



EPIDEMIOLOGY, MANNER AND OUTCOME OF FIREARM INJURIES IN NORTH INDIA: A ONE-YEAR PROSPECTIVE STUDY FROM A TERTIARY CARE CENTRE

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ABSTRACT

Background: Firearm-related violence is a major cause of injury and death worldwide and poses significant medico-legal and public health challenges, particularly in low- and middle-income countries where illegal firearms are widely available. In India, firearm injuries show marked regional variation, and systematic hospital-based epidemiological data remain limited, especially from northern regions where country-made and unlicensed weapons are commonly used.

Objectives: To evaluate the epidemiology, manner of injury, weapon type, and clinical outcome of firearm injury cases presenting to a tertiary care centre in North India.

Methods: This was a prospective, observational, hospital-based study conducted in the Emergency Department of S. N. Medical College and Hospital, Agra, from March 2016 to February 2017. All patients presenting with firearm-related injuries and referred for medico-legal examination were included. A total of 124 cases were enrolled using universal sampling. Data on demographic characteristics, manner of injury (homicidal, suicidal, accidental), type of weapon used, number of shots, and clinical outcome were recorded using a structured proforma. Outcomes were categorized as conservative management, surgical intervention, or death. Data were analyzed using descriptive statistics and presented as frequencies and percentages.

Results: Of the 124 firearm injury cases, 112 (90.3%) were homicidal, 2 (1.6%) suicidal, and 10 (8.1%) accidental. Males constituted 114 cases (91.9%), and the most affected age group was 21–30 years (51.6%), followed by 31–40 years (24.2%). Shotguns (47.6%) and rifled firearms (45.2%) were used almost equally. A majority of patients required surgical intervention (78.5%), while 12 (9.7%) were managed conservatively. The case fatality rate was 11.8% (14 deaths).

Conclusion: Firearm injuries in North India predominantly involve young adult males and are largely homicidal, with a high burden of severe injuries requiring operative management. Both shotguns and rifled firearms contribute substantially to this violence, reflecting the widespread availability of illegal

and locally manufactured weapons. These findings underscore the urgent need for stricter arms control, improved trauma care infrastructure, and targeted public health interventions to reduce firearm-related morbidity and mortality in the region.

Keywords: Firearm injuries; Gunshot wounds; Homicidal violence; Trauma epidemiology; Illegal firearms; North India

INTRODUCTION

Firearm-related violence remains one of the most devastating and complex forms of interpersonal and self-directed injury worldwide. The capacity of a projectile to deliver massive kinetic energy to human tissues results in a unique pattern of trauma characterized by extensive tissue destruction, hemorrhage, and high fatality rates, often exceeding those associated with other forms of mechanical injury [1,2]. Despite advances in trauma care, firearm injuries continue to impose an enormous burden on emergency departments, forensic services, and the criminal justice system, particularly in low- and middle-income countries where illegal firearms are widely available and pre-hospital care is limited [3].

Globally, violent injuries constitute a major public health problem, ranking among the leading causes of death in young adults [4]. Firearms are a prominent contributor to this burden. While high-income countries such as the United States report high absolute numbers of firearm deaths, largely due to suicide and interpersonal violence, several low- and middle-income regions experience a disproportionate impact from homicide and accidental firearm injuries driven by weak regulation, illicit manufacturing, and socio-political instability [5–7]. In many parts of Asia and Africa, the ready availability of unlicensed or country-made firearms has resulted in a pattern of firearm violence that differs markedly from that observed in Western countries, with a predominance of homicidal injuries and younger male victims [8].

India occupies a unique position in the global epidemiology of firearm injuries. Although its overall firearm-related mortality rate is lower than that of some Western nations, the country harbors one of the largest civilian firearm populations in the world, the majority of which are unlicensed [9]. Estimates suggest that of the approximately 40 million civilian-owned firearms in India, barely 15–20% are legally registered, leaving a vast reservoir of illegal weapons circulating within communities [10]. These weapons, often locally manufactured and of poor ballistic quality, are commonly used in interpersonal conflicts, political violence, and criminal activities, thereby contributing disproportionately to firearm-related morbidity and mortality [11].

The medico-legal and public health implications of firearm injuries in India are substantial. Gunshot wounds are frequently associated with severe hemorrhage, organ damage, long-term disability, and death, making them a major cause of trauma-related hospital admissions and forensic autopsies [12]. In addition to the immediate medical costs, firearm injuries impose profound social and economic consequences on victims, families, and communities, including loss of productive life years, psychological trauma, and destabilization of social structures [13]. For forensic and legal authorities, accurate documentation and interpretation of firearm injuries are crucial for determining the manner of death—whether homicidal, suicidal, or accidental—and for reconstructing the events surrounding the shooting [14].

Patterns of firearm injury vary considerably across geographic regions and are influenced by cultural practices, socioeconomic conditions, weapon availability, and law enforcement effectiveness. Studies from Europe and North America have shown a predominance of firearm suicides, often involving legally owned weapons and single gunshot wounds to the head or chest [15]. In contrast, research from South Asia, the Middle East, and parts of Africa consistently reports a higher proportion of homicidal firearm injuries, frequently involving multiple gunshot wounds inflicted by illegal or high-velocity weapons during interpersonal conflicts or criminal activities [6,7,11]. Such regional

differences highlight the need for locally generated data to guide prevention strategies and policy interventions.

Within India, firearm-related violence exhibits marked regional heterogeneity. Northern and central Indian states, including Uttar Pradesh, Bihar, and parts of Rajasthan and Madhya Pradesh, have long been recognized as hotspots for illegal firearm manufacture and use, particularly of smooth-bore and country-made weapons [9,10]. In these regions, firearms are often used to settle disputes related to land, honor, and political rivalry, and are sometimes fired during social celebrations, increasing the risk of accidental injuries [11]. However, despite the recognized magnitude of the problem, systematic, hospital-based epidemiological data on firearm injuries from many of these regions remain scarce.

Previous Indian studies have largely focused on fatal firearm injuries identified at autopsy or on specific weapon types, such as shotguns, leaving a gap in our understanding of the broader spectrum of firearm-related trauma presenting to emergency departments [8,12]. Internationally, several authors have emphasized the importance of combining epidemiological analysis with clinical outcome data to obtain a more comprehensive picture of firearm injury burden [5,16]. Such integrated analyses can identify high-risk groups, common circumstances of injury, and predictors of mortality, thereby informing targeted prevention and trauma-care strategies.

Agra, a major urban center in North India with a large rural catchment area, represents a region where illegal and locally manufactured firearms are readily available and frequently used in violent encounters. The Emergency Department of S. N. Medical College and Hospital serves as a tertiary referral center for this region, receiving a substantial number of firearm injury cases annually. Yet, prior to the present investigation, no contemporary, systematic study had evaluated the epidemiology, manner, and outcomes of firearm injuries in this population.

Understanding the demographic profile of victims, the prevailing manner of injury (homicide, suicide, or accident), and the clinical outcomes of firearm trauma is essential for both public health planning and medico-legal practice. Young adult males, who are often the primary breadwinners, are particularly vulnerable to firearm violence, making such injuries not only a medical emergency but also a socioeconomic crisis for affected families and communities [6,12]. Moreover, differentiating between homicidal, suicidal, and accidental gunshot wounds has important legal ramifications and requires accurate, data-driven insight into local patterns of firearm use [14].

Against this background, the present one-year prospective study was undertaken to analyze firearm injury cases presenting to a tertiary care center in North India. By systematically documenting demographic variables, manner of injury, and clinical outcomes, this study aims to provide a comprehensive epidemiological profile of firearm injuries in the Agra region. The findings are expected to contribute to the limited body of Indian data on firearm-related trauma and to assist clinicians, forensic experts, and policymakers in developing more effective prevention, regulatory, and management strategies tailored to the regional context.

MATERIALS AND METHODS

Study Design and Setting: This was a prospective, observational, hospital-based study conducted in the Emergency Department of S. N. Medical College and Hospital, Agra, Uttar Pradesh, India, a major tertiary care referral center catering to both urban and rural populations of the Agra region and adjoining districts. The study was conducted over a period of one year, from March 2016 to February 2017.

Study Population: All patients presenting to the emergency department during the study period with firearm-related injuries and referred for medico-legal examination were included in the study.

Sample Size: A total of 124 firearm injury cases fulfilling the inclusion criteria were enrolled during the study period. Since all eligible cases presenting during the defined one-year period were included, universal sampling was adopted.

Inclusion Criteria

Patients were included if they fulfilled any of the following:

- History of firearm injury as reported by the victim, attendant, or police
- Presence of clinical and/or forensic evidence suggestive of firearm injury
- Cases referred for medico-legal examination with suspected firearm trauma

Exclusion Criteria

The following cases were excluded:

- Doubtful cases where firearm injury could not be confirmed
- Medico-legal cases due to other causes such as road traffic accidents, burns, poisoning, blunt or sharp force injuries without firearm involvement

Data Collection Procedure: All eligible cases were examined following standard medico-legal and clinical protocols. Information was collected from:

- Victims or attendants
- Police and investigating officers
- Hospital medical records

A pre-designed and pre-tested proforma was used to record data, which included:

- Demographic details: age, sex, occupation, and residence
- Circumstantial details: date, time, and place of incident
- Manner of injury: homicidal, suicidal, or accidental
- Weapon characteristics: shotgun, rifled firearm, or others
- Clinical details: number of shots, anatomical sites involved
- Outcome: conservative management, surgical intervention, or death

For patients who expired, the cause of death was confirmed from post-mortem examination reports.

Operational Definitions

- Homicidal injury: firearm injury inflicted by another person
- Suicidal injury: self-inflicted firearm injury
- Accidental injury: firearm injury without intention to harm, including mishandling or celebratory firing
- Outcome categories:
 - Conservative management – treated without surgery
 - Operative management – required surgical intervention
 - Death – expired due to firearm injury or its complications

Statistical Analysis: Data were entered into a Microsoft Excel spreadsheet and analyzed using standard statistical methods. Categorical variables were expressed as frequencies and percentages. Data were presented using tables, bar diagrams, and pie charts. Descriptive statistics were used to summarize demographic variables, manner of injury, weapon type, and clinical outcomes. No inferential statistical tests were applied, as the objective of this study was descriptive epidemiological profiling of firearm injuries.

Ethical Considerations: The study was conducted after obtaining approval from the Institutional Ethics Committee of S. N. Medical College, Agra. All cases were medico-legal in nature and handled

as per institutional and legal protocols. Confidentiality of patient identity and records was strictly maintained, and data were used solely for academic and research purposes.

RESULTS

A total of 124 firearm injury cases were analyzed during the study period from March 2016 to February 2017.

Homicidal firearm injuries overwhelmingly predominated, accounting for more than 90% of cases, indicating that interpersonal violence is the principal cause of firearm-related trauma in this region.

Table 1 shows the distribution of firearm injuries by manner of injury.

Table 1. Distribution of Firearm Injuries by Manner of Injury (n = 124)

Manner of injury	Number	Percentage (%)
Homicidal	112	90.3
Suicidal	2	1.6
Accidental	10	8.1
Total	124	100

Firearm injuries were predominantly seen in males, who constituted nearly 92% of all victims, reflecting greater exposure of males to violent encounters and high-risk situations. Table 2 shows sex distribution of firearm injury victims.

Table 2. Sex Distribution of Firearm Injury Victims (n = 124)

Sex	Number	Percentage (%)
Male	114	91.9
Female	10	8.1
Total	124	100

The 21–30 year age group was the most affected, contributing to more than half of all cases, followed by the 31–40 year group, showing that firearm injuries predominantly affect the economically productive young adult population. Table 3 shows the age distribution of firearm injury victims.

Table 3. Age Distribution of Firearm Injury Victims (n = 124)

Age group (years)	Number	Percentage (%)
0–10	2	1.6
11–20	11	8.9
21–30	64	51.6
31–40	30	24.2
41–50	4	3.2
51–60	10	8.1
>60	3	2.4
Total	124	100

Both shotguns and rifled firearms were almost equally responsible for firearm injuries, with a slight predominance of shotguns, highlighting the widespread use of locally manufactured and smooth-bore weapons in the region. Table 4 shows the type of firearm used in injuries.

Table 4. Type of Firearm Used in Injuries (n = 124)

Type of firearm	Number	Percentage (%)
Shotgun (smooth bore)	59	47.6
Rifled firearm	56	45.2
Others / undetermined	9	7.2
Total	124	100

A large majority of patients (78.5%) required surgical management, indicating the severe nature of firearm injuries. The case fatality rate was 11.8%, underscoring the high lethality associated with gunshot trauma. Table 5 shows the clinical outcome of firearm injury cases.

Table 5. Clinical Outcome of Firearm Injury Cases (n = 124)

Outcome	Number	Percentage (%)
Conservative management	12	9.7
Surgical intervention	98	78.5
Death	14	11.8
Total	124	100

The present study demonstrates that firearm injuries in the Agra region predominantly affect young adult males and are largely homicidal in nature. Both shotguns and rifled firearms contribute substantially to injury burden. The high requirement for surgical intervention and notable mortality emphasize the serious clinical and public health impact of firearm-related violence in this region.

DISCUSSION

The present study provides a detailed epidemiological and clinical overview of firearm injuries presenting to a tertiary care centre in North India. Firearm-related trauma constituted a significant proportion of medico-legal emergencies in this region, reflecting the growing burden of gun violence in northern India. The findings of this prospective study demonstrate that firearm injuries predominantly affected young adult males, were largely homicidal in nature, and frequently required surgical intervention, highlighting their serious medico-legal and public health implications.

Homicidal firearm injuries accounted for 90.3% of cases in the present study. This proportion is remarkably high and is comparable to reports from other parts of India. Kohli and Aggarwal observed homicidal firearm deaths in 92.6% of cases in Delhi [9], while Singh and Singh reported 70% homicidal firearm cases in northern India [8]. Similar patterns have been documented in Pakistan and Egypt, where illegal firearms are widely used for interpersonal violence [10,11]. In contrast, European and North American studies demonstrate a predominance of suicidal firearm deaths, largely due to easier access to legally owned firearms [5,7]. The very low proportion of suicidal firearm injuries in the present study (1.6%) is consistent with Indian sociocultural trends, where suicide is more often committed using hanging or poisoning rather than firearms [4].

Males constituted 91.9% of firearm injury victims, a finding that aligns with almost all previous studies. Singh and Singh reported male victims in 78% of cases [8], Kohli and Aggarwal in 90.7% [9], and Zahid et al. in 85.2% of firearm deaths [11]. Similar male predominance has been reported internationally in studies from South Africa and Italy [6,7]. This marked male predominance is attributed to greater exposure of men to interpersonal conflict, criminal activity, political rivalry, and occupational stress, all of which increase the risk of firearm-related violence.

The present study showed that 75.8% of victims were aged between 21 and 40 years, with the highest incidence in the 21–30 year age group (51.6%). These findings are consistent with Hagrais et al., who reported that 96.6% of victims in Egypt were between 20 and 40 years of age [10], and Kohli and Aggarwal, who found a similar peak in the 21–30 year group in Delhi [9]. Studies from Pakistan and South Africa also demonstrate that young adults represent the most vulnerable group [6,11,12]. This pattern is of major public health concern, as firearm violence disproportionately affects the economically productive segment of the population, resulting in significant social and economic loss.

Shotguns (47.6%) and rifled firearms (45.2%) were almost equally responsible for firearm injuries in the present study. This differs from urban and conflict-prone regions where rifled and automatic weapons dominate. Zahid et al. reported rifled weapons in 96.5% of cases in Peshawar [11], and Kohli and Aggarwal observed rifled firearms in 82.2% of Delhi cases [9]. The relatively higher use of shotguns in the present study reflects the widespread availability of locally manufactured, smooth-bore and country-made firearms in rural and semi-urban North India, which are cheaper, easier to procure, and commonly used in interpersonal disputes and celebratory firing [8,10]. The proliferation of such illegal firearms has been recognized as a major driver of firearm-related violence in low- and middle-income countries [16].

In the present study, 78.5% of patients required surgical intervention, and the case fatality rate was 11.8%. These findings are comparable to hospital-based studies from Pakistan and Egypt, where reported mortality ranges from 6% to 15%, depending on injury severity and access to trauma care [10–12]. Autopsy-based studies typically report higher fatality rates because they include only fatal cases [6,7]. The high operative rate observed in this study reflects the severe internal injuries commonly associated with firearm trauma, particularly involving the chest, abdomen, and major blood vessels, which often necessitate urgent surgical management [2,3].

Firearm injuries constitute a major public health problem worldwide, particularly in regions where illegal weapons are easily accessible [15]. The overwhelming predominance of homicidal firearm injuries in this study underscores the urgent need for stricter enforcement of arms control laws, targeting illegal and country-made firearms. From a medico-legal perspective, the epidemiological profile identified in this study—young male victims, predominantly homicidal intent, and high surgical and fatality rates—provides crucial contextual information for interpreting firearm injury cases and reconstructing events during forensic investigations [4,14].

Limitations

Being a hospital-based study, cases that died at the scene or were treated elsewhere may not have been captured. In addition, socioeconomic and psychological factors influencing firearm violence were not assessed. Nevertheless, the prospective design and comprehensive medico-legal documentation strengthen the reliability and relevance of the findings.

CONCLUSION

This one-year prospective study provides a comprehensive epidemiological profile of firearm injuries presenting to a tertiary care centre in North India. The findings reveal that firearm-related trauma in the Agra region predominantly affects young adult males and is overwhelmingly homicidal in nature, reflecting the pervasive role of interpersonal violence and the easy availability of illegal firearms. The near-equal contribution of shotguns and rifled weapons highlights the coexistence of locally manufactured smooth-bore guns and factory-made firearms in violent incidents. The very high requirement for surgical intervention (78.5%) and a case fatality rate of 11.8% underscore the severe clinical burden imposed by gunshot injuries on trauma services. Together, these findings emphasize that firearm violence is not merely a medico-legal issue but a major public health and socioeconomic problem in North India. Strengthening arms control, improving trauma care systems, and addressing

underlying social determinants of violence are essential to reduce firearm-related morbidity and mortality in this region.

Declarations

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