The Lethality of the American Gun Lobby

Pro-gun lobbying efforts and mental health effects on suicide by gun

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Introduction

Gun violence continues to be a staple of American politics, especially following a series of high-profile assassination attempts on President-Elect Trump and the recent murder of UnitedHealthcare CEO Brian Thompson. Americans in opposition to federal gun ownership restrictions often cite mental health as the reason for America's gun violence epidemic. In contrast, supporters of gun restrictions regularly blame America's comparatively loose regulatory environment and special interest group involvement for the violence.

According to the Centers for Disease Control and Prevention (CDC), suicide by firearm accounts for more than half of gun deaths in the United States. While school shootings, mass shootings, and high-profile assassinations are regularly brought into mainstream political discourse, suicide by gun is less frequently discussed. In this study, we investigate the potential relationships between pro-gun special interest group activity, mental health, and suicide by firearm. We aggregate over ten million responses to CDC health surveys, three million special interest group reports, and suicide by firearm rates for all 50 states. These data are then used to build a multiple linear regression model to control for the impact of lobbying efforts and mental health on rates of suicide by gun.

The Data

We have aggregated and cleaned data from three distinct sources. First, mental health data is pulled from the CDC Behavioral Risk Factor Surveillance Survey (BRFSS). The survey began including mental health questions in 1994. The question of interest for this study is:

"Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?"

Responses are given an integer value between 1 and 30. Respondents with zero days of poor mental health are encoded with the value 88, which we have re-encoded as 0. Non-responses are not considered. Ultimately, 10,249,613 were considered, aggregated by state and year, and

included in the model. We encode these responses as binary: "Poor" or "Good" mental health. The CDC defines 15 or more days of poor mental health in a 30-day period as concerning, so we encode responses of 15 or greater as "Poor" and others as "Good."

The CDC also provides absolute number and per-capita suicide data by state through their CDC WONDER platform. Per-state proportions of suicides that were completed with firearms were compiled by the RAND Corporation, a non-profit, non-partisan think tank that tracks and reports on several high-profile political issues in the United States. We calculate total firearm suicide deaths by multiplying the total suicides of all types reported by the CDC and the proportion of those that were completed by firearm reported by RAND.

Special interest group activity is provided by Hall et al. (2024). Their special interest dataset reports 13,619,409 individual state-level special interest group positions. We filter those positions using regular expression filters built by hand from group names listed on OpenSecrets, the website of the eponymous non-profit organization that tracks lobbying groups and campaign finance in Washington, DC. We aggregate firearm-related special interest group activity by year to include in the model.

We aggregate all of these data (unique interest activity, suicide count, gun-specific suicide rate, reported mental health) into a single dataset that we use to build our model.

Methodology

Each row in our final dataset represents a single year as a national aggregate. Although health and firearm data is aggregated by state, lobbying efforts occur in fewer than half of all states, so we simply take the total number of lobbying efforts nationwide to avoid losing the majority of states that do not have state-level lobbying efforts. Because inter-state gun transfers are common (Roberts et al., 2024), taking a national aggregate is justified, even when many states are not represented.

Since the resulting dataset has one row per year, we are left with only 19 observations. Although tens of millions of observations were combined to arrive at the data, we must take some special consideration when building a regression model with fewer than 30 observations.

First, to avoid over-fitting, we use only use two predictors. A common heuristic in statistics is that the degrees of freedom should be no more than $\frac{n}{10}$, or two predictors in this case. Initially, we chose three predictors, but after observing a strong negative correlation between two of them, we ultimately removed one and arrived at two predictors: lobbyist activity count and the proportion of people reporting poor mental health. (See the results section for additional detail).

To test the validity of our findings (especially with $n = 19$ observations), we also conduct a Shapiro-Wilk test on our residuals to verify the assumption of residual normality that linear regression requires. We further verify our results by constructing a quantile-quantile plot and

discussing its content. Finally, we will use adjusted R^2 instead of traditional R^2 to discuss the model, as adding predictors will always increase R^2, even if those predictors are not truly meaningful. This problem is more pronounced in models trained with smaller datasets. Using adjusted R^2 will help us combat that problem.

Results

In our multiple linear regression model, our outcome variable is the number of suicides by gun per 100,000 citizens of the United States. Initially, we constructed our model with three predictors: lobbying activity, the proportion of poor mental health, and the mean proportion of all suicides that were completed with firearms. Using three predictors for $n = 19$ observations violates our heuristic discussed in the methodology section (using $\frac{n}{10}$ degrees of freedom), which we will discuss below. Our three-predictor model is shown below:

to test the validity of our findings, especially with few observations, we calculate the pearson coefficients for our predictors. for our use case, we will consider correlations with an absolute value greater than 0.8 too high for combined use in our model. figure 2 shows the pearson coefficients of our three predictors:

Model results (three predictors)

Variable	Estimate	Std. Error	Statistic	P-value
Intercept	5.227	6.678	0.783	0.446
Number of lobbying activities	0.001	<0.001	6.803	<0.001
Rate of poor mental health	52.227	34.389	1.519	0.150
Rate of suicides by gun	2.230	8.259	0.270	0.791

(a) Figure 1: Model results

Pearson Coefficients

	Lobbying	Gun Suicide	Mental Health
Lobbying	1.000	−0.390	0.428
Gun Suicide	−0.390	1.000	**−0.814**
Mental Health	0.428	**−0.814**	1.000

(a) Figure 2: Pearson coefficients

To avoid potential multicollinearity in our model and to get closer to our $\frac{n}{10}$ degrees of freedom heuristic, we remove the proportion of suicides by gun from the model. Because we are specifically interested in the effects of mental health and lobbying activities, eliminating mental health reports from our model to reduce the probability of multicollinearity would be unwise. Thus, we are left with our final two predictors and a new model. The results of that model are shown in Figure 3.

Model Results (two predictors)

Variable	Estimate	Std. Error	Statistic	P-value
Intercept	6.943	1.993	3.484	0.003
Number of Lobbying Activities	0.001	<0.001	7.009	<0.001
Rate of Poor Mental Health	45.011	21.010	2.142	0.048

Figure 3: Model results

Both of our predictors are statistically significant at the $\alpha = 0.05$ significance level. However, the amount of lobbyist activity has a substantially lower p-value ($p < 0.001$), and our model has an adjusted R^2 of 0.82. However, because of our small dataset, further investigation is necessary to confirm our findings. First, we should verify the residual normality assumption. Figure 4 shows the distribution of our residuals, but with $n = 19$ residuals, it is difficult to confirm their normality visually. Instead, we can conduct a Shapiro-Wilk test to test the probability that our residuals come from a normal distribution.

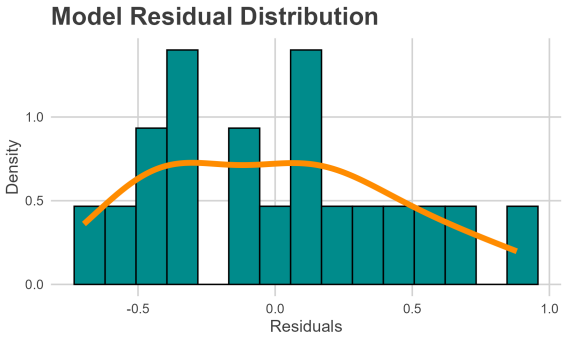
In a Shapiro-Wilk test, our null hypothesis is that our data *is* normally distributed. As such, a p-value of less than 0.05 means that our residual normality assumption is violated. However, with a p-value of 0.73, our residuals are likely to be normally distributed. We construct a quantile-quantile plot in Figure 5 to further verify our performance. With each point closely approaching the mathematical ideal, Figure 5 gives additional confidence to our findings.

While holding the proportion of the population reporting poor mental health constant, every additional pro-gun lobbyist effort adds an expected 0.001 deaths per 100,000 people. The United States population is around 338,000,000 people. Therefore, an expected increase of 0.001 deaths per 100,000 people means each additional lobbying effort produces an expected 3.38 additional deaths while holding mental health problems constant.

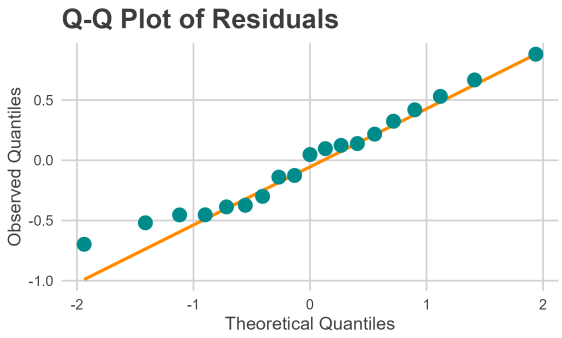
Interpreting mental health's effect is more subtle because the predictor's range is 0-1. Although we see that a one-unit increase in poor mental health rate gives 45 additional deaths per 100,000, it is more reasonable to divide that coefficient by 100 to discuss every 1-percent increase. Thus, while holding the amount of pro-gun lobbying constant, we can say that every 0.01-unit increase in poor mental health rate causes an expected 0.45 deaths per 100,000 by self-inflicted gunshot, or 1,521 deaths nationwide.

Discussion

In this study, we found statistically significant evidence that additional pro-gun lobbying efforts cause additional suicides using firearms while holding the rate of poor mental health constant.



(a) Figure 4: Residual distribution



(a) Figure 5: Quantile-quantile plot

Although we built the model using only $n = 19$ observations, we conducted a Shapiro-Wilk test to verify the normality of our residuals, used adjusted R^2 instead of traditional R^2, and constructed a quantile-quantile plot to increase confidence in our findings. However, our research could have been improved in multiple ways.

First, although we used several methods to deal with our small training dataset, additional data would be welcome. Although most data goes back to somewhere in the mid to late 1990s, RAND has only reported the proportion of suicides completed with guns until 2016. Much has likely changed in this area of research since 2016, and updated data from RAND or other sources would assist in expanding this study to recent, especially post-COVID-19, developments in suicide and firearm legislation.

Second, additional independent variables would be ideal. In this study, we focus on mental health, as it is a commonly cited cause by those who oppose anti-firearm legislation. For example, the CDC reports veteran status, which could be an interesting expansion to our work. However, with only 19 rows of data, it is difficult to justify adding additional predictors. More recent data, as well as more historical data, would give us room to increase the degrees of freedom of our model to include such predictors.

Additionally, replacing lobbying activity with another proxy for pro-gun legislative activity could allow for state-by-state data instead of national averages. Our work had to be aggregated nationally due to a lack of representation in the lobbying data for each state. Still, a per-state metric would lead to a dataset of over 1,000 entries (even without additional years), allowing predictors and a per-state analysis of significance. Ultimately, we recommend future work substitute lobbying activity for a metric with more robust data from every state.

Conclusion

The American gun debate shows no signs of ceasing anytime soon. However, we have shown that there is reasonable doubt to the claim that America's gun violence problems are caused by mental health alone. Although our result leaves room for future research, there is statistically significant evidence that, even when holding reported mental health status constant, pro-gun lobbying activity causes deaths at an expected 3.38 deaths for each additional pro-gun special interest effort. While there are philosophical aspects to the gun debate that statistics can never affirm or deny, we can be reasonably confident that the specific claim of mental health being the sole cause of American gun violence is not supported by evidence. Although the dispute continues, we hope our humble contribution to the national discussion can help advance the cause of rational, evidence-based debate on this life-or-death issue.