

IMPACT OF GUN CULTURE IN THE U.S.: A SPATIAL ANALYSIS OF STATEWIDE SCHOOL MORTALITY AND SHOOTINGS

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1. SUMMARY

This paper analyzes the impact of gun culture in the United States at the state level, using as proxies the rate of gun ownership and the political affiliation of the ruling party in each state. Its relationship with the firearm death rate and the incidence of school shootings is examined. To this end, spatial analysis techniques such as the global Moran index and the Local Spatial Autocorrelation Analysis (LISA) are applied, which allow the identification of significant clusters in the geographical distribution of these variables.

Mapping makes it easier to interpret these spatial patterns, showing clusters of high and low values that reflect the influence of gun culture on gun violence. The results show a strong correlation between gun culture and gun mortality, and a weak correlation with the rate of school shootings. In addition, a significant spatial autocorrelation is observed in the three variables, with a high coincidence of geographical groupings between them.

This spatial approach brings a deeper understanding of how cultural and political differences translate into territorial patterns of gun violence, suggesting the need for public policies that consider both regional characteristics and the political context to effectively address this problem in the United States.

2. INTRODUCTION

Gun violence, particularly gun deaths and school shootings, represents one of the most urgent and polarizing social issues in the United States. According to the American College of Surgeons, from 1970 to 2021 the rate of child victims of school shootings has quadrupled, and, in 2024, U.S. Surgeon General Vivek

Murthy declared gun violence in the U.S. a public health crisis.(Joseph, y otros, 2021)(The New York Times, 2024)

Gun culture in the United States is considered the leading cause of gun violence, mass shootings and lax gun policy in the country, with the gun being an identifying symbol of Americans.(Mastellone, 2020)

This problem raises the debate about which policies would be the most effective. The proposals tend to differ mainly depending on whether they come from the Democratic or Republican parties. The former tends to advocate for stricter gun control laws, while the latter tends to hold a contrary stance, preferring to facilitate access to guns as a response to increasing violence in the form of self-defense. (Molina, 2021)

This study focuses on identifying and understanding the existence of significant spatial patterns in gun ownership, firearm mortality, and school shootings in the United States. It is analyzed whether these phenomena present spatial autocorrelation and how they relate to each other, using gun ownership and political affiliation as proxies of the gun culture in each state. Given that this culture is strongly influenced by ideological factors, different bibliographic perspectives are used to help contextualize the spatial patterns detected and to interpret their possible political and social origin.

Three main research questions are posed: (1) Can political affiliation along with gun ownership be understood as a proxy for gun culture in America? (2) Are there spatial clusters in the distribution of gun ownership, gun mortality, and school shootings in the United States? (3) How do these spatial distributions relate to each other?

To answer these questions, the following specific objectives are defined: (1) To analyze the spatial autocorrelation of the rate of gun ownership in the U.S. and relate it to the political affiliation of each state (2) To study the spatial autocorrelation of the rate of death from firearms and school shootings. (3) To identify regions that simultaneously present high or low values in these variables.

3. METHODOLOGY

This study is based on the collection and analysis of data from various official and recognized sources, which provide up-to-date (within the limits of availability in open data portals) and relevant information on the key variables analyzed: gun ownership, firearm mortality, school shootings, and state political affiliation.

- Firearm Mortality: Death Rate¹ by firearms per 100,000 inhabitants in 2022.(National Center for Health Statistics, 2022)
- Gun Ownership by State: Percentage of Households Owning Guns in 2025.(World Population Review, 2025)
- School Shootings²: The information on school shootings in the United States during the year 2024 was obtained from the list available on Wikipedia, which was purged to consider only intentional events. In some cases, the number of victims includes the perpetrator.(Wikipedia, 2025)
- Political affiliation of states: Classification of states as "red" (Republican) or "blue" (Democratic) based on political configuration in 2023.(Jagran Josh, 2024)

To examine the possible spatial relationships between these variables, various geospatial and statistical analysis techniques were used, with the aim of detecting both general patterns and significant local groupings.

First, a linear Pearson correlation was applied to assess the strength and direction of the relationships between the variables at the state level. This technique allows us to obtain a first approximation of whether, for example, a higher percentage of gun ownership is associated with a higher mortality or frequency of school shootings

However, since the focus of the study is spatial, Moran's global index (*Moran's I*) was also used to assess the spatial autocorrelation of each variable. This index measures whether the values of a variable in one state tend to resemble those in its neighboring states. Positive and statistically significant values indicate a geographic grouping of similar values, suggesting the existence of spatial clusters.

¹ Gun deaths include homicides, suicides, and unintentional fatal injuries.

² The concept of "school" used throughout the work refers to any American educational center.

For a more detailed exploration, Local Spatial Autocorrelation Analysis (LISA) was applied. This technique allows the identification of specific areas where there are statistically significant clusters of high or low values. Specifically, it classifies states according to four types of local association:

- *High-High*: states with high values surrounded by other states with high values,
- *Low-Low*: states with low values surrounded by other low values,
- *High-Low* and *Low-High*: states with outliers with respect to their environment, which allows the detection of possible anomalies or *outliers*.

The results of the LISA analysis were evaluated with standard significance levels ($p < 0.001$, $p < 0.01$ and $p < 0.05$), by random permutations to ensure the statistical validity of the clusters detected.

Finally, for the analysis of school shootings, it was necessary to apply a *forward geoencoding* process, which consists of transforming place names (cities, states, schools) into geographical coordinates (latitude and longitude). This procedure made it possible to map the events accurately and thus incorporate them into the spatial analysis and the mapping of the results.

4. RESULTS

Although a high correlation was observed between the rate of gun ownership and firearm mortality ($r = 0.79$), the relationship between gun ownership and the rate of school shootings was considerably lower ($r = 0.21$). However, when considering the spatial dimension using the Moran I test, a significant spatial autocorrelation was identified for the three variables analyzed. The values obtained are shown in Table 1.

Variable	Moran I Statistician	Expected value	P-value
Weapon ownership	0.52	-0.02	≈ 0
Mortality rate	0.56	-0.02	≈ 0
School Shooting Rate	0.54	-0.02	≈ 0

Table 1 - Results of the Moran I test

These results show a strong spatial autocorrelation, since the p-value close to 0 in the three variables analyzed suggests the presence of significant and non-random geographical patterns.

4.1. Gun ownership rate and political affiliation as proxies

To continue with the local analysis (LISA), the gun ownership map and the electoral map are used for comparison. A clear spatial relationship is observed: states with high levels of gun ownership tend to be governed by the Republican Party, while states with low levels are mostly Democratic. A notable exception is Vermont, a Democratic state with a high rate of gun ownership compared to its northeastern neighbors, which positions it as an outlier.

Vermont has historically maintained some of the most permissive gun laws in the country. A prominent example is that legal gun owners between the ages of 18 and 21 can carry firearms without needing a permit. This modality, known as *Vermont carry*, has its roots in the state constitution that dates back to 1791. (Hewitt, 2022)

This deep-rooted gun culture may be related to the fact that 64.9% of its inhabitants resided in rural areas in 2020. At the national level, it is estimated that three-quarters of the rural population owns at least one weapon since its use is more normalized for activities such as hunting, which is part of recreational and cultural practices in these communities. (United States Census, 2022)(Igielnik, 2017)

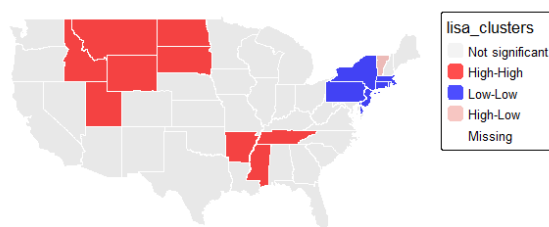


Figure 1- LISA State Cluster Map on Gun Ownership in the U.S., 2025

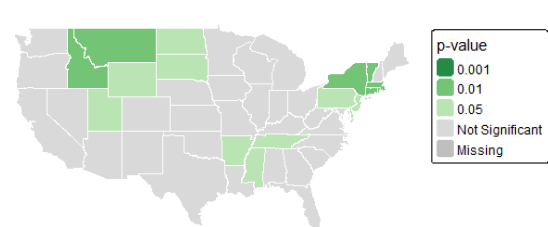


Figure 2 – LISA State Significance Map of Gun Ownership in the U.S., 2025

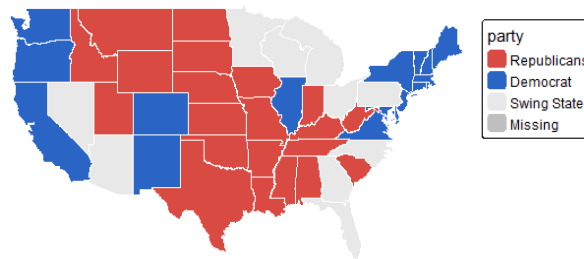


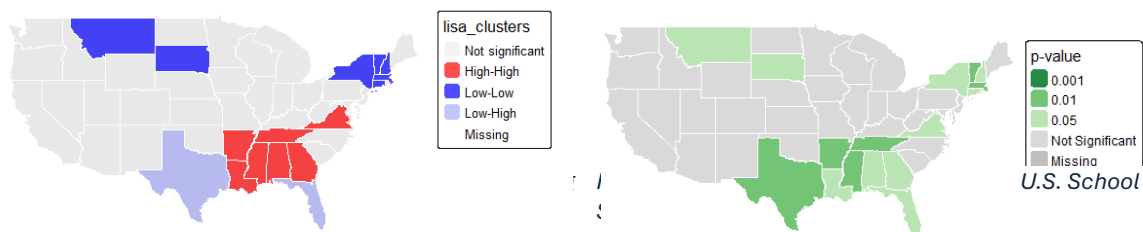
Figure 3- U.S. Election Map, 2023

This spatial coherence between political affiliation and gun ownership, excluding Vermont, reinforces their joint interpretation as indicators of the same socio-cultural reality: gun culture. Therefore, within the framework of this study, both variables will be considered complementary proxies to represent this concept.

4.2. Relationship between gun culture and school shootings

Local analysis showed spatial patterns consistent with the findings of the Moran Index test. In the Northeast region³, a cluster of states with low gun culture and low levels of school shootings is identified, with Vermont being the only significant exception: this state has a high possession of weapons, which makes it an outlier within its regional environment.

Similar^{4 5} clusters with gun culture were also seen in the South and Midwest, especially in Arkansas, Missouri, and Tennessee. However, the states of Montana and South Dakota, in the north of the country, showed a unique behavior: they presented clusters of the High-High type in gun possession, but Low-Low in school shootings, which indicates a dissociation between both variables in that area.



³ Northeast Region: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, New Jersey, New York, and Pennsylvania.

⁴ Southern Region: North Carolina, South Carolina, Delaware, District of Columbia, Florida, Georgia, Maryland, Virginia, West Virginia, Alabama, Kentucky, Mississippi, Tennessee, Arkansas, Louisiana, Oklahoma, Texas.

⁵ Midwest Region: Illinois, Indiana, Michigan, Ohio, Wisconsin, North Dakota, South Dakota, Iowa, Kansas, Minnesota, Missouri, Nebraska.

To complement the spatial analysis, a dot map is incorporated that represents the location of school shootings recorded in 2024. This allows the geographical distribution of incidents to be observed, identifying specific sources of school violence. A greater concentration is seen in the South, although most of these events have a small number of victims. In contrast, less frequent shootings in states with low gun ownership rates, such as Wisconsin and Iowa, have proved more deadly.

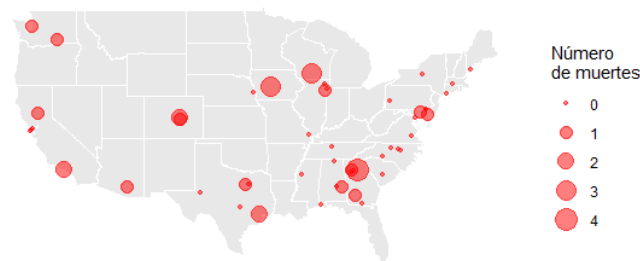


Figure 6- U.S. School Shooting Location Map, 2024

This pattern suggests that, in regions with a higher gun culture, school shootings are more common, but mostly not very lethal, possibly linked to spontaneous conflicts between students. Conversely, in states with less access to guns, shootings, while less common, tend to be more deadly, which can involve more planning of the attack. This difference justifies the low correlation previously observed: committing a school shooting does not rely heavily on the availability of guns.

4.3. Relationship between gun culture and gun mortality

The relationship between gun ownership and gun mortality is very robust and statistically consistent. In this case, the clusters identified largely overlap with those detected for gun ownership, although with some relevant exceptions: no northern state showed statistical significance in mortality, which excludes it from the cluster despite its high levels of possession; and, again, Vermont, which

presents an interesting attitude, *Low-Low* even though it has a high rate of gun ownership, reinforcing the idea that their use must be mostly for hunting.

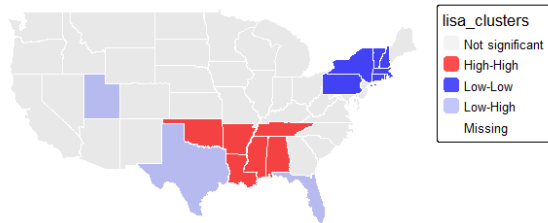


Figure 8- LISA State Cluster Map on U.S. Firearm Death Rate, 2022

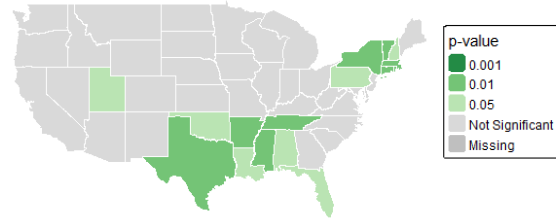


Figure 7 – LISA State Significance Map on U.S. Firearm Death Rate, 2022

5. CONCLUSIONS

The results obtained support that both gun ownership and political affiliation can act as consistent proxies of gun culture in the U.S., by presenting similar spatial patterns to each other.

This cultural proxy shows a clear and significant relationship with firearm mortality, evidenced by a high correlation ($r = 0.79$) and coincident spatial clusters excluding the northern area. In the case of school shootings, although the relationship is weaker ($r = 0.21$), spatial analysis reveals very similar geographic patterns, except for Montana and South Dakota, which are areas with safer schools even though they have a large gun culture.

These findings suggest that gun culture, assessed through ownership and political affiliation, directly influences gun mortality and has a more complex and localized effect on the incidence of school shootings, highlighting the importance of spatial analysis to understand these dynamics.

Regarding the implications for solutions from politics, two opposing positions are observed: on the one hand, gun advocates advocate the Theory of Deterrence, proposing harsher punishments for criminals and a greater presence of armed citizens as a method of prevention. On the other hand, the Democratic Party maintains that restricting access to guns, especially to those under 21 years of

age, is essential to reduce the occurrence of school shootings.(Lemieux, 2014)(Hamlin, 2021)

However, this problem seems to have deeper structural roots. Legislative decentralization in arms matters at the state level hinders the effectiveness of control policies, since the mobility of illegal weapons between states can compromise the restrictive measures adopted locally. This phenomenon could be illustrated in the case of Vermont, a state that although Democratic has relatively lax regulations since it maintains a deep-rooted gun culture. If more demanding gun policies typical of the state ruling party were carried out, it would encourage the illegal purchase and smuggling of cheaper weapons from outside states with looser policies.(Kahane, 2020)

In sum, this study provides empirical evidence from spatial analysis that reinforces the need to address gun culture and its relationship with political affiliation and legislation from a more integrated and coordinated perspective at the federal level to mitigate its impacts on public health.

6. REFERENCES

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7. ANNEXES

The R codes and databases used for the spatial analysis of this study have been uploaded to a public repository on GitHub, to facilitate the transparency and

reproducibility of the results. All the material can be accessed at the following link:
<https://github.com/agathadelolmo/USA-shooting-report>