Investigating Factors in Firearm Fatalities in Pediatric Populations

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Abstract

Despite advancements in public health initiatives, preventable firearm injuries among children persist in the United States. This study investigates correlations between household income,
single parent households, severe housing problems, and firearm fatalities among pediatric populations in Ohio counties. Utilizing data from the County Health Rankings and the National Center for Health Statistics–Mortality Files, our analysis reveals a negative correlation between household income and firearm fatalities, emphasizing the role of socioeconomic factors in firearm safety. Additionally, we found a positive correlation between single parent households and firearm fatalities. Furthermore, a weak positive correlation suggests a potential link between severe housing problems and increased risk of firearm incidents. These findings highlight the need for targeted interventions to promote firearm safety in vulnerable communities, aiming to reduce preventable firearm injuries among children in Ohio.

Key Words: Firearm fatalities, household income, Ohio, West Virginia, Pennsylvania, severe housing problems, pediatrics

Introduction

Currently, there are many preventable firearm injuries that need to be explored. Specifically, children in the United States (or Ohio) are at risk for firearm fatalities despite this being preventable. A recent statistic, there is a 41.6% increase in the amount of firearm death rates in pediatric populations from 2018 to 2021.¹ Currently it is unknown how risk factors correlate with firearm fatalities in children. Specifically, these risk factors include single parent
households and low-income counties. However, current understanding of this topic is not conclusive. The gaps we address in this study are: 1. understanding how current state gun laws influence firearm fatalities for children since each state has their own policies. 2. Understanding of how important gun safety is for children. 3. Knowledge of how a lack of resources affects firearm safety and child mortalities. Providing research on this conversation can inspire leaders to provide resources and legislation to the underserved population to prevent firearm death rates in pediatric populations. This data can also urge parents to use stricter gun safety protocols to keep guns out of reach for children. Lastly, the data can also serve to help identify the underlying causes a child may have accidental firearm fatalities.

A study uses 7 years of data from the National Trauma Data Bank to analyze trends by characterizing firearm injuries to indicate that there is a difference in mortality rates between infants, adolescents, and adults. In the pediatric population, the highest case fatality rate is related to firearms compared to MVA, trauma, and other categories. In other areas, legislation in states can constitute the potential rates of firearm fatalities in pediatric populations. One study found that there is a negative correlation between the stringency of legislation in the states and firearm fatality rate. Depending on the stringency of legislation, we can prevent possible firearm fatalities in pediatric populations, and this could serve as a template for many states that have higher firearm fatalities. The gap is that there is differing legislation in each state which is resulting in different mortality rates among pediatric populations, thus we must dive into the states with stringent legislation and low pediatric mortality rates to make conclusions about their policy for other states.

One study explores unintentional firearm deaths among children in different age groups from 0-14 years old. The data used was from the National Violent Death Reporting System for
16 states from 2005 - 2012. This article also demonstrates how unintentional gun deaths among children’s data is underestimated, though the data was not for the full pediatric years (0-18 years old). Key findings include: an average of 110 unintentional firearm deaths for children from 0-14 years old. The victims consisted of 81% males. Also, roughly 66% of shootings are from another child (33% resulting in self-injuries) with 97% of those cases involving a male shooter. The study addresses how most of the fatalities are due to accidents and the importance of keeping firearms away from children. From the accidents that occur, researchers explored the risk factors of fatal / nonfatal firearm injuries among children including intent, demographics, state patterns, and circumstances. Results show annually 1300 children die and 5790 children are treated for gunshot wounds. Boys, older children, and minorities were disproportionately affected according to the results. Further, southern states and some midwestern states showed the highest firearm homicide rates. Households with family conflict were correlated with firearm homicides. Lastly, the most common circumstance of accidental firearm injury was due to playing with a gun. However, there is a neglect of exploring underserved individuals who are either low income or are single parent households and their ability to secure their weapons within their homes. Because of this gap in research, we hope to explore underserved populations and incidence of firearm fatalities in pediatric populations. In doing this, we can provide an insight for local and national leaders to pursue change in policy and resources to make firearms safer to own.

**Research Questions**

1. What is the correlation between firearm fatalities and household income within Ohio counties in 2022?

2. How do household income, severe housing problems, high school graduation, and mental distress, predict the rates of firearm fatalities in 2022?
3. What is the correlation between single parent households and firearm fatalities within Ohio counties?

4. What is the difference in child mortality rate among Pennsylvania, Ohio, and West Virginia in 2022?

5. What is the correlation between severe housing problems and firearm fatality within Ohio counties?

   a. Severe housing problems are defined as: overcrowding, high housing costs, lack of kitchen facilities, or lack of plumbing facilities.

Methods

Data Collection

Our primary source of data comes from County Health Rankings which is a database composed of data from many different national databases such as American Community Survey, National Center for Health Statistics, etc. For our study, we are using data from County Health Rankings in 2016 and 2023. Most of our research questions are using data for all Ohio counties, however, one research question we proposed includes Ohio, Pennsylvania, and West Virginia.

In our study, we wanted to compare several variables to find correlations and potential reasons for the rate of pediatric firearm fatalities in counties or states. Our most important variable, firearms fatality rate, was collected from the National Center for Health Statistics - Mortality Files. Firearms fatality rate is incorporated into almost all of the research questions to explore different associations with the associated variable. Another variable used is the child mortality rate collected from the National Center for Health Statistics–Mortality Files to examine
the potential difference in the child mortality rate between 2016 and 2022. The next variable we used was severe housing burden collected from American Community Survey 5-year estimates to explore a correlation between firearm fatalities and severe housing burden for families. We imagined that with a severe housing burden, families with firearms do not have the capacity to store their firearms resulting in pediatric misfires or unintentional firearm deaths. This assumption is further discussed as one of our study's limitations. The next variable we decided to use is the percentage of single parent households collected by the American Community Survey 5-year estimate to explore a correlation between firearm fatalities and single parent households. We thought this was worth exploring because with single parent households, there is limited supervision of children which could potentially result in mishandling of weapon systems within homes. The last variable we included in our research question was the 80th percentile income and 20th percentile income collected by the American Community Survey–5-year estimates. These percentiles were used specifically because the income data collected by the American Community Survey were households in the 20th, 50th, and 80th percentile. We propose that with different subsets of income, families with higher incomes have better resources to provide safe-handling methods of firearms within their households such as safes or bolt-lock devices. We understand that a correlation can be due to many factors, so this is further discussed as a limitation.

Our inclusion criteria for our study were to include firearm fatalities in individuals less than 18 years old or if families or individuals have firearms within their household, including families that own more than one firearm. Using countyhealthrankings, there was no way to report the number of firearms a family owns, rather just if the family owned at least one. Our exclusion
criteria only includes that we remove data with firearm fatalities in individuals greater than 18 years old.

Data Analysis

In our data analysis, we used several tests to reach conclusions about our research questions described above. Firstly, to find a correlation between firearm fatalities and household income, a Pearson correlation was utilized. Secondly, we used a regression to see if median household income, households with severe housing problems, high school completion, and mental distress predict rates of firearm fatalities in 2022. Thirdly, a Spearman correlation was employed to determine a correlation between single parent households and firearm fatalities. Additionally, an ANOVA test was used to determine whether differences in firearm fatalities exist between Ohio, Pennsylvania, and West Virginia. Lastly, using the Spearman correlation, we investigated if there is a correlation between severe housing problems and firearm fatalities.

Results

When comparing firearm fatalities and household income in Ohio counties in 2022, using Pearson correlation, we found there was a negative correlation (p < 0.001) (Figure 1). Using regression analysis, we used median household income, severe housing problems, mental distress frequency, and high school graduation rate to predict the rates of firearm fatalities. We employed the step wise method for this regression and found the best fitting model was significant (F_{2,77} = 26.233, p < 0.001), accounting for 40.5% of the variance in firearm fatalities. Median household income contributed the most to the model (B = -0.000, t = -5.698, p < 0.001), followed high school graduation rate (B = -0.137, t = -2.627, p = 0.010). The variables of frequency of mental
distress and severe housing problems did not significantly contribute to the model. Using Spearman’s Correlation, we found a positive correlation between the amount of single parent households and firearm fatalities ($R = 0.635$) with a $p$ value of less than 0.001 (Figure 2). Using ANOVA, we examined the difference between child mortality rates among Pennsylvania, Ohio, and West Virginia. We found a statistically significant ($p < 0.001$) difference between the child mortality rate within these states. With West Virginia having the highest child mortality rate and the lowest child mortality rate in Pennsylvania. Lastly, using Spearman correlation, we examined a correlation between severe housing problems and firearm fatalities in all Ohio counties. The results determined a weak positive correlation ($R = 0.32$) with statistical significance ($p = 0.004$) (Figure 3).

![Figure 1: Scatter plot showing the Pearson correlation between household income and firearm fatalities in Ohio counties in 2022. Each point represents a county. The trend line represents a statistically significant inverse relationship ($p < 0.001$).](image-url)
Figure 2: Scatter plot illustrating the Spearman correlation between the percentage of single parent households and firearm fatalities in Ohio counties in 2022. Each point represents a county. The trend line indicates a statistically significant positive relationship ($R = 0.635$, $p < 0.001$).
Discussion

In our results, we found that there is a negative correlation between firearm fatalities and household income, showing that as household income increased, firearm fatalities decreased. From the step wise regression model, median household income had the strongest negative association with firearm fatality rates, indicating that higher income levels are associated with lower fatalities. High school graduation rates were also negatively associated with firearm fatalities, showing that higher educational attainment is linked to lower firearm fatalities. We propose higher income individuals have access to gun safety and handling of firearms, in addition, they have the income to purchase safe weapon handling equipment to avoid misfires or unintentional firearm deaths. Researchers conducted a study where the highest risk for firearm fatalities are low-income neighborhoods. In addition, among different races, African American
children were the highest regardless of socioeconomic status for firearm fatalities. Next, we found that there was a positive correlation between the amount of single parent households and firearm fatalities. A study described that since the COVID-19 pandemic, there was an exacerbated amount of pediatric firearm injuries due to neglect of supervision from the children.\textsuperscript{11} While we are still recovering from the COVID-19 pandemic, from previous studies, there still shows a 42.6\% percent increase in the amount of firearm fatalities from 2018 to 2021.\textsuperscript{1}

In our study, we investigated child mortality rates amongst three states: Ohio, Pennsylvania, and West Virginia. Using ANOVA, we found a statistically significant difference ($p < 0.001$) in child mortality rates between the three states. West Virginia was found to have the highest mortality rate, while Pennsylvania had the lowest. These findings highlight the importance of understanding regional disparities in child health outcomes and targeted interventions to improve child survival rates. According to the National Center for Health Statistics, West Virginia had a preterm birth rate of 13.0\%, higher than the national average.\textsuperscript{7} This indicates an underlying problem that may need to be addressed, leading to the higher preterm birth rates. According to the CDC, racial and ethnic disparities have a lot to do with infant mortality. In one study conducted by the CDC, efforts to improve prenatal care and address social determinants of health affect child mortality rates; states that address these issues may have lower rates of child mortality.\textsuperscript{8} Additionally we explored the correlation between severe housing problems and firearm fatalities in Ohio counties using a spearman correlation. The data showed a weak correlation ($R = 0.32$) that was statistically significant ($p = 0.004$). This suggests that counties with higher rates of severe housing problems may also experience higher firearm fatalities among children. Addressing housing instability and improving living conditions could potentially help reduce these childhood fatalities.\textsuperscript{9}
Our limitations with our study would first be that our data was only gathered from the County Health Rankings website, however, they pull surveys from various nationwide databases. For our study, we only performed a retrospective study looking at trends and disparities among pediatric populations previously. If we wanted to gather more concrete data to recognize the disparities among pediatric populations, a prospective study where we looked into more factors than just what we have described to make more concrete conclusions about firearm fatalities in pediatric populations. Additionally, every state has their own unique laws on firearm protocols. Due to this, generalizing to other states is compromised when trying to push for legislation in states outside of Ohio, Pennsylvania, and West Virginia. Lastly, the certainty of bias in our study may have focused our data to reflect that there is neglect for firearm fatalities in pediatric populations since there may be implementations or legislation that we were not aware of.

The future directions of our study can be to conduct a prospective study to gather comprehensive data on factors that contribute to firearm fatalities among children. This study should include more variables like access to mental health services, community safety measures, and effectiveness of firearm safety education programs. This study allows us to identify causal relationships and potential areas of intervention to reduce fatalities. In our research, we also assumed that households classified as having severe housing burdens would have a lack of safe firearm storage. This was backed by very minimal research, so a future study can be conducted to determine whether there is a correlation. Along with this, we proposed that households at the 80% income threshold have safer handling methods of firearms. However, there are many confounding variables that can lead to firearm use discrepancies between income classes, so this should be studied further. Another future study can investigate the impact of existing and proposed legislation regarding firearm safety. This analysis should include an examination of
firearm laws, safe storage regulations, enforcement mechanisms, and effectiveness of these laws in reducing firearm injuries among children. Additionally, there is no current data on differentiating whether a household has more than one firearm. This distinction could provide insight on if owning more than one firearm correlates with firearm fatalities, so it should be studied further. Furthermore, it is important to repeat the current study in the future, using more updated years to increase validity, especially if the results are statistically significant using a $p < 0.05$ cutoff. Lastly, reproducing this study with more, if not all the states across the United States would allow generalizations to be made to broader populations.

**Conclusion**

In conclusion, our study highlights the prevalent issue of preventable firearm fatalities among pediatric populations in the United States, more specifically, Ohio. We have identified several correlations and trends related to firearm fatalities related to household income, single parent households, and severe housing problems. Our results indicated a negative correlation between household income and firearm fatalities, suggesting that higher-income families may have better resources for gun safety. In contrast, we observed a positive correlation between single parent households and firearm fatalities, showcasing the importance of supervision and safe firearm storage. Lastly, within the tri-state area, West Virginia had the highest child mortality rate when compared to Pennsylvania and Ohio, suggesting that legislation and resources provided by individual states could be different and need to be further examined.

Our study suggests potential interventions to address these disparities listed above, including targeting legislation, community safety protocols, and firearm safety educational programs. Future research such as a prospective study could be used to identify additional
variables not discussed in this study and to gather more of a concrete database. Overall, our findings conclude the importance of policy change and allocation of resources in the United States to prevent further firearm fatalities in pediatric populations.

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