

# A Study on Prevalence of Firecracker Injury and Outcomes with Demographic Profile of Patients Visiting the Emergency Department of a Tertiary Care Center of North India during the Festive Season of Diwali

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## ABSTRACT

**Introduction:** Avoidable blindness is defined as blindness that could be either treated or prevented by cost-effective or known means. As per the National Programme for Control of Blindness (NPCB), the prevalence of blindness in India was 1.1% in 2001–2002 and 1% in 2006–2007.

**Aim:** To study the demographic and clinical profile of patients sustaining firecracker injuries in the eye during the Diwali festival in the Emergency Department of Dr Rajendra Prasad Centre for Ophthalmic Sciences, AIIMS, New Delhi, India.

**Methodology:** A self-validated questionnaire was developed after a pilot study for 1 week with a sample of 30 patients. A sample size of 3,374 was taken; of which, 76 patients met the inclusion criterion. The questionnaire had two sections of which the first section describing the demography of patients which was filled by the patient/relative. The other section was concerned with the clinical profile of patients filled by the doctor/nursing staff. The data was analyzed on STRATA 12.

**Results and observation:** Out of 83 patients with eye casualties, 76 patients met our inclusion criteria where 85.11% were males and 14.45% were females. About 93.4% of the affected population belonged to the Hindu religion and 72.37% were residents of Delhi. The age of 10 were below 30.76% and 47.37% belonged to 10–20 year age-group while 3.95% were above 50. Most were bystanders (48.6%) and others were injured (47.3%) by themselves while lighting firecrackers. Major complication observed was the unilateral partial temporary loss of vision (93%) and unilateral permanent complete loss of vision in 1 (1.32%) patient and a bilateral permanent complete loss of vision in 1 (1.32%) patient.

**Conclusion:** Eye injuries (2.3%) due to firecrackers during the festive season of Diwali were males (85.53%), unsupervised children, and teenagers belonging to 10–20 year age-group (47.37%) and the majority were Hindus (93.4%).

**Keywords:** Diwali, Emergency department, Firecracker.

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## INTRODUCTION

India is one of the most religiously diverse and ethnically distinct countries where all festivals are celebrated equally. Diwali is one such joyous festival which is loved and celebrated by everyone over the country as the festival of lights. It is celebrated by lighting oil lamps and firecrackers like a bomb, flowerpots, chakri, rockets, etc.

Lightening of firecrackers is an expression of happiness and ecstasy on a joyous occasion especially among children and young adults it has deleterious effects in case of any negligence. Firecrackers consist of aluminium, potassium percholate, and added chemicals that act as binders, stabilizers, oxidizers, reducing agents, and coloring agents, moreover to create the multicolored glitter effect the colors are made up of antimony sulphide, barium nitrate, aluminium, copper, lithium and strontium. These pollutants contribute to poor air quality, smog, noise, and water pollution. Apart from these effects on the environment, it has harmful effects at the individual level like burn injuries, irritation in the eyes, hearing loss, asphyxia, tympanic membrane rupture, and also detrimental to an infant's mental and physical growth. Firecrackers taken in the study included sparklers and all varieties of firecrackers available commercially.

The data was first collected retrospectively from the Medical Records Department of sustained firecracker injuries in the eye

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during Diwali in the period of the last 2 years. The number of cases was found to be 47 and 87 respectively in the years 2017–2016.

With this background information, the following study was done to assess the prevalence of firecracker eye injury during one month period of Diwali festive season in the year 2018.

**OBJECTIVES**

- To study the prevalence of patients with firecracker injury affecting the eye in contrast to ophthalmic emergencies attending the emergency department of Dr RPC Ophthalmic Sciences.
- To study the Demographic and Clinical profile of patients visiting the Emergency Department of Dr RPC Ophthalmic Sciences with firecracker injury during the Diwali festive season.
- To study the prevalence of patients with firecracker injury involving the eye during the study period and compare it with the previous data available retrospectively.

**METHODOLOGY**

A cross-sectional observational study was conducted in the Emergency Department of Dr RP Centre of Ophthalmology, AIIMS, New Delhi, for 1 month to assess the trend of patients who sustained firecracker injuries affecting eyes during the festive period of Diwali. For this, a self-validated questionnaire was prepared and a pilot study was conducted for 30 patients and according to which necessary changes were done before the start of the study. The questionnaire was divided into two sections containing demographic and incident-related details filled by patients/relatives/guardians and another section containing diagnosis, treatment, and complications filled by doctors/nursing staff. Direct interviews were conducted regarding the incident of the event after written consent was provided by relatives/patients to be a part of this study. The data so collected was entered in MS-Excel and analyzed on STRATA 12.

**Inclusion Criteria**

- All patients attending eye casualty with firecracker injuries.
- Patients giving consent to participate in the study. In cases of minors, consent was given by the parent/guardian accompanying.

**Exclusion Criteria**

- Injuries not associated with any firecracker device.
- Injuries due to firecracker and not affecting the eye.

Sample size: 3,374 patients

Study period: From 15th October 2018 to 15th November 2018.

Study population: Patients reporting to the ophthalmic emergency department with firecracker injury during the Diwali festival.

**RESULTS AND OBSERVATION**

Out of 3,374 patients, a total of 76 (2.25%) patients had reported with ocular injuries out of which 65 (85.53%) were men (Table 1). Being a multi-religious festival patients with different religious backgrounds were too affected involving 71 (93.4%) Hindu patients followed by 5 (5.7%) Muslim patients (Table 2). Age-groups as shown in Table 3 and Fig. 1, 10–20 year group (47.37%) was most affected by firecracker injuries followed by unsupervised children below the age of 10 (30.26%) and young adults of 20–30 years (9.21%). The minimum age of injured patients was found to be 3 years and the maximum 62 years. Out of these 76 patients 27 (35.5%) had secondary

**Table 1:** Gender distribution of all patients

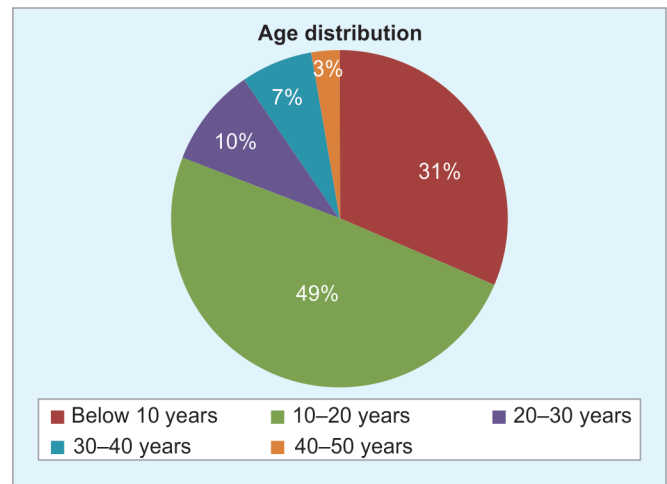
	Gender	
Males	65	85.53%
Females	11	14.5%
Others	0	0
Total	76	100%

**Table 2:** Patient distribution based on religion

	Religion	
Hindu	71	93.4%
Muslim	4	5.7%
Sikh	1	1.3%
Others	0	0
Total	76	100%

**Table 3:** Age-groups of all cases reported to casualty

Age-groups	Affected cases		Routine emergencies		Total	
Below 10 years	23	30.26%	153	4.63%	176	5.3%
10–20 years	36	47.37%	303	9.1%	339	10%
20–30 years	7	9.21%	543	16.4%	550	16.3%
30–40 years	5	6.58%	668	20.27%	673	20%
40–50 years	2	7.63%	789	23.9%	791	23.4%
Above 50	3	3.95%	842	25.5%	845	25.0%
Total	76	100%	3298	100%	3374	100%



**Fig. 1:** Age distribution of patients with firecracker ocular injuries

education followed by 24 (31.58%) having primary education, 10 (13.16%) high school, 8 (10.58%) graduates and pre-primary schooling was observed in 5 (6.58%) patients (Table 4). The difference between the percentages of education status of patients with firecracker-related injuries and other ophthalmic emergencies was found to be significant (*p*-value patients suffering from 0.00023).

Patients suffering from firecracker injuries were higher in incomes (Table 5) ranging from Rs. 20,000–30,000 (31.58%) followed by 30,000–40,000 (25%), above 50,000 (19.73%), 10,000–20,000 group (15.79%) and least among 40,000–50,000 (7.89%). The

**Table 4:** Education status of all patients

Education status	Affected cases	Routine emergencies	Total
Pre-primary	5 6.58%	150 4.5%	155 4.6%
Primary	24 31.58%	418 12.6%	442 13.2%
Secondary	27 35.53%	657 19.9%	684 20.4%
High school	10 13.16%	852 25.8%	862 25.5%
Graduate	8 10.58%	610 18.4%	618 18.3%
No education	2 2.63%	608 18.3%	608 18%
Total	76 100%	3298 100%	3374 100%

**Table 5:** Monthly income of all patients

	Income					
	Affected cases (N)	%	Routine cases (N)	%	Total	%
10,000–20,000	12	15.69%	654	19.8%	662	19.6%
20,000–30,000	24	31.58%	846	25.6%	924	27.4%
30,000–40,000	19	25%	554	16.7%	569	16.9%
40,000–50,000	6	7.89%	846	25.6%	806	23.9%
Above 50,000	15	19.73%	398	12.06%	413	12.2%
Total	76	100%	3,298	100%	3,374	100%

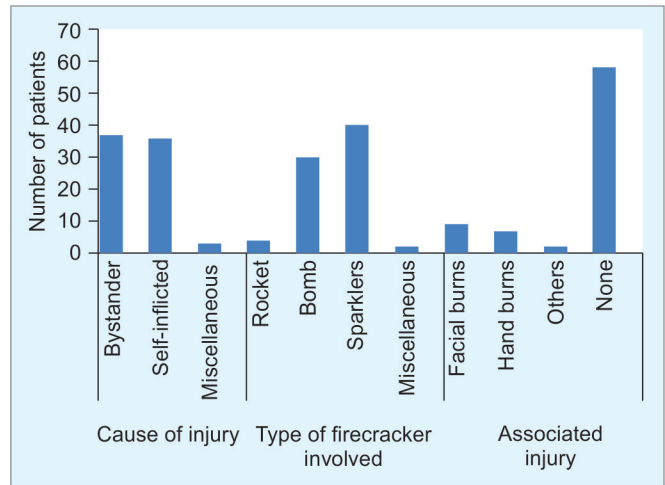
**Table 6:** Regional distribution of all patients

Area	
Delhi	55 72.4%
NCR	4 5.3%
Rajasthan	1 1.3%
Uttar Pradesh	9 11.8%
Haryana	7 9.2%
Total	76 100%

**Table 7:** Patients with associated injuries

Associated injury	
Facial burns	9 50%
Hand burns	7 33.33%
Others	2 11.11%
None	58 76.38%
Total	76

difference between the percentages of incomes of patients suffering firecracker injuries and other ophthalmic emergencies was found to be significant ( $p$ -value patients suffering from 0.0075). About 72.4% (55) were reported from Delhi itself (Table 6). Associated injuries (Table 7, Fig. 2) like hand (33.3%), and facial burns (50%) were observed in 50% of patients who were lighting firecrackers themselves. It was also observed that 37 (48.6%) of firecracker injuries were among the bystanders, 36 (47.4%) patients were involved in lighting the firecracker while the rest were miscellaneous (4%) as shown in Table 8. None of the bystanders or others had suffered from any type of associated injury. The maximum reporting time to AIIMS casualty after sustaining the injury was observed to be maximum of 5 days and minimum of



**Fig. 2:** Event-related details

**Table 8:** Causes of injury

Cause of injury	
Bystander	37 48.6%
Self-inflicted	36 47.4%
Miscellaneous	3 4%
Total	76 100%

**Table 9:** Referred cases from other healthcare facilities

Cases referred from other healthcare centers	
Referred	46 60.5%
Non-referred	30 39.5%
Total	76 100%

4 hours. The maximum time of consultation taken by the doctor at AIIMS casualty was observed to be 15–20 minutes due to increased patient flow during Diwali with minimum immediate care provided in 5 minutes. About 46 (60.5%) patients were referred from other healthcare centers to the Emergency Department of Dr. RP Centre. (Table 9). In our study more than one eye pathology was observed in most of the patients like corneal defects (35%), epiphora due to smoke (10%), foreign body (20%), lid injuries (20%), hyphema (5%), and open globe injury (10%). About 20 patients, out of 76 cases, were admitted for corneal surgery, and 4 (5.26%) patients had undergone minor surgeries and were discharged on the same day. A prescription of antibiotics and artificial tears was given in 32 (57.14%) patients, a combination of pressure banding and antibiotics in 12 (21.42%) patients, and eye irrigation with medication (17.85%). An overall outcome of patients attending the ophthalmic casualty had a unilateral partial temporary loss of vision affecting 71 (93%) patients and complete permanent loss of vision in 2 (2.63%) patients out of which one patient had a bilateral loss of vision. Retrospective data collected from the past 2 years it was found that there were 87 patients in 2016 followed by 56 in 2017 and 76 in the current year (Fig. 3). On average there were 100 patients reporting at the ophthalmic casualty of Dr. RP Centre every day with varying diseases like glaucoma, foreign body, cataract, etc. During the period of festivals like Diwali, and Dussehra cases of uveal prolapse, lid injury, thermal/chemical injury, open/close globe injury, corneal abrasions, hyphaema, eye burns, epithelial

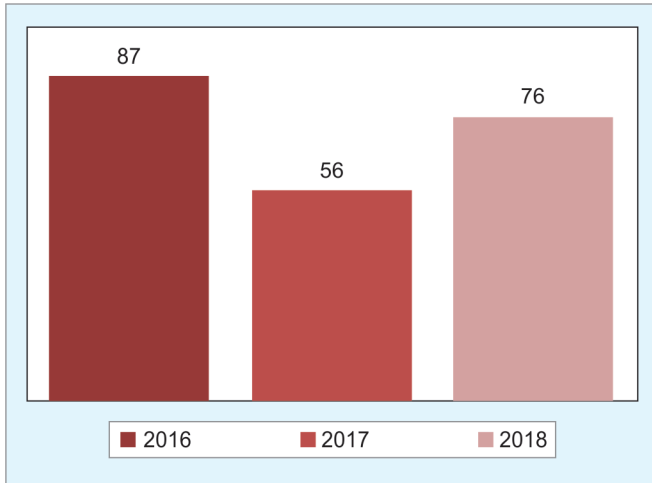


Fig. 3: Retrospective analysis of patients sustaining firecracker injuries



Fig. 5: A case of 5-year-old boy with facial burn

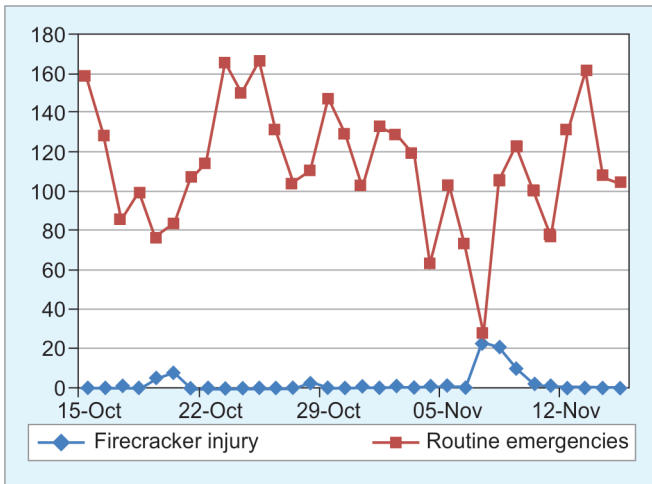


Fig. 4: Pattern of cases reporting during the festive period

defects, corneal damage, etc., increases primarily due to injuries caused by firecrackers. A sudden spike (Fig. 4) is observed during the days of Dussehra (17–21 October) and Diwali (5–12 November) when compared to patients having routine eye emergencies which have decreased during Diwali.

## DISCUSSION

After a retrospective study of the previous year's data of 2017 and 2016, a pilot study was done with self-validated questionnaire to study the firecracker injury related to the eye for a period of 1 month during the festive season of Diwali. Out of 3,378 patients studied during the period who had reported to the Emergency Department, 83 patients were identified for eye injuries related to thermal injury out of which only 78 patients had injuries associated with firecrackers. However, 2 patients denied to give consent to participate in the study hence only 76 patients participated with a response rate of 97.5%. Cases of facial burn (Fig. 5), eye irritation (Fig. 6), foreign body (Fig. 7), and blindness (Fig. 8) were reported and were included in the study.

Before the start of the pilot study the emergency staff (doctors, nurses, and the receptionist) were given training for three days. They were explained about the aims/objectives of the study and



Fig. 6: Foreign body in 6-year-old boy

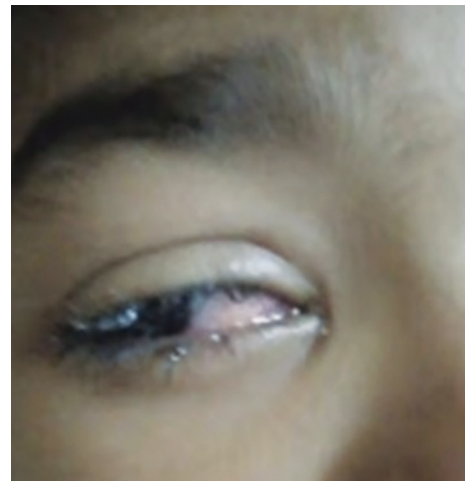


Fig. 7: Shows a case of eye irritation in 5-year-old boy

also regarding the data collection methods especially, in the case of illiterate patients. The data was collected by the author from 8:00 a.m. to 8:00 p.m. daily throughout the study period after 8:00 p.m. emergency duty staff collected the data till 8:00 a.m. of the next





**Fig. 8:** A case of 2nd degree burn in a 11-year-old child after 1st procedure of plastic surgery having blindness

**Table 10:** Type of firecracker involved in the event

Type of firecracker involved		
Type of firecracker	Number of cases	Percentage
Rocket	4	5.3%
Bomb	30	39.4%
Sparklers	40	52.7%
Miscellaneous	2	2.6%
<b>Total</b>	<b>76</b>	<b>100%</b>

morning. The nursing officer was then interviewed regarding the details of cases that were reported at night by the author.

A study conducted by Vassilia K et al.<sup>1</sup> in Greece found that 70% of injuries concerned children (10–14 years), mostly boys who were injured during lighting fireworks, whereas girls suffered injuries as bystanders which corresponds to the data in our study where we observed that 85.54% of total patients were males and 53.3% were more involved in being injured while lighting firecrackers while females (72%) suffered more as an onlooker. Another study by Puri et al.<sup>2</sup> in India also showed that 35% was seen in the age-group 5–20 years; 92% of these children were unsupervised similar pattern was observed in this study where we observed age-group 10–20 (*n* Patients suffering from 36) and below 10 years (*n* Patients suffering from 23) to be most susceptible to firecracker injury.

With the help of direct interviews conducted with patients and their relatives the most common reason for injury negligence (80%) in the form of multiple attempts to reignite a bomb (18%), device malfunction (2%), unsupervised children (40%) and watching/lighting less than an arms distance (20%) where most used cracker (Table 10) were found to bombs (39.4%), sparklers (52.7%) rocket (5.3%) and other miscellaneous firecrackers (2.6%) which are in lined with the study conducted by Smith GA et al.<sup>3</sup> where Firecrackers were associated with 42% of injuries, followed by bottle rockets (12%), other types of rockets (7%), Roman candles (11%), sparklers (7%), fountains (5%), jumping jacks (4%), and class B (illegal) fireworks (4%).

As per Witsaman RJ et al.<sup>4</sup> in the US associated injuries involved the face (20.0%), and hands (19.8%) which is as compared to similar to data in our data where there a total of 23.09% associated injuries involving face (50%) arm (38.89%) and others (11.12%).

According to a study conducted by, Mansouri MR et al.<sup>5</sup> in Iran during the festive season of Persian Wednesday Eve found Lid injuries (67.7%), corneal abrasions (51.6%), hyphema (48.1%), superficial foreign bodies (32.5%), and corneal contusions (13.8%), 33 cases of monocular blindness, 54 (12.3%) cases of open globe corresponding to present study where it was found that corneal defects (35%), epiphora due to smoke (10%), foreign body (20%), lid injuries (20%), hyphema (5%), and open globe injury (10%). The serious complication was observed in 2 (2.6%) patients who had suffered from permanent complete vision loss. A study conducted by Sacu S et al.<sup>6</sup> during New Year's Eve reported 32 patients (28%), ocular trauma resulted in visual impairment, mainly due to corneal scars or retinal pathologies.

It is a misfortune for people who are a mere onlooker/passers-by to suffer from such injuries even after not being involved in burning firecrackers directly entirely due to irresponsible behaviour of those who are actually involved.

## CONCLUSION

After analyzing a total number of 3,374 patients, 76 (2.25%) patients had suffered unilateral/bilateral ocular injuries associated with firecrackers which indicates that 2.25% of eye injury cases could have been prevented although, this percentage appears to be low when compared to other modes of eye pathologies it is only the tip of an iceberg which were reported in a tertiary care center. Out of all the reported cases most were males, Hindu and unsupervised children without a guardian (60%). Incidence of ophthalmic injuries due to firecrackers has not changed significantly over the years implying a lack of awareness regarding the deleterious repercussions of firecrackers. Since, the eye casualty cases have not been improved over the years and necessary precautions must be taken like:

- Eye protection glasses should be worn while lighting firecrackers.
- Bystanders should always stand at a safe distance from crackers.
- First aid kit, water supply, blankets, and mobile phones should be kept ready in case of emergencies.
- Children should not be left unsupervised.
- Do not kneel or try to reignite a firecracker and should maintain at least an arms distance while lighting.
- Awareness should be increased regarding such injuries and other harmful effects of firecrackers.
- Parents should encourage their children for celebrating a cracker-free Diwali by lighting dias or candles which cannot only prevent such injuries but will also benefit the environment.

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