The Impact of Gun Control Legislation on Mass Shootings in Chicago: An Analysis Across COVID-19 Periods (2018-2024)

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An Analysis Across COVID-19 Periods (2018-2024)

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This paper examines the impact of five major gun control laws enacted in Illinois between 2018-2024 on mass shooting patterns in Chicago, analyzing their effectiveness across pre-pandemic, pandemic, and post-pandemic periods. Through comprehensive analysis of Gun Violence Archive data, we investigate how legislative measures influenced shooting frequency, casualty rates, and incident characteristics during this unprecedented period of societal change. Using Interrupted Time Series Analysis, we evaluated both immediate and sustained effects of each intervention while controlling for COVID-19 related disruptions. Our findings reveal varying levels of effectiveness across different legislative approaches, with administrative measures like FOID Modernization showing superior outcomes compared to specific prohibitions. The research demonstrates significant shifts in incident patterns, with traditional weekend/weekday ratios and seasonal variations transforming notably during the pandemic period. While overall victim counts decreased following certain interventions, we observed concerning displacement effects, including increases in gang-related activities and shifts in incident locations. These results suggest that successful gun violence prevention requires a combination of comprehensive administrative frameworks and targeted enforcement measures, with careful attention to implementation timing and potential adaptive responses.

CCS CONCEPTS •Applied computing~Law, social and behavioral sciences~Law •Mathematics of computing~Probability and statistics~Statistical paradigms~Time series analysis

Additional Keywords and Phrases: Gun control legislation, Mass shootings, COVID-19, Chicago, Interrupted time series analysis, Public safety policy

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1 INTRODUCTION

Gun violence remains a deeply entrenched public health crisis in the United States, with mass shootings contributing significantly to its toll. Chicago, in particular, has emerged as a critical focal point in this crisis, consistently ranking as the city with the highest number of mass shootings nationwide [1]. The city's persistent struggle with gun violence, combined

with Illinois' evolving legislative landscape, presents a unique opportunity to examine the effectiveness of gun control measures at the municipal level. The onset of COVID-19 further complicates this issue, as the pandemic has potentially altered both societal behaviors and legislative responses [2].

This paper seeks to evaluate whether Illinois' gun control laws from 2018 to 2024 have had any measurable impact on the frequency, intensity, and nature of mass shootings in Chicago across three distinct periods: before, during, and after COVID-19. Using interrupted time series analysis (ITSA), we examine five key legislative interventions: Red Flag laws, Dealer Licensing requirements, FOID Modernization, Ghost Guns regulations, and Assault Weapons restrictions. Our methodology incorporates multiple temporal horizons (3, 6, and 12 months) to assess both immediate and long-term impacts while controlling for seasonal variations and weekend effects.

Key findings reveal varying degrees of effectiveness across different legislative measures. The FOID Modernization Act demonstrated the most comprehensive impact, achieving a 58.64% reduction in total incidents and a 458.07% reduction in total victims in the short term. However, long-term sustainability varied significantly across measures, with some showing diminishing returns and others producing unintended consequences. Notably, the analysis revealed significant shifts in incident patterns during the COVID-19 period, including changes in weekend/weekday ratios and seasonal variations, suggesting fundamental changes in gun violence dynamics during societal disruption.

2 PROBLEM DEFINITION

2.1 Research Questions

Our study addresses three primary research questions:

RQ1: How do multiple concurrent gun control legislative interventions interact and evolve in their effectiveness across different temporal horizons in Chicago? This question examines the synergistic effects and temporal evolution of multiple policy implementations, particularly focusing on the combined impact of concurrent legislation such as the Red Flag and Dealer License laws.

RQ2: How did the COVID-19 pandemic influence both the implementation effectiveness of gun control measures and the underlying patterns of mass shooting incidents? This explores the fundamental shifts in violence patterns across pre-COVID, during-COVID, and post-COVID periods, including changes in temporal distributions and seasonal variations.

RQ3: What are the nature-specific impacts and potential displacement effects of different gun control measures across various incident categories and intensity levels? This investigates how different types of gun control legislation affect specific categories of mass shootings and whether reductions in one type of incident lead to increases in others.

2.2 Analysis Framework

Preliminary data analysis reveals temporal and spatial dynamics in Chicago's mass shooting incidents. Weekend concentrations and seasonal variations suggest underlying socio-behavioral patterns that may respond differently to legislative interventions. The predominance of neighborhood-based and drive-by shootings (70% of cases) points to specific patterns that require targeted policy responses. These incidents demonstrate varying intensity levels, with distribution patterns shifting notably across COVID-19 periods.

Our analysis framework incorporates multiple dimensions of assessment. First, we examine the interaction and evolution of concurrent policy implementations, recognizing that gun control measures often operate in combination rather than isolation. Second, we analyze the impact of COVID-19 as both a disruptive force and a natural experiment in

behavioral change. Finally, we investigate the specific effects of legislation across different incident categories, acknowledging that gun violence manifests in various forms requiring distinct policy approaches.

To address these complexities, this research employs Interrupted Time Series Analysis (ITSA), examining the effectiveness of gun control legislation while accounting for pandemic-related changes. This methodological approach enables the investigation of both immediate and long-term legislative impacts while controlling concurrent societal disruptions. The analysis focuses on three key dimensions: temporal patterns of occurrence, incident intensity variations, and the evolving nature of mass shootings in relation to specific legislative measures.

3 DATA IN USE

3.1 Data Description

This study utilizes mass shooting incident data from the Gun Violence Archive (GVA) spanning January 2018 through October 2024 [1]. The raw dataset contains the following key fields:

Table 1: Description of Raw Data Fields from Gun Violence Archive (GVA)

Incident ID	Unique identifier for each event
Incident Date	Date and time of occurrence
Geographic Information	State, City/County, Address
Victims Information	Number of victims killed; Number of victims injured
Operations	Characteristics and details of the incident

3.2 Data Processing

The raw dataset underwent systematic preprocessing to enable rigorous analysis. Temporal feature extraction involved generating time-based indicators from incident dates, including year, month, day, and weekday indicators (1-7). We defined three distinct COVID-related periods to capture policy effects across different societal phases: Pre-COVID (January 2018 - January 2020), During COVID (March 2020 - May 2023), and Post-COVID (May 2023 - October 2024).

The victim aggregation process combined fatalities and injuries for each incident into a total victim count metric, providing a standardized measure of incident severity. For incident classification, we extracted and categorized events based on their operational characteristics into specific types including neighborhood-based, drive-by, party-related, and other location or context-specific categories. This classification system enables analysis of how different types of mass shooting incidents respond to legislative measures across various periods and intensity levels.

Using the total victim count, we implemented an intensity classification system based on tercile quantiles, categorizing incidents as low (below 33rd percentile), medium (between 33rd and 67th percentiles), or high (above 67th percentile). The resulting processed dataset supports analysis of mass shooting patterns across multiple dimensions - temporal trends, geographic distribution, incident severity, and casualty patterns - providing a foundation for evaluating gun control legislation impact.

4 RELATED WORK

4.1 Policy Evaluation Methods

Ben-Michael et al. [3] developed a policy trial emulation framework for assessing gun policies' impact, particularly in cases of staggered adoption across jurisdictions. Their work on right-to-carry laws and violent crime demonstrates the utility of difference-in-differences and synthetic control methods in policy evaluation. Building on this, Zhang and Rottman [4] advanced the methodological discourse by examining interrupted time series analysis, focusing on human capability to assess causality in policy interventions. Ukert, Andreyeva, and Branas [5] highlighted the importance of accounting for underlying time trends in policy analysis, using Australia's 1996 firearm law as a case study to demonstrate the significance of robust temporal analysis in gun policy research.

4.2 Network Analysis and Predictive Modeling

Green et al. [6] developed an innovative social contagion model to predict gun violence in Chicago. Using a dataset of 138,163 individuals, they applied machine learning techniques to social networks, demonstrating that modeling gun violence as an epidemic that spreads through social connections improved prediction accuracy by 62.4%. Their work showed that an individual's exposure to gun violence through social relationships was a significant predictor of becoming a victim.

Expanding on network-based approaches, Papachristos et al. [7] employed social network analysis to study gun violence in Boston. Using police records and a cascading network model, they identified that 85% of gunshot injuries occurred within a single connected network of approximately 763 individuals, highlighting the potential for targeted intervention strategies.

4.3 Machine Learning for Risk Assessment

Wang et al. [8] implemented a random forest algorithm to predict gun violence risk in urban environments. Analyzing data from 2006 to 2019 across multiple cities, they achieved an accuracy of 74% in identifying high-risk locations for gun violence incidents. Their model incorporated various features including temporal patterns, geographical data, and socioeconomic indicators.

4.4 Natural Language Processing for Gun Violence Research

Blevins et al. [9] developed an NLP-based system to analyze social media discussions surrounding mass shootings. Using transformer models and sentiment analysis, they achieved 83% accuracy in identifying gun violence-related discussions and potential indicators of future incidents. Their work demonstrated the value of social media analysis in understanding the broader context of gun violence.

5 BACKGROUND AND MOTIVATION

5.1 Legislative Background

Chicago has long been at the center of the gun control debate, operating under Illinois' comprehensive regulatory framework. The state's Firearm Owners Identification (FOID) Card Act [10] established the foundation for monitoring gun ownership, while the Firearm Concealed Carry Act [11] introduced strict licensing for concealed weapons. These laws set a precedent for recent policies affecting Chicago between 2018 and 2024.

Several significant pieces of gun control legislation were enacted between 2018-2024, focusing on various aspects of firearm regulation. The following highlights some key areas these acts addressed:

5.1.1 Firearm Restraining Orders

The Illinois General Assembly enacted the Firearm Restraining Orders Act, Public Act 100-0607, establishing "Red Flag Laws" that allow family members or law enforcement to petition courts for firearm removal [12]. The law enables temporary removal of firearms from individuals posing immediate danger, while creating due process procedures for both firearm removal and return. The legislation sets a maximum restraining order duration of 6 months.

5.1.2 Firearm Dealer License Certification Act

The Firearm Dealer License Certification Act, Public Act 100-1178, mandated state licensing for firearm dealers beyond federal requirements and created new provisions against illegal gun trafficking [13]. The Act implemented comprehensive dealer oversight measures, requiring video surveillance systems in dealer locations, establishing employee training requirements, implementing electronic record-keeping systems, and creating inspection protocols for dealer inventory.

5.1.3 FOID System Modernization

Through Public Act 102-0237, the FOID System Modernization Act significantly enhanced firearm ownership verification by implementing universal background checks for private gun sales and creating an electronic FOID card system [14]. The Act required fingerprinting for FOID card applications, established an automated renewal system, and created a prohibited person portal for law enforcement.

5.1.4 Ghost Guns Ban Act

The Ghost Guns Ban Act, introduced as Public Act 102-0889, addressed the emerging threat of unserialized firearms by prohibiting their possession and sale, requiring serial numbers on existing privately made firearms, and banning the distribution of 3D printed gun files [15]. The legislation established penalties for violations and created a tracking system for ghost gun incidents.

5.1.5 Protect Illinois Communities Act

The Protect Illinois Communities Act, Public Act 102-1116, implemented broader restrictions on assault weapons, banning their sale and manufacture while prohibiting high-capacity magazines (over 10 rounds for long guns, 15 for handguns) [16]. The Act required registration of existing assault weapons, expanded safe storage requirements, and enhanced penalties for violations.

These acts represent a progressive tightening of firearm regulations, with provisions extending beyond these highlighted areas to create a comprehensive framework for gun control. Chicago's implementation of these state laws occurs against a backdrop of unique local challenges, including high rates of neighborhood-based and drive-by shootings. The city's distinct patterns of gun violence, particularly the concentration of incidents in specific neighborhoods, necessitate examination of how state-level policies translate to municipal impact.

5.2 Motivation behind Chicago

Based on comprehensive exploratory data analysis, Chicago emerged as the optimal location for examining the effectiveness of gun control legislation for three primary reasons:

5.2.1 Highest Incident Concentration

Chicago demonstrates the highest concentration of mass shooting incidents among all U.S. cities, with Illinois leading all states in mass shootings. This concentration provides the necessary statistical power for robust analysis of legislative impact on different types of shooting incidents.

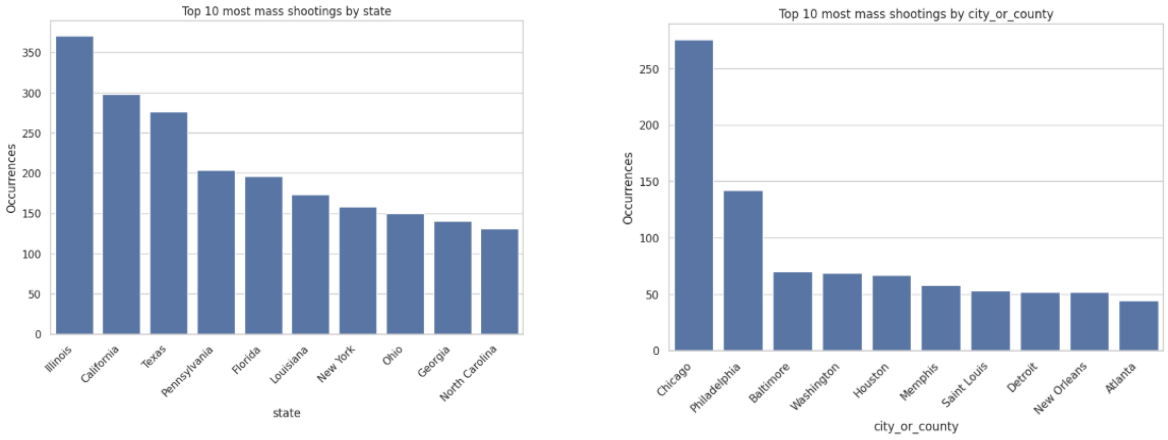

Figure 1: Top 10 States and Cities by Number of Mass Shootings (2018-2024)

5.2.2 Diverse Incident Patterns

Chicago exhibits the greatest variety in incident types among all Illinois cities. Our analysis reveals that 70% of cases are split between neighborhood and drive-by incidents, with the remaining cases distributed across various settings including parties, clubs, gang activity, and domestic violence. This diversity enables examination of how legislative measures affect different types of mass shootings incidents.

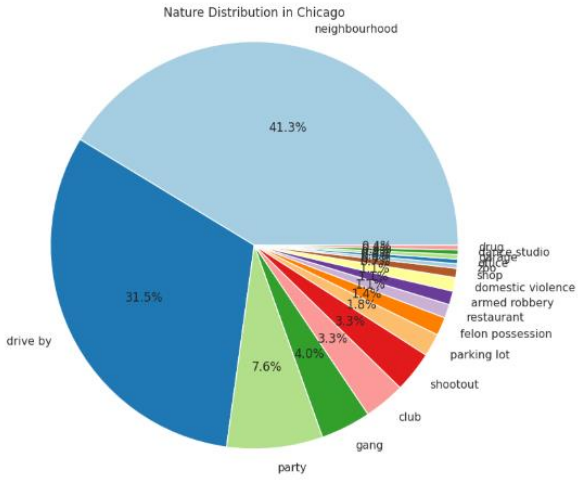

Figure 2: Distribution of Mass Shootings Incidents by Nature in Chicago (2018-2024)

5.2.3 Temporal Analysis of Chicago

First, Figure 4 demonstrates Chicago's clear peak in mass shooting occurrences during 2020-2021, showing significantly higher incident rates compared to other major cities. Chicago consistently recorded the highest number of incidents across all years, with a particularly pronounced spike reaching nearly 60 incidents in 2020, far exceeding the levels observed in other metropolitan areas like Philadelphia and Baltimore.

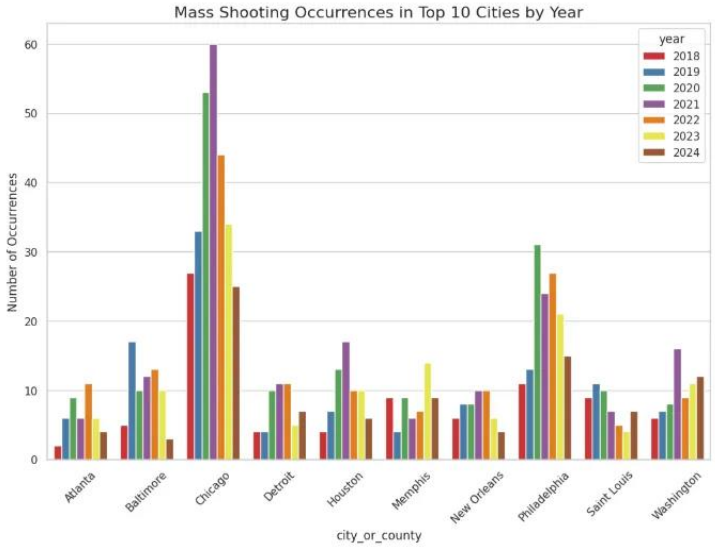

Figure 4: Comparative Analysis of Mass Shooting Incidents Across Major U.S. Cities

Second, the seasonal distribution of incidents, illustrated in Figure 5's heatmap, reveals intense concentration during summer months. Chicago's pattern is particularly pronounced, with victim counts reaching peaks of 250-314 during June-

August. This seasonal intensity far surpasses other cities in both scale and consistency, providing robust data for analyzing how legislative measures perform across different seasonal contexts.

Figure 5: Monthly Distribution of Mass Shooting Victims Across Top 10 U.S. Cities

Third, Figure 6 presents a striking visualization of victim patterns across COVID-19 periods, showing a dramatic increase in both injuries and fatalities during the pandemic period. The "During COVID" phase exhibits nearly triple the victim count compared to pre- and post-pandemic periods, creating distinct temporal segments for analyzing legislative effectiveness under different societal conditions.

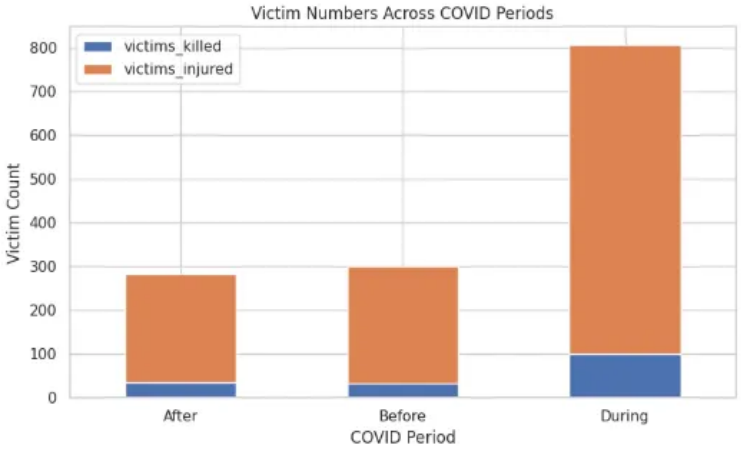

Figure 6: Comparative Analysis of Mass Shooting Victims Before, During and After COVID-19 Periods

Fourth, the weekday distribution analysis shown in Figure 7 reveals distinct patterns across all three COVID periods. The data shows a consistent concentration of incidents during weekends, with particularly pronounced weekend clustering during the COVID period where Chicago's incident rates notably exceeded other cities. This pattern persists, though at

different scales, across all three temporal phases (Before, During, and After), providing valuable insight into how enforcement and legislative effectiveness may vary throughout the week.

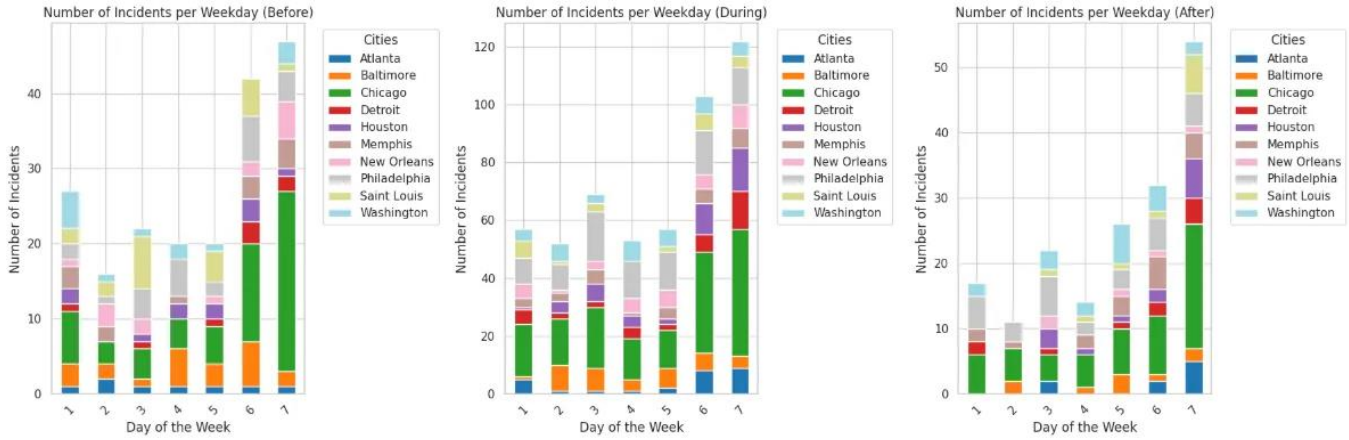

Figure 7: Weekday Distribution of Mass Shooting Incidents Across COVID-19 Periods in Top 10 Cities

5.2.4 Nature and Intensity Distribution

Our analysis reveals two critical patterns that reinforce Chicago's suitability for this study. First, the nature of mass shooting incidents shows a clear evolution across COVID periods. While neighborhood and drive-by incidents dominated in the pre-COVID era, the distribution became increasingly diverse in later periods, with the emergence of various incident types including party-related violence and domestic incidents.

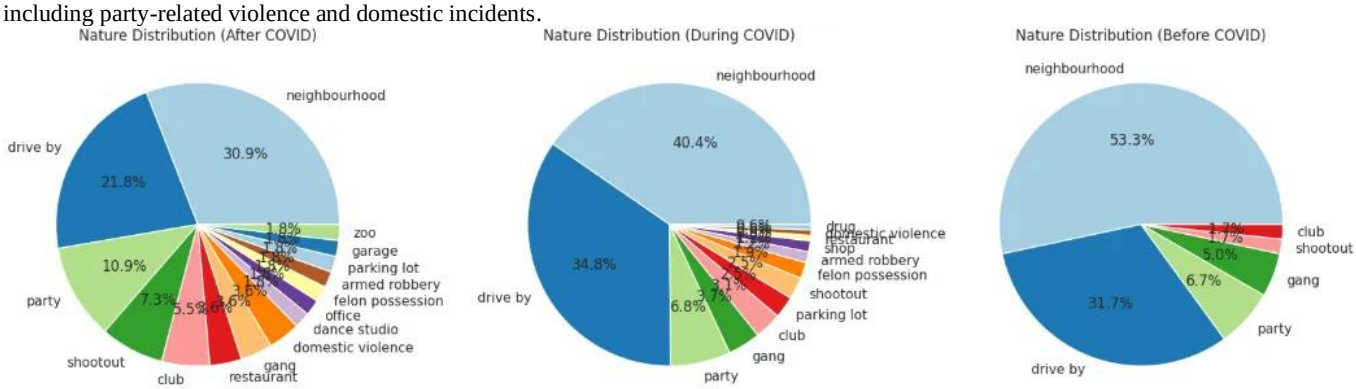

Figure 8: Distribution of Mass Shooting Types Across COVID-19 Periods

Second, the analysis of incident intensity distributions reveals distinct patterns across severity levels. Each intensity category - low, medium, and high - demonstrates unique characteristics in how different types of mass shootings manifest, particularly in the varying prominence of neighborhood-based incidents, drive-by shootings, and party-related violence.

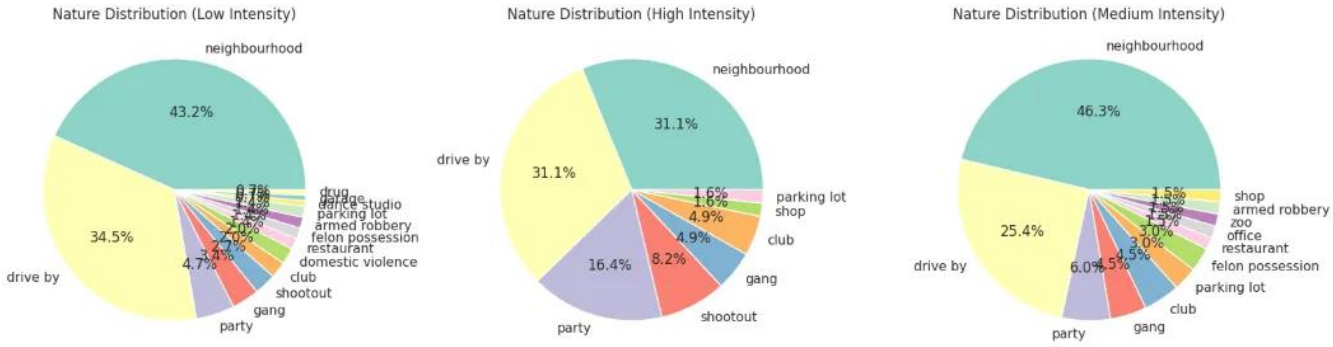

Figure 9: Distribution of Mass Shooting Types by Incident Intensity Level

These four characteristics, supported by comprehensive visualization data, establish Chicago as an ideal case study for examining the impact of gun control legislation across multiple dimensions and contexts.

6 METHODOLOGY

This study employs an interrupted time series analysis (ITSA) approach to evaluate the impact of gun control legislation on mass shootings in Chicago across COVID-19 periods from 2018 to 2024. The methodology is structured to address the complex nature of policy intervention analysis while accounting for the unique challenges presented by the COVID-19 pandemic [17].

6.1 Analytical Framework

The study utilizes a segmented regression analysis with multiple interruption points, implemented through an Unobserved Components Model (UCM) structure [18]. This approach was selected for several compelling reasons. First, it provides the ability to handle multiple overlapping policy interventions. Second, it offers robustness to population-wide changes, which proved particularly important during the COVID-19 pandemic [19]. Third, it maintains independence from potentially invalid control groups. Fourth, it demonstrates the capacity to capture both level and slope changes in violence trends [20]. Finally, it shows the ability to account for pre-existing trends and seasonal patterns. The analysis specifically examines five key legislative interventions: Red Flag laws (January 2019), Dealer Licensing requirements (January 2019), FOID Modernization (January 2021), Ghost Guns regulations (May 2022), and Assault Weapons restrictions (January 2023).

6.2 Data Organization and Structure

The data organization process was designed to maximize analytical precision while maintaining statistical power. Monthly aggregation was employed as the primary temporal unit, balancing the need for adequate statistical power with the ability to detect policy implementation effects [21]. Monthly intervals were selected over weekly data to reduce noise from random fluctuations while still maintaining enough granularity to detect policy effects. Weekly data would have been too volatile for reliable trend analysis, while quarterly aggregation would have reduced statistical power and obscured important short-term policy impacts. The data structure includes several key components: core metrics encompassing incident counts, victim counts, and nature types. We also incorporated temporal indicators for multiple analysis horizons (3, 6, and 12 months), along with seasonal components accounting for summer months and weekend effects. The COVID period

segmentation divided the timeline into pre-COVID (2018-February 2020), during COVID (March 2020-May 2023), and post-COVID (June 2023-2024). The study incorporates seventeen distinct nature categories for incident classification, including drive-by shootings, gang-related incidents, domestic violence, and various location-specific events, enabling nuanced analysis of policy impacts across different types of gun violence.

6.3 Statistical Implementation

The statistical analysis employs a robust framework incorporating several key components. Our time series analysis utilizes a Heteroskedasticity and Autocorrelation Consistent (HAC) error framework with Newey-West correction (12-month lag) [22]. This framework includes horizon-specific models for different temporal periods and cumulative effect calculations. For pattern recognition, we implemented structural break testing for significant pattern changes, seasonal pattern analysis for recurring temporal variations [23], and weekend effect assessment for day-of-week variations. The analysis includes specific controls for weekend effects and seasonal variations, with particular attention to summer months when gun violence typically increases. These controls were implemented based on established patterns in urban violence. Research has shown that weekend periods typically show higher incident rates due to increased social activity and alcohol consumption [24]. Additionally, summer months consistently demonstrate elevated violence rates due to longer daylight hours, increased outdoor activities, and higher temperatures correlating with aggressive behavior [25]. By controlling for these known patterns, we achieve more precise isolation of policy effects from recurring temporal variations.

6.4 Impact Assessment Framework

The impact assessment strategy operates across multiple dimensions, following established frameworks in policy evaluation research [26]. Based on the methodological approach developed by Zhang et al. [27], our temporal analysis encompasses three distinct periods. The short-term analysis (3 months) focuses on immediate policy impact assessment. The medium-term analysis (6 months) examines the intermediate adaptation period. The long-term analysis (12 months) evaluates sustained effects. Our effect measurement framework incorporates four key components: immediate impact quantification, trend change analysis, nature-specific evaluation, and intensity-level assessment categorized as low, medium, and high. We selected these specific intervals based on established policy implementation patterns. The three-month period captures immediate compliance effects. The six-month window allows for institutional adaptation and public awareness to develop. The twelve-month timeframe provides sufficient time to observe sustained behavioral changes while controlling for annual seasonal variations.

6.5 Results Integration

The final methodological component involves the systematic integration of findings across multiple dimensions. This integration encompasses four primary areas: effect aggregation across different time horizons, pattern synthesis across analytical dimensions, policy interaction analysis, and comprehensive impact assessment. The methodology constructed here provides a robust framework for analyzing the complex relationships between gun control legislation and mass shooting incidents. This framework accounts for the unique circumstances of the COVID-19 pandemic and various temporal and spatial patterns specific to Chicago [28]. Through this comprehensive approach, we ensure that our analysis captures both the direct and indirect effects of legislative interventions while accounting for contextual factors that might influence their effectiveness.

7 RESULTS/ EVALUATION

The following analysis presents key findings from an extensive examination of Chicago's gun control legislation impact. The complete study encompassed 17 different incident categories, 5 gun control laws, 3 COVID-19 periods (pre, during, and post), and multiple temporal analyses (short, medium, and long-term). While comprehensive statistical data is available for all possible combinations of these factors, this section focuses on the most significant findings that demonstrate clear patterns and implications for policy effectiveness. The results presented below represent critical insights drawn from this broader analysis, highlighting the most impactful and statistically significant outcomes.

7.1 Effect Aggregation Across Time Horizons

7.1.1 Red Flag Law and Dealer License Act (2019)

The Red Flag Law and Dealer License Act, implemented concurrently in January 2019, demonstrated significant initial impact with a 60.5% implementation effect. Their most notable achievement was a 30.48% reduction in total victims during the short-term period ($p < 0.0001$), coupled with a significant decrease in weekend incidents (-5.51, $p < 0.0001$) and club-related incidents (-4.83, $p < 0.0001$). The medium-term analysis revealed some concerning trends, with victim counts rebounding by 18.87% ($p = 0.0572$), though weekend incident control remained effective. High-intensity incidents showed promising short-term reduction (-4.10, $p = 0.0632$), but this was partially offset by an increase in low-intensity incidents (+4.38, $p < 0.0001$). Long-term sustainability varied across categories, with weekend incidents maintaining modest improvement (1.72, $p < 0.0001$) while other metrics largely returned to baseline levels.

7.1.2 FOID Modernization Act (2021)

The FOID Modernization Act demonstrated remarkable short-term effectiveness in its first three months of implementation. The legislation achieved a 58.64% reduction in total incidents ($p = 0.0005$) and an impressive 458.07% reduction in total victims ($p < 0.0001$). Additional short-term impacts included a 16.09% reduction in armed robbery ($p < 0.0001$) and a 37.54% reduction in low-intensity incidents ($p = 0.0264$), indicating broad-spectrum effectiveness across different types of gun violence.

Medium-term effects, measured over six months, showed sustained but gradually diminishing impact. The Act maintained a 39.74% reduction in total incidents ($p < 0.0001$) and a 230.48% reduction in total victims ($p < 0.0001$). Drive-by shootings decreased by 12.54% ($p < 0.0001$), while low-intensity incidents showed an 18.26% reduction ($p < 0.0001$). However, long-term analysis over twelve months revealed a significant decline in effectiveness, with effects stabilizing near baseline. Total incidents showed only a minimal 0.18% decline ($p = 0.9803$), and total victims actually increased by 13.21% ($p = 0.7096$).

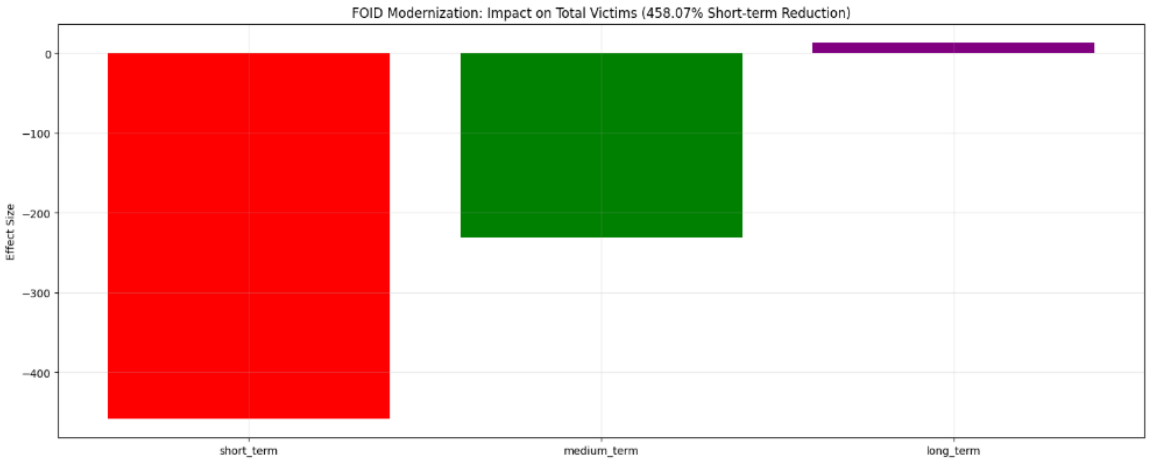

Figure 10: Effect of FOID Modernization on Victim Numbers in the Short Term

7.1.3 Ghost Guns Regulation (2022)

The Ghost Guns legislation produced complex and sometimes contradictory outcomes in its initial implementation phase. Short-term effects were marked by a substantial 96.85% reduction in high-intensity incidents ($p < 0.0001$) and a 61.31% reduction in neighborhood incidents ($p = 0.0074$). However, these positive outcomes were accompanied by concerning increases, including a 682.84% rise in total victims ($p = 0.0158$) and a 24.75% increase in domestic violence incidents ($p < 0.0001$).

Medium-term analysis revealed some stabilization of these effects. Drive-by shootings decreased by 9.18% ($p = 0.0200$), and domestic violence showed a 7.48% reduction ($p = 0.0005$). However, low-intensity incidents increased by 7.70% ($p = 0.0905$). Long-term impacts demonstrated mixed sustainability, with a 10.28% sustained reduction in total incidents ($p = 0.0002$) but a 45.65% increase in total victims ($p = 0.0140$) and a 7.63% rise in low-intensity incidents ($p < 0.0001$).

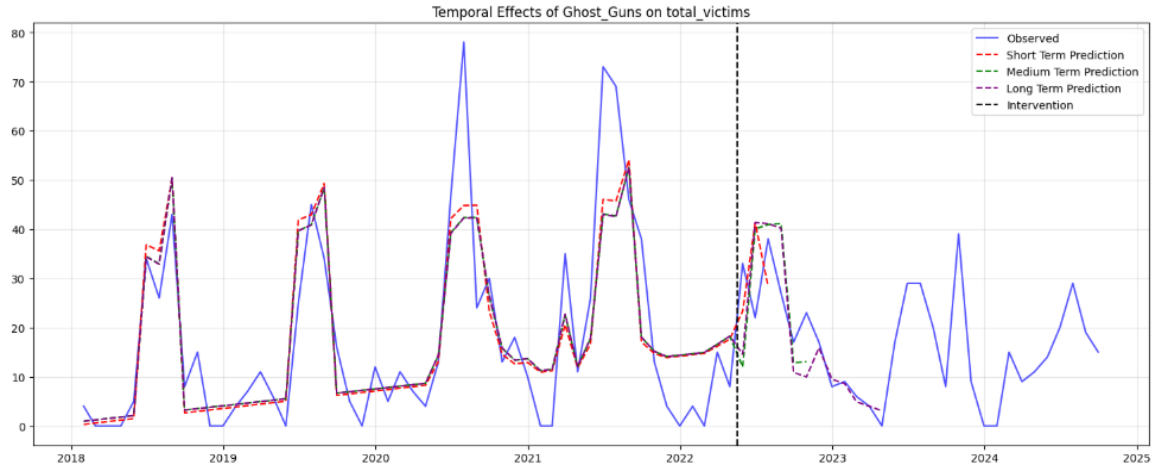

Figure 11: Temporal Effects of Ghost Guns on Total Victims

7.1.4 Assault Weapons Ban (2023)

The Assault Weapons Ban showed targeted effectiveness in its short-term implementation. Gang-related incidents decreased by 29.76% ($p < 0.0001$), restaurant incidents reduced by 28.71% ($p < 0.0001$), and medium-intensity incidents dropped by 27.46% ($p < 0.0001$). However, total victims increased by 67.86% ($p = 0.0339$), suggesting possible displacement effects. Medium-term data showed partial sustainability of these effects, with gang-related incidents maintaining a 9.68% reduction ($p = 0.0001$), though total victims increased by 42.28% ($p = 0.3852$) and armed robbery incidents rose by 8.16% ($p = 0.0025$).

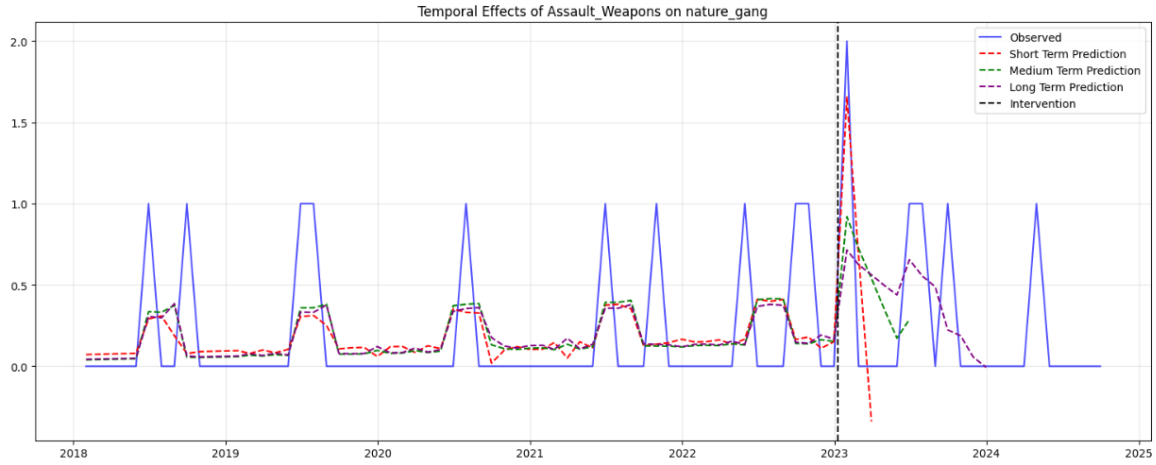

Figure 12: Temporal Effects of the 2023 Assault Weapons Ban on Gang-Related Incidents

7.2 Pattern Synthesis Across Analytical Dimensions

The analysis revealed significant shifts in incident distribution patterns across implementation periods. Neighborhood-based incidents decreased from 39.7% to 31.7%, while drive-by shootings showed a reduction from 29.6% to 20.1%.

However, gang-related activities doubled from 4.0% to 8.0%, suggesting possible displacement effects. Party-related incidents decreased from 15.6% to 9.6%, while club incidents showed a slight increase from 3.7% to 5.7%.

Temporal distribution analysis demonstrated clear COVID-19 period impacts on incident patterns. The weekend/weekday ratio evolved from 1.42 pre-COVID to 1.00 during COVID, slightly increasing to 1.04 post-COVID, indicating a fundamental shift in temporal patterns. Seasonal variations showed a decreasing disparity between summer and non-summer incident rates across COVID periods, moving from a 6.67x difference pre-COVID (7.00 vs. 1.05) to a 3.66x difference during COVID (9.33 vs. 2.55), and finally a 2.05x difference post-COVID (4.83 vs. 2.36).

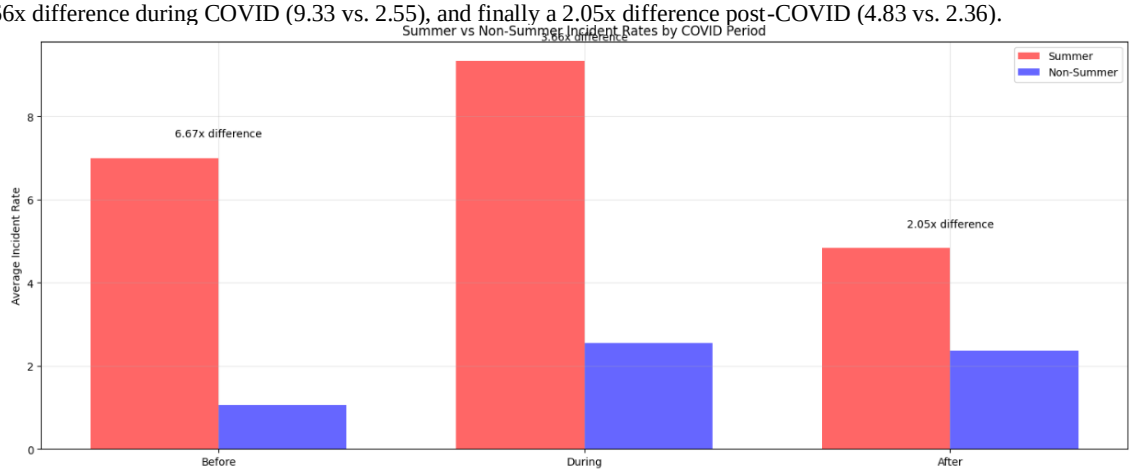

Figure 13: Seasonal Variation in Gun Violence Incidents Across COVID-19 Periods

7.3 Policy Interaction Analysis

The concurrent implementation of Red Flag and Dealer License laws in 2019 demonstrated significant synergistic effects. Together, these measures achieved a combined 30.48% reduction in total victims ($p < 0.0001$) and a 4.30% reduction in total incidents ($p < 0.0001$). Both laws showed identical impact patterns with an 84.7% percentage change and the same immediate effects (1.91 for incidents), suggesting their complementary nature in addressing gun violence.

The sequential implementation analysis revealed a progressive evolution of policy effectiveness. The Red Flag/Dealer License combination showed strong initial impact followed by stabilization, though long-term effects proved minimal ($p = 0.2497$). The FOID Modernization Act followed with the strongest immediate impact (168.8% change) and most significant victim reduction of all measures. The Ghost Guns regulation demonstrated mixed effects but achieved strong location-specific impacts, while the Assault Weapons Ban showed targeted effectiveness for specific incident types with significant short-term effects.

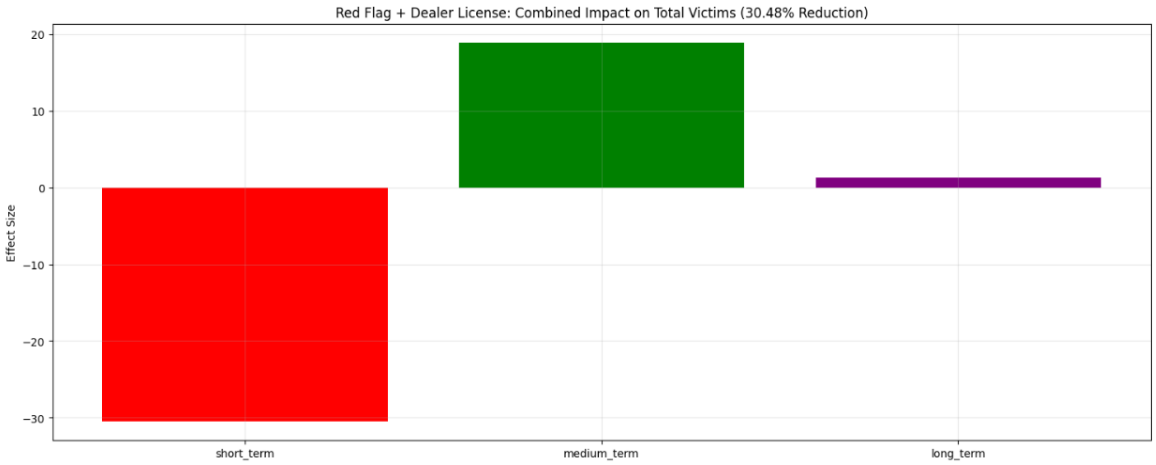

Figure 14: Temporal Effects of Combined Red Flag Laws and Dealer Licensing on Total Shooting Victims

7.4 Comprehensive Impact Assessment

Each major legislation demonstrated distinct strengths in addressing different aspects of gun violence. The FOID Modernization emerged as the most comprehensive solution, achieving the highest total victim reduction with the most consistent short-term effects and significant results across multiple metrics. The Ghost Guns regulation proved most effective in reducing high-intensity incidents and showed strong neighborhood-specific effects with sustained long-term impact ($p = 0.0002$). The Assault Weapons Ban demonstrated particular strength in reducing gang-related activities and restaurant incidents, though with mixed victim impact effects.

The COVID period significantly influenced implementation effectiveness across all measures. Pre-COVID patterns showed traditional weekend/weekday ratios and seasonal variations. During COVID, these patterns were disrupted, while post-COVID showed lower ratios and more stable patterns, suggesting a fundamental shift in gun violence dynamics.

Several unintended consequences emerged from these legislative interventions. The Ghost Guns law, while effective in its targeted areas, led to significant increases in victim counts and domestic violence in the short term. Displacement effects became evident through increases in gang-related activity (4.0% to 8.0%), shifts from neighborhood to club incidents, and increases in medium-intensity incidents under specific laws.

Success factors emerged across three main dimensions. Comprehensive implementation, as demonstrated by the FOID Modernization Act, showed the importance of multiple metric improvements and sustained effect patterns. Targeted interventions proved effective when focused on specific locations and intensity levels. Implementation timing emerged as crucial, with post-COVID timing showing better stability and sequential implementation providing cumulative benefits. The importance of seasonal considerations in implementation strategy became evident through the analysis of temporal patterns.

The overall assessment reveals that while individual measures showed varying degrees of success, the most effective approach combined comprehensive administrative frameworks with targeted enforcement mechanisms. The interaction between different legislative measures, coupled with the influence of COVID-19 periods, demonstrated the complex nature of gun violence prevention and the need for adaptive, multi-faceted policy approaches.

8 DISCUSSION

8.1 Key Findings and Research Questions

Our analysis of multiple concurrent gun control legislative interventions revealed varying effectiveness across temporal horizons. The FOID Modernization Act demonstrated the strongest immediate impact with a 58.64% reduction in total incidents and a 458.07% reduction in victims in the short term, but showed diminishing returns over time. The synergistic effects observed between the Red Flag and Dealer License laws, which achieved a combined 30.48% reduction in total victims, suggest that carefully timed concurrent implementations can enhance overall effectiveness. However, these effects varied significantly across different time horizons, highlighting the challenge of maintaining long-term policy impact.

The pandemic period significantly altered traditional patterns of gun violence, affecting policy implementation effectiveness. The shift in weekend/weekday incident ratios from 1.42 pre-COVID to 1.00 during COVID, and 1.04 post-COVID, indicates fundamental changes in behavioral patterns. These changes influenced how different legislative measures performed, with some showing enhanced effectiveness during periods of restricted movement and others requiring adaptation to new patterns of gun violence.

Our analysis revealed significant variations in how different types of gun control measures affected various categories of mass shootings. The Assault Weapons Ban showed particular effectiveness in reducing gang-related incidents with a 29.76% decrease, while the Ghost Guns legislation led to a 96.85% reduction in high-intensity incidents but was accompanied by concerning increases in other areas, including a 682.84% rise in total victims. These findings highlight the complexity of policy impacts and potential displacement effects.

8.2 Methodological Limitations

This study's methodological approach, while comprehensive, faces several important limitations. Our interrupted time series analysis assumes linear trends between intervention points, potentially oversimplifying complex behavioral changes [17]. The HAC error framework with a 12-month lag structure may not fully capture longer-term autocorrelations, particularly in cases where policy effects manifest gradually. Additionally, our analysis faces challenges in accounting for spatial autocorrelation in neighborhood-level effects.

Data structure poses significant challenges to our analysis. Monthly aggregation, while necessary for statistical power, masks finer temporal patterns that could provide deeper insights into policy effectiveness. Our fixed categorization of incident types and three-level intensity classification system may inadequately capture the evolving nature of gun violence. The study period's overlap with COVID-19 introduces substantial confounding factors that prove challenging to isolate from policy effects, a common challenge in recent policy evaluations [29].

Implementation assessment presents another crucial limitation. Our analysis cannot effectively measure enforcement intensity across different laws or track compliance rates for specific policies. This is particularly problematic when examining concurrent policy implementations, as interaction effects between different interventions may be more complex than our current analytical framework can capture [30].

8.3 Future Directions

Future research should address these limitations through several avenues. Methodologically, developing non-linear time series models could better capture complex policy responses, while integrating spatial analysis techniques would better account for neighborhood-level effects. Data collection should prioritize daily incident data for finer temporal resolution and more nuanced incident severity metrics.

Implementation research represents another crucial area for future work. Detailed studies of enforcement mechanisms and compliance patterns across different communities could provide valuable insights for policy refinement. Cross-jurisdictional analysis, comparing Chicago's experience with similar cities, could offer broader perspectives on policy effectiveness.

Technical improvements should focus on developing enhanced statistical methods for concurrent policy analysis and better tools for handling missing data in violence research. Future studies should also investigate optimal policy sequencing and analyze enforcement resource requirements to better understand resource allocation impacts on policy success.

These research directions offer pathways to enhance our understanding of gun control policy effectiveness while addressing current methodological limitations. By pursuing these avenues of investigation, researchers can contribute to more effective policy design and implementation in urban violence prevention.

9 CONCLUSION

This research examined the effectiveness of Illinois' gun control legislation on mass shootings in Chicago from 2018 to 2024, a period marked by unprecedented societal changes due to COVID-19. Through comprehensive interrupted time series analysis of five major legislative interventions, we addressed fundamental questions about how concurrent policies interact, how the pandemic influenced their effectiveness, and what nature-specific impacts emerged.

The analysis revealed that Chicago's experience offers crucial insights for urban gun violence prevention. The FOID Modernization Act's remarkable short-term effectiveness (458.07% reduction in victims) contrasted with the mixed results of other measures highlights how administrative frameworks can outperform specific prohibitions. However, the observed displacement effects, such as the shift from neighborhood-based to gang-related activities, demonstrate the complex challenges in implementing gun control measures during periods of societal disruption.

These findings suggest that effective urban gun violence prevention requires more than isolated legislative measures. The success of concurrent implementations (like the Red Flag and Dealer License laws) and the varying effectiveness patterns across COVID-19 periods indicate that policy timing and societal context significantly influence outcomes. As cities continue to develop strategies for reducing gun violence, this research emphasizes the need for adaptive regulatory approaches that can respond to evolving patterns of urban violence while maintaining enforcement effectiveness.

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