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Article

Economic and social drivers of school shootings: Analyzing recent trends

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SUMMARY

Since the start of the 2023 school year, Henrico County, Virginia has installed metal detectors in response to the rise in shooting threats throughout the county, which have negatively impacted students' mental health, reduced instructional time, and created significant disruptions. This issue is part of a broader national trend, with 349 school shootings occurring in the United States in 2023. We evaluated the impact of five key factors on school shootings: COVID-19 cases, gun supply, social media usage, income inequality, and inflation rate. We hypothesized that social media would show the strongest association with school shootings. Using a multiple linear regression model, we found social media usage, gun supply, and inflation rate to be significant factors, with social media having the strongest positive association, followed by inflation. Unexpectedly, gun supply showed a negative relationship, while COVID-19 cases and income inequality were not statistically significant. The significant factors (social media usage, gun supply, and inflation rate) highlight the urgent need to address the role of social media in amplifying harmful ideologies, the economic stress from inflation, and the importance of tracking gun accessibility. Future research should consider additional factors, such as mental health and school security measures, and conduct studies geographically to understand regional variations in these characteristics and the factors mentioned within our study using advanced modeling techniques to validate and expand upon these conclusions.

INTRODUCTION

According to the K-12 school shooting database, there were roughly 349 individual school shooting incidents in the United States in 2023 alone, with cases rising sharply from 2020 to 2023 (1). This distressing trend extends beyond high school campuses, reaching even elementary schools (2). With the rise in these threats, many states have taken action to reduce the presence of such violence in schools. For instance, starting in 2023, Henrico County, Virginia has taken proactive steps to reduce gun threats by introducing metal detectors in schools (3). This precautionary measure follows a series of incidents including nearby shootings and firearm threats on social media (4-7). Following these incidents, schools were put in mandatory “lock and hide” procedures. While some of these threats turned out to be false alarms, the sustained presence of metal detectors has demonstrated adverse effects on students' mental well-being (8). Concerned parents, deeply worried about their children's safety, grapple with persistent threats. Schools have seen an increase in time needed to enter because of metal detectors. This poses a significant inconvenience for students, teachers, and administrators. Unfortunately, metal detectors are necessary due to the increase of school shooting incidents that are not unique to Henrico County. Our motivation for this study was to observe how different social and economic factors are associated with school shootings in the United States (U.S.) and then identify which factor has the strongest association.

Multiple research papers have examined the individual factors contributing to mass shootings, including gun accessibility, mental health, social rejection, and financial stress (9-15). Some studies relied on qualitative approaches based on media reports or literature synthesis (10-11), while others adopted quantitative analyses. For example, time-series analyses have shown statistically significant associations between spikes in social media activity and the timing, location, and severity of school shootings (12). Poisson and negative binomial regression models have assessed the relationship between income inequality and the frequency of mass shootings across U.S. counties (13). Logistic regression has been used in multiple studies to investigate how: the COVID-19 pandemic influenced firearm access among households, school connectedness and social support relate to firearm carrying among students, and socioeconomic variables such as poverty and urbanicity are associated with school shootings (9, 14, 15). Despite these previous studies providing meaningful discoveries, few have attempted to develop a multivariate framework that jointly evaluates the relative influence of key socioeconomic and contextual variables on the incidence of school shootings. Furthermore, studies on general gun violence have limited applicability to education-focused policy and prevention strategies.

Therefore, our study aimed to fill these gaps by constructing a unified quantitative model that integrated multiple domains of risk. We examined five factors: COVID-19 cases, social media use, income inequality, financial inflation, and gun supply (measured by gun sales). While prior research has investigated other variables such as school connection, family dynamics, local crime rates, and shooter’s profile, we focused on the selected five factors for two reasons (9-15). First, these factors have both theoretical and empirical support across multiple studies as being linked to school shootings, either directly or indirectly. Second, we prioritized variables that are reliable and comparable at the national level. Potentially relevant variables, such as individual-level shooter profiles, local crime rates, or family background, lacked consistent national-level data so we excluded them. COVID-19, with its profound impact on mental health during quarantine, was scrutinized through the "average number

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of cases" nationally (16). This metric symbolized the rapid spread of the pandemic and the profound toll it took on people. Social media, seen as a powerful tool for spreading ideas, was investigated for its role in spreading harmful ideologies, inciting cyberbullying, and influencing teenagers to engage in dangerous activities, including school shootings (12). Social media may be a catalyst for negative mindsets, increasing frustration, anger, and depression. The number of active Facebook users represented social media usage. Moreover, economic hardships and lack of opportunities contribute to feelings of frustration and hopelessness, increasing the likelihood of violent behavior. A previous study indicates that income inequality is positively correlated with shootings (13). The Gini coefficient, which ranges between 0 and 1, is a common measure for income inequality (17). A higher Gini coefficient value indicates greater levels of income inequality. Additionally, the inflation rate is one of the most closely monitored economic indicators. Rising inflation reduces the purchasing power of families and households, which may contribute to greater frustration, anger, depression, and anxiety. As a result, inflation is an important factor in school shootings. Gun supply was measured through the number of guns sold nationally. Gun supply was examined for its role in shaping the availability and distribution of firearms, which may affect access to guns and contribute to the frequency of school shootings (18).

We hypothesized that social media would have the greatest correlation with school shootings due to its widespread use among students and adults. As a platform for sharing ideas, social media has the potential to directly influence people globally, contributing to the rapid dissemination of radical ideas, such as extreme beliefs, violent messages, or harmful group content, including those that may lead to school shootings. Additionally, with the rise of COVID-19 and the associated lockdowns beginning in 2020, social media use surged as people sought connections while isolated at home (19). This increased engagement may amplify the influence of social media, correlating with increased school shootings during the pandemic (4). Our results support this hypothesis: social media is the most positively correlated factor with school shootings, followed by gun supply and inflation. This result signifies the importance of educating people, especially youth, on the negative effects of social media use. Based on our findings, programs and interventions can be developed to promote safer and more supportive learning environments.

RESULTS

To compare the impact of factors on mass shootings, we used a multiple linear regression model with the number of the shootings as the target variable and standardized factors as input variables: COVID-19 cases, gun supply, social media usage, income inequality, and inflation rate (**Table 1**). The overall model was statistically significant ($F(5,108) = 20.39$, $p < 0.001$) and explained approximately 48.6% of the variance in school shootings ($R^2 = 0.486$, adjusted $R^2 = 0.462$).

Among the factors, inflation was positively associated with school shootings ($\beta = 8.37$, $t = 3.451$, $p = 0.001$), indicating that higher inflation is linked to a greater number of incidents. Social media use also showed a significant positive relationship ($\beta = 17.15$, $t = 5.299$, $p < 0.001$), suggesting that increased social media engagement corresponds with more shootings. In contrast, gun supply was negatively associated with school shootings ($\beta = -9.93$, $t = -2.098$, $p = 0.038$), indicating that higher gun supply was linked to fewer reported incidents in this sample. Income inequality ($\beta = 96.73$, $t = 0.710$, $p = 0.479$) and COVID-19 cases ($\beta = -1.08$, $t = -0.168$, $p = 0.867$) were not statistically significant predictors. These results suggest that, within the factors examined, inflation, social media use, and gun supply have strong associations with the frequency of school shootings, while income inequality and COVID-19 cases did not show statistical significance in this model.

All variables have variance inflation factor (VIF) values of less than five, indicating no significant multicollinearity concerns in the model, and the coefficients can be considered reliable (**Table 1**). The coefficients for these significant standardized factors can be used to rank their effect on the number of school shootings (**Table 1**). Among the significant factors, social media had the most prominent influence on school shootings, supporting our hypothesis.

Input Variables	Standardized Coefficient	*p*-value	VIF
Inflation	8.36	0.001	1.342
Gun Supply	-9.93	0.038	1.980
Income Inequality	96.73	0.479	1.484
Social Media	17.14	0.000	2.840
COVID-19 Cases	-1.08	0.867	1.257

Table 1: Linear regression coefficients and *p*-values. Linear regression was used to estimate the standardized coefficients, *p*-values, and VIF of the input variables. The *p*-values test the null hypothesis that each coefficient equals zero (no relationship between the input variable and the number of school shootings). *p*-values less than 0.05 for inflation, gun supply, and social media indicate the significance of those variables in relation to the school shooting. VIF values less than 5 for all variables indicate no significant multicollinearity concerns.

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DISCUSSION

We found that social media has the most significant correlation with the frequency of school shootings. This finding supports a previous publication and quantifies the strength of this relationship relative to other factors included in our study (12). Increased social media usage during the COVID-19 lockdowns likely intensified this effect, as students spent more time online and were exposed to a wider range of disruptive content. The incident of thirteen-year-old, Lucia Bremer, shot by a fourteen-year-old teenager is one example (4). Social media platforms, especially those popular with teenagers, play an important role in developing attitudes and behaviors. Only Facebook users were analyzed specifically due to its popularity compared to other social media platforms such as Snapchat or Instagram, which had not surpassed Facebook's overall users, especially in the earlier time span of our data collection in the early 2010s. Additionally, Facebook had more expansive data regarding its users online than the other two platforms. To reduce the impact of extremists, those platforms should enforce stricter age verification (12). Companies can also use artificial intelligence (AI) detection software to pinpoint and remove harmful information in real time. Schools should develop clear anti-bullying policies with proper systems to support students and monitor their online digital behaviors. Indeed, increased school connectedness and social support significantly reduces weapon-related violence (14). Addressing the impact of social media on youth behavior and mental health should be a priority for education. In addition, in future research, other social media platforms can be studied (e.g., Snapchat and Instagram).

Inflation, which affects the purchasing power of families, can promote economic insecurity and stress. Prior research has shown that poverty and local economic strain are associated with increased school violence (15). For example, as product prices rise due to inflation, this disproportionately targets low-income families. Those families struggle to afford the necessities such as food, water, housing, and transportation as prices rise. As such, students of these low-income households suffer from inadequate living conditions and anxiety obtained from the parent's financial stress. Uncomfortable living conditions or lack of financial security at home can greatly affect student's mental health as they attempt to balance these issues on top of their academics and social lives. Economic support programs aimed at reducing income inequality and alleviating the effects of inflation can help prevent school shootings.

Even though our study indicates gun supply is an important factor, its relationship with the frequency of school shootings is counterintuitive. The result might be caused by the limitation of the data. We used the number of guns sold instead of the accessibility of firearms. An increase in gun sales, when accompanied by safe storage practices and better control of accessibility does not necessarily lead to an increase in firearm-involved violence (9). As such, our use of gun sales versus gun accessibility may have skewed the results as gun accessibility would have been a more accurate indicator of the risk of school shootings. After all, by tracking only gun sales, we are unaware of who has access to these weapons, which is essential in the context of school shootings. This result warrants further investigation and discussion. Measuring gun accessibility can be challenging due to the various factors involved, such as legal restrictions, cultural attitudes, and the availability of firearms through legal and illegal means. Conducting household surveys asking respondents about gun ownership, storage practices, and ease of access may mitigate this issue.

COVID-19 did not have a significant impact on school shootings, which contrasts with previous findings that pandemic-related social security increased firearm access and risk behaviors (9). Factors including social media, inflation, and gun supply could be associated with behavioral changes that emerged from the pandemic rather than direct cases due to COVID-19. In addition, since most of the data predates the pandemic, the variable of COVID-19 death may be skewed, potentially underestimating its influence in the analysis. While pre-pandemic data may dilute COVID-19's impact, the purpose of our study was to compare its effects with long-standing factors, as school shootings were a concern well before 2020. The insignificance of income inequality in our study contrasts with previous studies that investigated all types of public mass violence, not just school-specific shootings (13). The minimal impact of income inequality may also reflect data limitations. Because of the lack of monthly data, the annual income inequality of the United States was extrapolated to each month, resulting only 10 unique observations are available to measure income inequality.

We recognize that excluding other factors included in literature may limit the completeness of the findings. It is possible that other variables not included in the model may show stronger correlations with school shootings. However, our study is not intended to be exhaustive. Instead, our study aims to contribute to the broader discussion of the social drivers of school shootings by systematically analyzing key social and economic indicators within a single quantitative framework—an approach uncommon in the literature. In the future, additional factors such as household income, mental health, rates of bullying in schools, parenting styles and supervision, metal detectors and surveillance cameras in schools, and crime rates should be included in the model. Previous research has stated that student mental illness in schools contributes to the frequency of mass school shootings (11). This correlation should therefore be further analyzed to determine their specific relationship and better understand what factors are associated with student mental health. Rates of bullying in schools may correlate with school shootings, as stronger school support is associated with reduced bullying. It has also been stated that school support and connectedness were inversely related to weapon violence (14). Additionally, it has been observed that high violent crime rates create a higher probability of school shootings, which is why crime rates could be included as an additional factor in future model studies (15). More advanced modeling algorithms should also be explored. The linear regression model was chosen due to its interpretability and transparency, aligning with the goal of clearly identifying and ranking the relative importance of each factor. However, linear regression assumes additive and linear relationships between predictors and the target variable. On the other hand, the tree-based modeling algorithms (e.g., Random Forest, XGboost) can better capture the non-linearity

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of relationships and allow for evaluation of interaction effects. However, due to the absence of standardized coefficients, an alternative metric is needed to measure and compare factor importance in tree-based models. Additionally, future studies can be conducted at the geographic level to better understand how the impact of different factors on school shootings vary by location. For example, the number of school shootings from 2020 to 2021 in Illinois increased from 8 to 23, while Nebraska saw a decrease from 3 to 1 (2). Understanding the significant difference between state-specific school shootings can provide additional perspectives on the relationship between studied factors and school shootings. These results can support the development of customized policies for each state.

In all, gun supply, social media, and inflation were shown to be social and economic drivers of school shootings, with social media having the greatest association. As a result, action should be taken to implement programs that not only prohibit exposure of harmful social media content but also educate youth on avoiding violent subject matter. Our study provides a novel method for assessing the influence of social and economic drivers on school shootings and encourages further exploration into the factors researched. With further exploration, certain initiatives can be executed to create safer learning environments and reduce the risk to students.

MATERIALS AND METHODS

Data Collection

The predictors and the target variable were first chosen. Then, data regarding these variables were gathered and prepared using Microsoft Excel (Version 2508). Monthly data from January 2013 to June 2022 were obtained from reliable and approved sources for all variables unless specified below (16-22). The time window was selected to ensure there was a sufficient sample size to build a robust regression model and capture the long-term trends of school shootings. Monthly intervals were chosen to balance granularity and model stability. The target variable, number of shooting incidents at K-12 Schools, was downloaded from the Center for Homeland Defense and Security (20). Gun supplies were extracted from the Bureau of Alcohol, Tobacco, Firearms and Explosives website (18). Social media usage was obtained on the global data website and consisted of the number of daily active Facebook users per quarter (21). Income inequality using the Gini Index was found in Statistics between 1990-2022 (17). The COVID-19 death numbers were downloaded from the Centers for Disease Control and Prevention from 2020-2023 monthly (16). Inflation rate was downloaded from the U.S. Inflation Calculator (22).

Data Preparation and Cleaning

After the data was collected, data preparation included both cleaning and standardization. The missing data was observed in both the target variable (the number of school shootings) and factors (the number of deaths due to COVID-19 and number of Facebook users). The number of school shooting events July 2013 and July 2014 was missing. The average of the pre- and post-COVID-19 months were used to impute their values. COVID-19 emerged in the first month of 2020. Thus, the number of COVID-19 deaths for all previous months were imputed as zero.

In addition, Facebook average daily active users were calculated on a quarterly basis and applied to all three months in that quarter. Moreover, media data was missing for the second quarter of 2022. We applied the change ratio from Q1 to Q2 2021, and the volume in Q1 2022 to estimate the social media usage volume in Q2 2022. The interquartile range (IQR) plots were created to confirm that there are no outliers in our data. The IQR is calculated as the difference between the third quartile and the first quartile (e.g., Q3-Q1). The middle line in an IQR box plot illustrates fifty percent of the data. An outlier is a value that does not follow the common trend of the data and can be detected through box plots.

The last step of data preparation was transforming all input variables into the same scale to make impact factors comparable through min-max normalization. Each value is transformed by subtracting the minimum of the variable and dividing by the range of the variable, which is defined as the difference between its maximum and minimum. This method was chosen because it transforms our data to a fixed range between 0 and 1, ensuring all variables contribute equally to the model without the influence of different scales. After the factors were standardized to have a scale of [0,1], we were able to compare their coefficients. For each percent increase in an input variable, the number of school shootings increases or decreases by the value of its coefficient. Compared to other standardization methods such as having a mean of 0 and standard deviation of 1, the min-max normalization approach keeps the relative position of the data points and makes it easier to interpret the range of each input variable. In addition, the IQR box confirmed that there are no outliers in our data set that support the choice of normalization method. Otherwise, other standardization methods could be considered.

Multiple Linear Regression Model

Next, we created a multiple linear regression model containing all variables. A linear regression model was used to find relationships between the target and input variables. The ordinary least squares (OLS) method was used to estimate the intercept and coefficients of the input variables. OLS methods minimize the sum of squares of the differences between the observed target and the predicted output, which is calculated as a linear function of the input variables

Analysis of Results

Lastly, we examined key model outputs including the p-value of each variable, the magnitude of coefficients, and VIF values to assess statistical significance, variable importance, and multicollinearity. Variables with low p-values ($p < 0.05$) are considered significant, meaning their relationship with the target is unlikely to occur due to chance. Standard coefficients indicate variable importance and a larger magnitude of coefficient suggests a stronger effect, with the sign showing the direction (positive or negative). Low VIF values (below five) indicate that variables are not highly correlated with each other, ensuring stable coefficient estimates. Three Python (version 3.9) packages—Pandas, Statsmodels, and Numpy—were used to conduct the analysis in the last two steps.

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