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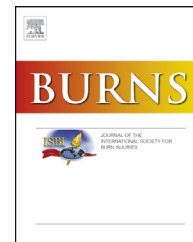
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Firework injuries at a major trauma and burn center: A five-year prospective study

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ABSTRACT

Background and objective: In China, fireworks are an integral part of the celebration of the annual Spring Festival, but the number of injuries associated with their private use seen in emergency rooms increases dramatically. To raise awareness and help guide future prevention practices in this city, we investigated the epidemiology of firework-related injuries presented at our trauma and burn center in Beijing during the Spring Festivals of 2007–2011. **Methods:** Patients were interviewed using a pre-coded questionnaire to elicit information regarding age, gender, causes, injured body part, type of injury, diagnosis, and disposition. **Result:** From 2007 to 2011, during the Spring Festivals 734 patients with fire-work related injuries were seen at our trauma and burn center in Beijing, the median patients of the five year were 140(136–150). The mean age of the patients was 26 ± 15.3 years (range, 1–95 years). Of the 734 patients, the highest proportion of injuries were the 5–14 year-old age group The majority of the patients were male (87.9%), the overall male:female ratio was 7.41:1, and males were predominant in all age groups. For all 5 years, the incidence of firework-related injuries during the Spring Festival Holidays peaked specifically on the first, fifth, and last days, respectively. Injuries were mainly due to improper handling (415/610, 68.0%) or setting off illegal fireworks (195/610, 32.0%). The most frequently injured body parts were the hands and fingers (32.0%), head or face except eyes (28.3%), and trunk (22.4%). Burns were the most common type of injury (65.7%), most of the burned patients (437/453) were between 1% and 10%, and the most common region burned were hands and fingers (218/754). Contusions or lacerations were the second common type of injury (34.3%). Most of the patients (642, 87.5%) were treated and released, while 37 (5%) were treated and transferred, and 55 (7.5%) were admitted for advanced treatment.

Conclusion: The private use of fireworks during the Spring Festival Holidays is associated with a considerable number of injuries to various parts of the body. We can minimize the number and severity of accidents by raising awareness of safety practices, encouraging professional displays only and motivating manufacturers to adhere to strict quality control.

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1. Introduction

People use fireworks worldwide to celebrate national and cultural holidays [1–18], but the mishandling of fireworks by private individuals is associated with serious preventable injuries. Many studies from countries around the world have recognized the importance of this global issue [3,5,13,19–24]. Setting off fireworks during the Chinese Spring Festival Holidays is an ancient custom traditionally thought to drive away evil spirits. Yet such activity was completely forbidden in Beijing from 1993 to 2005, after the government took safety, noise, and pollution factors into consideration. Since 2006, the use of fireworks has been allowed, but only during the Spring Festival.

The Spring Festival is the most important holiday for the Chinese people, a time when all family members get together in a way similar to Thanksgiving and Christmas in Western countries. Beginning in the early days of the last (12th) lunar month, the holiday continues until the 15th day of the New Year. The most important days are Spring Festival (New Year's) Eve and the first three days. During the Spring Festival, we see many patients with firework-related injuries in our emergency room at the Trauma and Burn Center of Beijing, the Fourth Clinical College of Peking University.

In developed countries, studies that describe firework-related injuries have raised awareness of the seriousness of this issue and have led to strong legislation regulating the use or distribution of fireworks [6,8,9,11–16,19,20,25–30]. Such studies in China have been very rare [4,31,32], especially for major Chinese cities such as Beijing. This study investigated the epidemiology of firework-related injuries, based on patients who visited our trauma and burn center. Our findings should help guide future firework-related safety practices in this city.

2. Materials and methods

The Trauma and Burn Emergency Center of Beijing Jishuitan Hospital, the Fourth Clinical Medical College of Peking University, is a tertiary referral center, serves a local population of about 23 million. We estimate about 1–1.5 million people in Beijing play firework during Spring Festival, and the rough incidence is 0.1–0.2%. We prospectively studied 734 cases of injuries due to fireworks presented at our trauma and burn emergency center in Beijing from 2007 to 2011. History of injury was obtained from the patients or accompanying persons. Patients were received 24 h per day and 7 days per week, and were interviewed by the doctors using a pre-coded questionnaire, and age, gender, causes, injured body part, type of injury, diagnosis, and disposition were recorded. Patients were then classified by age (0–4, 5–14, 15–24, 25–44, or ≥ 45 years), causes of injury (misuse, which means people set off firecrackers not in accordance with the instructions, illegal fireworks, which means people buy them from illegal stores, and the fireworks have problems in quality, and missing), injured body part (head/face except eyes, eye, extremities, trunk, and missing), injury type (burns, contusions/lacerations, missing), and disposition (treated and released from the emergency room to the clinic for further treatment; treated and transferred to the specialty hospital, such as an eye

hospital, or the patients were injured seriously enough to be admitted to the hospital). The Ethics Committee of Beijing Jishuitan Hospital approved the study. All the patients or their parents gave written informed consent.

Statistical analyses were performed using SPSS 15.0 software. Differences between various groups were assessed using the chi-squared test. A P -value < 0.05 was considered statistically significant.

3. Results

3.1. Numbers of patients

From 2007 to 2011, 734 patients with firework-related injuries were treated in Beijing Jishuitan Hospital, the median patients of the five years were 140 (136–150). Although there were some year-to-year fluctuations, no statistically significant trend was observed over the 5-year period in regard to the total number of patients per year ($P > 0.05$; Fig. 1).

3.2. Age and gender distribution

The mean age of the patients was 26 ± 15.3 years (range, 1 to 95 years). Of the 734 patients, the highest proportion of injuries were the 5–14 year-old age group, Although injury rates by age group fluctuated over time, there was a significant increasing trend only for the 25–44 year-old age group ($P < 0.05$; Fig. 2).

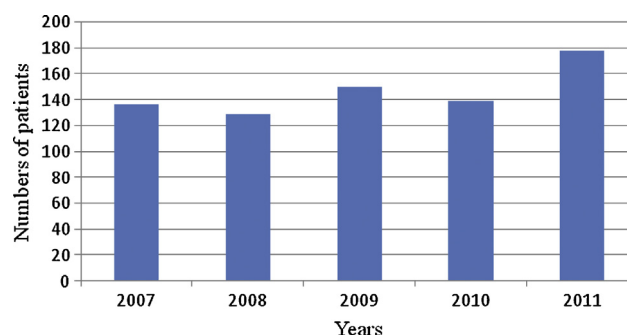


Fig. 1 – Number of patients injured annually by fireworks from 2007 to 2011.

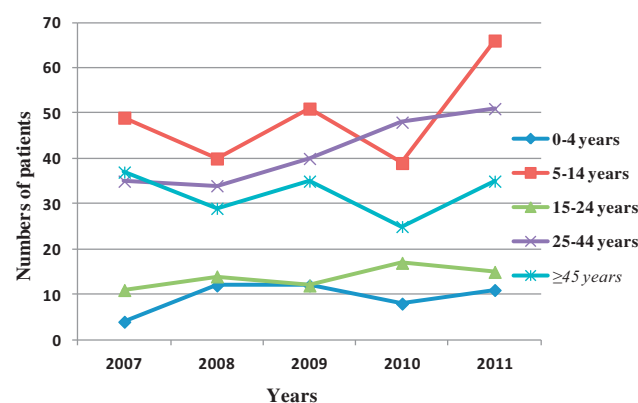


Fig. 2 – Age distribution of patients injured by fireworks from 2007 to 2011.

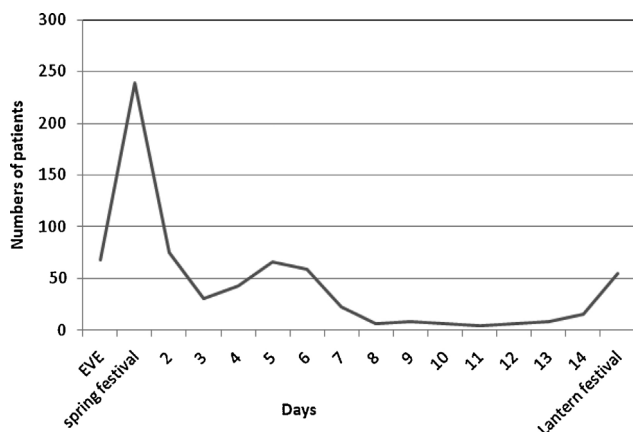


Fig. 3 – Incidence of firework-related injuries during the Spring Festivals, 2007–2011.

The majority of the patients were male (87.9%), with a male:female ratio 7.41:1. The number of males was higher in each age group.

3.3. Peak times of firework injuries

In each of the 5 years under study, during the Spring Festival Holidays there were consistently three specific days of significantly higher numbers of firework-related injuries (Fig. 3). The greatest number of incidents occurred on the Spring Festival (New Year's) Day, with collectively 239 persons injured, followed by the fifth day (the God of Wealth's birthday) with 66 cases, and then the Lantern Festival, the last day of the holidays, 55 cases.

3.4. Clinical profile of injuries

The majority of patients (415, or 68.0%) were injured due to firework misuse in all age groups, and 195 patients (32.0%) after using illegal fireworks. The most frequently injured body parts were hands and fingers (32.0%) in all age groups, head or face except eyes (28.3%), trunk (22.4%), and eye (11.4%) were also common. Burns were the most common type of injury (65.7%), most of the burned patients (437/453) were between 1% and 10%; 14 patients were between 10% and 30%, among them, 4 patients' clothing caught on fire; only 2 patients were between 30% and 40%, both of their clothing caught on fire. The most common region burned were hands and fingers (218/754). Contusions and lacerations were the second common type of injury (34.3%). Most of the patients (642, 87.5%) were treated with debridement and released for outpatient clinic dressing change, 37 patients (5%) were treated and transferred to specialized hospital such as eye hospital, and 55 patients (7.5%) were admitted for advanced treatment, of whom 20 patients underwent operative intervention, such as debridement, skin transplant. No one died in our study (Table 1). For all patients, crackers were the fireworks that caused injury to the most people (316/689), and the flare/fountains were the second dangerous fireworks (105/689), however, in contusions/lacerations group patients, double-bang firecracker was the second dangerous firework (Table 2).

4. Discussion

Fireworks are used globally to celebrate religious and cultural festivals and holidays. These include the Fourth of July and New Year's Eve in the United States [9,33,34], Diwali in India

Table 1 – Firework-related injuries according to cause, body site injured, injury type, and disposition by age groups, 2007–2011.

	0–4 years	5–14 years	15–24 years	25–45 years	≥45 years	Number of cases	Percentage (%)
Cause							
Misuse	31	138	24	121	101	415	68.0
Illegal fireworks	7	57	18	52	61	195	32.0
Missing	10	52	27	35	0	124	
Total	48	247	69	208	162	734	100
Body site injured							
Head/face except eye	13	70	15	56	37	191	28.3
Eye	7	14	5	25	26	77	11.4
Hands and fingers	15	78	20	58	45	216	32.0
Arms	2	1	2	5	7	17	2.5
Lower extremities	3	2	7	6	5	23	3.4
Trunk	5	65	11	48	22	151	22.4
Missing	3	17	9	10	20	59	
Total	48	247	69	208	162	734	100
Injury type							
Burns	28	175	46	123	81	453	65.7
Contusions/lacerations	16	54	18	74	74	236	34.3
Missing	4	18	5	11	7	45	
Total	48	247	69	208	162	734	100
Disposition							
Treated and released	42	211	48	192	149	642	87.5
Treated and transferred	5	13	7	7	5	37	5.0
Admitted	1	23	14	9	8	55	7.5
Total	48	247	69	208	162	734	100

Table 2 – Relationship between firework type and injuries.

Firework	Number of cases	Number of injuries	
		Burn	Contusions/lacerations
Ground spinner	80	66	14
Double-bang	93	45	48
Flare/fountain	105	72	33
Crackers	316	200	116
Rocket	95	70	25
Missing	45		
Total	734	453	236

[35], Hari Raya Festival in Malaysia [36], Halloween in Northern Ireland [23], Guy Fawkes Day in Great Britain [37], Greek Orthodox Easter in Greece [11], and New Year's Day in Denmark [38], Austria [15], South Africa [39], Italy [23,40], Iran [7], and the Philippines [24], among others. Yet fireworks are clearly a health hazard to the public.

The present study investigated the numbers, types of injuries, and circumstances surrounding firework-related accidents of patients seen at a major trauma and burn center in Beijing during the Spring Festival Holidays. Over the years from 2007 to 2011, there was no significant change in the total number of injured patients per year. As there was no decrease over the five years, this suggests that we should take some measures to deal with the issue. The age group most likely to sustain injuries was the 5–14 year-olds, which is consistent with the findings of other studies [9,11,33]. This could be due to the typically active, incautious, and experimental nature of children [21]. In addition, in our study firework-related injuries occurred most frequently among males, which is also in accord with other studies [2,10,18,34]. This is probably because in China during the Spring Festival Holidays women are busy with household duties, while the men play with fireworks along with the children, leading to the high injury rate among men.

A plot of the number of firework-related patients against the days of the festival period clearly shows that the number of injuries seen at our burn and trauma center is highest on the first day, the Spring Festival Day. The practice of playing with fireworks originated as a way to frighten the legendary monster Nian, who, tradition says, preys on and eats people on this day. In modern times however, fireworks are an integral part of the traditional celebration; everyone plays with fireworks and the maximum number of injuries annually on this day reflects the universality of the practice.

The day of the festival period on which the second highest number of firework-related injuries occurs is the fifth day. The start of a 5-day vacation for many people, on this day people play with fireworks to drive away the God of Poverty and ensure good luck in the coming year. The day of the lowest peak in numbers of firework-related injuries annually is the last day of the holidays, the Lantern Festival. On this day, people enjoy the variety of celebratory lanterns, guess lantern riddles, and eat yuanxiao (filled dumplings). For many, the celebration also includes fireworks, and this leads to the last peak in the incidence of injuries.

From the epidemiology of injuries due to fireworks, we can see that 68% of patients were hurt due to firework misuse,

which means people set off firecrackers not in accordance with the instructions, most commonly by holding crackers in the hand, delayed withdrawal, close proximity to lighted fireworks, or picking up misfired fireworks. These findings are consistent with that of other studies [21]. Many other patients (32%) were injured because of illegal fireworks, most of which were homemade or illegal factory manufactured. Other studies have shown that injuries due to such illegal fireworks are typically more serious than injuries from the legal fireworks manufactured commercially [2,33,34].

In our study, hands and fingers were the most common body part to suffer injury in all age groups (32.0%). The hand especially is at risk because it is closest to the fireworks at the time of lighting, and people may be foolhardy enough to hold the firework as it is lit [21,22,30]. The head and face are also often injured if the person lighting the firework bends over to watch it closely, and in our study, accidents involving the head or face occurred in 28.3% of these patients. Some studies found that injury to the eyes was commonest [13,20,25,27], but only 11.4% of our patients suffered from eye injury.

Injuries associated with fireworks are often a combination of burns, soft tissue losses, bone injuries, contusions and lacerations. In our study, burns were the leading injury, which is consistent with other studies [9,21,34]; most burns were to the head and face. Most of the burned patients (437/453) were between 1% and 10%; 14 patients were between 10% and 30%, among them, 4 patients' clothing caught on fire; only 2 patients were between 30% and 40%, both of their clothing caught on fire. Clothing caught on fire increases the severity of firework-related burn. For all patients, crackers were the fireworks that caused injury to the most people (316/689), because crackers were the most common firework in festival, and the flare/fountains were the second dangerous fireworks (105/689), however, in contusions/lacerations group patients, double-bang firecracker was the second dangerous firework. In double-bang firecrackers, gunpowder is separated into two layers at the bottom; the first layer gunpowder will spray down the air flow to produce upward thrust, to push firecrackers to the air. At this time, the fuse just ignites the upper end of the closed gunpowder and causes secondary combustion – explosion, most people get hurt when the double-bang firecrackers failed to fly to the air and exploded in hands. Most of the injured patients were treated and released from the emergency room to the clinic for further treatment in all age groups; only 5% were treated and transferred to a specialty hospital, such as an eye hospital. Some (7.5%) of the patients were injured seriously enough to be admitted to the hospital. Burns were predominant in all kinds of disposition (Table 3).

4.1. Study limitations

This study only collected data on individuals who sought care in our hospital and does not include those patients who were treated in other hospitals or those whose injuries were left untreated. Therefore, the findings of this study represent only the most severe injuries and undoubtedly underestimate the true number of firework-related injuries in Beijing. The numbers we report are a conservative estimate of firework-related injuries and this fact should underscore the urgent need for prevention measures. Few publications have

Table 3 – Relationship between firework injury types and disposition.

Disposition	Injury types			Total
	Burns	Contusions/lacerations	Missing	
Treated and released	412	201	29	642
Treated and transferred	18	15	4	37
Admitted	23	20	12	55
Total	453	236	45	734

described or evaluated community interventions [23]. Therefore, additional research is needed in this area. Also, the information we have collected are limited, more effort should be made to this study in future.

5. Conclusion

Fireworks used during the Spring Festival Holidays are responsible for a considerable number of injuries to different parts of the body. Beijing fireworks safety regulations was promulgated on September 9th 2005, the law call people to set off fireworks under instructions; schools should educate students the danger of firework; illegal manufacture, store, transport, and sale fireworks will be punished; places around station, school, hospital, gas station, forest, power station were firework forbidden. Stricter enforcement of the existing laws, and further education of children and the general public to the dangers of fireworks is needed. We can minimize the number and severity of accidents by raising awareness of safety procedures, encouraging professional displays over those that are private, and motivating manufacturers to adhere to strict quality control.

Conflict of interest

The authors declare that there is no conflict of interest.

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