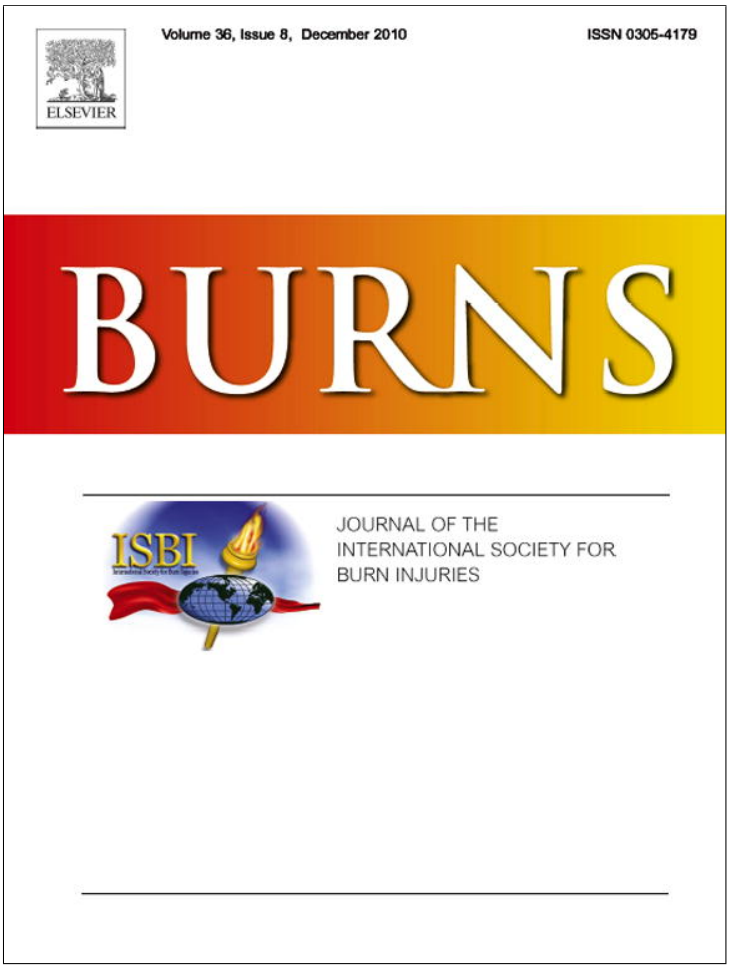

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Burn disasters in the middle belt of Ghana from 2007 to 2008 and their consequences

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ABSTRACT

Aim: To study the survival and mortality trends in four fire disasters in the middle belt of Ghana from 2007 to 2008 and to explore measures that could minimize the risk of future disasters.

Methods: Data were collected from clinical records from the Burns Intensive Care Unit and the Casualty Unit of the Komfo Anokye Teaching Hospital, Kumasi, Ghana and from the various disaster sites and the Ghana Police Service.

Results: A total of 212 were injured from four burn disasters; 37 (17%) died on the spot; 175 (83%) reported to the Casualty Unit out of which 46 (26%) were admitted. The victims admitted had mean age 24.6 years with male to female ratio 2.3:1; 25 (54%) of the admitted victims died. The average burned surface area of the admitted victims was 63%, with a mean survival rate of 46%. Statistical analysis for mortality when the surface area of the burn was >70% was 0.0005 (*P*-value).

Conclusion: The four petrol-related fire disasters showed variable mortality rates. Death and severe disability of victims of future disasters can be avoided if intensive road accident preventive measures and massive public education are encouraged.

1. Introduction

Burns and their sequelae are responsible for significant mortality and morbidity worldwide, especially in developing countries [1,2]. Petrol-related fires, caused by an overturned fuel tanker, are particularly common in developing countries, where transport systems are poor, law enforcement for traffic violations is weak, emergency response services are limited, public resources devoted to fire fighting are few and knowledge about fire safety amongst the general public is low. A burn disaster in this context is a catastrophe caused by petrol-related fire which claims human lives or causes trauma to the affected individuals within a period of time.

Fuel-related accidents do not happen by chance. It is a chain of events that eventually end up in the accident, a disaster in this case. If the chain is broken in any way, an accident will not occur. Some of the events that cause accidents may be preventable, while others may not. If just

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one of the avoidable events is prevented from occurring, no accident will happen. Fire-related burns represent an extremely stressful experience for both the burn victims as well as their families. An extensive burn profoundly affects the patient's physique, psyche, financial situation and family. Patients with extensive burns frequently die, and for those with lesser injury, physical recovery is slow and painful. In addition to their dramatic physical effects, burn injuries frequently cause harmful psychological complications [2].

In developing countries burns are much more common (exact numbers are difficult to determine) than in the USA and Europe [3] or other affluent developed countries due to poverty, overcrowding and illiteracy [1,4]. Globally, fire-related burns are responsible for about 265,000 deaths annually [5]. Over 90% of these fatalities occur in developing countries with south-east Asia alone accounting for over half of fire-related deaths [4,6]. India for instance, with a population of over 1 billion, has 700,000–800,000 burn admissions annually [4]. There are approximately 1500 severe burns cases in Ghana each year, and a sizeable fraction of these burns occur in large-scale disasters caused by petrol-related fires. Petrol-related fires, such as those instigated by an overturned fuel tanker, are particularly common in developing countries [7]. In Kenya, on 31st January 2009, a tanker with approximately 30,000 l of fuel overturned, caught fire and exploded, killing more than 90 local residents who were siphoning the petrol [8].

The management of burns and their sequelae, even in well-equipped, modern burn units, remains demanding despite advances in surgical techniques and development of tissue-engineered biomaterials available to these burn centres [9]. Difficulties experienced in burn management are amplified many times in developing countries [1] and lack of government initiative and low literacy rates preclude effective prevention programmes [4]. The cost of managing burns is invariably high [10]. It is a fact that countries with sound economies as depicted by the gross national product per capita tend to have a better health status. Related to the economy is health expenditure, which is also likely to have an impact on health status [11,12]. Poor facilities and health structures are a common denominator in most parts of the developing world. Most existing burn centres are situated in large cities and are insufficient for the high incidence of injuries [4]. Regardless of inadequate physical structures, these centres are invariably plagued with lack of resources, lack of operating time and shortage of blood. Often there are few dedicated burn surgeons and it is mostly general surgeons without formal training who are involved in burn care [4]. Burn nursing is also not a recognized concept [4]. Resuscitation is often delayed as patients have to travel long distances and transport facilities are poor [4,13].

Ambulance and pre-hospital services are nonexistent [13]. Despite the reported annual increase in expenditure for burn care in a large number of developing countries and improving conditions of existing burn centres, burn management remains particularly inadequate in rural areas [1]. Moreover, there is generally no coordination between district hospitals and tertiary burn centres [4].

Burns are quantifiable and pathophysiologic derangement is related to the size of the injury. The surface area of a patient's palm is approximately 1% of their total body surface area and provides a quick estimate of burn size in smaller injuries. Typically, burn size estimations are derived from the ''Wallace's Rule of Nines'' [14]. The body's surface is divided into areas of roughly 9% each, which includes the head and neck, the chest, the abdomen, the upper back, the lower back, each lower limb and each upper limb; the perineum is rated as 1%. Although useful in adults, the ''Rule of Nines'' overestimates burn size in children. The head and neck account for a larger proportion of the total body surface area (TBSA) in children, more than 21% BSA in toddlers and babies. For greatest accuracy and reproducibility, burn size should be determined by plotting the burn wound on Lund and Browder burn diagrams [14]. A major burn is defined as greater than 25% BSA involvement (15% in children), or more than 10% BSA full-thickness involvement. Major burns require aggressive resuscitation, hospitalization and appropriate burn care. Additional criteria for major burns include: deep burns of the hands, feet, eyes, ears, face or perineum; inhalation injuries; and electrical burns. Moderate thermal burns of 15–25% BSA or 3–10% BSA full-thickness, often require hospitalization for optimal patient care. Other criteria for admission include concomitant trauma, significant pre-existing disease and suspicion of child abuse. Minor burns can generally be treated as out-patients [14].

A careful study of burn survival and mortality trends in these four disasters is presented in this paper. The aim is to make a critical analysis of survival and mortality in Komfo Anokye Teaching Hospital (KATH)-Burns Intensive Care Unit (BICU) of the Reconstructive Plastic Surgery and Burns Unit with a view to explore measures that could minimize the risk of future disasters and improve treatment for victims.

Table 1 – Age distribution of the victims.

Age (years)	Frequency	Percent
0–9	2	4.3
10–19	11	23.9
20–29	22	47.8
30–39	9	19.6
40–49	1	2.2
50–59	1	2.2
Total	46	100.0

Table 2 – TBSA distribution of the victims.

TBSA (%)	Frequency	Percent
<10	1	2.2
11–20	3	6.5
21–30	1	2.2
31–40	6	13.0
41–50	7	15.2
51–60	4	8.7
61–70	4	8.7
71–80	6	13.0
81–90	4	8.7
91–100	10	21.8
Total	46	100.0

Table 3 – Outcome of admitted victims for each disaster site.

Disaster site	Frequency	Outcome	
		Dead (%)	Alive (%)
Asokwa	7	3 (12.0)	4 (19.1)
Adum	6	1 (4.0)	5 (23.8)
Atwedie	7	5 (20.0)	2 (9.5)
Techiman	26	16 (64.0)	10 (47.6)
	46	25 (100.0)	21 (100.0)

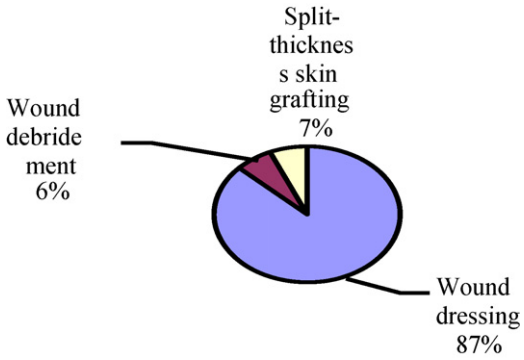

Fig. 2 – Burns treatment administered.

2. Methods and materials

2.1. *Data collection and analysis*

With ethics approval, data of fire victims admitted at the Komfo Anokye Teaching Hospital (KATH) in Kumasi, Ghana, from September 2007 to November 2008 were collected from the clinical records of the Burns Intensive Care Unit (BICU) of the Reconstructive Plastic Surgery and Burns Unit. Also data were collected from the Casualty Unit, for victims who were treated and discharged. Similarly, data was collected from accident sites and from the Ghana Police Service. Demographic details, clinical assessment of the wound, duration in hospitalization, treatment, survival and costs incurred were recorded for each subject and analyzed with SPSS version 12.0 (SPSS, Inc., Chicago, IL, USA).

2.2. *Study setting*

The Komfo Anokye Teaching Hospital (KATH) in Kumasi is the second-largest hospital in Ghana and the only tertiary health institution in the middle belt of the country. It is the main referral hospital for the Ashanti, Brong-Ahafo, Northern, Upper East and Upper West Regions.

The hospital was built in 1954 as the Kumasi Central Hospital. It was later named Komfo Anokye Hospital after Okomfo Anokye, a legendary fetish priest of the Ashantis. It was converted into a teaching hospital in 1975, affiliated to the School of Medical Sciences of the Kwame Nkrumah University of Science and Technology. The hospital is also accredited for postgraduate training by the Ghana College of Physicians and Surgeons, West African College of Surgeons and the West African College of Physicians in surgery, obstetrics and gynaecology, paediatrics, otorhinolaryngology, ophthalmology, radiology, internal medicine, child health, family medicine and emergency medicine. The hospital currently has about 1000 beds; up from the initial 500 when first built.

The Surgery Directorate is among the nine directorates in KATH. The Reconstructive Plastic Surgery and Burns Unit, are among the units of the Surgery Directorate having the state of art equipment in KATH.

3. Results

Four similar petrol fire disasters were examined. In total, 212 people were injured, of which 37 (17%) died on the spot and 175 (83%) were seen at the KATH Casualty Unit; 46 of the 175 (26%) were admitted to the KATH-BICU, while 129 (74%) were treated and discharged from the Casualty Unit. Those discharged patients frequently visited the out-patients department for wound dressing and were eventually discharged; there were no mortality recorded among them. The age of those admitted ranged from 3 to 53 years, with a mean age of 24.6 years (Table 1). Most (n = 36, 78%) were between the ages of 16 and 35 years, with a peak at 20–29 years. The male to female ratio of those brought to hospital was 2.3:1. More than half (25 of 46, or 54%) of those admitted died (Table 3), with a mean duration in hospital of 16.5 days (Fig. 1). The mean length of stay of survivors in the hospital was 23.6 days. The average burn surface area was 63% (Table 2). Table 9 shows the statistical summary data of the study. Also, the total cost

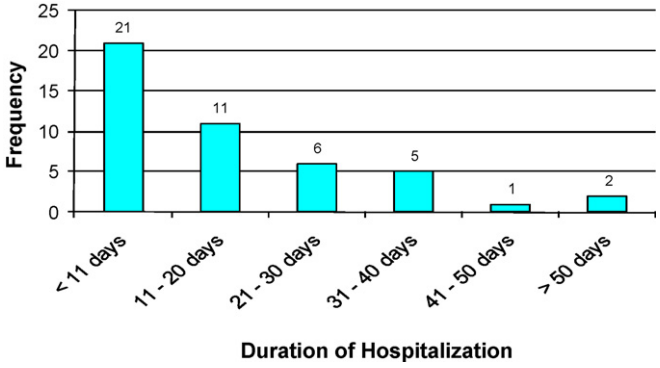

Fig. 1 – Duration of hospitalization of the admitted victims.

Table 4 – Road distances between the disaster sites and KATH.

Disaster site	Distance to KATH (km)
Asokwa	7.00
Adum	3.54
Atwedie	79.40
Techiman	206.86

of treatment incurred on all the patients was $ 56,230.00 (Table 10).

3.1. *Duration of hospitalization during treatment*

A total of 760 days were spent in the hospital by victims of the 4 fire disasters, with a mean hospitalization days of 16.5. Twenty-one (47%) of the victims spent less than 11 days in the hospital, whiles 2 (4%) spent more than 50 days (Fig. 1).

3.2. *Fire disasters, their places and dates of occurrence*

3.2.1. *Disaster 1: 21 September 2007, at Asokwa, a suburb of Kumasi, Ashanti Region, Ghana*

An LP gas tanker exploded at a filling station. People gathered, attracted by the noise. A second explosion injured 136 people, 7 of whom were admitted to KATH-BICU. Of the admitted victims, 3 died (between 8 and 10 days after admission). The remaining 4 patients were discharged after treatment, having spent an average of 17.5 days in hospital. Total body surface area (TBSA) burned was between 78% and 98%. Table 5 shows the statistical data of the study.

3.2.2. *Disaster 2: 22 August 2008, at Adum, the business centre of Kumasi, Ashanti Region, Ghana*

A petrol tanker overturned and its fuel ran 300 m down a slope at the side of a road. It caught fire on a burning stove where a woman was cooking. The flame then spread back to the street and injured 8 people, of who 2 died on site and the other 6 victims were admitted to KATH-BICU. One person died 4 days after admission (71% TBSA burned). Table 6 shows the statistical data of the study.

3.2.3. *Disaster 3: 23 August 2008, at Atwedie, Ashanti Akim North District of the Ashanti Region*

A fuel tanker overturned and exploded. The flames reached a nearby home and killed 4 people instantly; 7 people were admitted to KATH-BICU, of whom 5 died. One patient, a 3-year-old girl who lost both parents in this disaster, had 65% TBSA and spent 92 days in hospital; was discharged home in a fairly good condition. Dressings were done on an OPD basis; she was re-admitted for anemia, and died 4 days later in the hospital. There were 2 survivors: a woman of 27 and a man of 20, who sustained 47% and 59% TBSA and spending 16 and 40 days in hospital, respectively. Table 7 shows the statistical data of the study.

3.2.4. *Disaster 4: 26 November 2008, at Techiman, Brong-Ahafo Region, Ghana*

A petrol tanker overturned and fuel leaked out. The driver's companion tried to remove the car battery, worried someone might try to steal it. This ignited fumes, and an explosion injured the people who had gathered to scoop up the leaking fuel. Sadly, 31 people died at the site; 26 were admitted to the KATH-BICU and other wards, where 16 of them died. Mean TBSA was 76% (range 36–99%). Table 8 shows the statistical data of the study.

Table 5 – Statistical data of the Asokwa disaster.

No.	Age (years)	Sex	TBSA (%)	Treatment	Outcome
1	33	F	78	Wound dressing	Died
2	30	M	98	Wound dressing	Died
3	27	M	90	Wound dressing	Died
4	38	M	32	Skin grafting	Discharged
5	27	M	28	Wound dressing	Discharged
6	17	F	20	Wound dressing	Discharged
7	14	M	75	Wound debridement	Discharged

3.3. *Treatment*

Types of treatments used during the study are elaborated in Fig. 2, showing that 87% ($n = 39$) had wound dressing, 7% ($n = 4$) split-thickness skin grafting and wound debridement accounted for 6% ($n = 3$).

3.4. *Multiple logistic regression analysis*

Table 11 shows the adjusted odds ratios for mortality amongst the 46 patients admitted to the hospital. Available factors for each case were the age, gender, surface area of the burn and the distance between the site of the fire and the hospital. Although age is generally regarded as an important risk factor, the odds ratio found here (11.2) did not reach significance because of the very small numbers of older people in this cohort. The distance between the fire and the hospital played no role as a risk factor for mortality, while the percentage of the surface area involved in the burn was the key factor.

4. Discussion

In developing countries, overturning and explosion of fuel tankers, killing or causing disabilities to many people has been reported several times [1,2,4,8]. Danilla et al. reported a mortality rate of 2.1% per 100,000 persons in developed countries [15]. Mortality is the most important and most readily quantifiable outcome in burn patients.

The findings of our study showed a mortality rate of patients admitted to be 54% (25 out of 46). The mortality rate

Table 6 – Statistical data of the Adum disaster.

No.	Age (years)	Sex	TBSA (%)	Treatment	Outcome
1	28	M	71	Wound dressing	Died
2	15	M	33	Skin grafting	Discharged
3	23	M	39	Wound dressing	Discharged
4	14	F	18	Wound dressing	Discharged
5	23	F	9	Wound dressing	Discharged
6	27	M	14	Wound dressing	Discharged

Table 7 – Statistics data for the Atwedie disaster.

No.	Age (years)	Sex	TBSA (%)	Treatment	Outcome
1	6	M	56	Wound dressing	Died
2	3	F	43	Wound dressing	Died
3	28	F	44	Wound dressing	Died
4	27	F	47	Skin grafting	Discharged
5	53	M	58	Wound dressing	Died
6	33	M	82	Wound debridement	Died
7	20	M	45	Wound dressing	Discharged

was higher as compared to similar instances reported in Kenya and Nigeria [8,16–18] and much higher to other reports from developed countries [19–22]. The difference in mortality rate may be due to the high TBSA (63%) of patients (Tables 2 and 11), which according to the report of O'Sullivan et al. (2007) is the major risk factor predicting the outcome of burns. Other risk factors in our study such as long distance from hospital (Table 4), gender and age of victims were not significant in terms of survival of victims (Table 11).

This significant association between TBSA and mortality rate in our study, was also reported by Olaitan et al. (2006) in a study in Nigeria [23]. A study in India found that a TBSA more than 60% resulted in 100% mortality, and that as TBSA increases then mortality also increases [24]. Our study also found that a TBSA of more than 75% resulted in 100% mortality (Tables 5–8). These differences in mortality in relation to TBSA could be due to the set-up of the treatment centers, since KATH-BICU has state of the art facilities and fully trained health personnel.

Table 9 – A statistical summary of the four Burn disasters.

# People injured	212
# Deaths on the scene	37
# Seen at casualty	175
# People admitted	46
# Patient deaths	25
# Total deaths	62
Age rage of patients admitted	3–3 years
Mean age of patients	24.6 years
Male:female ratio of patients	2.3:1
Range of total burns surface area (TBSA) of patients	9–99%
Mean TBSA	62.80%
Mean length of stay (LoS) of survivors	23.56 days
Survival rate of patients admitted	45.7%

The ages of patients admitted were between 3 and 53 years, with a mean age of 24.6 years, where most patients (n = 36, 78%) were between the ages of 16 and 35 years (Table 1). The ratio of males to females was found to be 2.3:1. This sex distribution where males outnumber females in burns disaster (Table 9) has also been reported by Olaitan et al. [23] and in other cases [25,26]. As the age increases, survival rate also decreases, hence the higher the patients age the lower his/her survival rate. Bull et al. (1954) suggested that the principal determinant whether a patient lived or died was the size of the burn and the age of the patient. In our study, the multiple logistic regression analysis for survival found that age was not a significant factor (Table 11). This does not follow the trend of the reports in the literature [26,27]. There is a suggestion that older age has a worse prognosis, but the result does not reach significance because there were so few older people in this series.

Table 8 – Statistics data for the Techiman disaster.

No.	Age (years)	Sex	TBSA (%)	Treatment	Outcome
1	15	M	97	Wound dressing	Died
2	22	F	98	Wound debridement	Died
3	28	M	58	Wound dressing	Discharged
4	30	M	38	Wound dressing	Discharged
5	18	M	79	Died soon after admission	Died
6	28	M	99	Wound dressing	Died
7	23	F	45	Wound dressing	Discharged
8	30	M	98	Wound dressing	Died
9	38	M	90	Wound dressing	Died
10	28	M	94	Wound dressing	Died
11	38	M	80	Wound dressing	Died
12	18	F	75	Wound dressing	Discharged
13	35	F	90	Wound dressing	Died
14	23	M	98	Wound dressing	Died
15	25	F	98	Wound dressing	Died
16	25	F	68	Wound dressing	Died
17	25	M	70	Wound dressing	Discharged
18	17	M	36	Wound dressing	Died
19	26	M	98	Wound dressing	Died
20	18	M	51	Wound dressing	Discharged
21	42	M	65	Wound dressing	Died
22	19	M	35	Wound dressing	Discharged
23	22	M	50	Wound dressing	Discharged
24	28	M	91	Wound dressing	Died
25	29	M	45	Skin grafting	Discharged
26	19	M	65	Wound dressing	Discharged

Table 10 – Type of treatment and cost incurred.

	Average cost per patient ($)	Total cost ($)
Wound dressing	826.00	46× = 38,000.00
Medication	305.00	46× = 14,030.00
Surgery	600.00	7× = 4200.00
Total cost ($)		56,230.00

Fire-related burns prevention is an essential part of any integrated burn management protocol anywhere. Stakeholders in developing countries such as Ghana should focus on burn prevention and treatment since it remains the major and probably the only available way of reducing the current state of morbidity and mortality. Many health authorities, agencies, corporations and even medical personnel in many developing countries, consider injury prevention to have a much lower priority than disease prevention for understandable reasons. Consequently, burns prevention programmes fail to receive the government funding that they deserve [27]. In Ghana, if burns prevention were made a national programme, this could ensure sufficient funds are available and lead to proper research and coordination of district, regional and tertiary care centres. The existing burns unit at KATH in Kumasi and other referral centres for burn patients should be expanded. More bases for emergency services vehicles, especially along roads frequented by petrol tankers and new equipment to help victims of petrol explosions should be provided (e.g. equipment for resuscitation of severely burned patients). Also, long-term investments in safer vehicles, better petrol transport systems and massive public education should be encouraged.

Rehabilitation of each burn patient typically includes physiotherapy, occupational therapy, splinting and reconstructive surgery in future years to correct deformities arising from scar contractures, keloids or amputations and counseling to help with emotional trauma. All these would add to the cost that would have to be paid to enable the fire victims to fit into society (Fig. 2, Table 10). Thus many of debts would be incurred; monies which could have been utilized in the development of the nation. Other authors have also reported cost of treatment to be high and in some developing countries, the patient, if alive is solely responsible for the payment of treatment [23].

Ghana has discovered oil in commercial quantity, and active exploration starts from 2010. If the suggested recommendations are not taken into consideration, the transportation of the end products of this oil could lead to a rise in the fuel-related disasters and increased mortality rate of victims.

5. Conclusion

The study has shown that a high mortality rate was recorded from the four petrol-related fire disasters. The total burn surface area of patients (Table 11) was found to be the only significant factor associated with mortality.

Public education on the danger of hydrocarbon substances should be encouraged, especially among communities along the fuel transport roads in Ghana.

Table 11 – Burns analysis for all patients admitted (n = 46).

Risk factor	Odds ratio	95% C.I.	P-value
AGE (>30 years)	11.2	0.79–158.5	0.073
Distance (>100 km)	1.5	0.29–7.7	0.64
Sex (M vs. F)	2.0	0.30–13.3	0.47
TBSA (>70%)	26.7	4.17–170.6	0.0005

Long-term investment in safer vehicles, better petrol transport systems, for example, by railway and public education are ways in which petrol-related fire disasters can be prevented in the future; this will subsequently avoid such huge expenditures on patients treatment and loss of valuable lives.

Conflict of interest

The authors declare that they do not have any conflict of interest.

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