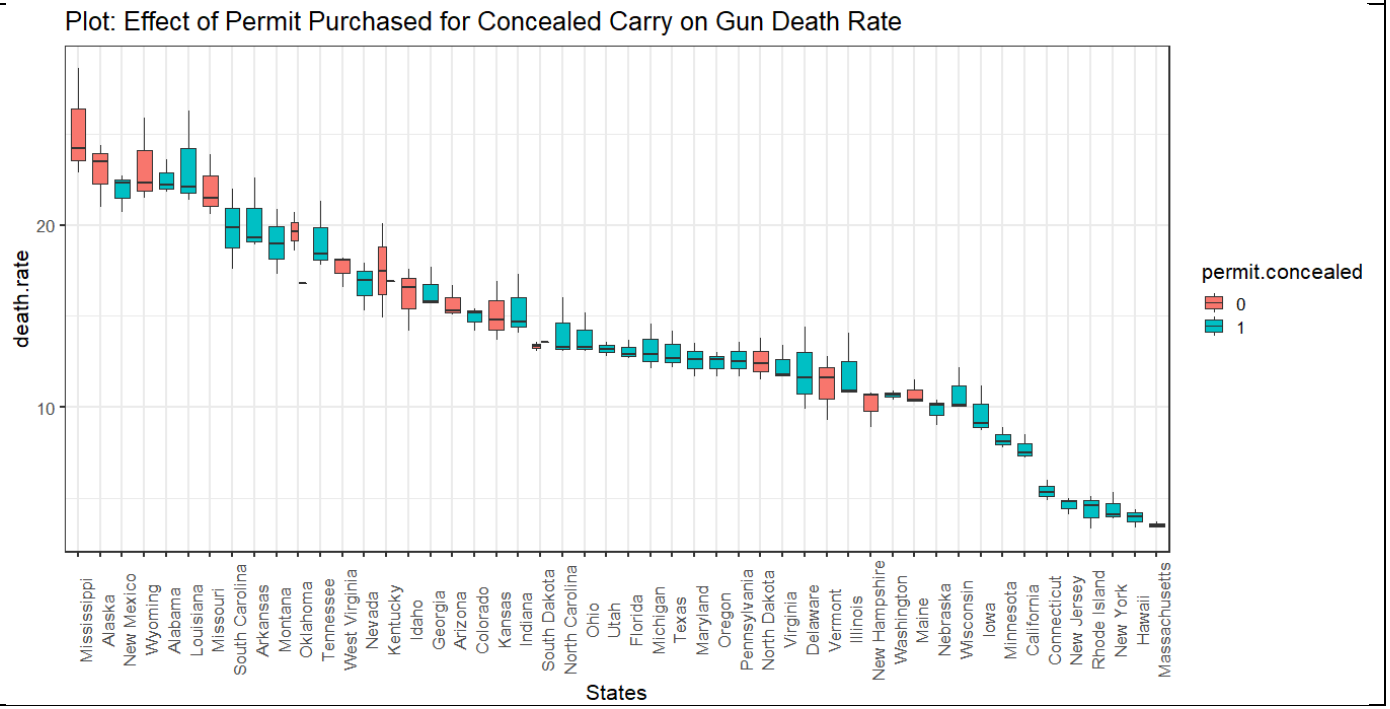
Plot: Effect of Permit Purchased for Concealed Carry on Gun Death Rate
death.rate
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permit.concealed
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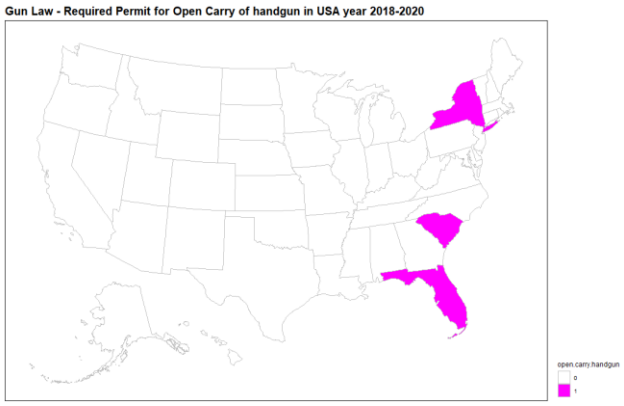
Gun Law - Required Permit for Open Carry of handgun in USA year 2018-2020
open.carry.handgun
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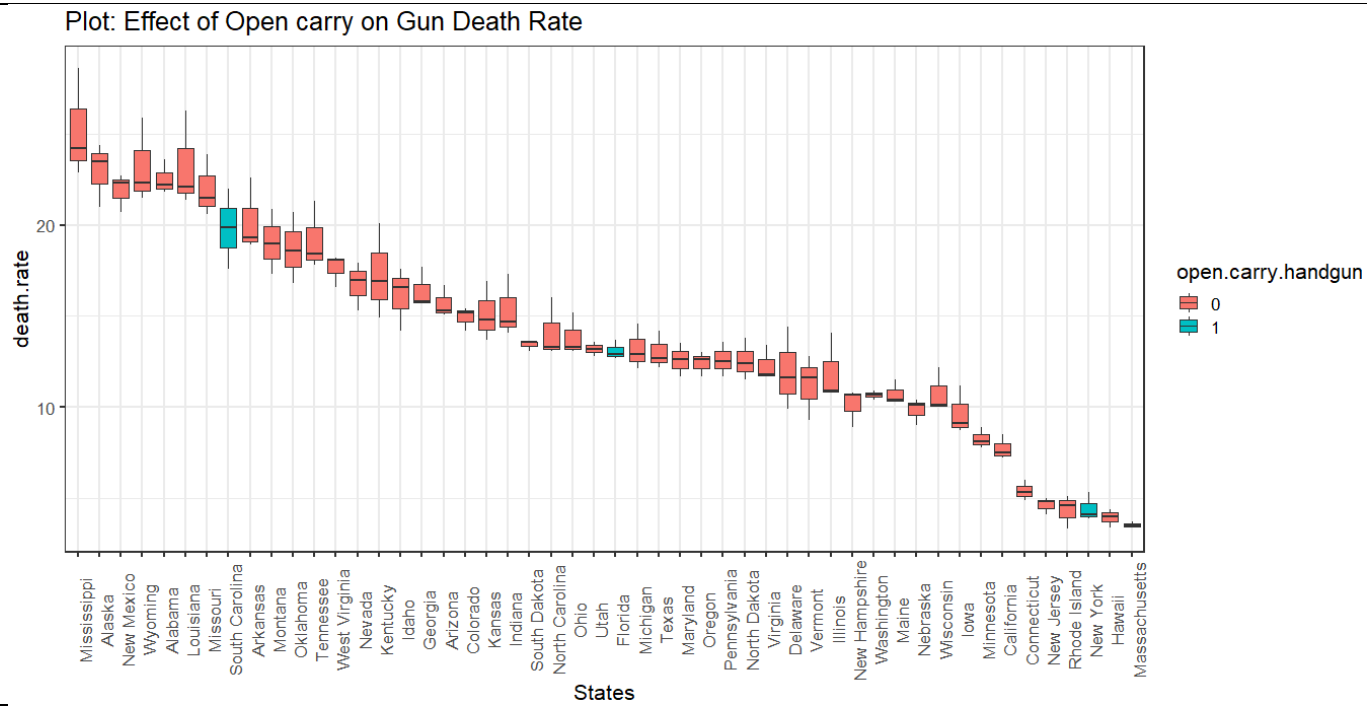
Plot: Effect of Open carry on Gun Death Rate
death.rate
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open.carry.handgun
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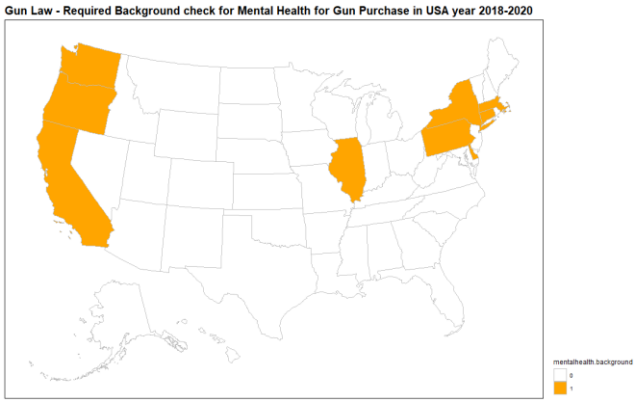
Gun Law - Required Background check for Mental Health for Gun Purchase in USA year 2018-2020
mentalhealth.background
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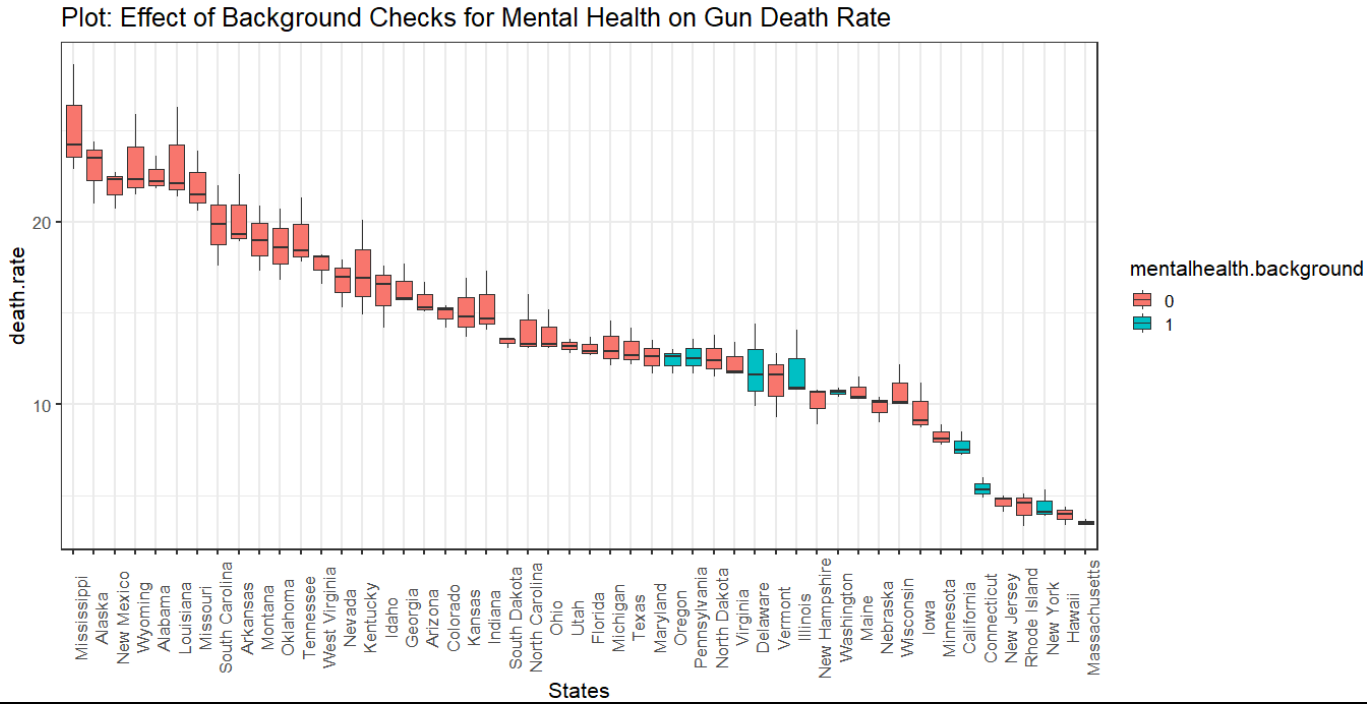
Plot: Effect of Background Checks for Mental Health on Gun Death Rate
death.rate
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mentalhealth.background
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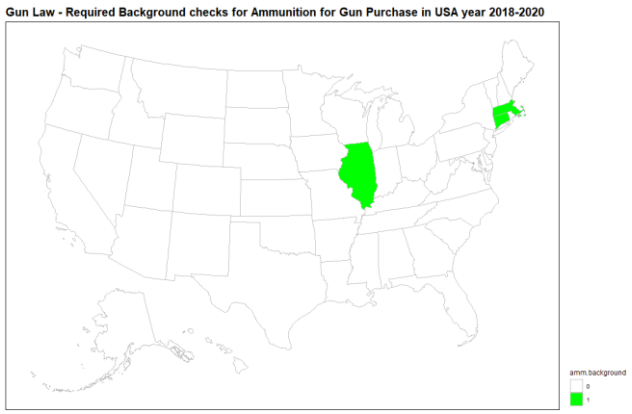
Gun Law - Required Background checks for Ammunition for Gun Purchase in USA year 2018-2020
amm.background
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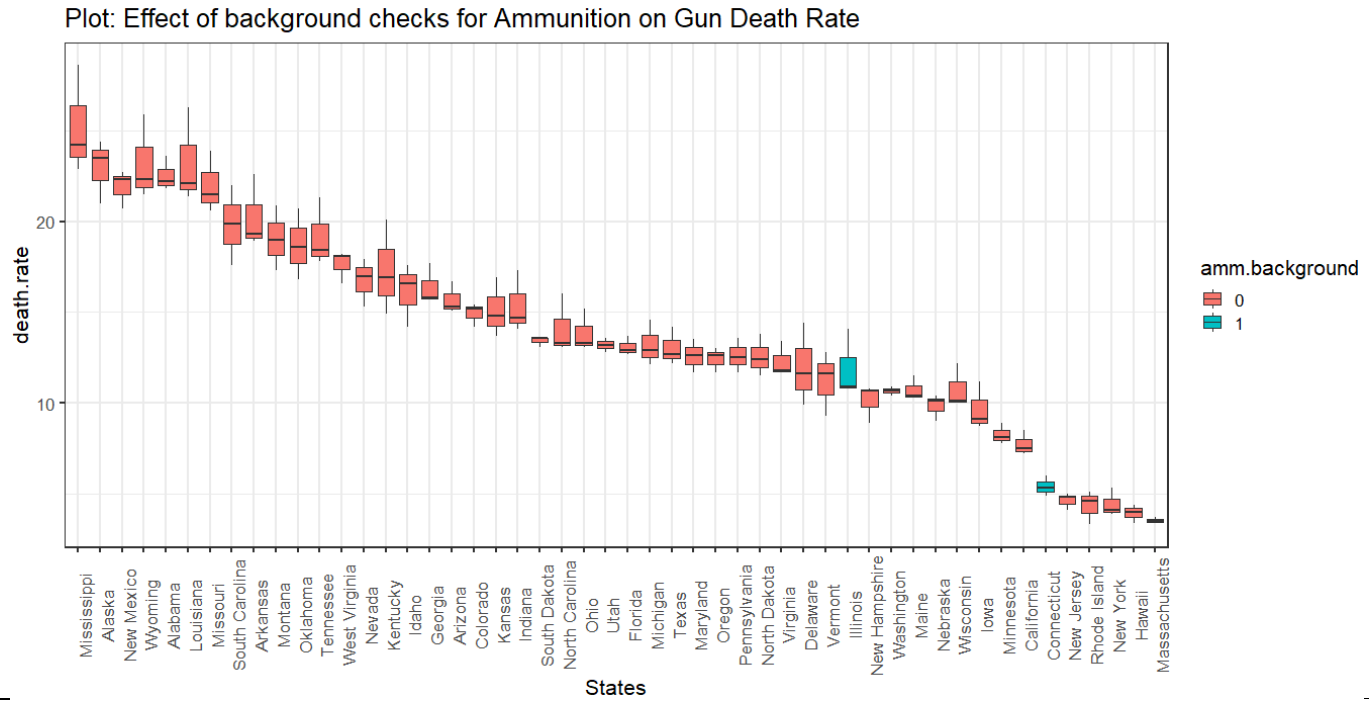
Plot: Effect of background checks for Ammunition on Gun Death Rate
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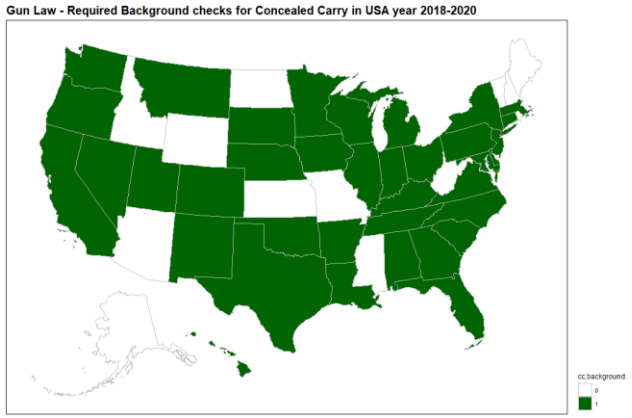
Gun Law - Required Background checks for Concealed Carry in USA year 2018-2020
cc.background
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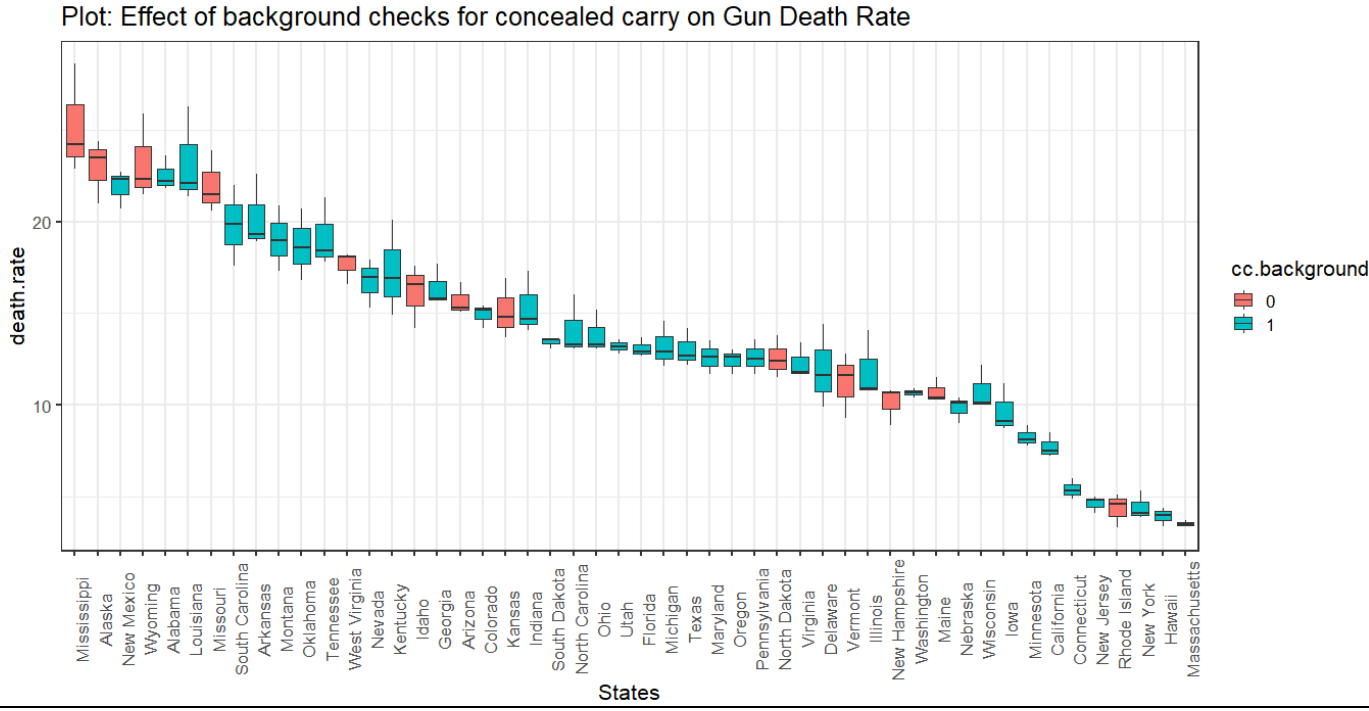
Plot: Effect of background checks for concealed carry on Gun Death Rate
death.rate
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cc.background
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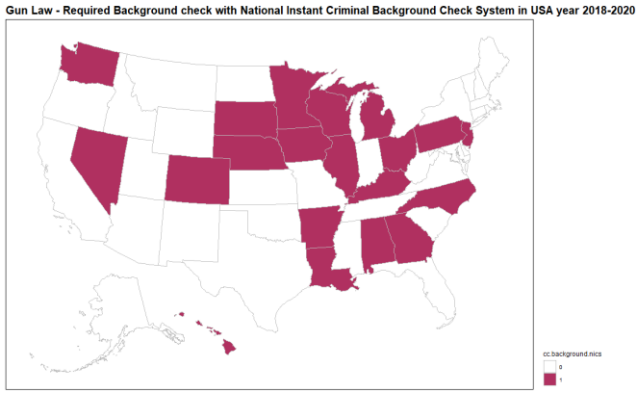
Gun Law - Required Background check with National Instant Criminal Background Check System in USA year 2018-2020
cc.background.nics
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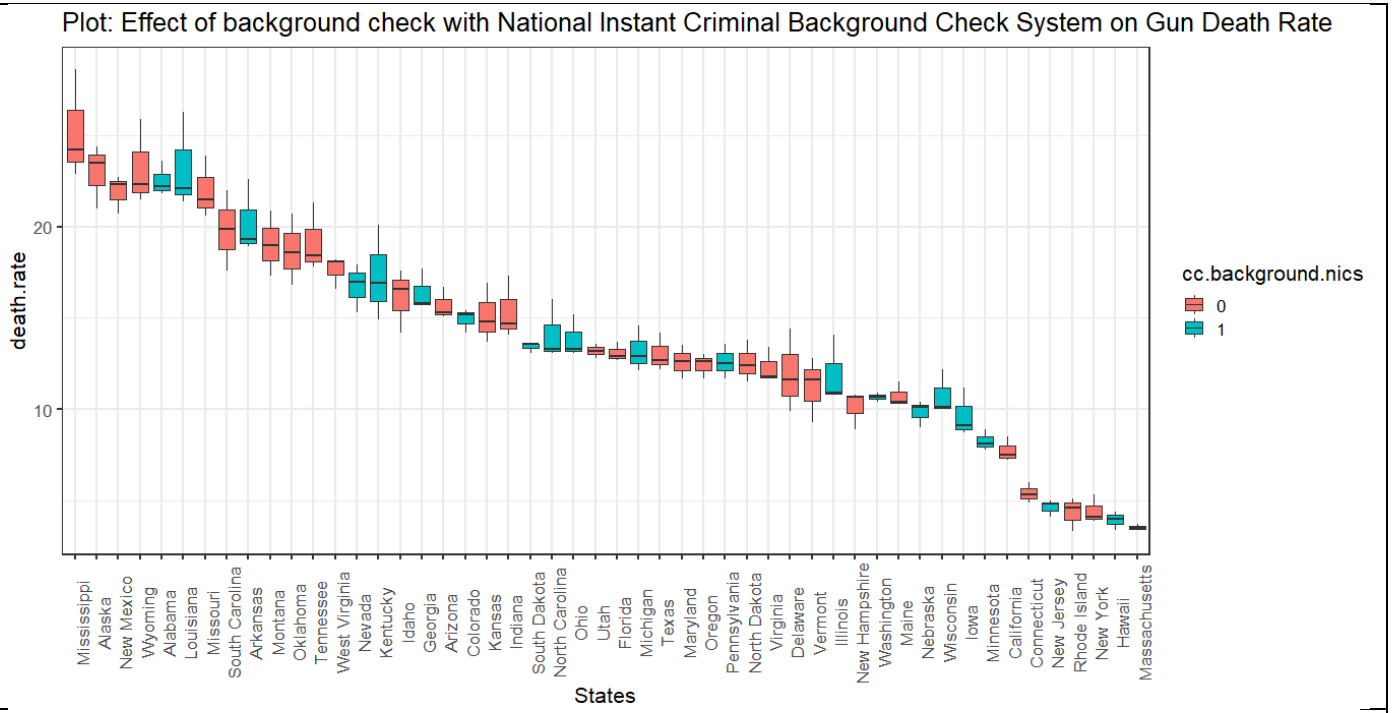
Plot: Effect of background check with National Instant Criminal Background Check System on Gun Death Rate
death.rate
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cc.background.nics
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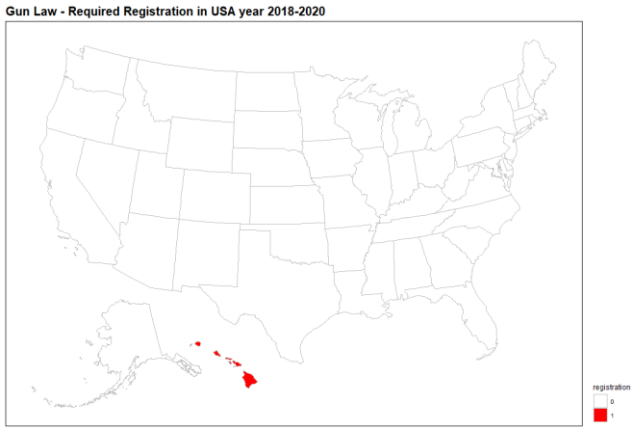
Gun Law - Required Registration in USA year 2018-2020
registration
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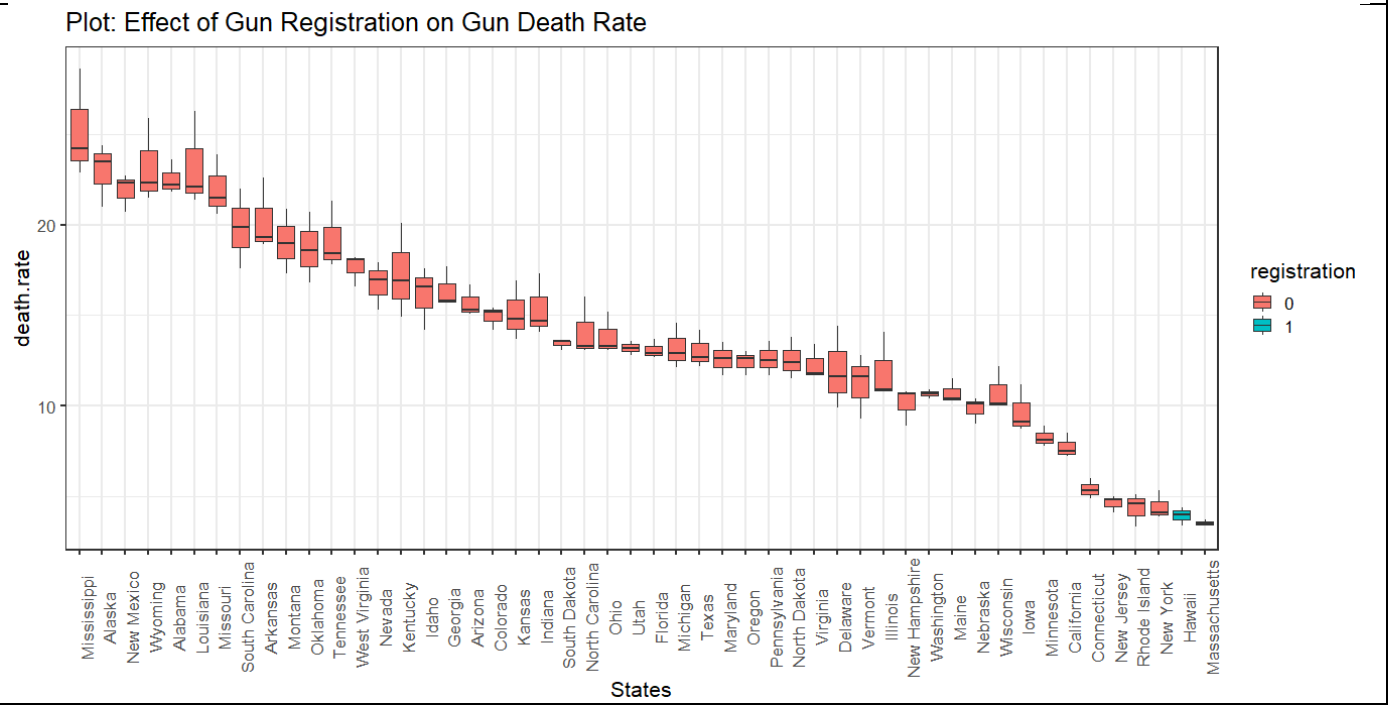
Plot: Effect of Gun Registration on Gun Death Rate
death.rate
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registration
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M O D E L S

Based on the data and analysis we choose to use the lmer models from the lme4 library for mixed effects.
The 3 models are…

1. Baseline Model with no gun law variables
2. Model 2 with gun law variables and all the variables from the baseline model
3. Interaction model having variables as in Model 2 plus some interaction terms to analyze the interaction effects of gun laws on other predictors.

We are also analyzing if there is a delay or a lag of the gun laws effect on the death rate by performing a lag analysis. We see the delayed effects of gun laws of 2019 on the death rates of 2020 as well as the delayed effects of gun laws of 2018 on the death rates of 2020.

Below is the stargazer comparison of our 3 models

	Dependent variable:		
	death.rate		
	(1)	(2)	(3)
permit.purchase1		-8.256*** (2.715)	-9.064*** (2.750)
permit.concealed1		-0.148 (0.682)	25.522** (12.775)
open.carry.handgun1		-1.747 (2.881)	-1.775 (2.860)
mentalhealth.background1		-3.176 (2.077)	-35.142 (26.433)
amm.background1		3.286 (3.807)	3.909 (3.767)
cc.background1		0.137 (2.035)	1.173 (2.232)
cc.background.nics1		-0.577 (1.562)	-20.589 (24.166)
registration1		-3.705 (5.320)	-2.671 (5.390)
covid1	3.198*** (0.516)	2.917*** (0.523)	3.061*** (0.545)
log.unemployment.rate	-2.106*** (0.699)	-1.703** (0.706)	-2.175** (0.980)
log.gdp	-1.511** (0.715)	-0.555 (0.770)	0.089 (1.162)
gov.party1	0.355 (0.390)	0.223 (0.393)	0.304 (0.395)
permit.concealed1:log.gdp			-1.892** (0.927)
permit.concealed1:log.unemployment.rate			0.366 (0.676)
mentalhealth.background1:log.gdp			2.143 (1.740)
mentalhealth.background1:log.unemployment.rate			-0.184 (0.601)
cc.background.nics1:log.gdp			1.334 (1.627)
cc.background.nics1:log.unemployment.rate			0.107 (0.530)
Constant	37.628*** (10.377)	25.377** (10.424)	17.250 (15.662)
Observations	150	150	150
Log Likelihood	-320.462	-310.097	-307.455
Akaike Inf. Crit.	656.924	652.194	658.910
Bayesian Inf. Crit.	681.009	700.364	725.144
Note:			*p<0.1; **p<0.05; ***p<0.01

General Model Equation:

$$Y_{death.rate} = \beta_0 + \beta_{permit.purchase}X_{permit.purchase} + \beta_{permit.concealed}X_{permit.concealed} + \beta_{open.carry.handgun}X_{open.carry.handgun} + \beta_{mentalhealth.background}X_{mentalhealth.background} + \beta_{amm.background}X_{amm.background} + \beta_{cc.background}X_{cc.background} + \beta_{cc.background.nics}X_{cc.background.nics} + \beta_{registration}X_{registration} + \beta_{covid}X_{covid} + \beta_{log.unemployment.rate}X_{log.unemployment.rate} + \beta_{log.gdp}X_{log.gdp} + \beta_{gov.party}X_{gov.party} + \beta_{permit.concealed*log.gdp}(X_{permit.concealed} * X_{log.gdp}) + \beta_{permit.concealed*log.unemployment.rate}(X_{permit.concealed} * X_{log.unemployment.rate}) + \beta_{mentalhealth.background*log.gdp}(X_{mentalhealth.background} * X_{log.gdp}) + \beta_{mentalhealth.background*log.unemployment.rate}(X_{mentalhealth.background} * X_{log.unemployment.rate}) + \beta_{cc.background.nics*log.gdp}(X_{cc.background.nics} * X_{log.gdp}) + \beta_{cc.background.nics*log.unemployment.rate}(X_{cc.background.nics} * X_{log.unemployment.rate})$$

$Linear\ Mixed-Effects\ Equation$:

$$Y_{death.rate} = 17.25 - 9.064X_{permit.purchase} + 25.522X_{permit.concealed} - 1.775X_{open.carry.handgun} - 35.142X_{mentalhealth.background} + 3.909X_{amm.background} + 1.173X_{cc.background} - 20.589X_{cc.background.nics} - 2.671X_{registration} + 3.061X_{covid} - 2.175X_{log.unemployment.rate} + 0.089X_{log.gdp} + 0.304X_{gov.party} - 1.892(X_{permit.concealed} * X_{log.gdp}) + 0.366(X_{permit.concealed} * X_{log.unemployment.rate}) + 2.143(X_{mentalhealth.background} * X_{log.gdp}) - 0.184(X_{mentalhealth.background} * X_{log.unemployment.rate}) + 1.334(X_{cc.background.nics} * X_{log.gdp}) + 0.107(X_{cc.background.nics} * X_{log.unemployment.rate})$$

1. For every unit increase in permit purchases, we expect the death rate (the Firearm mortalities by state) to decrease at the rate of 9.06 per 100,000 people.
$$Y_{death.rate} = 17.25 - 9.064X_{permit.purchase}$$
2. For every unit increase in permit purchases for concealed carry, we expect the death rate (the Firearm mortalities by state) to decrease at the rate of 25.52 per 100,000 people.
$$Y_{death.rate} = 17.25 - 25.522X_{permit.concealed}$$
3. For every unit increase in open carry handgun permit, we expect the death rate (the Firearm mortalities by state) to decrease at the rate of 1.77 per 100,000 people.
$$Y_{death.rate} = 17.25 - 1.775X_{open.carry.concealed}$$
4. For every unit increase in mental health background checks, we expect the death rate (the Firearm mortalities by state) to decrease at the rate of 35.14 per 100,000 people.
$$Y_{death.rate} = 17.25 - 35.142X_{mentalhealth.background}$$
5. For every unit increase in background checks for ammunition, we expect the death rate (the Firearm mortalities by state) to increase at the rate of 3.9 per 100,000 people.
$$Y_{death.rate} = 17.25 + 3.909X_{amm.background}$$
6. For every unit increase in overall background checks, we expect the death rate (the Firearm mortalities by state) to increase at the rate of 1.173 per 100,000 people.
$$Y_{death.rate} = 17.25 + 1.173X_{cc.background}$$
7. For every unit increase in background checks on NICS database, we expect the death rate (the Firearm mortalities by state) to decrease at the rate of 20.589 per 100,000 people.
$$Y_{death.rate} = 17.25 - 20.589X_{cc.background.nics}$$
8. For every unit increase in registration required, we expect the death rate (the Firearm mortalities by state) to decrease at the rate of 2.671 per 100,000 people.
$$Y_{death.rate} = 17.25 - 2.671X_{registration}$$

TEST OF ASSUMPTIONS

Predictor	Predicted Effect	Model Effect	Rationale
			DV: death.rate and death
permit.purchase	-	-	Additional restrictions causing less impulsive gun purchase, lower predicted death.rate and death
permit.concealed	-	+	Additional restrictions causing less impulsive gun purchase, lower predicted death.rate and death
open.carry.handgun	-	-	Additional restrictions causing less impulsive gun purchase, lower predicted death.rate and death
mentalhealth.background	-	-	Additional restrictions causing less impulsive gun purchase, lower predicted death.rate and death
amm.background	-	+	Additional restrictions causing less impulsive gun purchase, lower predicted death.rate and death
cc.background	-	+	Additional restrictions causing less impulsive gun purchase, lower predicted death.rate and death
cc.background.nics	-	-	Additional restrictions causing less impulsive gun purchase, lower predicted death.rate and death
registration	-	-	Additional restrictions causing less impulsive gun purchase, lower predicted death.rate and death
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unemployment.rate	+	-	Higher unemployment, more stress, higher predicted death.rate and death
GDP	+	+	Higher GDP, better economy, lower predicted death.rate and death
gov.party	+	+	Since 0 = Democrat, 1= Republican, and because Democrats are pro- gun laws, the death rate might be higher if Republican
			Excluded: NA

ANALYSIS

The initial assumptions of effects of the predictor variables on the response variable were mostly accurate (8 out of 12). The model predicted that the concealed weapon permit would have a positive effect on the death rate as opposed to a negative one. This could be because the increased issuance of concealed weapon permits increases the total number of guns circulating in the US which increases the number of gun deaths i.e., more guns, the chance for someone to be killed by a gun increases whether accidental or intentional. The model showed that the ammo background check and the cc background check have a positive effect on the death rate instead of a negative effect. Yet, the more intensive background which uses the criminal database to check individuals has a negative effect on the death rate. It appears the ammo and cc background checks aren't as rigorous as the NICS background check. Therefore, more guns and ammo are sold to people who are more likely to commit acts of gun violence. It was expected that the unemployment rate would cause an increase in gun deaths due to the stress and frustration associated with not be able to pay bills etc. The model predicted that unemployment has a negative effect on the death rate. This could be explained by the dates associated with the dataset used in this analysis. The period that was covered (2018-2020) covers the time during COVID in which the US gov't issued relief checks to citizens, suspended evictions, and mortgage payments. This alone reduced the amount of stress and frustration that is typically associated with unemployment. Overall, our assumptions were that the implementation of gun laws controlling the accessibility of guns will have a negative effect on the death rate.

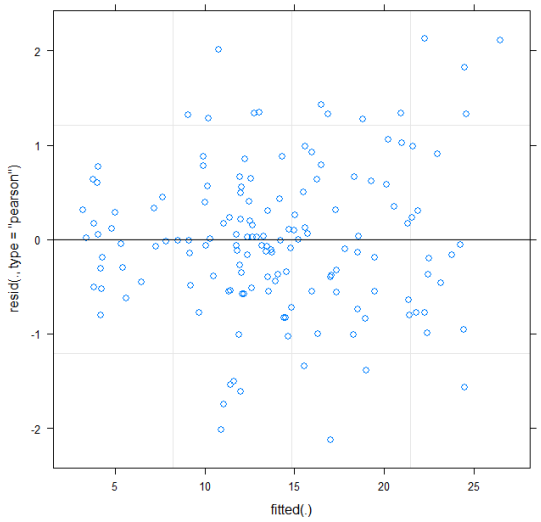
ASSUMPTIONS OF REGRESSION

Based on the plots below we can say that the model (interaction model which is used for the analysis) satisfies the assumptions of Regression

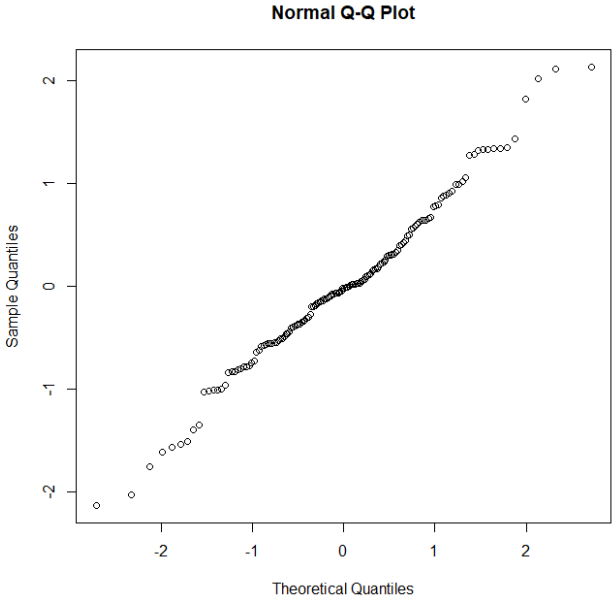
- Multi-collinearity - Pass

```
> vif(interaction)
                                                permit.purchase                                                  permit.concealed
                                                       2.610584                                                       443.917787
                                                open.carry.handgun                                           mentalhealth.background
                                                       1.323318                                                       295.716856
                                                  amm.background                                                 cc.background
                                                       2.294425                                                         2.749725
                                             cc.background.nics                                                   registration
                                                     401.922299                                                         1.633080
                                                           covid                                          log.unemployment.rate
                                                      10.808764                                                       18.943003
                                                         log.gdp                                                      gov.party
                                                       4.369669                                                         1.114793
                                      permit.concealed:log.gdp                        permit.concealed:log.unemployment.rate
                                                     461.655562                                                         9.262528
                   mentalhealth.background:log.gdp                mentalhealth.background:log.unemployment.rate
                                                     300.150834                                                         1.952785
                         cc.background.nics:log.gdp                      cc.background.nics:log.unemployment.rate
                                                     393.116132                                                         2.911564
```

- Homoscedasticity – No clear pattern, seems uniformly distributed so pass



- Normality – Fairly normal for most values except for the tails



INSIGHTS AND RECOMMENDATIONS

- **Push for Gun Permits for the states that don't have them**
  - every unit increase in permit purchases, we expect the death rate (the Firearm mortalities by state) to decrease at the rate of 8.37 per 100,000 people.

- **Push for Concealed Carry Permits for the states that don't have them**
  - every unit increase in permit purchases for concealed carry, we expect the death rate (the Firearm mortalities by state) to decrease at the rate of 25.52 per 100,000 people.

- **Push for Extensive Background Checks like NICS for more states**
  - every unit increase in background checks on NICS database, we expect the death rate (the Firearm mortalities by state) to decrease at the rate of 20.589 per 100,000 people.

- **Extensive mental health background checks for more states**
  - every unit increase in mental health background checks, we expect the death rate (the Firearm mortalities by state) to decrease at the rate of 35.14 per 100,000 people.