Social Medicine
Health For All
ISSN: 1557-7112

ORIGINALRESEARCH

# Risk Factors of Gun-Related Homicides in the District of Columbia, USA: A Public Crisis

# Factores de riesgo en homicidios con armas de fuego en el Distrito de Columbia, EUA: una crisis de salud pública

**Anand Gourishankar.** Division of Pediatric Hospital Medicine. Children's National Hospital/George Washington University, Michigan Avenue, NW, Washington, District of Columbia, United States of America.
Email: agourishan@childrensnational.org , https://orcid.org/0000-0003-4344-7032

**Received:** December 30, 2024.
**Accepted:** April 1, 2025.
**Conflicts of interest:** None.
**DOI:** https://doi.org/10.71164/socialmedicine.v18i3.2025.1957

**Abstract**

**Introduction.** The rising incidence of gun violence in the United States, particularly in the District of Columbia (DC), calls for a deeper examination of its patterns and implications. This study explores the geographic distribution of gun-related crimes, focusing on neighborhood trends, associations with other criminal activities, and the disproportionate impact on disadvantaged communities. Our goal is to identify key areas for targeted intervention and prevention strategies. **Methods.** We conducted descriptive statistical analyses of gun violence incident data from 2015 to 2023. The Chi-square test of independence was used to assess relationships between categorical variables. Spatial analysis was employed to examine homicide and Assault with a Deadly Weapon (ADW) rates, as well as their geographic overlap. Additionally, public and private schools were mapped on Kernel density plots to assess their proximity to gun violence hotspots during nighttime hours. **Results.** Annually, there were 708 ADW incidents and 131 homicides on average. A statistically significant majority occurred after midnight ($p < 0.001$). Both ADW and homicide rates were highest in southern DC. Kernel density mapping revealed that public and private schools are frequently near gun violence hotspots. Spatial collocation analysis showed a significant association between ADW and homicide incidents. **Conclusions.** Gun violence-related homicides predominantly affect disadvantaged communities, necessitating improved surveillance, targeted resource allocation, and focused interventions. Effective prevention requires a comprehensive, community-based policy approach tailored to the unique needs of these neighborhoods.

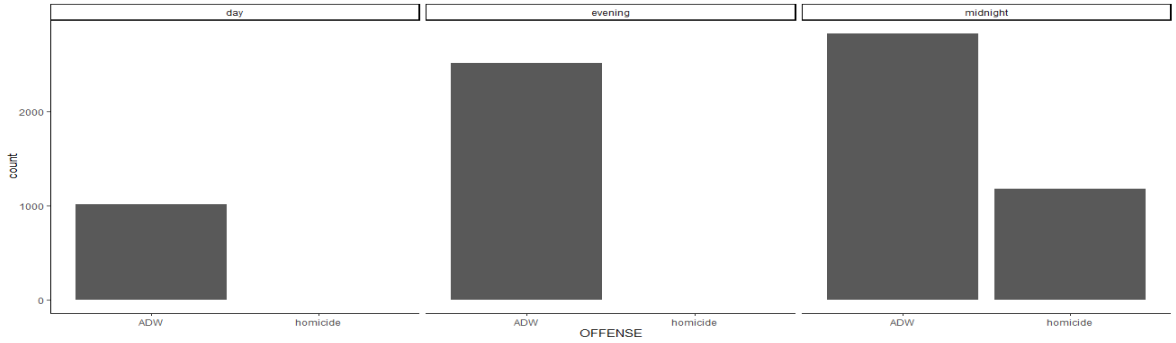
**Keywords**: Gun violence, mapping, homicide risk

**Resumen**

**Introducción.** La creciente incidencia de violencias con armas de fuego en Estados Unidos, en particular, en el Distrito de Columbia (DC), exige un análisis más profundo de sus patrones e implicaciones. Este estudio explora la distribución geográfica de los delitos con armas de fuego, centrándose en tendencias vecinales, su asociación con otras actividades delictivas y su desproporcionado impacto en comunidades desfavorecidas. Nuestro objetivo es identificar áreas clave para diseñar estrategias específicas de intervención y prevención. **Métodos.** Realizamos un análisis estadístico descriptivo con datos sobre el fenómeno entre 2015 y 2023. Se utilizó la prueba de chi-cuadrada de interdependencia para evaluar las relaciones entre variables categóricas. Se empleó un análisis espacial para examinar las tasas de homicidio y agresión con arma letal (AAM), así como su distribución geográfica. Además, se mapearon escuelas públicas y privadas en gráficos de densidad para evaluar su proximidad a posibles focos de violencia con armas de fuego durante la noche. **Resultados.** Anualmente, se registran un promedio de 708 incidentes de violencia armada y 131 homicidios. Una mayoría, estadísticamente significativa, ocurrió después de la medianoche ($p < 0.001$). Tanto las tasas de violencias armadas, como las de homicidios, fueron más altas en el sur del Distrito de Columbia. El mapeo por *kernels* de densidades reveló que las escuelas públicas y privadas se encuentran frecuentemente cerca de focos de hechos con violencias armadas. El análisis de distribución espacial mostró una asociación significativa entre estas violencias y los homicidios. **Conclusiones.** Los homicidios relacionados con las violencias armadas afectan predominantemente a las comunidades desfavorecidas, las cuales requieren mejor vigilancia, una asignación específica de recursos e intervenciones focalizadas. Una prevención eficaz demanda un enfoque integral de políticas comunitarias adaptadas a las necesidades específicas de estos barrios.

**Palabras clave**: violencia armada, mapeo, riesgo de homicidio

**Figure 1. Gun-related Crimes in the District of Columbia during three shifts**




**Source:** al the charts were made by the author

## Introduction

Rising gun violence in the United States, particularly in the District of Columbia (DC), urgently demands a deeper understanding of this critical social and public health issue.[1,2]The lives of individuals are at risk due to this preventable violence, which continues to increase.[3] The United States leads in homicide rates among high- and low-income countries.[4] In recent years, there has been growing concern about the impact of gun violence and its proximity to schools within the district.[5] As tragic incidents increase, understanding the link between gun-related violence and its proximity to educational institutions has become imperative.

Most homicides in the district were committed using a firearm, and took place either in a residential dwelling or on a public road.[6] The motivation for geographic analysis derives from the fact that community gun violence includes neighborhood or place-based risk factors. Our study focuses on the geographical patterns of gun-related crimes in D.C., which ranks 20th in the nation for gun fatalities.[7]There is limited knowledge about the geographic distribution of homicide, a growing area of research.[8,9]This analysis aims to delve into the intricate dynamics of these issues, examining the data and identifying potential patterns or correlations that may provide insights for preventive measures and interventions. By shedding light on this complex and pressing issue, we hope to contribute to the ongoing efforts to create safer communities for students and residents.

## Methods

We employed descriptive statistics to analyze continuous data, such as the number of gun violence incidents, from 2015 to 2023.[10] Addresses were geocoded (a geographical method to locate crime events) to the DC map using *ArcPro* 3.0 (ESRI, Redlands, CA). We utilized the Chi-square test of independence to examine the relationship between categorical variables. Additionally, we conducted a spatial analysis to identify rates of homicides and Assaults with a Deadly Weapon (ADW), and mapped their location. To do this, we first created maps to show the rates of homicide and ADW in census tracts of D.C. Then, we employed the advanced Colocation Analysis tool, which utilizes the colocation quotient statistic to quantify the local spatial association patterns between two categories of point features. The tool generates a map that shows the probability of a spatial relationship between the two analyzed categories. The map includes additional information, such as the colocation quotient value and p-value.[11]A $p < 0.05$ was considered statistically significant. There was an overlay of private and public schools after creating a Kernel density of nighttime incidents of homicide and ADW.

## Results

The research revealed that the annual rate of Aggravated Assault with a Deadly Weapon (ADW) was 708, significantly higher than the homicide rate of 131 over nine years. Figure 1 shows the

frequency distribution of ADW and homicide offenses, with both peaking during the midnight shift. This midnight association was statistically significant ($p < 0.001$), while negligible homicides were observed during the day and evening shifts.

Figure 2 displays two choropleth maps illustrating the geographic distribution of gun-related incidents in the District of Columbia after midnight, with rates per 1,000 population. The top panel shows ADW rates, and the bottom panel shows homicide rates. Both maps reveal a clear spatial pattern, with the highest rates concentrated in darker blue areas, mainly in the southeastern parts of DC, particularly east of the Anacostia River. Lighter-colored areas, indicating lower rates, are found in the northwestern parts of the city. The overlap of ADW and homicide rates during the midnight shift highlights areas with elevated levels of both types of gun violence.

**Figure 2. Homicide and ADW rates in the District of Columbia**

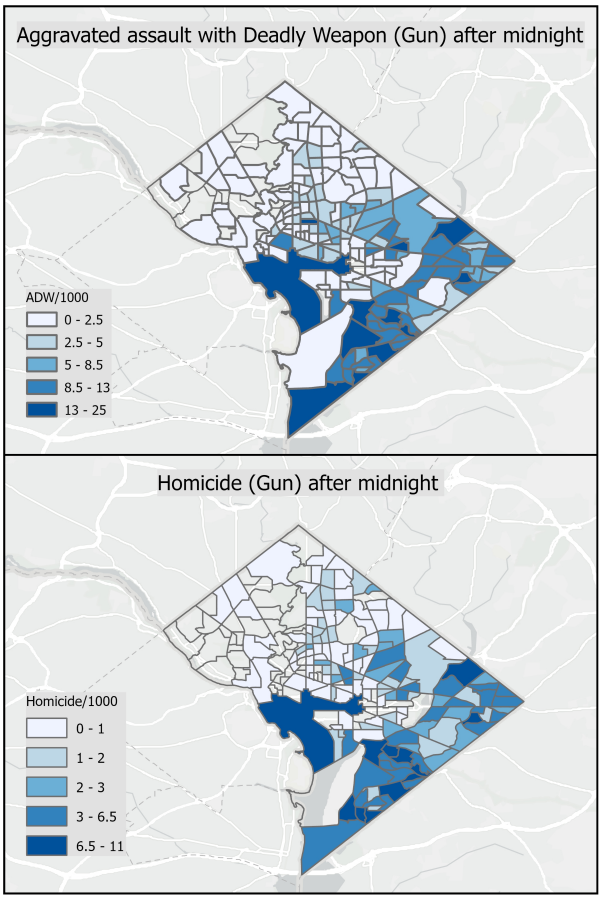
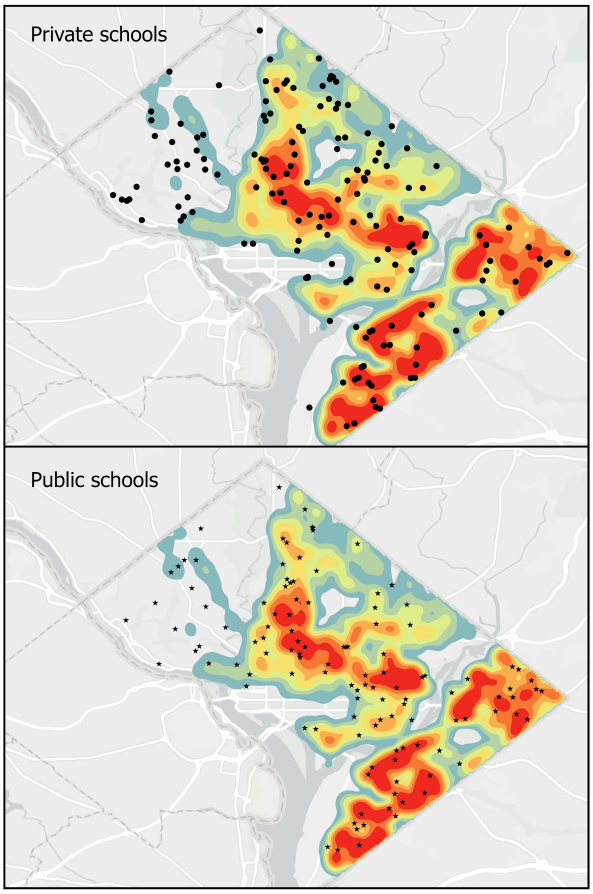


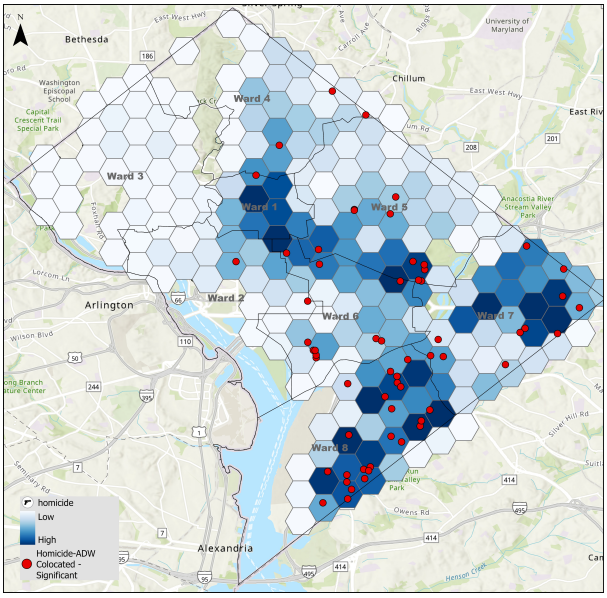

Figure 3 presents a Kernel Density map of gun crimes, showing that both public and private schools are located near hotspots of high gun crime density. Warmer colors (red and yellow) represent areas with higher densities, while cooler colors indicate lower densities. Schools are positioned within or adjacent to these high-density areas, especially in the southeastern and central/eastern regions of the District.

**Figure 3. Kernel density map overlayed with public and private schools**




Finally, Figure 4 shows the collocation map, which illustrates the significant spatial overlap between ADW and homicide incidents. The map uses hexagonal bins colored by homicide rate intensity, with red dots marking locations of statistically significant collocation ($p < 0.05$). These significant overlaps are primarily clustered in the southeastern (Wards 7, 8) and central/eastern (Wards 1, 5, 6) parts of the District.

**Figure 4. Homicide distribution in the District of Columbia with overlaid collocation**




## Discussion

The spatial analysis highlighted concentrated areas of violence, offering insights into geographical risk factors. The higher rates noted in this study are concerning, as reflected in the 2021 age-adjusted standard-population rate of 11.1 deaths per 100,000 males and 2.1 deaths per 100,000 females.[12] This study noted that homicides happened predominantly at night. The Federal Bureau of Investigation's examination in 2017 found that more violent crimes, including homicide, occurred at night across ten major cities in the United States. In this study, 54% of aggravated assaults and 65% of murders/non-negligent manslaughters occurred during nighttime hours. Among these ten cities, the rates of aggravated assault were 135.7 per 10,000 residents during the day and 159.9 per 10,000 residents at night.[13] Barboza et al. highlighted that gun violence was concentrated near schools.[9] Similar patterns were observed in the District of Columbia, where higher homicide rates are found in the southern parts of the city, areas with larger proportions of non-white and low-income residents (Figure 2). It is concerning that schools are closely surrounded by homicide events in DC (Figure 3), as it poses a higher risk of mental health issues. Vasan *et al.*[16] found that children living within 1/8 mile of a shooting are more likely to visit the emergency department for mental health concerns.[15] This underscores the need for a comprehensive, multidisciplinary approach involving all stakeholders to address and reduce gun violence (Vasan *et al.*, 2015; Barboza *et al.*, 2017).[16,17]

This study, focusing on ecological-level research into homicide and gun violence, emphasizes the importance of addressing research needs and gun policies within different communities. It highlights the value of community-level approaches, particularly when evidence shows that state- and federal-level laws—such as those restricting access to firearms for individuals under domestic violence orders—are linked to a reduction in intimate partner homicides.[18] While the District of Columbia and several other states have enacted laws prohibiting individuals at high risk of harming themselves or others from purchasing firearms, geographic disparities in homicide rates (Figure 2) and social determinants of health remain significant. In addition to predictive factors like education and poverty, structural disadvantages such as family disruption, residential segregation, and drug-related activities contribute to community gun violence. To address these issues, it is essential to foster public trust in community-level welfare programs and spending.[19]

There must be synergy between enforced laws and policies, accountability, and efforts to counteract those undermining these principles. To achieve this, a multilevel approach to addressing alcohol and drug-related issues in the community is essential. Additionally, hospitals, healthcare agencies, and gun violence advocacy groups should implement intervention programs, provide education, and offer community support. The success of prevention and intervention efforts relies on collective action, political will, staff support, and adequate funding.

The United States experiences higher rates of gun violence and related fatalities compared to other high-income countries. This disparity is largely due to the stricter gun ownership regulations in many other countries, which limit civilian access to firearms, in contrast to the Second Amendment rights in the U.S.A. However, evidence supporting the effectiveness of these regulations is often difficult to obtain due to methodological

limitations, highlighting the need for furtherresearch on this issue.[20] Several low- and middle-income countries, such as Brazil, Mexico, and El Salvador[21] experience high gun violence similar to Washington, D.C., or the U.S. AD CD in general. In these countries, the violence is often driven by gang activity and drug cartels, indicating a global trend in high-violence contexts. Across the globe, countries have adopted a wide range of approaches. Some countries have reduced gun violence by adopting specific policies; for example, Australia implemented gun buyback and banned certain firearms, Japan prohibits firearm possession with few exceptions, the United Kingdom bans handguns and many rifles, and Canada maintains a much stricter licensing and registration process.

Public health institutes in the United States offer several solutions to address gun violence, including: a) Firearm Purchaser Licensing, b) Firearm Removal Laws, c) Safe and Secure Gun Storage, d) Regulating the Public Carry of Firearms, and e) Community Violence Intervention. These solutions are most effective when they involve collective action from stakeholders, policymakers, bipartisan lawmakers, governance bodies, and relevant agencies.[22]An example of collective action at the community level is addressing the social and economic disparities rooted in historic redlining and exclusionary zoning laws, which have contributed to neighborhood structural segregation. These disparities lead to downstream effects, such as food insecurity, lack of affordable housing, environmental inequalities, inadequate education, unemployment, and limited social capital. These factors compound community gun violence. Without a comprehensive, multipronged approach, efforts in isolation will yield only marginal benefits.

This study highlights the need for best practices: strong legal regulations on firearms, complemented by public health interventions, focused policing, and a meaningful approach to addressing social and structural inequalities. Our findings support the environmental injustice of gun violence.[23] The novel collocation of ADW and homicide (Figure 4) events calls for prioritizing interventions in these areas. A moderate correlation between homicide and assault further supports this finding. We identify these associations among vulnerable populations as critical opportunities forintervention. While our results provide valuable insights, they are subject to certain limitations, including the scope of the data and potential reporting biases (e.g., accuracy of reporting after midnight). We plan to investigate further the association between the social vulnerability index and social factors.[25,26] Future research should explore the underlying factors contributing to these patterns and develop targeted intervention strategies.

## References

1. Worsham CM, Jena AB. Recent Improvements in Data From the Gun Violence Archive—Will They Lead to Change? JAMA Network Open 2023; 6(6): e2316512-e.
2. Roberts BK, Nofi CP, Cornell E, Kapoor S, Harrison L, Sathya C. Trends and Disparities in Firearm Deaths Among Children. Pediatrics 2023; 152(3).
3. CDC. Firearm Homicide Trends. Available at: https://www.cdc.gov/violenceprevention/firearms/firearm-homicide-trends.html. Accessed February 2, 2024.
4. Krug EG, Powell KE, Dahlberg LL. Firearm-related deaths in the United States and 35 other high- and upper-middle-income countries. Int J Epidemiol 1998; 27(2): 214-21.
5. Sen-Crowe B, Autrey C, Newsome K, Mckenney M, Elkbuli A. Mass Shootings and Their Proximity to a Public or Private School: Protecting the Health and Livelihood of Our Children. The American Surgeon™ 2022; 88(11): 2695-702.
6. Karch DL, Logan J, McDaniel D, Parks S, Patel N. Surveillance for violent deaths--National Violent Death Reporting System, 16 states, 2009. MMWR Surveill Summ 2012; 61(6): 1-43.
7. CDC. Firearm Mortality by State. Available at: https://www.cdc.gov/nchs/pressroom/sosmap/firearm_mortality/firearm.htm. Accessed February 2, 2024.
8. Messner SF, Anselin L, Baller RD, Hawkins DF, Deane G, Tolnay SE. The Spatial Patterning of County Homicide Rates: An Application of Exploratory Spatial Data Analysis. Journal of Quantitative Criminology 1999; 15(4): 423-50.
9. Barboza G. A Secondary Spatial Analysis of Gun Violence near Boston Schools: a Public Health Approach. J Urban Health 2018; 95(3): 344-60.

10. Building Blocks DC. Available at: https://www.buildingblocks.dc.gov/. Accessed December 12, 2023.
11. Colocation Analysis (Spatial Statistics). https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-statistics/colocationanalysis.htm. Accessed on March 31, 2025.
12. QuickStats: Age-Adjusted Rates of Firearm-Related Homicide, by Race, Hispanic Origin, and Sex — National Vital Statistics System, United States, 2021. MMWR Morb Mortal Wkly Rep 2023;72:737. DOI: http://dx.doi.org/10.15585/mmwr.mm7226a9.
13. Crimes that Happen While You Sleep. Available at: https://www.thesleepjudge.com/crimes-that-happen-while-you-sleep/. Accessed on February 2, 2024.
14. Spitzer. S, Dey. T, Salim. A, Jarman. MP. School Redistricting's Impact on Firearm Injury: A Study in Community Disruption. Journal of the American College of Surgeons 2023; 237(5): S511-S76.
15. Vasan A, Mitchell HK, Fein JA, Buckler DG, Wiebe DJ, South EC. Association of Neighborhood Gun Violence With Mental Health-Related Pediatric Emergency Department Utilization. JAMA Pediatr 2021; 175(12): 1244-51.
16. Byrdsong TR, Devan A, Yamatani H. A Ground-Up Model for Gun Violence Reduction: A Community-Based Public Health Approach. Journal of evidence-informed social work 2016; 13(1): 76-86.
17. Santaella-Tenorio J, Cerdá M, Villaveces A, Galea S. What Do We Know About the Association Between Firearm Legislation and Firearm-Related Injuries? Epidemiol Rev 2016; 38(1): 140-57.
18. Zeoli AM, McCourt A, Buggs S, Frattaroli S, Lilley D, Webster DW. Analysis of the Strength of Legal Firearms Restrictions for Perpetrators of Domestic Violence and Their Associations With Intimate Partner Homicide. Am J Epidemiol 2018; 187(7): 1449-55.
19. Kim D. Social determinants of health in relation to firearm-related homicides in the United States: A nationwide multilevel cross-sectional study. PLoS medicine 2019; 16(12): e1002978-e.
20. Krüsselmann K, Aarten P, Liem M. Firearms and violence in Europe-A systematic review. PLoS One 2021; 16(4): e0248955.
21. World Population Review. Gun Violence by Country 2025. https://worldpopulationreview.com/country-rankings/gun-violence-by-country. Accessed on March 31, 2025.
22. Gun Violence-Solutions. https://publichealth.jhu.edu/center-for-gun-violence-solutions/solutions. Accessed on March 31, 2025.
23. Shour AR, Anguzu R, Zhou Y, et al. Your neighborhood matters: an ecological social determinant study of the relationship between residential racial segregation and the risk of firearm fatalities. Injury Epidemiology 2023; 10(1): 14.
24. van Breen JA, Devarakonda SK, Liem M. Can Homicide Serve as an Indicator of Non-lethal Crime? A Systematic Literature Review. International Criminology 2023; 3(2): 99-115.
25. Barrett JT, Lee LK, Monuteaux MC, Farrell CA, Hoffmann JA, Fleegler EW. Association of County-Level Poverty and Inequities With Firearm-Related Mortality in US Youth. JAMA Pediatr 2022; 176(2): e214822.
26. Spitzer S, Castillo-Angeles M, Thomas A, et al. Social vulnerability index and firearms: How neighborhood health disparities affect trauma outcomes. Surgery in Practice and Science 2022; 11: 100130.

Social Medicine
Health For All
ISSN: 1557-7112