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The Changing Epidemiology of Gunshot Victims: A Cohort Study of Nonfatal Shootings Before and During the COVID – 19 Pandemic

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Abstract

Background: During the COVID-19 pandemic many U.S. urban cities observed unprecedented increases in firearm violence. Beyond a known increase in nonfatal shootings, little is understood about how patterns of nonfatal shooting victimization changed during the COVID pandemic compared pre-pandemic.

Methods: A retrospective cohort study of nonfatal shootings from 2017 to June 2021 in Indianapolis, Indiana. Shooting incident data include victim demographics, shooting location, nonfatal shooting motive. Neighborhood characteristics contain racial/ethnic composition of census tract and residents living below the federal poverty line. Population-based rates were calculated per 100,000 population-years, descriptive statistics and differences across race, gender, and age were accessed using X^2 and t-tests. Indiana University institutional review board determined this study exempt.

Results: Nonfatal shooting rates increased 8.78%, from 58.1 per 100,000 person-years in pre-pandemic years to 63.2 per 100,000 person-years during the pandemic (p < 0.000). The rate of male victims (93.0 vs 94.4 per 100,000; p < 0.000) and Black victims (148.5 vs 158.2 per 100,000; p < 0.000) increased slightly during the pandemic. Rates of female victims (15.3 vs 22.9 per 100,000; p < 0.000) and non-Black victims (18.2 vs 21.5 per 100,000; p < 0.000) increased significantly during the pandemic compared to the pre-pandemic period. Neighborhoods with higher levels of poverty (IRR: 1.025, 95% CI 1.012, 1.040), residents who identify as Black (IRR: 1.008, 95% CI 1.003, 1.012), and more abandoned homes (IRR: 1.436, 95% CI 1.121, 1.838) was positively associated with higher rates of nonfatal shootings during the pandemic, controlling for pre-pandemic nonfatal shootings.

Conclusions: There was a considerable increase in nonfatal shootings during the COVID-19 pandemic; however different victim groups were disproportionately impacted. Efforts are needed to expand and rethink current firearm prevention efforts that both address the diversification of victimization and the larger societal effects of firearm violence.

KEYWORDS: nonfatal shootings, COVID-19, neighborhoods, health disparities, racial inequities

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Strengthens and Limitations

- A study of nonfatal shooting assaults drawn from police records allows for a complete population-based cohort study of gunshot wound survivors in a large U.S. urban city.

- Leveraging police records of nonfatal shootings allowed us to examine differences in victimization rates by race, sex, age, incident motive, and geographic patterns during the COVID-19 pandemic compared to pre-pandemic.

- Our findings highlight the need to expand and rethink current firearm prevention efforts that both address the diversification of victimization and overall health of the community.

- Given the lack of nonfatal shooting data at the national level we were unable to compare rate increases in female and older victims to other large urban cities.

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Introduction

During the COVID-19 pandemic many urban cities in the United States observed unprecedented increases in firearm violence. Homicide and firearm assault rates increased in 2020 and have continued to increase by as much as 16 percent during the first half of 2021 in 25 major cities across the United States.[1] There have been noted increases in firearm injuries among young children,[2] and larger increases in nonfatal shootings compared to fatal shootings in Buffalo, NY suggesting changes in patterns of firearm violence.[3] Other cities, however, have not observed such increases in firearm violence.[4] These studies are limited in their scope, as they only include a brief period in 2020 or only examine aggregate city-level trends. Prior studies also overlook the demographics of the victims and geographic patterns of nonfatal shootings, which may have changed during the recent increase in firearm violence. This study examines victimization trends and geographic patterns of nonfatal shootings before and during the COVID-19 pandemic.

Nonfatal shootings are well established sources of health inequity. Nonfatal shootings are four times more prevalent than fatal shootings and approximately 85,694 nonfatal shootings occurring annually.[5] Nonfatal shootings most often occur in structurally disadvantaged urban communities[6,7] and survivors of nonfatal shootings are disproportionately young Black men between the ages of 15 and 29.[8] Survivors of nonfatal shootings are more likely to suffer adverse health outcomes such as physical disabilities, chronic pain, posttraumatic stress disorder, depression, and substance use.[9-11] Beyond nonfatal shooting survivors, a growing body of research suggests exposure (both direct and indirect) to fatal and nonfatal shootings increases adverse health outcomes, such as worse mental health outcomes for residents.[12-14] Community rates of nonfatal shootings are associated with higher levels of obesity, smoking, lack of sleep, physical inactivity, and higher levels of disability at the community level, compared to fatal

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shooting rates.[15,16] These findings speak to the unique dynamics of nonfatal shootings and how community nonfatal shooting rates contribute to health disparities and health inequities within our society. The COVID-19 pandemic added disproportionate stresses to many already struggling communities, with increased rates of infections and deaths, reduced access to services, and increased potentials for conflict during periods of stricter quarantine.[17]

Indianapolis, Indiana is one of the urban cities that experienced an increase in nonfatal shootings and was the 11th most violent U.S. city in 2020 according to Federal Bureau of Investigation Uniform Crime Reports.[1] Given the established prevalence of nonfatal shootings versus fatal shootings and limited research focused on the epidemiology of nonfatal shooting victims during the COVID-19 pandemic, this study uses official police records combined with multiple data sources to examine victimization rates, geographic patterns, and neighborhood characteristics of nonfatal shooting rates before and during the COVID-19 pandemic. As it is imperative to identify changes in the epidemiology of nonfatal shooting survivors in order to recognize new health disparities and better inform public health responses for nonfatal shooting survivors and communities.

Methods

Study design and measures

This is a retrospective cohort study of nonfatal shootings from January 1, 2017 to June 30, 2021. Study data come from Indianapolis (Marion County), Indiana, the largest county in the state. In 2019 the population of Indianapolis was estimated at 874,005 and is 53% White, 28% Black, 11% Hispanic or Latino, and 4% Asian.[18] Data were obtained from the Indianapolis Metropolitan Police Department (IMPD), the Indianapolis Open Data Portal, and the U.S. Census Bureau. We

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followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. Measures

Data on nonfatal shootings were obtained from the Indianapolis Metropolitan Police Department (IMPD) between January 1, 2017, through June 30, 2021. Due to mandatory reporting laws[19] police records provide more complete records compared to clinical data.[20,21] A nonfatal shooting is defined as a criminal assault in which a projectile weapon with a powder discharge causes a penetrating injury.[22] All assault related nonfatal shooting victims were included. All self-inflicted, accidental, and police-involved shootings are excluded from this study. Data include victim demographics, incident location, incident date, and incident motive.

Victim race/ethnicity (White, Black, other), sex, and age at time of incident were used as recorded by IMPD reports. Age categories were defined as: 0-14, 15-17, 18-20, 21-24, 25-29, 30-34, and ≥ 35 years. Incident motives provide context to the shooting event and were classified as illegal activity (e.g., robbery, drugs), interpersonal dispute (e.g., argument, fight), bystander (e.g., drive-by, untended target), domestic violence, money/other and unknown.[23]

Census tract characteristics were defined based on incident location using U.S. census data. Measures included the % of Black residents, % of Hispanic residents, % of residents living below poverty line, % single female headed households, % of residents with a high school diploma, % unemployed, % of disability, and total population per census tract. The number of abandoned homes were obtained from the Indianapolis open data portal (data.indy.gov).

Patient and public involvement

Patients and/or the public were not involved in the design, analysis, reporting, or dissemination plans of this research.

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Geocoding

Addresses from nonfatal shootings were geocoded to street location using ArcGIS v 10.8 and

Marion County base maps. Of the nonfatal shootings (n=2,578), 96% (n=2,478) were

successfully geocoded, geotagged, and aggregated to their associated census tracts. Incidents that

did not geocode (n=100) contained missing address information or unknown incident locations.

Analysis

We compared characteristics of nonfatal shooting victims during the pre-pandemic period (2017-

2019) with those of nonfatal shooting victims during the COVID-19 pandemic (2020 – June

2021). Across, characteristics, we calculated the rate per 100,000 person-years and the absolute

and percentage rate changes between observation periods. Rates calculated for sex, age, race

were adjusted estimated population size; incident motive rates used total population adjusted for

the number of years in the pre-post COVID-19 period. We assessed differences across pre-post

COVID-19 periods using X^2 and Fisher exact tests at statistical significance level of $p < 0.05$.

To assess differences in neighborhood characteristics on nonfatal shootings before and during the

pandemic three multivariate models were assessed. Because nearly a quarter of census tracts did

not experience a nonfatal shooting a zero-inflated negative binomial regression model was

conducted. To estimate the excess zeros the total population was included. Pre and during

pandemic nonfatal shooting rates were modeled as a function of neighborhood characteristics

and the incident rate ratios (IRR) estimated for each neighborhood characteristics. A Bayesian

information criterion (BIC) and Akaike information criterion (AIC) were included to measure

model fit. Data were analyzed in fall of 2021 using Stata.

Results

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A total of 2,578 nonfatal shootings occurred during our study period. Victims were predominately male (n=2128 (83%); 448 female (17%)), Black (n=1,995 (77%); 574 non-Black (22%)), with a mean age of 29.9 years (SD: 11.8). The rate of nonfatal shootings increased 8.78%, from 58.1 per 100,000 person-years in pre-pandemic years to 63.2 per 100,000 person-years during the pandemic ($p < 0.000$). The rate of male victims (93.0 vs 94.4 per 100,000; $p < 0.000$) and Black victims (148.5 vs 158.2 per 100,000; $p < 0.000$) increased significantly during the pandemic months. Nonfatal shooting rates increased substantially for female victims (15.3 vs 22.9 per 100,000; $p < 0.000$) and for non-Black victims (18.2 vs 21.5 per 100,000; $p < 0.000$) during the pandemic compared to the pre-pandemic period. Nonfatal shooting rates of victims under age 21 years decreased among groups less than 15 years (6.14 vs 5.53 per 100,000; $p < 0.000$, those, 15-17 years (75.0 vs 74.1 per 100,000; $p < 0.000$) and among those 18-20 years (192.0 vs 190.7 per 100,000; $p < 0.000$) during the pandemic compared to pre-pandemic period. Victims over 20 years of age significantly increased during the pandemic (21-24 years: 158.8 vs 163.7 per 100,000; $p < 0.000$; 25-29 years: 104.8 vs 113.9 per 100,000; $p < 0.000$; >= 35 years: 30.1 vs 34.2 per 100,000; $p < 0.000$, with the largest increase of 24% observed for victims between 30 and 34 years of age (92.9 vs 115.1 per 100,000; $p < 0.000$), compared to the pre-pandemic period (Table 1).

When shooting motive was known, illegal activity (14.6 vs 11.8 per 100,000; $p < 0.000$) and domestic violence (1.83 vs 1.75 per 100,000; $p < 0.000$) slightly decreased during the pandemic. Being a bystander (4.51 vs 5.60 per 100,000; $p < 0.000$), money/other (2.64 vs 3.15 per 100,000; $p < 0.000$) and interpersonal disputes (15.5 vs 16.7 per 100,000; $p < 0.000$) significantly increased during the pandemic compared to the pre-pandemic period (Table 1).

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Table 1. Count, Incidence Rate, and Rate Change of Nonfatal Shooting Victimization in Indianapolis, Indiana, January 1, 2017 – June 30, 2021

Characteristic	Individuals, No.(%)					Rate, per 100,000		Absolute rate change, pre/during COVID-19	Change in rate pre/post, %
	2017	2018	2019	2020	Jan – June 2021	Pre-COVID-19	During COVID-19		
N	486	484	524	706	378	**58.1**	**63.2**	5.1	8.78
Race									
Black	379	377	410	536	293	**148.5**	**158.4**	9.9	6.67
Non-Black	102	107	112	170	83	**18.2**	**21.5**	3.3	18.1
Sex									
Male	418	413	438	553	306	**93.0**	**94.4**	1.4	1.51
Female	68	71	85	153	71	**15.3**	**22.9**	7.6	49.7
Age group, y									
<15	9	11	15	14	7	**6.14**	**5.53**	-0.61	-9.93
15-17	29	22	31	38	16	**75.0**	**74.1**	-0.90	-1.20
18-20	67	74	84	99	50	**192.0**	**190.7**	-1.3	-0.68
21-24	76	94	86	112	64	**158.8**	**163.7**	4.9	3.09
25-29	98	89	81	138	56	**104.8**	**113.9**	9.1	8.68
30-34	82	67	58	111	60	**92.9**	**115.1**	22.2	23.9
>= 35	125	127	169	194	125	**30.1**	**34.20**	4.1	13.6
Motive									
Unknown	161	167	161	242	173	**19.0**	**24.2**	5.19	27.4
Illegal Activity	126	143	106	148	54	**14.6**	**11.8**	-2.79	-19.2
Interpersonal Dispute	126	101	172	188	99	**15.5**	**16.7**	1.22	7.74
Bystander	40	38	38	67	29	**4.51**	**5.60**	1.09	24.2
Domestic violence	15	15	17	23	7	**1.83**	**1.75**	-0.08	-4.37
Money/other	18	20	30	38	16	**2.64**	**3.15**	0.51	19.3

Bolded values indicate p = 0.000

We conducted three multivariate models comparing neighborhood characteristics on nonfatal

shooting rates pre-pandemic and during the pandemic (Table 2). In model 1, higher levels of

poverty (IRR: 1.044, 95% CI 1.028, 1.062), residents who identify as Black (IRR: 1.019, 95% CI

1.014, 1.024), and more abandoned homes (IRR: 1.653, 95% CI 1.294, 2.111) was positively

associated with higher rates of nonfatal shootings pre-pandemic. Higher levels of single female

headed households was negatively associated with higher rates of pre-pandemic nonfatal

shooting rates (IRR: 0.952, 95% CI 0.930, 0.979). Similar results were observed for

neighborhood characteristics and nonfatal shooting rates during the pandemic in Model 2. Model

3 adjusted for pre-pandemic nonfatal shooting rate and neighborhood characteristics. Pre-

pandemic nonfatal shooting rates (IRR: 1.001, 95% CI 1.001, 1.002) was positively associated

with nonfatal shooting rates during the pandemic. Similar to prior models, higher levels of

poverty (IRR: 1.025, 95% CI 1.012, 1.040), residents who identify as Black (IRR: 1.008, 95% CI

1.003, 1.012), and more abandoned homes (IRR: 1.436, 95% CI 1.121, 1.838) was positively

associated with higher rates of nonfatal shootings during the pandemic, controlling for pre-

pandemic nonfatal shootings. More single female headed households (IRR: 0.966, 95% CI 0.946,

0.987) was associated with lower nonfatal shooting rates during the pandemic. The AIC and BIC

indicate better model fit in the final model.

Table 2. Incident Rate Ratios of Nonfatal Shooting Rates by Census Tract Characteristics, Indianapolis, Indiana

	Model 1 Pre-COVID-19 NFS Rate IRR (95% CI)	Model 2 During COVID-19 NFS Rate IRR (95% CI)	Model 3 During COVID-19 NFS Rate IRR (95% CI)
Pre-COVID-19 NFS	--	--	**1.001 (1.001, 1.002)**
% Poverty	**1.044 (1.028, 1.062)**	**1.032 (1.015, 1.049)**	**1.025 (1.012, 1.040)**
% Black	**1.019 (1.014, 1.024)**	**1.013 (1.008, 1.018)**	**1.008 (1.003, 1.012)**
% Hispanic	1.006 (0.995, 1.018)	1.003 (0.991, 1.015)	1.003 (0.992, 1.014)
% Single Female Households	**0.952 (0.930, 0.979)**	**0.963 (0.939, 0.987)**	**0.966 (0.946, 0.987)**
% High School Diploma	1.012 (0.998, 1.026)	1.005 (0.991, 1.018)	0.997 (0.985, 1.008)
% Unemployed	1.007 (0.986, 1.029)	1.020 (0.995, 1.046)	1.016 (0.991, 1.042)
% Disability	1.003 (0.985, 1.022)	1.002 (0.983, 1.021)	0.999 (0.984, 1.016)
Abandoned Homes	**1.653 (1.294, 2.111)**	**1.682 (1.271, 2.226)**	**1.436 (1.121, 1.839)**
AIC	2320.65	2177.77	2154.68
BIC	2361.16	2218.28	2198.60

Bolded values indicate p <0.05. IRR = incident rate ratios; AIC = Akaike information criterion; BIC = Bayesian information criterion.

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Discussion

This study compared the trends and geographic patterns of nonfatal shooting victims during the

COVID-19 pandemic compared to the pre-pandemic period. The results demonstrate three

important findings: 1) the rate of nonfatal shootings increased by 9% compared to the pre-

pandemic period, 2) we identified more substantial increases in female, non-Black victims, and

older victims who suffered a nonfatal shooting during the pandemic vs before the pandemic, and

3) nonfatal shootings continued to occur within structural disadvantaged communities during the

pandemic.

Our finding that the rate of nonfatal shootings increased during the pandemic is consistent with

trends in national data on homicides that indicate a national increase of 30% during the COVID-

19 pandemic.[1] Given the lack of national data on nonfatal shootings, our findings are consistent

with findings from Buffalo, NY and Philadelphia, PA that demonstrate an increase in nonfatal

shootings since the beginning of the COVID-19 pandemic although our data extend the study

period into 2021.[3,24] Beyond an overall increase in the rate of nonfatal shootings, our findings

indicate changes in demographics of nonfatal shooting victims by sex and age. For instance, the

rate of female nonfatal shooting victims increased by nearly half during the pandemic period

compared to before, which is consistent with noted increases in police 911 calls for domestic

violence during the pandemic.[25] Other research has also observed similar increases in intimate

partner violence during 2020.[26] The pandemic has also increased unemployment, potentially

heightening financial stressors and social isolation due to stay-at-home orders, which has

previously been associated with intimate partner violence.[26-28] Our findings, however, do

demonstrate a decrease in domestic violence related shootings but an increase in interpersonal

disputes, which may speak to the changing nature of gun violence. Although we are not able to

determine causation in the increase of female nonfatal shootings, these findings do indicate a need for future research to better understand the mechanisms driving the increase in female victims.

Our findings also observed differences in the ages of nonfatal shooting victims before and during the pandemic. Our findings note slight decreases in pediatric nonfatal shootings, which differs from prior studies that indicated increases in pediatric firearm injuries.[2,29] These observed variations in findings may be due to differences in study period and nonfatal shooting data source. Furthermore, our study indicates there was a slight increase in nonfatal shooting victims between 21-24 years of age, which is a well-documented group most at risk for involvement in gun violence. The largest rate increase, however, was observed for nonfatal shooting victims 30 years of age and older. Additionally, older victims account for nearly half of all nonfatal shooting victims. Much less is known about older victims of nonfatal shootings, as the majority of research focuses on pediatric, adolescent, and young adult victims.[30] Older victims may experience more adverse health outcomes, such as mental illness and other chronic conditions compared to younger victims.[31]

Lastly, our findings indicate higher rates of nonfatal shootings continue to occur in majority minority, high poverty, structurally disadvantaged communities both before and during the pandemic. The increase in nonfatal shootings further continues to contribute to health disparities and inequity in communities that have experienced decades of structural disadvantage and racial inequalities.[32] Compounding these inequities is that nonfatal shooting victims are left to cope with the trauma of their injury, as many suffer from posttraumatic stress disorder, physical disabilities due to injury, or other psychological and emotional traumas following their injury,[10] however, post-discharge follow up care is often unavailable. Therefore, it is imperative that

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communities most impacted by firearm violence have the appropriate resources available as firearm violence impacts the health of the entire community. A growing body of research demonstrates levels of community firearm violence not only impacts the victim but contributes to higher levels of resident disability, adverse health outcomes, and mental health needs among adults and children who are indirectly impacted by the continued trauma of firearm violence.[14-16] Therefore, it is imperative to view and address community firearm violence as a public health crisis that needs to address the health of all residents within communities most impacted by firearm violence, not just the victims.

To prevent firearm violence through a public health approach, it is essential to understand the epidemiology of nonfatal shooting victims in order to design prevention efforts by identifying individuals and communities most affected by nonfatal firearm violence.[33] This study highlights three critical avenues to prevent future firearm violence and improve the health of those directly and indirectly impacted by nonfatal shootings. One, our findings clearly demonstrate that victimization rates of nonfatal shootings have shifted since the beginning of the COVID-19 pandemic with higher rates of female and older victims. There are current programs in place such as Hospital Based Violence Intervention Programs,[34] Cure Violence, and other community programs that seek to link victims of interpersonal violence to needed financial, health, legal, or other needed services post injury. Most hospital based-violence intervention programs (HVIPs) and other community-based programs, such as Cure Violence are largely focused on adolescents and young adults and reducing retalitation.[35] Such programs may need to expand resources and outreach to meet the needs of female victims, older victims of nonfatal shootings and communities most impacted by gun violence, not just the victim. Collaborations and partnerships between firearm prevention programs, community organizations, and other city organizations are

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crucial to expand resources to address food insecurity, housing insecurity, socioeconomic insecurity, and other community health needs most impacted by the continued high rates of nonfatal shootings.

Secondly, preventing firearm violence entirely would also address the need for additional post-hospital discharge care and trauma that communities experience. Our findings demonstrate communities with more abandoned homes experience higher rates of firearm violence. Efforts to eliminate and demolish abandoned homes has reduced firearm violence by 11% in Detroit, MI and other community greening projects have reduced gun assaults and overall community violence.[36,37] Improving the maintenance of vacant lots through community greening projects also reduces residents fear of crime and improves overall community mental health outcomes.[38]

Lastly, these findings speak to the need for nationally available data on nonfatal shootings to examine trends and patterns in victimization rates. Given the lack of available data, many have utilized the publicly available dataset compiled by the National Gun Archive. These data, however, are a collection of media reports that have demonstrated to be an undercount of official records by nearly half.[39] The use of these records may also explain the differences in our findings that child firearm injuries have decreased compared to other studies,[2,29] as the media is more likely to report child firearm injuries.[39] Additionally, nationally available nonfatal shooting data would allow for linkage with other national healthcare data to examine long-term health outcomes of those directly and indirectly affected by firearm violence.[40]

Limitations

There are several limitations of this study that should be noted. First, these results only include one city jurisdiction. However, our data provide victim demographics and incident motive which

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are not typically available at the national level. Given mandatory reporting laws to law enforcement, our use of police data includes all victims of nonfatal shootings that presented for care at an emergency room or reported their injury to police; however, these data do not include self-inflicted injuries, accidental injuries, or injuries not reported to the police. Additionally, this study is only descriptive, and results cannot speak to causation. Nonetheless, the findings of this study expand our current understanding of victims of firearm violence and provide direction for future studies into the increase of firearm violence during the COVID-19 pandemic.

Conclusion

Our study demonstrated an increase in nonfatal shootings, changing characteristics of victims who suffered a nonfatal shooting during the COVID-19 pandemic compared to pre-pandemic period in Indianapolis, Indiana, and that nonfatal shootings continue to occur within structural disadvantaged communities during the pandemic. These findings highlight the changing epidemiology of nonfatal shooting victims during the COVID-19 pandemic and that the increase in nonfatal shootings during the pandemic continues to contribute to health disparities within communities that have experienced racial equities and structural disadvantage for decades. These findings support the need to expand and rethink current firearm prevention efforts that both address the diversification of victimization, and the community health needs of residents within neighborhoods that experience high rates of nonfatal shootings.

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Ethics approval

The Indiana University institutional review board determined this study exempt (#10809).

Patient consent for publication.

N/A

Data availability statement

Data may be obtained from a third party or are available publicly.

Authors' contributions

LM developed the research question, obtained, analyzed the data, and wrote the manuscript. BL and DF helped with interpretation of results. All authors contributed to the writing and editing of the manuscript. All authors read and approved the final manuscript.
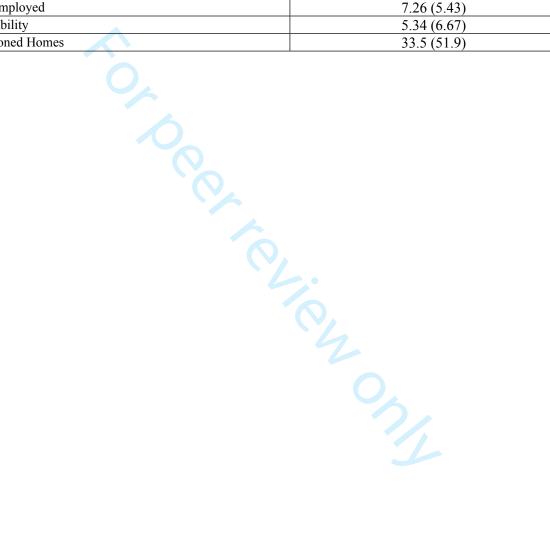
Competing Interests

The authors declare they have no competing interests.

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Supplementary Table A: Census Tract Community Characteristics, Indianapolis, Indiana, January 1, 2017 – June 30, 2021

Neighborhood Measures	Mean (SD)
% Poverty	28.2 (18.2)
% Black	33.7 (24.9)
% Hispanic	11.2 (9.30)
% Single Female Households	9.36 (8.97)
% High School Diploma	21.2 (9.99)
% Unemployed	7.26 (5.43)
% Disability	5.34 (6.67)
Abandoned Homes	33.5 (51.9)

STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	(a) 1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	(b) 3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, explain how loss to follow-up was addressed	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7-8
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	7-8
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	Report numbers of outcome events or summary measures over time	7-8

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-9
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	n/a

Discussion

Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	13

Other information

| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | 20 |

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

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The Changing Epidemiology of Firearm Injury: A Cohort Study of Nonfatal Firearm Victimization Before and During the COVID – 19 Pandemic, Indianapolis, Indiana

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Abstract

Objective: To examine victimization rates, geographic patterns, and neighborhood characteristics associated with nonfatal firearm injury rates before and during the COVID-19 pandemic.

Design: A retrospective cohort study.

Setting: City of Indianapolis, Indiana, US, January 1, 2017 to June 30, 2021

Participants: Intentional nonfatal firearm injury victims from Indianapolis Metropolitan Police Department records. The study included information on 2578 nonfatal firearm injury victims between ages 0 and 77. Of these victims, 82.5% were male and 77.4% were Black.

Primary and secondary outcome measures: Rates of nonfatal firearm injuries per 100,000 population by victim age, race, sex, and incident motive. Pre-pandemic and peri-pandemic nonfatal firearm injury rates.

Results: Nonfatal shooting rates increased 8.60%, from 57.0 per 100,000 person-years in pre-pandemic years to 65.6 per 100,000 person-years during the pandemic (p < 0.001). Rates of female victims (15.2 vs 23.8 per 100,000; p < 0.001) and older victims (91.3 vs 120.4 per 100,000; p < 0.001) increased significantly during the pandemic compared to the pre-pandemic period. Neighborhoods with higher levels of structural disadvantage (IRR: 1.157, 95% CI 1.012, 1.324) and pre-pandemic firearm injury rates (IRR: 1.001, 95% CI 1.001, 1.002) was positively associated with higher rates of nonfatal firearm injuries during the pandemic, adjusting for neighborhood characteristics.

Conclusions: Nonfatal firearm injuries increased significantly during the COVID-19 pandemic – particularly among female and older victims. Efforts are needed to expand and rethink current firearm prevention efforts that both address the diversification of victimization and the larger societal trauma of firearm violence.

KEYWORDS: nonfatal firearm injuries, COVID-19, neighborhoods, health disparities, racial inequities

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Strengthens and Limitations

- A study of nonfatal firearm injuries drawn from police records allows for a complete population-based cohort study of nonfatal firearm injury victims in a large U.S. city.

- Leveraging police records of nonfatal firearm injuries allowed us to examine differences in victimization rates by race, sex, age, incident motive, and geographic patterns during the COVID-19 pandemic compared to pre-pandemic.

- Given the lack of nonfatal firearm injury data at the national level we were unable to compare rate increases in female and older victims to other large cities.

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Introduction

During the COVID-19 pandemic many cities in the United States observed unprecedented

increases in firearm injuries and rates continued to increase by as much as 16 percent during the

first half of 2021.[1] Firearm injuries increased immediately following the onset of the pandemic,[2]

nonfatal firearm injuries increased at higher rates than fatal firearm injuries,[3] and firearm injuries

increased among young children as well.[4] Large increases in firearm purchasing and higher

unemployment rates are associated with spikes in firearm injuries early in the pandemic.[5,6] The

increase in firearm purchasing is also associated with increases in domestic related firearm

injuries during the onset of the pandemic.[5] Overall, higher rates of firearm ownership is

associated with higher rates of firearm injuries.[7] Prior studies, however, are limited in their

scope, as only a brief period of 2020 is included, or only aggregate national, state, or city-trends

are examined, and victim demographics, motives behind the shooting, and within-city

neighborhood variations are largely overlooked.

Nonfatal firearm injuries are well established sources of health inequity. Nonfatal firearm

injuries are four times more prevalent than fatal firearm injuries and approximately 85,694

nonfatal firearm injuries occurring annually.[8] Nonfatal firearm injuries most often occur in

structurally disadvantaged urban communities[9,10] and survivors of nonfatal shootings are

disproportionately young Black men between the ages of 15 and 29.[11] Survivors of nonfatal

firearm injuries are more likely to suffer adverse health outcomes such as physical disabilities,

chronic pain, posttraumatic stress disorder, depression, and substance use.[12,13] Beyond nonfatal

injury survivors, a growing body of research suggests exposure (both direct and indirect) to fatal

and nonfatal firearm injuries increases adverse health outcomes, such as worse mental health

outcomes for residents.[14,15] Community rates of nonfatal firearm injuries are associated with

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higher levels of obesity, smoking, lack of sleep, physical inactivity, and higher levels of disability at the community level, compared to fatal firearm injuries.[16,17] These findings speak to the unique dynamics of nonfatal firearm injuries and how community nonfatal firearm injuries rates contribute to health disparities and health inequities within our society. The COVID-19 pandemic added new stresses to many already struggling communities, with increased rates of infections and deaths, reduced access to services, and increased potentials for conflict during periods of stricter quarantine.[18] Therefore, the combination of pandemic-related stressors and greater firearm availability may expand the epidemiology of nonfatal firearm injury rates, consequently diffusing its health-related disparities to broader communities.

Indianapolis, Indiana is one of the cities that experienced an increase in nonfatal firearm injuries and was the 11th most violent U.S. city in 2020 according to Federal Bureau of Investigation Uniform Crime Reports.[1] Given the established prevalence of nonfatal firearm injuries versus fatal shootings and limited research focused on the epidemiology of nonfatal firearm injuries victims during the COVID-19 pandemic, this study uses official police records combined with multiple data sources to examine victimization rates, geographic patterns, and neighborhood characteristics of nonfatal shooting rates before and during the first 18 months of the COVID-19 pandemic. We must first determine if the epidemiology of firearm injury survivors has changed post pandemic onset in order to recognize new health disparities highlighted by the COVID-19 pandemic and better inform public health responses for firearm injury survivors and communities.

Methods

Study design and measures

This is a retrospective cohort study of nonfatal firearm injuries from January 1, 2017 to June 30, 2021. Study data come from Indianapolis (Marion County), Indiana, the largest county in the state. In 2019 the population of Indianapolis was estimated at 874,005 and is 53% White, 28% Black, 11% Hispanic or Latino, and 4% Asian.[19] Data were obtained from the Indianapolis Metropolitan Police Department (IMPD), the Indianapolis Open Data Portal, and the U.S. Census Bureau. We followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. The Indiana University Institutional Review Board determined this study exempt.

Measures

Data on nonfatal firearm injuries were obtained from IMPD. Due to mandatory reporting laws[20] police records provide more complete records compared to clinical data.[21] A nonfatal firearm injury is defined as an assault in which a projectile weapon with a powder discharge causes a penetrating injury.[22] All self-inflicted and police-involved shootings are excluded from this study. Data include victim demographics, incident location, incident date, and incident motive.

Victim race/ethnicity (White, Black, other), sex, and age at time of incident were used as recorded by IMPD reports. Age categories were defined as: 0-14, 15-17, 18-20, 21-24, 25-29, 30-34, and ≥ 35 years. Incident motives provide context to the shooting event and were classified as illegal activity (e.g., robbery, drugs), interpersonal dispute (e.g., argument, fight), bystander (e.g., drive-by, untended target), domestic violence, money/other and unknown.[23]

Census tract characteristics were defined based on incident location using U.S. census data. Using factor analysis, the percent of residents living in poverty, percent single female headed households, and percent unemployed were combined as a measure of structural disadvantage.[24]

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All measures loaded with factor scores above 0.8. Other measures included the percent of Black residents, percent of Hispanic residents, percent of residents with a high school diploma, percent of disability, and total population per census tract based on prior studies.[17] The number of abandoned homes were obtained from the Indianapolis open data portal (data.indy.gov), was divided into quartiles and included as a binary measure of the highest quartile versus all others.[10]

Patient and public involvement

Patients and/or the public were not involved in the design, analysis, reporting, or dissemination plans of this research.

Geocoding

Addresses from nonfatal firearm injuries were geocoded to street location using ArcGIS v 10.8 and Marion County base maps. Of the nonfatal firearm injuries (n=2,578), 96% (n=2,478) were successfully geocoded, geotagged, and aggregated to their associated census tracts. Incidents that did not geocode (n=100) contained missing address information or unknown incident locations.

Analysis

We compared characteristics of nonfatal firearm injury victims during the pre-pandemic period (2017 – February 2020) with those of nonfatal shooting victims during the COVID-19 pandemic (March 2020 – June 2021). Across, characteristics, we calculated the rate per 100,000 person-years and the absolute and percentage rate changes between observation periods. Rates calculated for sex, age, race were adjusted estimated population size; incident motive rates used total population adjusted for the number of years in the pre-post COVID-19 period. We assessed differences across pre-post COVID-19 periods using X^2 and Fisher exact tests at statistical significance level of $p < 0.05$.

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To assess differences in neighborhood characteristics on nonfatal firearm injuries before and during the pandemic three multivariate models were assessed. Because nearly a quarter of census tracts did not experience a nonfatal firearm injury a zero-inflated negative binomial regression model was conducted. To estimate the excess zeros the total population was included. Pre- and peri-pandemic nonfatal firearm injury rates were modeled as a function of neighborhood characteristics and the incident rate ratios (IRR) estimated for each neighborhood characteristics. A Bayesian information criterion (BIC) and Akaike information criterion (AIC) were included to measure model fit. Data were analyzed in fall of 2021 using Stata.

Results

A total of 2,578 nonfatal firearm injuries occurred during our study period. Victims were predominately male (n=2128 (83%)); Black (n=1,995 (77%)); with a mean age of 29.9 years (SD: 11.8). The rate of nonfatal firearm injuries increased 8.60%, from 57.0 per 100,000 person-years in pre-pandemic years to 65.6 per 100,000 person-years during the first 18 months of the pandemic (p < 0.001). The rate of male victims (91.1 vs 97.9 per 100,000; p < 0.001) and Black victims (144.5 vs 166.6 per 100,000; p < 0.001) increased significantly during the pandemic months. Nonfatal shooting rates increased substantially for female victims (15.2 vs 23.8 per 100,000; p < 0.000) and for non-Black victims (18.5 vs 21.3 per 100,000; p < 0.001) during the pandemic compared to the pre-pandemic period. Nonfatal firearm injuries rates of victims under age 21 years increased among groups less than 15 years (5.76 vs 6.14 per 100,000; p < 0.001, those, 15-17 years (72.9 vs 77.7 per 100,000; p < 0.001) and among those 18-20 years (185.6 vs 201.9 per 100,000; p < 0.001) during the pandemic compared to pre-pandemic period. Victims over 21 years of age significantly increased during the pandemic (21-24 years: 158.1 vs 165.4 per 100,000; p < 0.001; 25-29 years: 103.1 vs 118.0 per 100,000; p < 0.001; >= 35 years: 29.6 vs

36.3 per 100,000; p < 0.001, with the largest increase of 32% observed for victims between 30 and 34 years of age (91.3 vs 120.4 per 100,000; p < 0.001), compared to the pre-pandemic period (Table 1).

When shooting motive was known, illegal activity (14.4 vs 11.8 per 100,000; p < 0.001) and domestic violence (1.82 vs 1.75 per 100,000; p < 0.001) slightly decreased during the pandemic. Being a bystander (4.23 vs 6.22 per 100,000; p < 0.001), money/other (2.70 vs 3.11 per 100,000; p < 0.001) and interpersonal disputes (15.2 vs 17.5 per 100,000; p < 0.001) significantly increased during the pandemic compared to the pre-pandemic period (Table 1).

We conducted multivariate models comparing neighborhood characteristics on pre-pandemic nonfatal firearm injury rates and during the pandemic nonfatal firearm injury rates (Table 2). Higher rates of neighborhood structural disadvantage (Pre-pandemic – IRR: 1.407, 95% CI 1.219, 1.644 vs. during pandemic – IRR, 1.280, 95% CI 1.110, 1.476) abandoned homes (Pre-pandemic – IRR: 2.113, 95% CI 1.681, 2.656 vs. during pandemic – IRR, 1.960, 95% CI 1.523, 2.522), and neighborhoods with residents who primarily identify as Black (Pre-pandemic – IRR: 1.014, 95% CI 1.009, 1.019 vs. during pandemic – IRR, 1.011, 95% CI 1.005, 1.015) are associated with higher nonfatal firearm injury rates pre-pandemic and during the pandemic. Pre-pandemic neighborhood nonfatal shooting rates predicted higher (IRR 1.001, 95% CI 1.001, 1.002) neighborhood nonfatal firearm injury rates during the pandemic, when adjusting for all other neighborhood characteristics. The AIC and BIC indicate better model fit in the final model.

Table 1. Count, Incidence Rate, and Rate Change of Nonfatal Firearm Injury Victimization in Indianapolis, Indiana, January 1, 2017 – June 30, 2021

Characteristic	Individuals, No.(%)					Rate, per 100,000		Absolute rate change, pre/during COVID-19	Change in rate pre/post, %
	2017	2018	2019	2020	Jan – June 2021	Pre-COVID-19 (2017 – Feb. 2020)	During COVID-19 (March 2020 – June 2021)		
N	486	484	524	706	378	**57.0**	**65.6**	8.60	15.1
Race									
Black	379	377	410	536	293	**144.5**	**166.6**	22.2	15.3
Non-Black	102	107	112	170	83	**18.5**	**21.3**	2.86	15.1
Sex									
Male	418	413	438	553	306	**91.1**	**97.9**	6.85	7.46
Female	68	71	85	153	71	**15.2**	**23.8**	8.63	56.6
Age group, y									
<15	9	11	15	14	7	**5.76**	**6.14**	0.38	6.60
15-17	29	22	31	38	16	**72.9**	**77.7**	4.85	6.58
18-20	67	74	84	99	50	**185.6**	**201.9**	16.4	8.78
21-24	76	94	86	112	64	**158.1**	**165.4**	7.23	4.62
25-29	98	89	81	138	56	**103.1**	**118.0**	14.9	14.5
30-34	82	67	58	111	60	**91.3**	**120.4**	29.1	31.9
>= 35	125	127	169	194	125	**29.6**	**35.3**	5.69	19.3
Motive									
Unknown	161	167	161	242	173	**18.7**	**25.3**	6.53	35.3
Illegal Activity	126	143	106	148	54	**14.4**	**11.8**	-2.60	-18.1
Interpersonal Dispute	126	101	172	188	99	**15.2**	**17.5**	2.33	15.1
Bystander	40	38	38	67	29	**4.23**	**6.22**	1.99	47.0
Domestic violence	15	15	17	23	7	**1.82**	**1.75**	-0.07	-3.85
Money/other	18	20	30	38	16	**2.70**	**3.11**	0.41	15.2

Bolded values indicate p = 0.000

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Table 2. Incident Rate Ratios of Nonfatal Firearm Injury Rates by Census Tract Characteristics, Indianapolis, Indiana

	Model 1	Model 2	Model 3
	Pre-COVID-19 NFS Rate	During COVID-19 NFS Rate	During COVID-19 NFS Rate
	IRR (95% CI)	IRR (95% CI)	IRR (95% CI)
Pre-COVID-19 NFS Rates	--	--	**1.001 (1.001, 1.002)**
Structural Disadvantage	**1.407 (1.219, 1.644)**	**1.280 (1.110, 1.476)**	**1.157 (1.012, 1.324)**
% Black	**1.014 (1.009, 1.019)**	**1.011 (1.005, 1.015)**	**1.005 (1.001, 1.010)**
% Hispanic	**1.017 (1.006, 1.028)**	1.005 (0.994, 1.018)	1.004 (0.994, 1.015)
% High School Diploma	1.015 (0.999, 1.031)	1.006 (0.991, 1.021)	0.999 (0.987, 1.012)
% Disability	1.017 (0.991, 1.043)	1.013 (0.992, 1.035)	1.008 (0.993, 1.024)
Abandoned Homes	**2.113 (1.681, 2.656)**	**1.960 (1.523, 2.522)**	**1.504 (1.173, 1.927)**
AIC	2362.08	2157.99	2133.99
BIC	2395.83	2191.74	2171.12

Bolded values indicate p <0.05. IRR = incident rate ratios; AIC = Akaike information criterion; BIC = Bayesian information criterion.

Discussion

This study compared the trends and geographic patterns of nonfatal firearm injuries during the COVID-19 pandemic compared to the pre-pandemic period. Our results demonstrate three important findings about nonfatal firearm injuries during the pandemic: 1) the rate of nonfatal firearm injuries increased by 9% compared to pre-pandemic, 2) there were substantial increases in the rate of female and older victims and 3) nonfatal firearm injuries continued to be most prevalent within neighborhoods with higher rates of pre-pandemic firearm injuries, structural disadvantage, and structural racism. The increase of nonfatal firearm injuries during the pandemic is consistent with trends in national data. [25,26]

Most notably, the rate of female nonfatal firearm injury victims doubled during the pandemic period compared to pre-pandemic. Prior studies suggest an increase in intimate partner violence during the pandemic,[27] however, our findings demonstrate a decrease in domestic violence. This

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key finding may speak to the changing nature of gun violence, specifically for female victims during the pandemic. Our findings also highlight increases across all age groups, with the most notable increase in older victims. Nonfatal firearm injury victims 30 years of age and older experienced the largest rate increase during the first 18 months of the pandemic, with older victims accounting for nearly half of all nonfatal firearm injury victims. Pandemic related stressors such as unemployment, financial strain, increased unscheduled time, social isolation and the increase in access to firearms is associated with increases in firearm injuries and it is plausible such factors help explain the noted increases in both female and older victims.[6,18] Our findings also note a particularly high increase in shootings motivated by interpersonal disputes, which would support the notion of a shift in victim demographics – particularly among female and older victims - when pandemic related stressors and greater access to firearms facilitates conflicts that are handled with a firearm. Our findings also note a slight increase in pediatric nonfatal firearm injuries and victims between 21-24 years of age, which are well-documented groups at risk, however, our findings indicate these age groups are not driving the pandemic increase in firearm violence.[4,28]

Lastly, our findings indicate higher rates of nonfatal firearm injuries continue to occur in structurally disadvantaged communities, further contributing to health disparities in communities that have experienced structural disadvantage and racial inequalities for decades.[26,29] A growing body of research demonstrates levels of community firearm violence not only impacts the victim but contributes to higher levels of resident disability, adverse health outcomes, and mental health needs among adults and children who are indirectly impacted by the continued trauma of firearm violence.[15-17] Disadvantaged communities often lack available health care or post-hospital care is difficult for victims to obtain,[30] leaving victims and communities to cope with the trauma of their

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injuries alone, consequently compounding inequalities. Therefore, it is imperative to view and address community firearm violence as a public health crisis that needs to address the health of all residents within communities most impacted by firearm violence, not just the victims.

To prevent firearm violence through a public health approach, it is essential to understand the epidemiology of nonfatal firearm injury victims in order to design prevention efforts by identifying individuals and communities most affected by nonfatal firearm violence.[31] This study highlights three critical avenues to prevent future firearm violence and improve the health of those directly and indirectly impacted by nonfatal firearm injuries. One, our findings clearly demonstrate victimization rates of nonfatal firearm injuries have shifted during the first 18 months the COVID-19 pandemic with higher rates of female and older victims. Current programs focused on providing services to female victims of domestic violence exist, however, our findings suggest the increase in female victims is not driven by domestic related violence but interpersonal violence. Violence prevention programs such as Hospital Based Violence Intervention Programs (HVIPs), Cure Violence, and other community programs seek to connect victims of interpersonal violence to needed financial, health, legal, or other needed services post injury. Most HVIPs and other community-based programs, such as Cure Violence, which utilizes violence interpreters to mediate conflicts before they escalate to violence are largely focused on adolescents and young adults and reducing retalitation.[32] Programs should expand resources and outreach to meet the needs of female victims, for example, hiring more female violence interpreters who may better relate to the needs of female victims involved in interpersonal disputes. Much less is known about older victims of nonfatal firearm injuries, as research typically focuses on pediatric and young adult victims. Older victims may suffer more adverse health outcomes, such as mental illness and other chronic conditions,[33] and may have

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experienced more cumulative trauma and therefore respond differently to the emotional and physical trauma of their injury.[34] Older adults are more likely to be connected with a primary care provider, whom should utilize this opportunity to connect victims with mental health services.[35] Post-hospital discharge care programs provides ongoing mental health services outside of the managed care system and follows up weekly with patients,[36] and demonstrates an increase in mental health utilization among pediatric patients. Such a program should expand outreach to all victims, particularly female and older victims, to better connect them with needed services post injury. Additionally, collaborations and partnerships between firearm prevention programs, community organizations, and other city organizations are crucial to expand resources to address food insecurity, housing insecurity, socioeconomic insecurity, and other community health needs most impacted by the continued high rates of nonfatal firearm injuries.

Secondly, our findings demonstrate communities with more abandoned homes experience higher rates of nonfatal firearm injuries. Efforts to eliminate and demolish abandoned homes has reduced firearm violence by 11% in Detroit, MI and other community greening projects have reduced gun assaults and overall community violence.[37] Improving the maintenance of vacant lots through community greening projects also reduces residents fear of crime and improves overall community mental health outcomes.[38]

Lastly, these findings speak to the need for nationally available data on nonfatal firearm injuries to examine trends and patterns in victimization rates. Given the lack of available data, many have utilized the publicly available dataset compiled by the Gun Violence Archive. These data, however, are a collection of media reports that have demonstrated to be an undercount of official records by nearly half.[39] Additionally, nationally available nonfatal firearm injury data would

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allow for linkage with other national healthcare data to examine long-term health outcomes of those directly and indirectly affected by firearm violence.[40]

Limitations

There are several limitations of this study that should be noted. First, these results only include one jurisdiction. However, our data provide victim demographics and incident motive which are not typically available at the national level. Given mandatory reporting laws to law enforcement, our use of police data includes all victims of nonfatal firearm injuries that presented for care at an emergency room or reported their injury to police; however, these data do not include self-inflicted injuries, police-involved shootings, or injuries not reported to the police. This study is only descriptive, and results cannot speak to causation. Nonetheless, the findings of this study expand our current understanding of victims of firearm violence and provide direction for future studies into the increase of firearm violence during the COVID-19 pandemic.

Conclusion

Our study demonstrated an overall increase in nonfatal firearm injuries, shifting demographics of victims – particularly female and older victims, and that nonfatal firearm injuries during the pandemic continue to occur within structural disadvantaged communities that have experienced health and racial inequities for decades. These findings support the need to expand and rethink current firearm prevention efforts that both address the diversification of victimization, and how to address the health needs of residents within communities that experience the daily trauma of firearm violence.

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Ethics approval

The Indiana University institutional review board determined this study exempt (#10809).

Patient consent for publication.

N/A

Data availability statement

Data may be obtained from a third party or are available publicly.

Authors' contributions

LM developed the research question, obtained, analyzed the data, and wrote the manuscript. BL and DF helped with interpretation of results. All authors contributed to the writing and editing of the manuscript. All authors read and approved the final manuscript.

Competing Interests

The authors declare they have no competing interests.

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STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	(a) 1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	(b) 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7
Bias	9	Describe any efforts to address potential sources of bias	6-7
Study size	10	Explain how the study size was arrived at	6-7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, explain how loss to follow-up was addressed	
		(*e̲*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	Report numbers of outcome events or summary measures over time	8-9

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-9
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	n/a
Discussion			
Key results	18	Summarise key results with reference to study objectives	11-12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	18

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.