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Youth Firearm Victimization in Philadelphia: Trends and Disparities Among Middle and High School Aged Youth

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Abstract - Urban firearm violence remains a critical public health crisis, with adolescents, especially high-school-aged youth and young men of color, disproportionately affected compared with younger children. However, limited research distinguishes patterns of victimization between middle school-aged youth (11–13) and high school-aged youth (14–18), despite important developmental and contextual differences between these groups. This study examines annual, monthly, weekly, and hourly patterns among 16,229 shooting incidents in Philadelphia from 2015 to 2024, comparing demographic characteristics, temporal trends, and fatality outcomes across the two age categories. Chi-squared analysis revealed significant associations between race and sex, with Black males comprising the majority of victims, particularly among 14–18-year-olds (89.0%). Temporal trends showed pandemic-era surges peaking in 2021, followed by substantial declines by 2024. Age-stratified analysis demonstrated higher average fatality rates among 14–18-year-olds (14.9%) compared to 11–13-year-olds (10.2%), indicating greater severity among high-school-aged youth. By directly comparing these age groups, this study highlights distinct developmental vulnerability periods and informs targeted, school-aligned violence prevention strategies.

Keywords: Gun Violence, Philadelphia, Youth Firearm Violence, Urban Violence, Community Health

INTRODUCTION

Firearm violence is one of the most devastating public health crises affecting urban communities across the United States [2]. Philadelphia continues to experience persistently high levels of firearm violence, with profound social, economic, and psychological consequences for individuals, families, and communities [1][2][7]. Although firearm victimization rates among children and adolescents are lower than those among young adults ages 18–30, shootings involving people under age 18 are especially troubling because they result in death, disability, and trauma early in life. These incidents can also destabilize neighborhoods and contribute to ongoing cycles of trauma and retaliatory violence [1][7].

Youth ages 11–18 span two distinct developmental and school-based periods: typical middle school age, 11–13 years, and typical high school age, 14–18 years. These groups may differ meaningfully in their social environments, levels of independence, exposure to risk, and opportunities for prevention. Yet firearm violence research often combines all youth under age 18 into a single category, potentially obscuring important differences in victimization patterns and prevention needs across early and later adolescence [8].

Understanding demographic and temporal patterns in firearm victimization is critical for developing and evaluating interventions that can interrupt cycles of violence before they become entrenched. Examining annual, monthly, weekly, and hourly patterns can help identify periods of elevated risk and inform the timing and design of community violence intervention strategies for youth. Despite extensive research on youth firearm violence, few studies have directly compared demographic and temporal patterns among middle school-aged youth (11–13 years) and high school-aged youth (14–18 years) within the same urban setting. This study addresses that gap by examining differences in firearm victimization patterns between these two age groups in Philadelphia and considering how those differences may inform youth violence prevention programming.

MATERIALS AND METHODS

We analyzed a comprehensive dataset of 16,229 shooting-victim records in Philadelphia, spanning 2015 through 2024. Data were obtained from the City of Philadelphia’s publicly available data on shooting victims, maintained by the Philadelphia Police Department. From the full dataset, we identified 1,984 records involving youth aged 11–18, including 98 youth aged 11–13 and 1,886 youth aged 14–18. Variables included age, sex, race, fatal or nonfatal outcome, wound location (e.g., head, chest, or leg), incident date and time, and geographic coordinates. Race analyses were limited to records categorized as Black, White, or Asian in the source data. Records missing age or incident date were excluded. Because geographic location was not examined in the present analysis, missing geographic coordinates were not used as an exclusion criterion.

Annual age-specific shooting-victimization rates were calculated by dividing the number of shooting victims in each age group by the corresponding population estimate from the U.S. Census Bureau’s American Community Survey 5-year estimates and multiplying by 100,000. We focused on two specific age categories: youth aged 11–13, approximating

middle school age, and youth aged 14–18, approximating high school age. These categories were selected to support school- and community-aligned prevention planning and to distinguish developmental periods that may involve different patterns of firearm-violence exposure [8]. These age categories reflect approximate school-age groupings and do not confirm participants' school enrollment or grade level.

Demographic characteristics were summarized using frequencies, percentages, and contingency tables. Chi-squared tests of independence were used to assess associations between age group and categorical variables, including sex, race, fatality status, and wound location. Statistical significance was set at $p < 0.05$. Case-fatality analyses compared the proportion of fatal shootings among youth aged 11–13 ($n = 98$) and youth aged 14–18 ($n = 1,886$).

Descriptive temporal analysis examined incident patterns across multiple time scales: annual trends, monthly variations, day-of-week distributions, and hourly patterns. Data preprocessing, statistical analyses, and visualizations were performed using Python's scientific libraries, including pandas, NumPy, and matplotlib/seaborn.

RESULTS

Yearly Trends

Philadelphia youth shooting rates among both age categories increased steadily from 2015 to 2019, spiked 75% from 2019 to 2020, and reached over 300 per 100,000 residents annually in 2021 (Figure 1). By 2024, rates dropped to approximately 155 per 100,000 residents, representing a 48% decline from the 2021 peak. Unsurprisingly, absolute rates among 14-18 year-olds remained substantially higher than those among 11-13 year-olds.

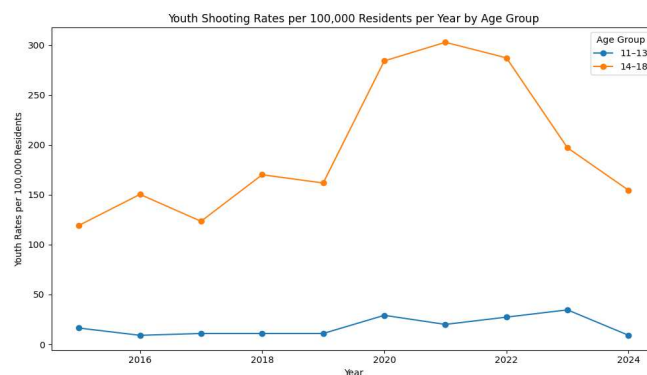


Figure 1. Youth Shooting Rates per 100,00 Residents per Year by Age Group

Demographic Breakdown

Black males accounted for the overwhelming majority of shooting victims, comprising 83% of all youth shooting victims aged 11–18. Males outnumbered females across all racial categories. Both age groups (11–13 and 14–18) exhibited similar racial and sex distributions among shooting victims. A chi-squared test confirmed a statistically significant association between race and sex ($p < 0.001$). Both the racial and gender disparities showed narrowing trends over the study period.

Temporal Patterns

Shootings occurred most often between 7 PM and 9 PM, with the peak hour at 9 PM recording approximately 185 incidents per 100,000 residents (Figure 2). Shootings increased steadily throughout the afternoon and evening, peaking at 9 PM before declining during overnight hours. Although both age groups experienced increased shooting rates during the evening hours, the peak occurred earlier among 11-13 year olds (approximately 7 PM) and later among 14-18 year olds (approximately 9 PM).

Shootings also peaked on Mondays in both age groups, with over 300 total incidents per 100,000 residents across the study period. Monthly patterns showed higher shooting rates during the summer months, particularly June through August, with rates peaking at approximately 35 incidents per 100,000 residents in July compared with approximately 20 incidents per 100,000 residents in January.

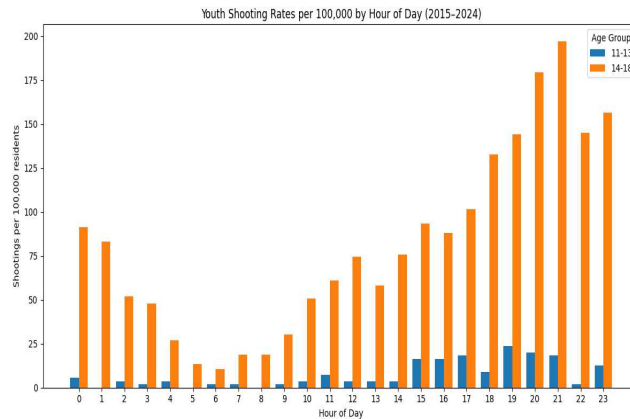


Figure 2. Shootings by Hour of Day During Study Period

Case Fatality Rates and Injury Locations

Case fatality rates varied across the study period, with the 14-18 age group demonstrating a higher average fatality rate (14.9%) than the 11-13 age group (10.2%) (Figure 3). Wounds were most common to the leg, head, arm, and chest across both age brackets (Figure 4). No statistically significant differences in injury location were observed between age groups.

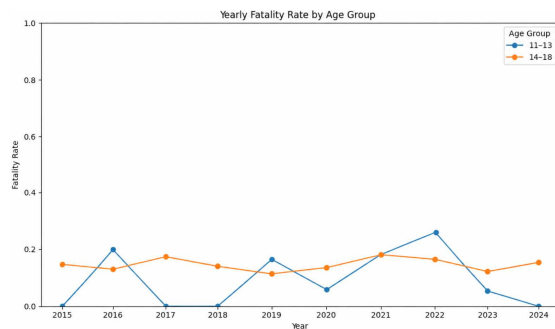


Figure 3. Yearly Fatality Rates by Age Group

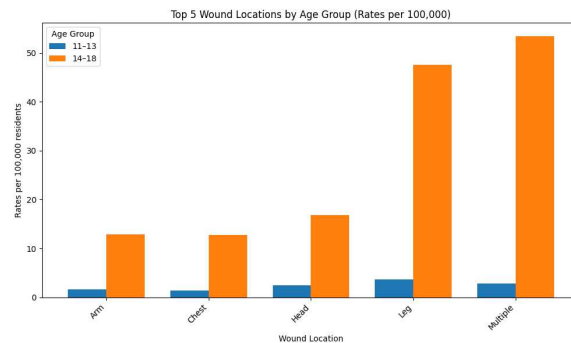


Figure 4. Top 5 Wound Locations by Age Group
(Rates per 100,000 Residents)

DISCUSSION

Overall, this analysis suggests that gun violence trends between middle-school aged and high-school aged youth represent small, but potentially important, differences.

Similar to existing data, Black youth experienced substantially higher firearm victimization rates than White and Asian youth, underscoring a stark racial disparity. This reflects broader patterns of structural inequality consistent in the literature including concentrated poverty, residential segregation, unequal educational opportunity, and differential exposure to community violence [3][4].

Among our study population, Black male adolescents represented a disproportionate share of victims compared to all pre-adolescent young people, underscoring how structural conditions may compound vulnerability during adolescence, particularly for males.

The surge in youth shooting incidents during 2020–2022 could reflect multiple pandemic-related factors, including school closures, economic stress, and disrupted social services [4]. The subsequent decline through 2023–2024 may reflect youth violence prevention and community violence intervention programs implemented across Philadelphia during the post-pandemic period [5][9]. These programs encompass those in reducing retaliatory violence and improving outcomes among high-risk populations and include outreach initiatives, violence interruption models, and hospital-linked intervention programs [1][5][9].

Notably, among our study population, 14-18 year-olds showed more dramatic increases than 11-13 year-olds in 2021 compared to pre-pandemic levels. This may indicate that in Philadelphia high-school-aged youth faced particular vulnerability to pandemic-related disruptions [4].

The higher average fatality rate observed among older adolescents also requires further inquiry and is consistent with criminological research on the victim–offender overlap, which suggests that victimization and offending often arise from shared social and routine activity contexts [10]. In this study, this pattern may reflect differences in exposure to high-risk environments, interpersonal conflicts, or firearm encounters involving greater injury severity. Older adolescents may also spend more unsupervised time in community settings where violent incidents are more likely to occur. Future research could examine incident circumstances and weapon characteristics to better understand age-related differences in fatality outcomes.

Annual fatality trends also differed between age groups. While fatality rates among 14-18 year olds remained relatively stable throughout the study period, rates among 11-13 year olds showed greater year-to-year variability, with a notable peak in 2022. This variability may reflect the smaller number of incidents among younger victims, making annual fatality rates more sensitive to fluctuations in case counts.

Temporal patterns showed modest variability across both age groups with middle school-aged youth experiencing earlier peaks compared to high school-aged youth (approximately 7:00pm and 9:00pm, respectively). The afternoon peak (4-6 PM) aligns with school dismissal, while the evening peak (9 PM-midnight) coincides more with community, familial, or social gathering times for both age groups. Differences in peak times may reflect several factors, including later social gathering times for high school-aged youth. In addition, these developmental stages may reflect differences in supervision, school engagement, peer interaction, and community exposure that influence firearm victimization risk. School-based and after-school programming may act as protective factors during these high-risk transition periods [1].

Importantly, both age groups experienced a higher rate of gun violence on Mondays compared to other days of the week, further suggesting implications for prevention strategies. This is consistent with current research and likely due to conflicts that may occur on weekends; however, more research is needed to better understand additional contextual factors to inform specific intervention strategies [11].

Limitations of this study include reliance on police report data, which may undercount incidents in communities with limited police engagement. The analysis also lacks individual-level covariates, such as socioeconomic status or prior victimization, and its cross-sectional design prevents causal inference.

Because the study focuses on a single urban setting in Philadelphia, findings may not generalize to other cities with different demographic or policy contexts. In addition, categorizing youth as middle- or high-school-aged does not confirm school enrollment and may not fully capture grade-level alignment; average ages for middle- and high-school grades in Philadelphia may differ from those in higher-SES settings because of contextual differences in school progression, attendance and educational disruption. Finally, this analysis did not compare geographic locations, which also may play a role. Future research incorporating multi-city temporal and geographic trends would strengthen external validity.

CONCLUSION

This analysis advances understanding of youth firearm violence by directly comparing demographic, temporal, and fatality patterns between middle school-aged (11–13) and high school-aged (14–18) youth in Philadelphia. The findings demonstrate that high-school aged experience substantially higher incidence rates, while both age groups share pronounced racial and gender disparities. These differences highlight the importance of age-stratified analyses when designing and evaluating violence prevention strategies.

By identifying distinct temporal peaks and developmental vulnerability periods, this study provides an empirical foundation for age-specific intervention timing and school-aligned programming. Future research should further investigate contextual factors driving these age-based differences and evaluate whether interventions tailored to developmental stage produce differential outcomes. Continued age-disaggregated analysis will be critical to refining evidence-based approaches to youth violence prevention.

DECLARATIONS

Funding

This research received no funding.

Competing interests

The authors declare no competing interests.

Ethics approval

This study analyzed publicly available shooting-victim records from the City of Philadelphia.

Consent for publication

Not applicable. The manuscript presents aggregate findings and does not include identifiable information about individual participants.

Data availability

The shooting-victim data analyzed in this study were obtained from publicly available records maintained by the Philadelphia Police Department. Population estimates were obtained from the U.S. Census Bureau's American Community Survey 5-year estimates.

Authors' contributions

Aditya Khurana drafted the manuscript. Brandy Blasko reviewed the manuscript. Sara Solomon contributed to writing and reviewing the manuscript.

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