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Post-pandemic Divergent Trends in Firearm Homicide and Suicide Across Demographic and Urbanization Strata in the United States: A National Ecological Study (2018-2024)

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Abstract

Background: Firearm-associated deaths and injuries represent a major public health issue in the United States. These rates changed during and after the COVID-19 pandemic due to socioeconomic factors. Disparities among different demographic groups are evident in the data. This study seeks to evaluate changes during and after the pandemic.

Objective: The aim of this study was to evaluate post-pandemic trajectories, demographic disparities, and urban-rural distributions of firearm homicides and suicides in the United States.

Methods: A retrospective, longitudinal ecological study was conducted using the Centers for Disease Control and Prevention Wide-Ranging Online Data for Epidemiologic Research (CDC WONDER) mortality data (2018-2024). Trends were stratified by intent, age, race, sex, and urbanization level. Multivariable Poisson regression models with robust standard errors estimated annual incidence rate ratios (IRRs).

Results: Post-pandemic data revealed a structural divergence between homicides and suicides. Firearm homicides rose 34.4% in absolute deaths between 2019 and 2020 (14,286 to 19,203), peaked in 2021 at 20,808 deaths, and then contracted through 2024 (annual IRR 0.89; 95% CI 0.86-0.91). Relative to the pre-pandemic trend, the homicide incidence rate was 64.3% higher during 2020-2021 (IRR 1.643). Homicides were concentrated primarily among Black or African American individuals and young adults; pediatric homicide incidence was 87.3% above pre-pandemic trend levels (IRR 1.873), with counts peaking in 2022. Suicides followed a chronic, sustained acceleration: the pandemic level shift was null (IRR 1.000), but the post-onset trend showed a 1.8% annual increase in incidence (IRR 1.018; 95% CI 1.002-1.034; p = 0.023), driven predominantly by non-Hispanic White populations. Geriatric suicides increased continuously from 6,327 (2018) to 7,440 (2024). Urban settings drove the acute homicide shock, whereas rural suicides outnumbered rural homicides by more than 3.5 to 1.

Conclusions: Firearm homicide acted as a transient, urban-concentrated social shock, whereas firearm suicide represents an escalating, long-term public health crisis. Prevention strategies must move past uniform frameworks to target the unique sociodemographic drivers of each intent.

Categories: Environmental Health, Emergency Medicine, Epidemiology/Public Health
Keywords: covid-19 pandemic, demographics, firearm homicides, firearm suicides, social disparities

Introduction

Firearm homicide and firearm suicide constitute major public health issues in the United States, each characterized by unique behavioral drivers, victim profiles, and socioenvironmental risk factors [1]. The magnitude of this burden is substantial, considering both the human loss and the immense strain on the healthcare system. In 2020, firearms were involved in 79% of all homicides and 53% of all suicides [1], and approximately 50,000 firearm-related deaths, with roughly twice as many nonfatal firearm injuries, occur in the country each year [2].

The COVID-19 pandemic significantly intensified these patterns, though not uniformly. The age-adjusted firearm homicide rate rose 34.6% from 2019 to 2020 [1]. During the pandemic period (April 2020 through

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December 2021), total firearm deaths exceeded the forecast by 14.7%, with the largest proportional excess for homicide (34.1%) and a far smaller excess for suicide (2.6%). The divergence became more pronounced in 2021, when the homicide rate rose a further 8.3%, and the suicide rate rose an identical 8.3% relative to 2020 [3].

Critically, the post-pandemic period shows no return to prior baselines. Firearm homicide and suicide rates in 2021 reached their highest documented levels since 1993 and 1990, respectively [3]. Furthermore, firearm-related emergencies in hospital and prehospital settings remained above 2019 levels through 2023 [2,4], and firearms have persisted as the leading cause of death among children and adolescents [5]. Yet, most national analyses of firearm mortality concentrate strictly on the acute pandemic years, extending only through 2021-2022 [3,6,7]. Conversely, long-range historical studies [8] do not systematically examine how homicide and suicide trajectories have diverged by age group and demographic population specifically in the post-pandemic period.

These mortality patterns are not uniformly distributed; geographic location, race, ethnicity, age, sex, and social conditions all contribute significantly [1,3,7,9]. Urbanization is a further axis of heterogeneity that the two intents do not share: firearm suicide has long been concentrated in nonmetropolitan counties, whereas firearm homicide has been concentrated in large metropolitan counties, and excess firearm mortality during the pandemic period was itself stratified by both intent and urbanization level [6]. Systemic disparities in economic, educational, housing, and employment opportunities, compounded by structural racism, have heavily contributed to these widening inequities [3].

This study uses national vital statistics data from 2018 through 2024 and is organized around one primary descriptive objective and three secondary inferential objectives. The primary objective is to quantify annual counts and rates of firearm homicide and firearm suicide, overall and within strata defined by age group, race and ethnicity, sex, and urbanization level, and to report absolute and relative changes across three prespecified windows: pre-pandemic (2018-2019), acute pandemic (2020-2021), and post-pandemic (2022-2024). This component makes no counterfactual claim and attributes no observed change to a specific cause. The secondary objectives, addressed with Poisson regression models, include comparing pandemic-period rates with those predicted by the pre-pandemic trend, expressed as an incidence rate ratio; determining whether any pandemic-associated elevation persisted into 2022-2024 and estimating the post-pandemic slope separately for each intent; and assessing whether the magnitude of change diverged across demographic and urbanization strata. Descriptive and inferential results answer different questions and are reported separately, with all estimates framed as ecological associations rather than causal effects.

Materials And Methods

Study design and data source

A retrospective, longitudinal ecological study was conducted utilizing mortality data from the Centers for Disease Control and Prevention Wide-Ranging Online Data for Epidemiologic Research (CDC WONDER). The exact query parameters defined the underlying causes of death using International Classification of Diseases, 10th Revision (ICD-10) codes specific to firearm intent: X93-X95 and U01.4 (homicide) and X72-X74 (suicide). The study timeline was operationally divided into three phases: pre-pandemic (2018-2019), pandemic (2020-2021), and post-pandemic (2022-2024). For geographic stratification, populations were classified using the 2013 National Center for Health Statistics (NCHS) Urban-Rural Classification Scheme for Counties. Counties designated as Large Central Metro, Large Fringe Metro, Medium Metro, and Small Metro were aggregated as urban/metropolitan, while Micropolitan and Non-core counties were aggregated as rural/nonmetropolitan.

Variables and stratification

To evaluate the demographic and spatial divergence in firearm mortality, data were stratified by injury intent (homicide vs. suicide), ten-year age groups, Single Race 6, and sex. To prevent data suppression by the CDC (which censors stratifications resulting in fewer than 10 deaths) and preserve statistical integrity, the extraction was systematically divided into longitudinal national queries (2018-2024) and cumulative spatial queries aggregated by state.

Statistical analysis

Baseline annual incidence rates were calculated by dividing the absolute death counts by the corresponding aggregated population, expressed per 100,000 population. 95% confidence intervals (CIs) for crude rates were independently calculated using the Poisson distribution standard error methodology.

To evaluate temporal trends, Poisson regression models were utilized to calculate incidence rate ratios (IRRs). The interrupted time-series analysis modeled the annual mortality count as the dependent variable, incorporating the natural log of the population as an offset term to appropriately model incidence rates. The regression equation specification included the year (as a continuous temporal variable), a binary pandemic-period indicator (evaluating pre- versus post-onset effects), and an interaction term (year × pandemic period) to quantify slope changes in mortality trajectories. All data extraction, rate calculations, and

statistical modeling were executed using Python software version 3.10 (Python Software Foundation), utilizing the pandas, NumPy, and statsmodels libraries. Supplementary analytical code is maintained by the corresponding author and is available upon reasonable request.

To formally evaluate the divergent temporal trajectories of firearm mortality in the post-acute pandemic phase, multivariable Poisson regression models were fitted to estimate the annual IRRs for both homicide and suicide. The models utilized absolute mortality counts as the dependent variable, continuous years as the independent time variable, and the natural logarithm of the annual population as an offset to account for underlying demographic expansion. To mitigate the acute, nonlinear volatility introduced by the pandemic shocks, models were estimated using heteroskedasticity-consistent (HC3) robust standard errors. Statistical significance was established at an alpha level of 0.05.

Results

Divergent longitudinal trajectories and incidence rate ratios (2018-2024)

Analysis of national firearm mortality from 2018 through 2024 revealed a profound structural divergence between homicide and suicide trajectories in the post-pandemic period. During the acute phase of the COVID-19 pandemic, firearm homicides experienced an unprecedented, anomalous surge, increasing by 34.4% in absolute deaths in our tabulations, from 14,286 deaths in 2019 to 19,203 in 2020. The published national age-adjusted firearm homicide rate rose 34.6% over the same interval, from 4.6 to 6.1 per 100,000 [1]. The count figure is not directly comparable to the rate-based estimates reported below because it combines change in population size with change in risk.

However, in the post-pandemic period (2022-2024), firearm homicides demonstrated a sharp and sustained contraction. Poisson regression confirmed a highly significant temporal decline after the 2021 peak (Figure *1*), with the firearm homicide incidence rate decreasing by about 11% annually (IRR = 0.89; 95% CI: 0.86-0.91; $p < 0.001$), reducing the absolute burden to 15,224 deaths by 2024.

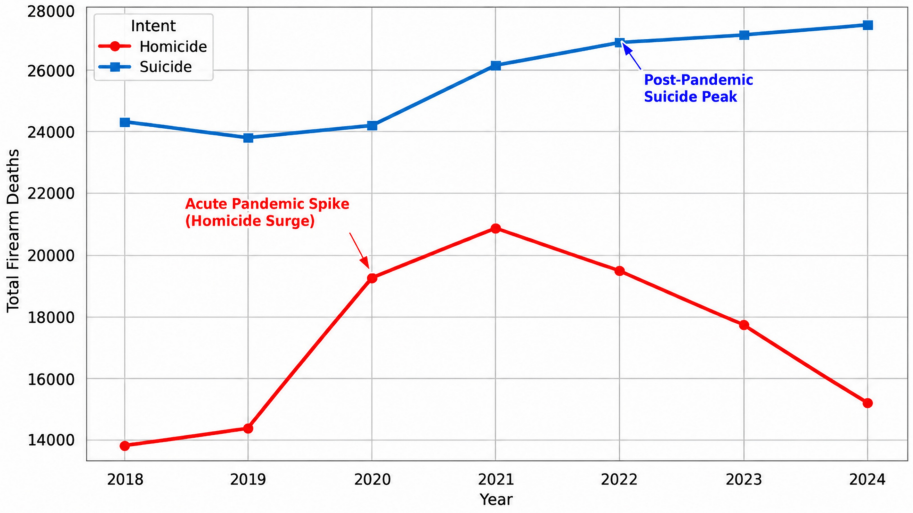


FIGURE 1: Divergent longitudinal trends in firearm homicide and suicide (2018-2024)

Firearm-related deaths by year, classified as homicide (red line) or suicide (blue line), from 2018 to 2024. Firearm-related homicides increased sharply during the COVID-19 pandemic, reaching their highest level in 2021 before declining through 2024. In contrast, firearm-related suicides generally increased over the study period, reaching their highest observed level in 2024. The annotations highlight the acute pandemic-associated increase in homicides and the sustained elevation in suicides during the post-pandemic period.

Conversely, firearm suicides followed an entirely distinct and escalating epidemiological path. While suicide counts remained relatively flat during the acute 2020 pandemic onset (24,160 deaths), they initiated a delayed, aggressive, and uninterrupted ascent. By 2024, firearm suicides reached a historic high of 27,469 deaths (Figure *1*). Poisson trend analysis verified that this post-pandemic surge represents a true structural acceleration independent of population growth, yielding a statistically significant annual increase in the suicide incidence rate from 2020 onward (IRR = 1.018; 95% CI: 1.002-1.034; $p = 0.023$). This divergent risk architecture solidifies a widening public health gap between the two intents.

Demographic fracturing in the post-pandemic era

Stratification of the post-pandemic cumulative data (2022-2024) confirmed that these two public health crises are driven by distinctly different populations.

The burden of firearm homicide remained highly concentrated among adolescents and young adults. The 15-24 and 25-34 age cohorts accounted for 57.9% of all homicides during this period (30,373 deaths). Analysis by race and ethnicity revealed severe structural disparities. The Black or African American population absorbed a grossly disproportionate 59.3% of the total firearm homicide burden (31,145 deaths) during the post-pandemic window (2022-2024), despite comprising a minority of the overall U.S. population (Table *1*). Furthermore, analysis of the cumulative 2018-2024 data highlighted a significant burden among the Hispanic/Latino population, which accounted for 26,419 firearm homicides and 33,546 firearm suicides over the seven-year study period. Conversely, the escalating firearm suicide crisis was overwhelmingly driven by the non-Hispanic White population, which accounted for 87.9% of all suicides in the post-pandemic era.

Category	Variable	Homicide (n)	Suicide (n)
Sex	Female	19,182	23,112
	Male	101,414	156,771
Ethnic/Race	American Indian or Alaska Native	1,278	1,420
	Asian	1,094	2,370
	Black or African American	72,511	14,170
	White	43,978	160,100
	Hispanic/Latino	26,419	33,546
	More than one race	1,631	1,781
	Native Hawaiian or Other Pacific Islander	104	42
Age Group	1-4 years	374	0
	5-14 years	2,007	1,216
	15-24 years	36,030	22,264
	25-34 years	36,553	27,613
	35-44 years	23,272	24,990
	45-54 years	12,025	26,017
	55-64 years	6,605	29,689
	65-74 years	2,616	23,491
	75-84 years	906	17,399
	85+ years	208	7,204

TABLE 1: Baseline demographics for firearm mortality by intent (2018-2024)

Data reflect total cumulative firearm mortality in the U.S. based on CDC WONDER.

CDC: Centers for Disease Control and Prevention; WONDER: Wide-ranging Online Data for Epidemiologic Research.

Geographic distribution and state-level burden (2018-2024)

Analysis of cumulative absolute mortality counts across the 50 U.S. states and the District of Columbia revealed distinct geographic concentrations for both firearm homicides and suicides. While the most populous states accounted for the highest absolute counts across both intents, with Texas, California, and Florida leading the nation, the remaining top-tier states showed intent-specific clustering (Figure *2*).

For firearm homicides, the absolute geographic burden was heavily concentrated in specific Southern and Midwestern hubs. The top five states, Texas (11,098 deaths), California (10,413 deaths), Florida (7,485 deaths), Illinois (6,956 deaths), and Georgia (5,993 deaths) (Figure *2*), accounted for a massive proportion of the national cumulative homicide count. The prominent inclusion of Illinois in the highest echelon

underscores a pronounced, localized concentration of interpersonal firearm violence that diverges from simple population-size predictability.

Conversely, the geographic distribution of firearm suicides reflected a distinct structural pattern. The top five states for cumulative firearm suicides were Texas (17,435 deaths), Florida (13,649 deaths), California (11,208 deaths), Georgia (7,274 deaths), and Pennsylvania (7,121 deaths) (Figure 2). The displacement of Illinois by Pennsylvania in the suicide burden highlights the severe, escalating impact of self-inflicted firearm injuries in states characterized by large, aging, and increasingly rural demographic populations.

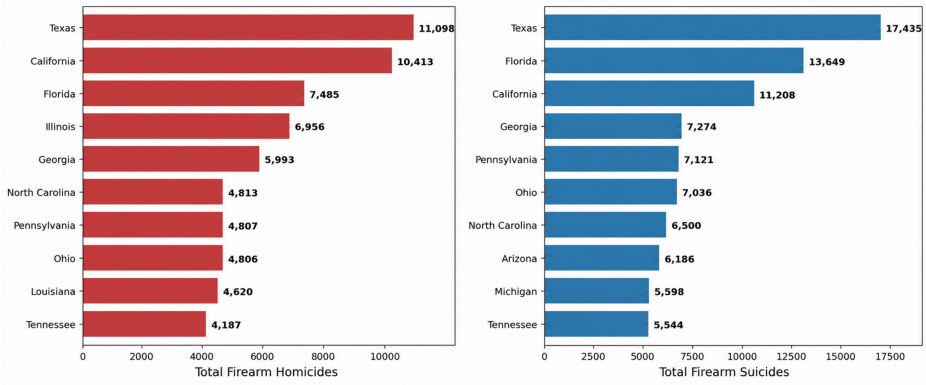


FIGURE 2: Top 10 U.S. states by cumulative absolute burden of firearm homicides versus firearm suicides (2018-2024)

Comparison of the 10 U.S. states with the highest cumulative numbers of firearm-related homicide (red bars, left panel) and suicide (blue bars, right panel) deaths between 2018 and 2024. Texas recorded the highest cumulative number of deaths in both categories, followed by California for homicides and Florida for suicides.

While the most populous states dictate the highest overall counts, the displacement of states like Illinois (homicide-heavy) by states like Pennsylvania and Arizona (suicide-heavy) highlights the distinct sociodemographic drivers of these two public health crises.

The acute COVID-19 shock (2020)

Interrupted time-series analysis utilizing Poisson regression confirmed that the onset of the COVID-19 pandemic in 2020 acted as a profound structural shock specifically for interpersonal violence. The pandemic era was independently associated with a massive 64.3% increase in the incidence rate of firearm homicides (IRR = 1.643; $p < 0.001$) after controlling for historical population growth. Conversely, the pandemic onset had no acute structural impact on self-inflicted violence, with the suicide incidence rate remaining unchanged during the initial shock (IRR = 1.000; $p = 0.999$). This validates that the 2020 surge was exclusively a homicide phenomenon (Figure 3).

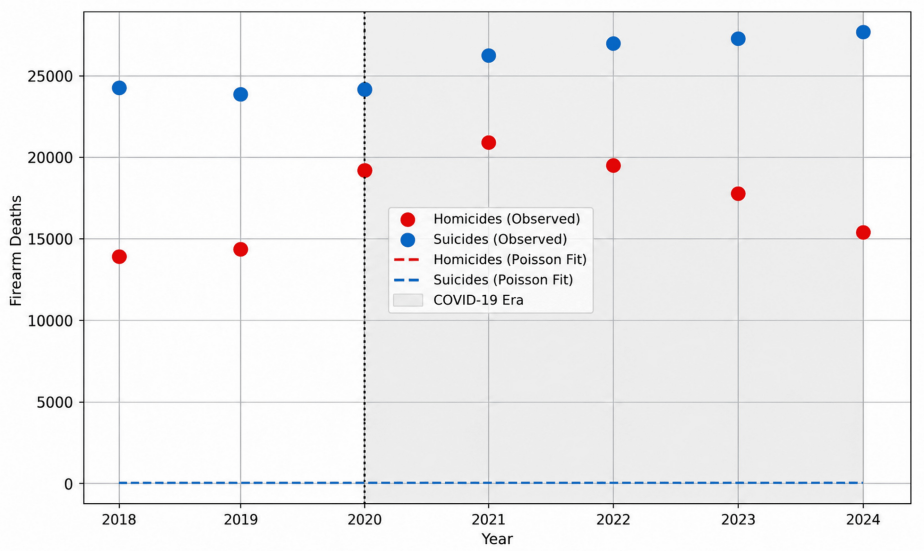


FIGURE 3: Poisson regression fit: COVID-19 structural impact on firearm mortality (2018-2024)

Firearm-related homicide (red circles) and suicide (blue circles) deaths in the United States from 2018 to 2024. The vertical dotted line marks 2020, the onset of the COVID-19 pandemic, while the shaded region identifies the pandemic and subsequent observation period (2020–2024). Observed homicide deaths increased sharply in 2020, peaked in 2021, and subsequently declined through 2024. In contrast, firearm-related suicide deaths demonstrated an overall upward trend during the study period.

Mortality surges at the demographic extremes: pediatric homicide and geriatric suicide

Beyond the general demographic shifts, structural analysis of the most vulnerable age cohorts, the pediatric (<15 years) and geriatric (≥65 years) populations, revealed severe, disproportionate escalations in firearm mortality at the extremes of the lifespan (Figure 4).

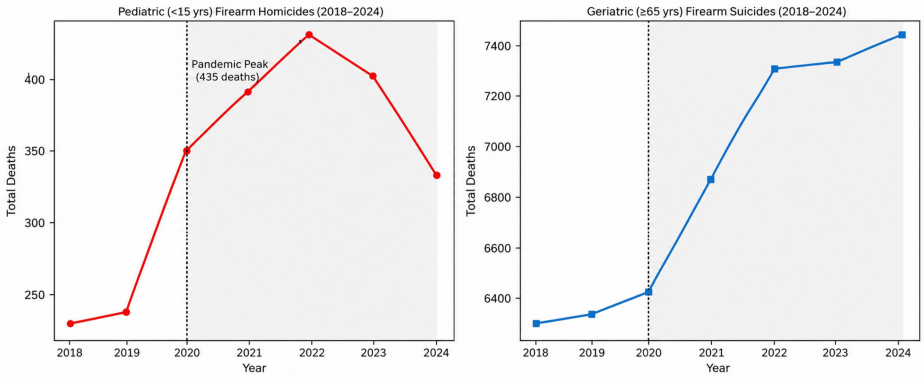


FIGURE 4: Divergent escalation of firearm mortality at demographic extremes (2018-2024)

The left panel illustrates the acute, pandemic-driven surge in pediatric (<15 years) firearm homicides, which peaked in 2022. The right panel demonstrates the continuous, structural rise in geriatric (≥65 years) firearm suicides, highlighting a chronic and expanding crisis among the aging population.

In the pediatric cohort (ages 1-14), firearm homicides experienced a catastrophic surge directly coinciding with the pandemic onset. Absolute pediatric homicides nearly doubled, climbing from a pre-pandemic baseline of 228 deaths in 2018 to a peak of 435 deaths in 2022. Poisson regression analysis confirmed that the pandemic era was independently associated with an 87.3% increase in the pediatric firearm homicide incidence rate (IRR = 1.873; $p < 0.001$). Geographic aggregation (2018-2024) indicated that this crisis was heavily concentrated in specific states, with Texas (246 deaths), Florida (147 deaths), and Ohio (143 deaths)

recording the highest cumulative pediatric homicide burdens.

At the opposite end of the demographic spectrum, the geriatric population (ages 65 and older) experienced a relentless, linear escalation in firearm suicides. Unlike the acute pandemic shock seen in pediatric homicides, geriatric firearm suicides demonstrated a continuous, structural ascent, rising from 6,327 deaths in 2018 to a historic high of 7,440 deaths in 2024. This escalating trajectory solidifies firearm suicide among older adults as a chronic, expanding public health crisis driven by an aging demographic and compounding sociobehavioral factors.

The left panel illustrates the acute, pandemic-driven surge in pediatric (<15 years) firearm homicides, which peaked in 2022. The right panel demonstrates the continuous, structural rise in geriatric (⩾65 years) firearm suicides, highlighting a chronic and expanding crisis among the aging population.

The urban-rural fracture in firearm mortality

Stratification of mortality data utilizing the 2013 NCHS Urban-Rural Classification Scheme exposed a profound spatial fracture driving the divergent trajectories. The acute pandemic shock in interpersonal violence was highly concentrated within densely populated metropolitan areas. Poisson regression modeling isolated to Large Central Metros confirmed a devastating structural surge, with the COVID-19 era associated with a 58.1% independent increase in the incidence rate of urban firearm homicides (IRR = 1.581; $p < 0.001$) relative to the pre-pandemic baseline.

In contrast, the rural firearm mortality landscape was dominated almost exclusively by self-inflicted violence. In nonmetro (rural and micropolitan) counties, cumulative firearm suicides (27,129 deaths) outpaced rural homicides (7,597 deaths) by a ratio of more than 3.5 to 1. As demonstrated by the spatial-intent divergence (Figure *5*), while urban homicides experienced a volatile, acute surge followed by a post-pandemic contraction, the rural firearm suicide burden maintained a persistent, high-baseline trajectory across the entire study window, reflecting a chronic and geographically entrenched public health crisis.

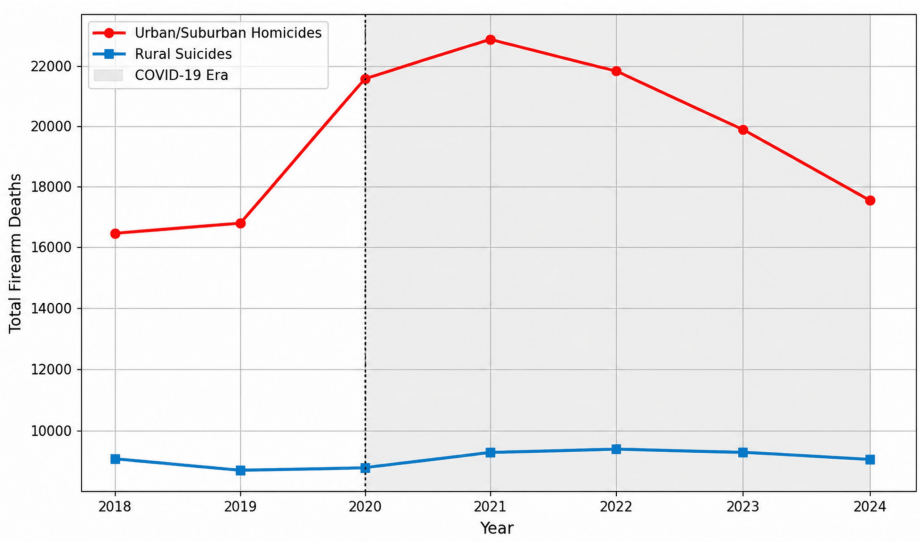


FIGURE 5: The urban-rural divergence in firearm mortality (2018-2024)

The red trajectory illustrates the acute, pandemic-driven shock in firearm homicides concentrated within Metropolitan (Urban/Suburban) areas. Conversely, the blue trajectory demonstrates the persistent and deeply entrenched burden of firearm suicides within Nonmetro (Rural/Micropolitan) communities, which remained largely impervious to the acute volatility of the pandemic era.

The red trajectory illustrates the acute, pandemic-driven shock in firearm homicides concentrated within metropolitan (urban/suburban) areas. Conversely, the blue trajectory demonstrates the persistent and deeply entrenched burden of firearm suicides within nonmetro (rural/micropolitan) communities, which remained largely impervious to the acute volatility of the pandemic era.

Discussion

The findings of this study demonstrate that the firearm-related violence crisis in the United States does not constitute a monolithic phenomenon; rather, in the post-pandemic era, it has bifurcated into two highly divergent epidemiological dynamics. On one hand, firearm-related homicides functioned as an acute societal shock; following a historic peak in 2021 (20,808 fatalities), they entered a phase of sustained

contraction, decreasing at an annual rate of 11% between 2022 and 2024 (IRR = 0.89; 95% CI: 0.86-0.91; p < 0.001). In stark contrast, firearm-related suicides maintained a trajectory of continuous structural growth beginning in 2020 (IRR = 1.018; 95% CI: 1.002-1.034; p = 0.023), reaching a historic maximum of 27,469 fatalities in 2024. This divergence indicates that while the peak in homicides was associated with temporary pandemic-related disruptions, suicide represents a chronic, expanding public health crisis that transcends the pandemic period [1,3,10].

Rates of firearm homicide increased abruptly in 2020 and 2021. This abrupt increase occurred amid a pandemic-related social shock superimposed on preexisting social vulnerabilities. Early in the pandemic, excess firearm mortality was driven primarily by homicide and was concentrated in urban areas [1,3,6]. Importantly, this increase was not distributed evenly across the population. Firearm homicide disproportionately affected younger populations and racial and ethnic minority groups, with particularly high rates among Black non-Hispanic young men and an increase in firearm homicide among Hispanic populations during the pandemic [3,7]. Pediatric populations also experienced substantial firearm mortality, with homicide accounting for the majority of firearm deaths among children and adolescents [5]. Several social and structural stressors, including economic instability, unemployment, severe housing problems, and disruptions in health and community services, may have contributed to the acute increase in firearm homicide during the pandemic [1,2,6]. Our analysis suggests that, following this pandemic-associated increase, firearm homicide subsequently declined (IRR = 0.89). This pattern suggests that the pandemic was associated with an acute disruption in firearm homicide rather than a sustained upward trajectory. From a spatial epidemiologic perspective, the concentration of excess firearm mortality in large metropolitan areas suggests that the effects of this transient disruption were geographically asymmetric, with urban centers experiencing a substantially greater impact than less densely populated areas [6].

In contrast to the transient and predominantly urban pattern observed for firearm homicide, firearm suicide demonstrated a more persistent and geographically distinct burden during the pandemic period. In 2021, the firearm suicide rate reached its highest recorded level since 1990, when national surveillance for firearm suicide began [1,3,6]. Unlike firearm homicide, which was consistently elevated earlier in the pandemic, firearm suicide was not higher than expected during the initial stages of the pandemic and became elevated later in the pandemic period [6]. This divergent temporal pattern is consistent with a longer-term burden that disproportionately affects older populations and nonmetropolitan communities. Firearm suicide rates have been particularly high among older White non-Hispanic men, with the highest rates observed among men aged 70 years and older [7]. In contrast, firearm suicide rates have remained high and increased over time in nonmetropolitan areas, particularly among adults aged 35 years and older, whereas metropolitan areas have consistently demonstrated higher firearm homicide rates [7]. National surveillance also documented substantial firearm injury morbidity during the pandemic, with firearm-related emergency department visits remaining elevated through 2022 [11]. The literature further indicates that the pandemic coincided with a substantial increase in firearm purchasing at the national level [12]. Although our ecological design does not allow us to assess individual-level household firearm access, it is plausible that greater availability of firearms at the population level may have interacted with psychological and social stressors during the pandemic [1,6,12]. These demographic and geographic differences suggest that firearm suicide represents a more chronic and geographically dispersed burden than the acute urban concentration observed for firearm homicide. Although social isolation, psychological stress, and disruptions in access to health and social services may have contributed to the increase in firearm suicide during the later pandemic period [1,6], our ecological design does not allow us to determine the contribution of individual-level mental health status or household firearm access.

Previous studies examining the acute phase of the COVID-19 pandemic documented substantial increases in firearm mortality through 2020-2021 [3,6]. By extending the analysis through 2024, our findings show that these initially concurrent increases evolved into markedly different post-pandemic trajectories. The rapid contraction in firearm homicide after its pandemic peak (IRR = 0.89), particularly following the acute surge in metropolitan areas, suggests that this pattern may have been linked to temporary disruptions in community and social structures that were most pronounced during the pandemic. In contrast, the continued increase in firearm suicide (IRR = 1.018), together with its persistent burden among older adults and rural and micropolitan populations, points to more enduring population-level vulnerabilities. Geographic isolation and limited access to primary and mental health care may be particularly important in these communities, where distance and reduced availability of services can create barriers to timely support. These conditions may also intersect with social isolation and broader deaths-of-despair pathways, potentially sustaining suicide risk beyond the acute pandemic period. Thus, our longitudinal findings suggest that the post-pandemic divergence between firearm homicide and suicide reflects not only different temporal trajectories but potentially different underlying population-level mechanisms that were not fully apparent in studies limited to the acute pandemic period.

The persistent burden of firearm suicide in rural and micropolitan communities, alongside the continuous rise in firearm suicide among adults aged 65 years and older, identifies two overlapping populations of particular public health concern. Previous evidence has similarly demonstrated important differences in firearm mortality according to urbanization and other place-based characteristics [6,9]. In our analysis, firearm suicides in nonmetropolitan areas outnumbered firearm homicides by more than 3.5 to 1, while firearm suicides among adults aged 65 years and older increased steadily throughout the study period.

Although these findings do not establish that the observed geriatric increase was specifically concentrated in rural areas, together they highlight the importance of healthcare accessibility when considering suicide prevention for older and geographically isolated populations. Rural communities face documented barriers to behavioral and mental health services, which may limit opportunities for timely assessment and support [13,14]. Primary care is therefore particularly relevant in this context, as rural patients may be more likely to seek care from medical professionals than from behavioral health specialists for mental health concerns [14]. Strengthening mental health screening and referral pathways within primary care may provide a practical means of reaching older adults and rural populations with limited access to specialized mental health services. These findings highlight the importance of adapting primary care and public health resources to the healthcare needs of aging and geographically isolated communities.

The 87.3% increase in homicide incidence among children younger than 15 years during the pandemic period, with a peak in 2022, was one of the most concerning findings of our analysis. Several factors related to the COVID-19 pandemic may help explain this trend. School closures disrupted children's daily routines and reduced their regular contact with teachers and other professionals who often play an important role in recognizing and reporting possible abuse or exposure to violence. Recent literature has reported changes in child maltreatment referral patterns related to school operating status during the pandemic, highlighting the protective role that schools play within child protection systems [15]. At the same time, firearm-related mortality among children remained elevated, with important racial and ethnic disparities continuing through 2023 [5]. Similarly, recent national data found that firearm homicide rates among children and young adolescents remained approximately twice pre-pandemic levels in 2022 and 2023 [16]. Taken together, these findings suggest that pandemic-related social disruption, combined with reduced access to established protective networks, may have contributed to the increased vulnerability observed among pediatric populations.

Limitations

The interpretation of these findings should take into account the ecological design and population-level nature of the data. Because the analysis relies on aggregated mortality data from CDC WONDER [10], it is susceptible to ecological fallacy; therefore, the demographic, state-level, and urbanization patterns observed cannot be causally extrapolated to individual-level risk. We therefore describe the pandemic-period estimates as ecological associations and attribute no observed change to the pandemic, to any policy, or to any single mechanism.

The mortality files contain no information on household income, education, employment, mental health or treatment access, firearm ownership or storage practices, or state firearm policy. Because these unmeasured determinants are correlated with the strata analyzed, stratum-specific differences may reflect their unequal distribution rather than age, race, or place, and we cannot distinguish compositional from contextual explanations [9]. Several measurement constraints apply. Death counts conflate burden with population size, so every geographic comparison is reported as a rate with the count retained and labeled, and each percentage change is identified as count-based or rate-based, since the two are not interchangeable.

These constraints define what the study can support: not causal claims about the pandemic, specific policies, or the mechanisms linking race, place, and firearm mortality, but a precise national description through 2024 of where and among whom the burden changed, the persistence of elevated homicide in large central metropolitan counties, and the distinct rural concentration of suicide, implying different targets, channels, and levels of geography for prevention.

Conclusions

In conclusion, the post-pandemic period has reshaped the demographic and spatial landscape of firearm mortality in the United States, revealing two epidemiologically distinct public health challenges. Firearm homicide followed an acute and volatile pandemic-associated trajectory, with a disproportionate burden among younger populations and metropolitan communities, whereas firearm suicide has emerged as a persistent and expanding burden concentrated among older adults and rural and micropolitan populations. These divergent demographic and spatial profiles demonstrate that firearm mortality should not be approached as a monolithic public health problem and that uniform prevention strategies are unlikely to adequately address both patterns. Public health priorities should therefore reflect this bifurcation by directing community violence-prevention resources toward younger populations and metropolitan settings, while strengthening access to primary care and mental health resources for older adults and geographically isolated rural and micropolitan communities. Aligning prevention resources with these distinct demographic and spatial patterns may provide a more targeted framework for addressing the evolving burden of firearm mortality in the post-pandemic United States.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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