Original Article

Epidemiology, Geographical Distribution, and Outcome Analysis of Patients with Electrical Burns Referred to Shiraz Burn Center, Shiraz, Iran during 2008-2019

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ABSTRACT

Background: Burn is one of the most significant injuries in industrial and developing societies and is one of the most important traumas leading to hospitalization. The aim of this study was to identify the epidemiology, geographical distribution, and outcome of electric burns in Fars province and to present the distribution map.

Methods: In this descriptive-analytical study, the study population involved all electrical burn victims admitted to Amir al-Momenin and Ghotbeddin Hospitals from 2008 to 2019 in Fars province in the south of Iran. Data were analyzed using SPSS software version 22.

Results: Among a total of 246 patients, the average age was 30.78 ± 11.07. The highest frequency among educational levels was among under-diploma patients (38.6%), and the majority were employed (87.4%). Also, most of the patients were from urban areas (70.3%). The majority of burn incidences occurred at the workplace (57.7%). Also, among the high voltage patients, 25 patients (30.9%) had an amputation, while among low voltage only 12 patients (16.2%) had an amputation. Non-surgical treatment was applied in 68 (28%) cases, while Escharotomy was performed in 28 (11.4%) patients. There was also a statistically significant association between burn voltage and amputation (P= 0.039).

Conclusion: Based on our report, the rate of electrical burn injuries in Iran is still high, which underlines the need for stronger efforts in effective prevention, such as better public education and the establishment of strict regulations regarding the distribution and use of electricity.

Keywords: Burn, Electrical Injury, Iran

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INTRODUCTION

Burn is one of the most common health problems globally, which due to longer hospital stay and complications that occur in the field of the disease and the need for long and multi-stage treatments, impose much economic burden on society[1]. A burn is a severe skin injury or other organic tissue that has causes the affected skin cells to die. Burn injuries cause an energy transfer to tissues, associated with various degrees of

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tissue destruction depending on the cause of burn[2]. Scald injuries, caused by moist heat, appear more superficial initially. Burn injuries classify according to their depth and size. First-degree burns are injuries involving the uppermost (epidermis) layer of skin because of limited superficial symptoms that resolve without scar formation. Second-degree burns, including superficial partial-thickness (2A) and Deep partial-thickness (2B), require wound care.

Burns has a variety of external sources, including thermal (heat-related), radiation, chemical, electrical, fires, and excessive sun exposure[3]. In thermal burns, the damage is from the surface to the depth, and in clinical examination, its amount can be estimated, but in contrast, in electric burns, the amount of damage in the depth of the tissue is more than its surface, which may not be seen in the initial examination. Deep, including muscles, may cause myonucleosis and require a fasciotomy[4]. In industrial societies, electrical burns are one of the predominant types of burns in public health issues[5]. Electrical burns are classified as flash burns secondary (electrical current passing through the body) and electric arc (no current passes through the body) or as high voltage (greater than 1000 V), low voltage (less than 1000 V) [6]. The electrical arc is generally considered to be a separate class and often causes superficial burns. On the other hand, electrical burns may lead to extensive and deeper burns and can lead to higher mortality[7]. The electric energy passing through the human body causes very complex reactions in the body's tissues and organs. On the other hand, these reactions affect the organism's histological, anatomical, biochemical and structural composition and, on the other, give rise to a series of electrotraumas.

The length of hospital stays and the cost of surgery and hospitalization in patients with electrical burns are longer than heat burns. Patients with electrical burns are at higher risk for infection, morbidity, and amputation, and the early use of flaps has been shown to reduce complications in these patients[8]. These burns also affect other body organs, including the heart, lungs, eyes, and kidneys[9]. The best treatment is prevention. Many long-term complications, especially in cases of high voltage, are irreversible[10].

Burn injuries have major mortality and morbidity, especially in developing countries. Implementation of a prevention strategy is necessary to reduce the mortality and morbidity mortality associated with burn injuries[11]. Previous studies show that in developed countries burn prevention programs have been successful[12]. Epidemiological studies provide essential information for the development of a well-designed prevention program and significantly contribute to the treatment of patients with electrical burns. A previous study indicate differences in the epidemiology and prevalence reported for electrical burns[7]. In this regard, separate epidemiological studies are required in each region to design prevention programs.

Although some projects have studied the epidemiology of electrical burns in Iran, there is no study on patients with electrical burns in Shiraz in the Fars province. Fars Province is one of the provinces of Iran, located in the southern part of the country. This province is the fourth largest province in Iran with a population of 4,851,274, according to the population of the Statistical Center of Iran in 2016. According to the country divisions of 2021 years, the province was divided into 37 cities.

Thus, considering the high prevalence of burn injury in Iran, we aimed to evaluate the epidemiologic and demographic data related to this traumatic injury. The purpose of this study was to get an epidemiologic point of view and hopefully be able to establish the necessary information on hazardous agents in the settings in which burns occur. Then, the geographical distribution of electric burns in Fars province was followed and its map was presented. Considering the importance of preventing electric burns and considering the high cost and morbidity of these patients, we decided to investigate the effective factors in the outcome of electric burns in patients referred to Shiraz burn centers between 2008 and 2019. The data of this study contribute to the process of documenting the epidemiological features and consequences of burn injuries in Shiraz in the Fars province.

MATERIALS AND METHODS

Study design and setting

The study design in this research was descriptive-analytical. In this study, the census method was utilized.

Patient population and data collection

The study population included all patients who had been referred and admitted to Qutbuddin and Amir Al-Momenin burn centers in Shiraz due to electrical burns and their medical records were available in the archives of these two hospitals. Inclusion criteria

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included admission with a diagnosis of electrical burns in Qutbuddin and Amir Al-Momenin hospitals in the 2008–2019 year and the presence of medical records in the two centers. In this study, the patients whose medical records were incomplete were excluded. There was not any age or gender limitation. Data collection was conducted based on the registry of clinical information and by preparing a data collection form. A predesigned checklist was used for data collection. The studied variables in the checklist included age, burn percentage, sex, the geographical location of the residence place, the causative substance of burn, marital status, length of hospital stay, level of education, accident location, and final condition of the patient (mortality rate).

Ethical Consideration

The present study was approved by the Medical Ethics Committee of Shiraz University of Medical Sciences (IR.SUMS.MED.REC.1399.494).

Statistical analysis

After recording all the data in the data collection form, all of them will be entered into SPSS software version 22 (IBM Corp., Armonk, NY, USA) under Windows and then using descriptive and analytical tests such as the Chi-square test and independent *t*-test and, if necessary nonparametric tests such as Fisher Exact test and Mann-Whitney test data will be analyzed. Data analysis included dispersion indicators of study, frequency distribution tables and graphs, and central tendency variables. Regression will be used to determine the predictive effect of factors on burn outcome. Quantitative data will be displayed as the mean (standard deviation), and qualitative data will be displayed as a number (percentage). In this study, a one-way statistical analysis of variance will be performed. In all analyses a 95% confidence level and two-way p-value less than 0.05 will be considered. Also, In order to quantify the distribution of the number of patients in Fars province, data entry into the GIS software environment (ArcGIS 10.2) and classification of different levels were used.

RESULTS

General characteristics

In this descriptive-analytical study, 246 hospitalized electrical burn patients from 2008 to 2019 were studied. Among a total of 246 patients, the average age was 30.78 ± 11.07. Other demographic characteristics are given in Table 1.

Table 1: Demonstrates the distribution of demographic features in study

Variable		Frequency; *N=246*
Gender	Male	240 (97.6)
	Female	6 (2.4)
Age	<6	5 (2.4)
	6 – 15	9 (4.4)
	16 – 45	171 (83)
	> 45	21 (10.2)
Educational Level	Illiterate	21 (8.5)
	Under-Diploma	95 (38.6)
	Diploma	66 (26.8)
	Academic	36 (14.6)
	Unknown	28 (11.4)
Occupation	Employed	215 (87.4)
	Freelance	76 (35.3)
	Farmer	10 (4.7)
	Manual Worker	69 (32.1)
	Electrician	21 (9.8)
	Employee of Electricity Department	9 (4.2)
	Unknown	1 (0.5)
	Others	16 (7.4)
	Employee	13 (6)
	Unemployed	28 (11.4)
	Unknown	3 (1.2)
Residence	Urban	173 (70.3)
	Rural	64 (26)
	Suburban Areas	8 (3.3)

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Treatment and clinical features

The results of this analysis show that the average total body surface area (TBSA) among our patients was 11% [IQR=15], ranging from 0 to 85%. The median ICU admission, duration for the patients was 8 [IQR=14] days, while the median number of received pack cells for blood transfusion was 3 [IQR=6]. The most dominant complication was increased CPK in 42 (17.1%) of the patients. The patients' need for the operation was 2 [IQR=4] times, while the median duration of admission was 15 [IQR=22] days. The mortality rate in our study was 3.3%. Non-surgical treatment was applied in 68 (28%) cases (Table 2).

Based on our data, among the burn patients, 81

Table 2: Treatment and clinical features of electrical burn patients

Variable		Frequency (%) n=246
ICU Admission	Yes	49 (19.9)
	No	197 (80.1)
Blood transfusion	Yes	80 (32.5)
	No	166 (67.5)
Fresh frozen plasma transfusion	Yes	13 (5.3)
	No	233 (94.7)
Treatment	Non-surgical	68 (28)
	Debridement without graft	6 (2.5)
	Debridement with graft	169 (69.5)
Complications	None	49 (19.9)
	Increased CPK	42 (17.1)
Type of surgery	Fasciotomy	13 (5.3)
	Escharotomy	28 (11.4)
	Fasciotomy + Escharotomy	8 (3.3)
Amputation	No	197 (80.1)
	Yes	49 (19.9)
	Upper limb	34 (13.8)
	Lower limb	7 (2.8)
	Upper and lower	7 (2.8)
Outcome	Live	217 (88.2)
	Deceased	8 (3.3)
	Transfer	21 (8.5)

Table 3: Evaluation of applied treatment based on demographic variables of electric burn patients

Variable		Treatment			*P*-value
		Non-surgical; *n=68*	Debridement without graft; *n=6*	Debridement with graft; *n=169*	
Age; mean ± Standard deviation		31.7 ± 12.3	32.8 ± 6.2	30.2 ± 10.7	0.575
Gender; n (%)	Male	68 (28.7%)	6 (2.5%)	163 (68.8%)	0.260
	Female	0 (0%)	0 (0%)	6 (100%)	
Education; n (%)	Illiterate	2 (9.5%)	0 (0%)	19 (90.5%)	0.384
	Under diploma	31 (32.6%)	2 (2.1%)	62 (65.3%)	
	Diploma	20 (30.3%)	3 (4.5%)	43 (65.2%)	
	Academic	7 (20.6%)	1 (2.9%)	26 (76.5%)	
	Unknown	8 (29.6%)	0 (0%)	19 (70.4%)	
Occupation; n (%)	Employed	62 (29.1%)	6 (2.8%)	145 (68.1%)	0.537
	Unemployed	5 (17.9%)	0 (0%)	23 (82.1%)	
	Unknown	1 (50%)	0 (0%)	1 (50%)	
Residence; n (%)	Urban	54 (31.6%)	5 (2.9%)	112 (65.5%)	0.306
	Rural	13 (20.3%)	1 (1.6%)	50 (78.1%)	
	Suburban	1 (12.5%)	0 (0%)	7 (87.5%)	

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(52.3%) were categorized as high voltage, and 74 (47.7%) were due to low voltage. Also, among the high voltage patients, 25 (30.9%) had an amputation, while among low voltage only 12 (16.2%) had an amputation.

The patient's features were evaluated based on the treatment method, the data of which are shown in Table 3. As demonstrated, none of the variables had a significant correlation with the treatment method of the patients.

The age of the patients was evaluated based on their outcome, and based on statistical analysis, there was no significant difference between the two groups (P=0.625) (Table 4).

In this study, the voltage was considered a dependent variable, and the rest of the variables were entered as independent variables in the stepwise regression model. The results showed that the degree, duration of admission, ICU, and body part burn variables entered the regression model and explained 31% of the data changes. Regression analysis of variance showed that regression was significant at the level of one percent.

Dispersion studies and maps

One of the targets of this study is to identify the geographical distribution of electric burns in Fars province and provide a map. In order to quantitatively investigate the distribution of the number of patients in Fars province, data entry into the GIS software environment was used. The results showed that the distribution of patients in the province is different, so the highest number of people with burns was observed in Shiraz with 69 cases. Moreover, Farashband, Pasargad, Arsanjan, Kharameh, and Sarvestan cities had the lowest reports (Figure 1)

However, based on the population ratio, the highest frequency of people with burns was related to Mamasani compared to the population, and Shiraz was an intermediate based on the population ratio (Figure 2).

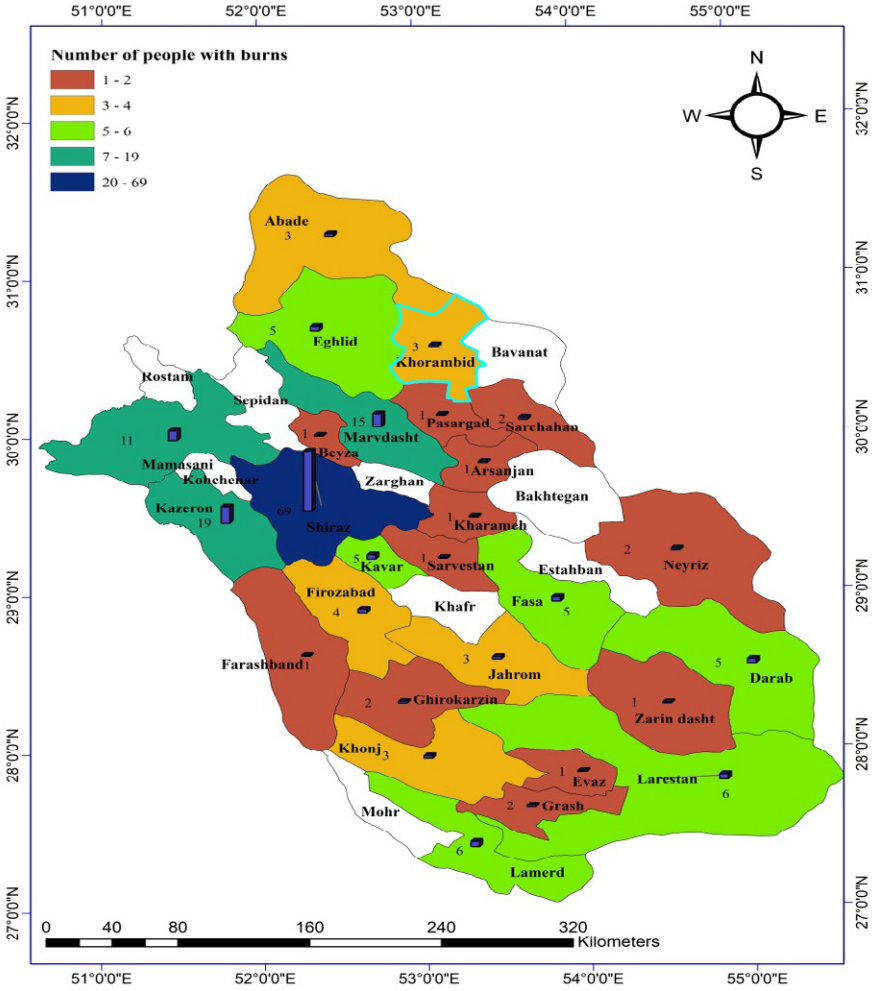


Figure 1: Distribution map of the number of people with electric burns in Fars Province

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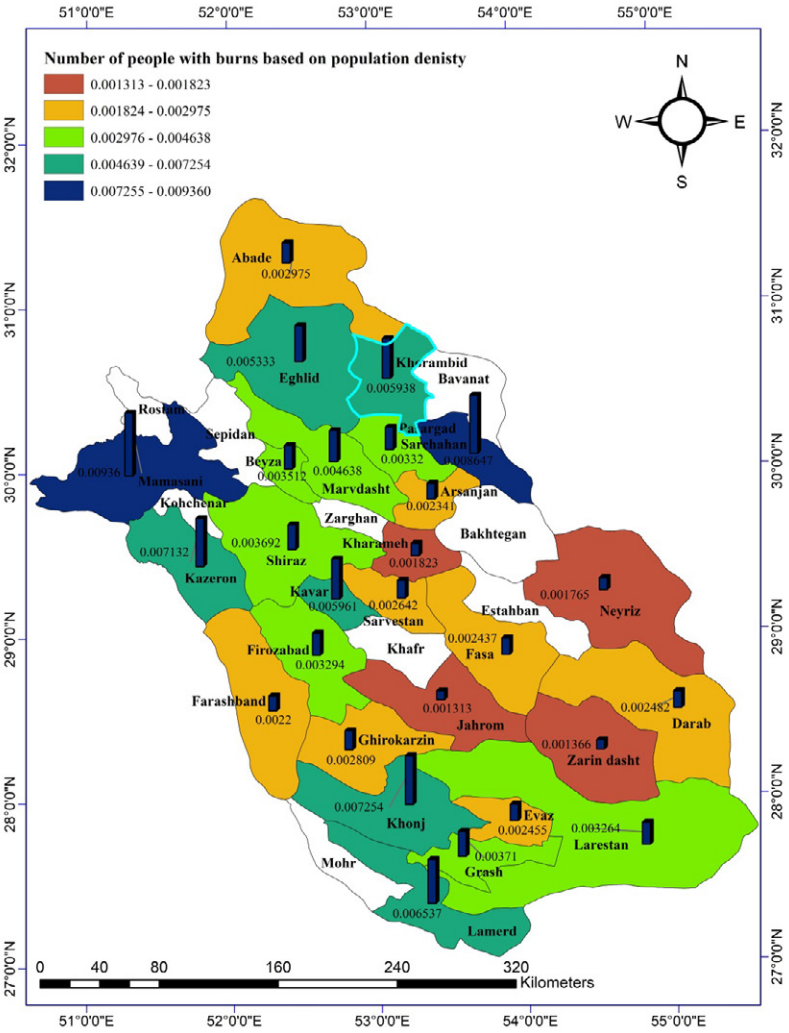


Figure 2: Distribution map of population ratio of electric burn people in each city in Fars Province

DISCUSSION

Burns are one of the most common causes of mortality and morbidity, with a prevalence of about 0.6% in the general population[13]. All over the world, electrical injuries are very frequent in the everyday practice of plastic surgery clinics. Increased electrical burns are due to the population growth and the increasing use of electricity in life. Therefore, studying patients with electrical burns is very important. In this regard, a total of 246 patients with burn injuries from 2008 to 2019 were studied. According to our information, the present study is one of the best regional epidemiological studies of burn patients in Fars province in the south of Iran. This retrospective study aimed to characterize the severity, TBSA, intent, time, and outcome of burn patients so as to provide epidemiologic data for future, policy-making, planning, and injury prevention measures.

In our research, male victims consisted of 97.6% of the electrical burns. The high participation of this sex is due to the high mobility of this sex's child and their risk-taking behavior, while males are more interested in occupations like manufacturing and factories among adults. Similar findings have been published in other reports[14-18]. The highest frequency among educational levels was among under-diploma patients, and the majority were employed. Also, most of our patients were from urban areas. The majority of burn incidences occurred in the workplace. A study in Turkey reported the majority of the electrical injuries happened outside and were caused by high-voltage overhead lines. In contrast to other literature, there is a claim that most electrical burns occur in the home due to children and infants chewing on cables[18]. The surface of burn wounds ranged from 0% to 85% of the body surface area, with a median of 11%. Also, the length of stay in the hospital differed

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greatly depending on the extent of the burns caused by the electric arch. Electrical burns are among the most serious and costly diseases, requiring a lengthy hospital stay and multiple surgical procedures. In our study, the median hospital stay for surgically treated patients was 15 days.

Treatment aims to achieve skin coverage to avoid infection and allow for early mobilization. Adults are more likely to be injured by electricity due to their work, while children are more likely to be injured unintentionally. Electrical injury has a wide range of severity, ranging from mild tissue damage to extreme multi-organ involvement, with both delayed and occult complications and death. Decompression is needed if signs and symptoms of compartment syndrome are present. Upper limb and trunk escharotomy and fasciotomies were performed to 36 relieve compartment pressure in the upper limb and improve ventilation. Amputations are required when the nerves, all blood vessels, tendons, and skin are damaged. In our study, Non-surgical treatment was applied in 68 (28%) cases, while Escharotomy was performed in 28 (11.4%) of the patients. Current that passes through the heart or thorax can cause direct myocardial and cardiac arrhythmias damage, while current that passes through the brain can cause respiratory seizures, arrest, brain injury, and paralysis. Cataracts can be caused by current passing too close to the eyes[15]. Our study's mortality rate was 3.3%, and the ICU admission rate in our study was 19.9%. It has been suggested that burn patients admitted late to the hospital have a higher mortality rate[19, 20]. However, a study by Nursal et al.[18] discovered that delayed admission had no statistically significant relationship with the length of stay in the hospital, the cost of treatment, the number of complications, or mortality. These variations may be attributed to the quality of the initial resuscitation provided by other local hospitals. Our study group's mortality rate was around 3.3%, which is lower than in industrialized countries[21, 22]. However, the other study in the American Burn Association's patient registry shows a mean burn size of 12% of TBSA, which is higher than our figure of 11 percent of TBSA[22]. The patients' age was evaluated based on their outcome, and based on statistical analysis; there was no significant difference between the two groups. However, other studies have shown that survivors' mean age was lower than no survivors'[18]. Also, specific burns, such as those in the hands, face, neck, and perineum, have been linked to a worse prognosis[18].

Spatial analysis of the frequency of electric burns showed that the Sarchahan and Mamasani districts, which are far from the center of the province and are some of the suburban cities of the province, have the highest percentage of burns compared to the population. This percentage is somewhat lower in central cities and therefore, educational programs are needed to raise awareness in the suburban cities of the province.

One of the limitations of the current study is the small number of patients with electrical burns. Also, the inclusion of the injured body part (hands, feet, face, etc.) and degree of burn in the information record form could better mention the details for a clearer determination of the factors affecting the burn percentage, length of hospital stay, and etc.

CONCLUSION

Awareness of the functional and aesthetic disabling effects of electrical burns, despite careful treatment, emphasizes the critical importance of accident prevention. To minimize tissue damage and avoid later complications, it is also necessary to perfect tissue-saving surgical procedures threatened by secondary necrosis. Electrical accidents can be prevented if proper safety precautions are taken. Work requiring interaction with electricity should be carefully prepared to ensure that anyone responsible for the different tasks is qualified to do so. At all times and all places, safety should be promoted from the home to the workplace. To prevent these accidents, education and adherence to safety measures and common sense and consideration of the possible dangers of electricity are still needed.

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CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships

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that could have appeared to influence the work reported in this paper.

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