DOI: https://doi.org/10.54393/pjhs.v5i08.1687

PAKISTAN JOURNAL OF HEALTH SCIENCES
https://thejas.com.pk/index.php/pjhs
ISSN (P): 2790-9352, (E): 2790-9344
Volume 5, Issue 8 (August 2024)

Original Article

OPEN ACCESS

Seasonal Pattern in Firearm Injury-Related Cases at Casualty Department of a Teaching Hospital

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ARTICLE INFO

Keywords:
Firearm Injuries, Seasonal Patterns, Temporal Trends, Emergency Cases, Preventive Strategies

How to Cite:
Pal, M. I., Rasheed, A., Aslam, N., Samad, A., Munir, U., Marvi, ., & Waseem, U. (2024). Seasonal Pattern in Firearm Injury-Related Cases at Casualty Department of a Teaching Hospital: Seasonal Trends in Firearm Injury Incidences. Pakistan Journal of Health Sciences, 5(08), 177–181. https://doi.org/10.54393/pjhs.v5i08.1687

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Received Date: 10th May, 2024
Acceptance Date: 24th August, 2024
Published Date: 31st August, 2024

ABSTRACT

Firearm injuries pose a substantial public health concern worldwide, with their incidence and patterns varying across different regions and time periods. Understanding the temporal trends and seasonal patterns of firearm injury-related cases is essential for guiding preventive strategies and optimizing healthcare resource allocation. **Objective:** To determine the seasonal patterns and trends in firearm injury-related cases. **Methods:** A retrospective observational study was conducted at Casualty Department, Forensic Medicine Toxicology, Liaquat University Hospital, Hyderabad, Pakistan from 1st January 2021 to 31st December 2023. Four hundred and forty-three emergency cases associated with firearm injuries across the three years were enrolled. **Results:** The occurrences decreased from February to March and November to December, with peaks in August and January.Seasonal decomposition analysis further confirmed the presence of a noticeable seasonal trend, with spikes observed in January and August, indicating a potential surge in firearm injury incidences during festivals. Moreover, an increasing trend in firearm-related injuries was observed from March to August, suggesting increase in such incidents during warmer months. **Conclusions:** The firearm-related injuries exhibit seasonal patterns, spiking in summer(months from March to August), the cause of which needs to be elaborated in future researches.

INTRODUCTION

Emergency departments serve as critical hubs for the assessment, management, and treatment of patients presenting with acute medical conditions, traumatic injuries, and emergencies [1, 2]. The nature of cases that are encountered in emergency departments is diverse and it ranges from medical emergencies such as myocardial infarction and stroke to traumatic injuries resulting from motor vehicle accidents, falls, and interpersonal violence, including firearm-related incidents [3]. Emergency department of a teaching hospital also receives cases with legal and urgent nature that underline the importance of prompt and efficient medical intervention, as well as the documentation and preservation of forensic evidence in emergency department for potential legal proceedings [4, 5]. Firearm injuries include both intentional (e.g., assaults, homicides, suicides) and unintentional (e.g., accidental discharges, mishandling) incidents and these represent a significant proportion of trauma cases seen in EDs worldwide. Approximately 251,000 individuals worldwide lose their lives annually due to firearm-related incidents [6]. Beyond the fatalities, a larger number of individual's experience nonfatal injuries from such incidents,

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resultingin long-term physical, emotional, and socioeconomic consequences [7]. These injuries can result in disabilities, chronic pain, psychological trauma, and financial burdens that may continue throughout their lifetimes, underscoring the far-reaching impact of firearm violence on individuals and societies globally [8]. The severity and complexity of firearm injuries can vary extensively, depending on factors such as the type of firearm, caliber of the bullet, distance from which the weapon was fired, and anatomical location of the injury [6]. Survivors of firearm injuries often require urgent medical attention, which often includes surgical intervention, resuscitation and intensive care management [9]. The occurrence of diseases and injuries may exhibit seasonal patterns due to various environmental, biological, and sociodemographic factors. Seasonal variation in diseases and health-related outcomes has been documented in many reports. For instance, infectious diseases have long been recognized to follow seasonal patterns [10]. However, not only infectious diseases but chronic conditions might also be affected under seasonality. For example, seasonal variations in all types of cardiovascular disease have been observed in diverse populations and climates, with a primary focus on temperate regions [11]. The activity of rheumatoid arthritis, a systemic autoimmune disease attributed to persistent synovitis, was also reported to be influenced by seasonal changes [12, 13]. Similarly, a number of studies have explored the seasonality of crimes, including violent offenses such as assaults, robberies, and homicides [14, 15]. However, the potential seasonality of firearm injuries, which involve both intentional acts of violence and unintentional incidents, has acquired comparatively less attention, indicating the need of localized research to determine time-based patterns in firearm injuries.

Therefore, the present study aimed to determine the seasonality of firearm injuries by assessing the cases that were reported at casualty department of a teaching hospital at Hyderabad.

METHODS

The retrospective observational study was conducted in the Emergency Department of Liaquat University Hospital, Hyderabad, Pakistanfrom 1st January 2021 to 31st December 2023 with approval letter No. LUMHS/FM/37/21. A total of 443 emergency cases associated with firearm injuries were enrolled. All patients across all age groups who presented with emergency cases related to firearm injury were included in the present study. Inclusion criteria were limited to cases of emergency nature, specifically focusing on firearm injury-related incidents, while excluding non-gunshot or unrelated cases. Upon arrival, patients with firearm injuries were subject to undergo rapid assessment to prioritize care based on the severity of their condition. To identify and address life-threatening injuries promptly, immediate assessment of airway, breathing, and circulation was performed. The extent and severity of injuries, including gunshot wounds, associated fractures, and potential internal organ damage were assessed. Subsequently, intravenous fluid administration and blood transfusion were accomplished where indicated. Similarly, advanced cardiac life support protocols were followed for patients in cardiac arrest or with life-threatening conditions. All patients received wound debridement followed by fixation either during the same procedure or in subsequent surgeries. Antibiotics were administered to prevent infection development in wound. Following stabilization, the patients were referred to ICU, further surgeries, or hospitalization based on clinical needs. Data collection was performed using MS Excel sheets. The monthly frequency of firearm injury-related cases was recorded in MS Excel. The average and total occurrence of firearm injury-related cases were calculated in Excel using Excel datasheets. Then, the month-wise data that were collected in MS Excel was inserted into Statgraphics Centurion XIX software to determine the seasonal patterns and trends in firearm injury-related cases. Sampling intervals in Statgraphics Centurion XIX software were defined based on the months of the year, and the software's built-in models for time-series analysis and seasonal decomposition were utilized to determine patterns in the occurrence of firearm injury-related cases over the study period [16]. The findings were presented in terms of monthly frequency distributions and mean ± standard deviation (mean ± SD) for the three-year duration. Visual representation of the results was achieved through line graphs depicting the outcomes of seasonal decomposition.

RESULTS

Within this timeframe, the distribution of firearm injury-related cases exhibited variability, with 140 cases recorded in 2021, followed by 149 cases in 2022, and 155 cases in 2023. A detailed breakdown of the monthly and quarterly distribution and total cases for each month across the three-year period, along with corresponding mean values and standard deviations, is provided in table 1.

Table 1: Frequency of Firearm Injury Cases for Consecutive Years 2021, 2022 and 2023

Months	Years			N (%)	Mean ± SD
	2021	2022	2023		
January	17	24	22	63 (14.19)	21 ± 2.94
February	6	3	4	13 (2.93)	4 ± 1.2
March	9	4	7	20 (4.50)	7 ± 2.1
April	9	7	9	25 (5.63)	8 ± 0.94
May	10	11	12	33 (7.43)	11 ± 0.82
June	13	15	22	50 (11.26)	17 ± 3.86
July	16	17	21	54 (12.16)	18 ± 2.16

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August	21	27	26	74 (16.67)	25 ± 2.62
September	17	21	19	57 (12.84)	19 ± 1.63
October	11	11	8	30 (6.76)	10 ± 1.41
November	7	5	3	15 (3.38)	5 ± 1.63
December	4	4	2	10 (2.25)	3 ± 0.94

This table highlights certain trends, notably a decrease in the number of firearm injury cases observed from February to March and November to December, suggesting potential seasonal fluctuations in incidence rates. Conversely, August emerged as the month with the highest average number of firearm injuries, closely followed by January. To further elucidate the seasonal patterns in firearm injury-related cases, a seasonal index plot was generated (Figure 1).

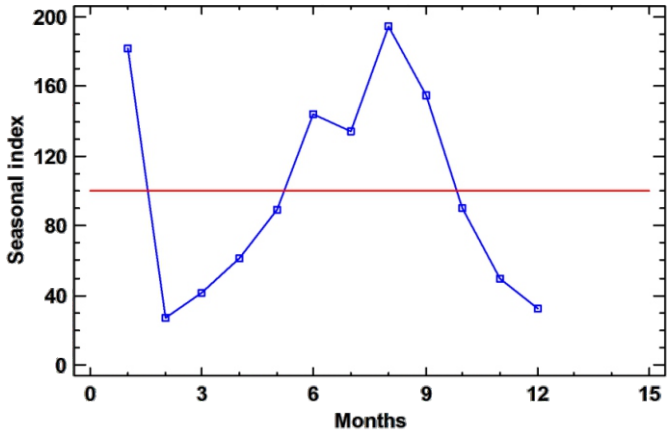

Figure 1: Seasonal Index Plot for Firearm Injury Cases

This graphical representation underscores the presence of a noticeable seasonal trend, with peaks observed in the months of January and August. Notably, there appears to be an upward trajectory in firearm injury cases from March to August, indicative of a seasonal surge in incidences during the warmer months. Conversely, a downward trend in reported firearm injuries is observed from September onwards, suggesting a potential seasonal decrease in incidence rates as cooler months approach. Moreover, Figure 2 provides additional insights into the distribution of firearm injury-related cases throughout the year at Liaquat University Hospital, Sindh, Pakistan. This graph highlights the variability in monthly frequency, with certain months exhibiting a notably higher number of cases compared to the average incidence across the year. Specifically, months such as January and August stand out as periods with elevated firearm injury-related case numbers, contributing to the decentered distribution observed around the average (Figure 2).

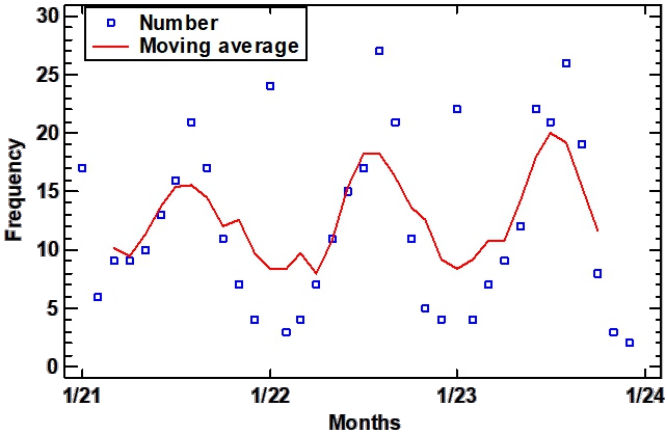

Figure 2: Smoothed Time Series Plot for Monthly Firearm Injury-Related Cases

DISCUSSION

Seasonal variation is important in healthcare, for example emergencies and medico-legal cases, because it can provide insights into the underlying factors that contribute to certain types of incidents or injuries. In the case of firearm injury-related cases, for example, seasonal variation can help to identify patterns in the timing and frequency of incidents, which can inform public health policies and interventions aimed at reducing firearm injury-related harms [15]. The present study observed that firearm injury-related cases show a potential link with seasonal variations, with higher incidences during certain months, particularly those characterized by warmer weather. Additionally, the highest incidences in January and August may be linked to the celebrations involving aerial gunshots for New Year and Independence Day celebrations, respectively. A previous study from Sindh, Pakistan reported that the primary occasions associated with aerial firing and subsequent stray bullet injuries were found to be wedding ceremonies, political rallies and New Year celebrations. Stray bullet injuries were also observed following aerial firing during cricket or hockey team victories, Pakistan Independence Day (14th August), cultural events in Sindh, and the Basant (Kite) festival in Punjab [16, 17]. When bullets from aerial firing descend and hit the ground, they can strike someone's head, spine, or other parts of the body. These injuries can range from superficial to very severe, potentially leading to fatal consequences [18]. Not only in developing countries like Pakistan, but the firearm injuries also appear to be a big challenge in developed countries with comparatively better implemented law and order. For instance, a viewpoint published in Journal of American Medical Association, a highly prestigious journal, termed the firearm-related injuries and mortality as a pandemic in United States [19]. Likewise, a study from United States found an alarming escalation in firearm injuries at five trauma centers during COVID-19, thus referring the firearm

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injuries as a parallel pandemic [20]. The present study also shows an upward trend in firearm-caused injuries with weather that exhibits monthly increase in temperature in the region. This observation has also been reported from other studies. Matthay ZA *et al.*, estimated the correlation between increased temperatures and elevated risk of firearm violence in the United States, both nationally and regionally [20]. The estimated risk of firearm incidents showed a nearly consistent increase as temperatures rose. Even moderately hot temperatures were linked to a higher risk of shootings. While the association was statistically significant, there was minimal variability between cities, suggesting that regional or climate-specific factors may influence the relationship between daily temperature and incident shootings. A research study in the United States utilized Arkansas Hospital Discharge Data spanning 10 years to identify factors predicting firearm assaults among young Black men aged 18 to 44. The analysis revealed that a significant proportion of hospital admissions due to firearm injuries occurred during the summer season [21]. Understanding the seasonal patterns of firearm injuries can inform preventive strategies, resource allocation, and emergency preparedness efforts aimed at reducing the burden of firearm-related violence and mitigating its impact on public health and safety. By analyzing the temporal distribution of firearm injury-related cases at a tertiary care teaching hospital's casualty department in Hyderabad, this study sought to contribute valuable insights into the epidemiology and dynamics of firearm violence in the region. The present study suggests a seasonal variation for firearm-related injuries being reported at emergency department of Liaquat University Hospital, Hyderabad. The incidence was higher in certain months, specifically those characterized by warmer temperatures. The observed decrease in firearm injury cases during the cooler months, from September onwards, suggests a potential seasonal decrease in incidence rates. This trend aligns with previous studies from the region, highlighting the impact of specific occasions and cultural practices, such as weddings, political rallies, and cultural festivals, on the occurrence of firearm-related injuries.

CONCLUSIONS

The firearm injuries follow a seasonal variation in the region, with higher incidences observed during certain months, particularly those characterized by warmer weather. The months of January and August emerged as periods with elevated firearm injury-related case numbers, which may be attributed to cultural and celebratory events involving aerial gunshots, such as New Year celebrations and Independence Day festivities. Firearm injuries represent a multifaceted public health issue with implications for emergency medicine, forensic science, and community well-being.

Authors Contribution

Conceptualization: MIP
Methodology: AR, NA
Formal analysis: HNA
Writing, review and editing: MIP, AS, UM, M, UW

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

Source of Funding

The authors received no financial support for the research, authorship and/or publication of this article.

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