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Original Article

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# Epidemiology of Chemical Burn Injuries in a Tertiary Burn Hospital: A Descriptive Cross-Sectional Study

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## Abstract

**introduction:** Chemical burns can cause serious skin damage, affecting human organs and leading to aesthetic and functional problems. Most patients need costly therapeutic interventions. This study aimed to evaluate the epidemiology of chemical burns among patients admitted to the largest burn center in Iran.

**Methods:** A cross- sectional retrospective study was conducted on patients with chemical burns from March 2022 to June 2023 at Motahari Burn Hospital. Demographic data, burn characteristics, therapeutic interventions, and hospital courses of all patients with burns due to acid, alkaline, and caustic materials were collected. Data were analyzed using SPSS (version 22.0) and t-test and one-way analysis of variance. The significance level was $P < 0.05$

**Results:** The prevalence of chemical burns was %5.1 of all admitted burn patients during one year, which is higher than the global average. The mean age of the patients was 32.18 ± 19.12 years, and most of the patients were male (69.4%). Most injuries were due to accidental events (86.7%), and 62.2% of chemical burns occurred at home. The most common chemical substance was acid (60.2%). Over 87% of victims had less than 20% total body surface area (TBSA) involvement. Limbs were injured in 91.8% of cases. The mortality rate was 3.1%. The difference in mean hospital stay duration between accidental and intentional burns was significant ($P$ = 0.020). A significant difference was also found in mean TBSA% across causative agent groups ($P$ = 0.048).

**Conclusion:** In our study, chemical burns were a small proportion of burn injuries, most of which occurred at home. The incidence of acid violence has not reduced compared to previous studies at our center. The majority of these injuries are preventable.

**Keywords:** Chemical burns, Epidemiology, Injuries

## Introduction

Chemical materials are classified as irritant substances and corrosive agents. Exposure to corrosive agents can seriously damage the skin and subcutaneous tissue [1]. Absorption of some chemicals has systemic effects on human organs. Most patients with chemical burns require therapeutic interventions, including medical and/or multiple surgical procedures [2]. Aesthetic and functional problems associated with chemical burns may affect the quality of life of patients [3]. Ocular injury due to chemical splashes may be severe and challenging to treat [4].

The rate of chemical burns in the United States from 1999 to 2013 was approximately 3% of all burn injuries [5]. However, the prevalence of chemical burns differs in different regions of the world and accounts for 1.4%-10.7% of burn injuries [2, 6, 7].

A wide range of causative substances can lead to chemical burns. Over 25,000 chemical materials used worldwide have the potential to cause chemical injuries [9]. Acids and alkalis are the most common

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causes of chemical burns [8]. Chemical burn incidents may occur in the workplace, at home, or in any other location. Unintentional chemical burns are due to accidental events. Intentional chemical injuries are caused by criminal assaults, suicide attempts, and chemical weapons [10, 11].

To reduce the number of chemical burns, it is essential to implement prevention programs. To achieve this goal, we need to have precise information about epidemiology and etiological factors that lead to chemical burns in our area. In this study, we aimed to identify the characteristics of patients with chemical burns to recommend proper measures to decrease the incidence of chemical burns.

## Methods

### *Study Design*

This cross-sectional study using retrospective data from medical records was conducted on patients with chemical burns from March 2022 to June 2023. The study was performed at Motahary Burn Hospital, the largest tertiary Burn Hospital in Iran.

### *Participants*

The inclusion criteria included all burn injuries due to acid, alkaline, and caustic materials that were admitted to Motahari Burn Center and met the chemical burn injury definition based on International Classification of Diseases (ICD-10)

codes. The exclusion criteria included patients

### *Data Measurement*

Immediately after admission to the emergency ward, during the first day after injury, except for dry lime, phenols, and elemental metals, the skin burned areas of all chemical burn patients were irrigated with tap water for at least 30 minutes. After the primary survey, fluid resuscitation was carried out if needed. Based on the burn depth, proper treatment, including medical and/or multiple surgical procedures, was performed.The source of the data was the patients' medical records. The demographic, burn characteristics, therapeutic interventions, and hospital course were collected as well. Demographics and clinical features of the patients included age, gender, nationality, occupational profile, total body surface area (TBSA %), injured body regions, mechanisms of burn (accidental, assault, suicide), place of occurrence, surgical procedures, duration of hospital stay, and mortality. Patients were categorized into three age subgroups: under 20 years, 20-40 years, and over 60 years.

### *Data Analysis*

The collected data were analyzed using SPSS (version 22.0) (IBM Corp., Armonk, NY, USA). The distributions of variables are expressed as a number (%) or mean ± standard deviation. Analysis of variance (ANOVA) test and independent samples t-test were used to compare the groups. The significance level was $P < 0.0$

## Results

A total of 98 patients with chemical burns out of the 1917 burn patients were admitted to Motahari Hospital between March 2022 and June 2023. The who had withdrawn from treatment.

prevalence of chemical burns was 5.1% of all burn patients, which is higher than the global average. The mean age of patients was 32.18 ± 19.12 years. Most patients were aged 20-60 years (70.4%). Most patients were male (69.4%). Most (93%) injured patients were Iranian (Table 1).

The most commonly affected groups were housewives and industrial workers (Table 1).

**Table 1.** Demographic Characteristics of Patients

| Variable | N(%) |
|---|---|
| Gender | |
| Male | 68 (69.4) |
| Female | 30 (30.6) |
| Nationality | |
| Iranian | 92 (93.9) |
| Foreigner | 6 (6.1) |
| Occupational profile | |
| Employee | 15 (15.3) |
| Industrial worker | 23 (23.4) |
| Housewife | 26 (26.5) |
| Student | 9 (9.1) |
| Unemployed | 25 (25.5) |
| Age (y), mean ± SD | 32.18 ± 19.12 |

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Most injuries were due to accidental events (86.7%), and 62.2% of chemical burns occurred in the home. A total of 60.2% of victims suffered acid burns (Table 2).

**Table 2.** Mechanism, Cause, and Place of Chemical Burns of Patients

| Variable | N(%) |
|---|---|
| Mechanism | |
| Accidental | 85 (86.7) |
| Assault | 13 (13.3) |
| Suicide | 0 (0.0) |
| Cause | |
| Acid | 59 (60.2) |
| Alkali | 31 (31.6) |
| Lime | 2 (2.1) |
| Cement | 1 (1) |
| Unknown | 5 (5.1.1) |
| Place | |
| HomeWork | 61 (62.2) |
| Place | 30 (30.6) |
| Street | 7 (7.1) |

TBSA involvement in 87.7% of patients was less than 20% (Fig.1).

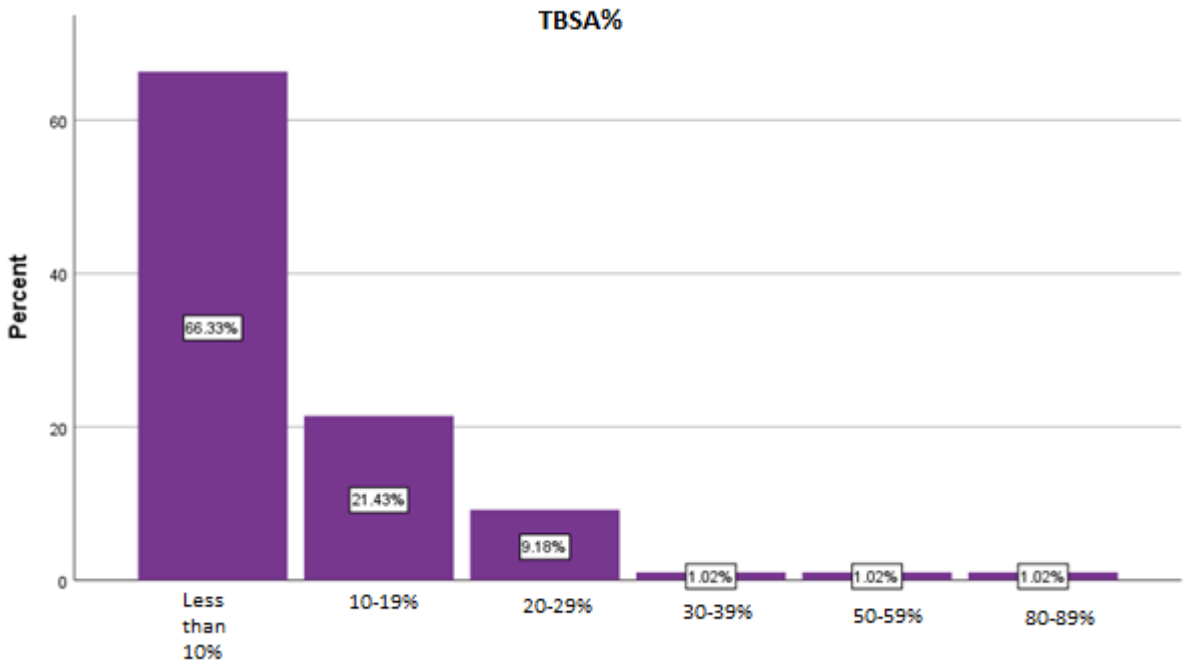


**Figure 1.** Total Body Surface Area (TBSA)% Groups Distribution of Chemical Burns

Limbs were the most common region of injury and were involved in 91.8% of cases, followed by head and neck burns (43.9% of cases). The incidence of ocular injuries was 11.2% of cases. Surgical procedure (excision and grafting) was done in 73.4% of patients. Mean hospital stay and mortality rate were 7.7 ± 8.3 days and 3.1%, respectively. Table 3 presents a significant difference in mean hospital stay duration between accidental (M = 6.8 days, SD = 7.5) and intentional burns (M = 12.3 days, SD = 9.1), t (96) = 2.37, *P* = 0.020, indicating longer hospital stays for intentional burns.

**Table 3**. Independent Samples t-Test Comparing Mean Hospital Stay Duration Between Accidental and Intentional Chemical Burns (N = 98)

| Group | N | Mean Hospital Stay (days) ± SD | *P*-value |
|---|---|---|---|
| Accidental | 85 | 6.8 ± 7.5 | 0.020 |
| Intentional | 13 | 12.3 ± 9.1 | |

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A one-way ANOVA was conducted to compare mean TBSA% across three causative agent groups: Acid (N = 59), alkaline (N = 20), and other caustic (N = 19). The analysis revealed a significant difference in mean TBSA% across the groups, F (2,95) = 3.12, $P = 0.048$ (Table 4). Post-hoc Tukey's honestly significant difference test indicated that other caustic burns had significantly higher TBSA% than alkaline burns ($P < 0.05$).

**Table 4.** One-Way Analysis of Variance (ANOVA) Comparing Mean Total Body Surface Area (TBSA%) Across Causative Agent Groups (N= 98)

| Causative Agent | N | Mean TBSA% ± SD | SD | *P*-value |
|---|---|---|---|---|
| Acid | 59 | 12.0 ± 6.0 | | 0.048 |
| Alkaline | 20 | 11.0 ± 5.7 | | |
| Other caustic | 19 | 14.5 ± 6.8 | | |

## Discussion

Based on literature, the prevalence of chemical burns is 1.4% to 10.7% of all burn patients [2, 6, 7, 12]. The prevalence of our center's chemical burns (5.1%) is in the worldwide range and does not differ significantly from previous studies in Iran [12-15].

Our findings revealed that most admitted patients with chemical burn were male (69.4%), as mentioned by Hardwicke et al. [16], and this finding is in accordance with most other studies [14,10, 17, 18,19,20]. In a report from India, 54% of victims were female due to the high frequency of assault and suicide [21].

In the present study, 70% of chemical burn cases occurred in the age group of 20-60, which was similar to findings of another study in Iran [15].

In terms of occupational profiles of patients, housewives were the most common group (26.6% of cases), followed by industrial workers. Domestic chemical burns were more frequent than industrial burns in the present study. Based on a review study [16], the number of domestic chemical burns and the incidence of female involvement have increased in recent years [16]. The other studies reported the workplace as the most frequent location of chemical burns [10, 22, 23]. In developed countries, occupational chemical burns are the most common etiology among these injuries [24]. Predominance of domestic chemical burns in Iran may be due to the easy availability of dangerous chemicals and the lack of restrictive regulations to prohibit their use by common people. Alkaline or acidic chemical drain cleaners are important factors in chemical burns in Iran. Unfortunately, they are available in every supermarket. Our finding is similar to a report from Saudi Arabia [18].

The causes of chemical burns are different in the studies. Acids were the most common causative agents (60.2% of cases) in our patients, as in many studies [10, 15, 17,22,25]. In a study, cleaners were reported as causative agents of chemical burns in Saudi Arabia [18]. In a study from Iran, tar was the most common cause [12].

The percentage of the TBSA in most patients (87.7%) was less than 20%. Compared to thermal burns, chemical burns were associated with a lesser TBSA in our center [13].

We found that the extremities were the most commonly injured body regions and were involved in 91.8% of cases. There is a variation concerning the distribution of affected body regions due to chemical exposure in the literature. Some studies reported that the head and neck are the most common burn regions [14, 15, 21], while some other findings were similar to our study [2, 10, 12]. It seems that the high frequency rate of head and neck chemical burns, which was reported in some studies, is due to high rates of assault in some countries [21].

Out of 98 cases, 13 patients were admitted due to criminal assault. Although accidental chemical burns were the most common mechanism of this kind of injury in our patients, intentional chemical burns due to criminal activities are still a serious challenge for our society. Compared to previous studies in Iran, our study revealed that the incidence of acid burn violence has not decreased [7, 15, 17]. Although, the most common incidence of acid assaults has been reported from developing countries, the occurrence rate of acid violence has gradually risen in the United Kingdom from 2006 [25, 28].

In the present study, acid agents and other corrosive substances, such as hypochlorites, tar, and industrial cleaners, were associated with higher TBSA involvement, compared to alkali exposures. The other previous clinical studies [12,14,16,18,24] have not demonstrated a significant difference in TBSA when comparing alkali to other caustic agents. Therefore, the higher TBSA observed in our cohort for acid and non-alkaline burns may reflect contextual or epidemiological factors unique to our patient population, including the specific types of industrial and household agents involved. Further



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multicenter studies with standardized reporting of TBSA and stratification by caustic category are required to better elucidate whether these differences are generalizable.

We found a mortality rate of 3.1% in injured patients, which was comparable with other studies [10-12]. The main reason for the low mortality rate in this kind of burn injury was that the TBSA of most patients was less than 20%.

Reduction of chemical burns needs a national determination to conduct a comprehensive prevention program [19]. To prevent chemical burns, it is necessary to educate all industrial workers on safety instructions, make people aware of the dangers of chemical materials, which are used as cleaners in homes, and raise public awareness about the benefits of emergency onsite massive water irrigation of exposed body areas to chemical substances. In addition, more restrictions against the sale of corrosive chemicals and increasing the penalty for perpetrators of "acid attacks" by legislating new laws should be considered.

Our study was limited because we could only access our data center. Unfortunately, the national burn registry system has not been activated in Iran yet, all epidemiologic studies regarding burns have been done by using only one burn data center's files. These kinds of studies may limit the provided data to the area in which the study was conducted.

## Conclusions

As anticipated, chemical burns constituted a smaller proportion of burn injuries compared to other types, with most occurring in domestic accidents. These injuries were more prevalent among males, with the majority involving a limited TBSA and acids as the predominant causative agent. The extremities, head, and neck were the most commonly affected regions. Although assault-related chemical burns were less frequent, their incidence has not decreased compared to prior studies. Implementing preventive strategies remains critical to reducing the prevalence of chemical burns.

## Ethics Approval and Consent to Participate

This study was approved by the Institutional Ethical Committee of Iran University of Medical Sciences, Tehran, Iran (Ethics code No. IR.IUMS.FMD.REC1396.9211216213). As this was a retrospective study based on anonymized medical records, individual patient consent to participate was not required, in accordance with institutional ethical guidelines.

## Consent for Publication

As this study utilized anonymized medical records and did not include identifiable patient information, individual consent for publication was not required. All data were handled in accordance with institutional ethical guidelines to ensure patient confidentiality.

## Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## Funding Statement

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## Authors' Contribution

S.H.S. designed the study, supervised data collection, and was a major contributor in writing the manuscript. K.A. collected and organized the medical record data from Motahari Burn Hospital. S.K. performed the statistical analysis, including descriptive and inferential statistics, in consultation with a statistician. S.A.S interpreted the clinical data regarding chemical burn characteristics and outcomes. A.A.J contributed to the literature review and drafting of the introduction and discussion sections. All authors read and approved the final manuscript.

## Conflict of Interest

The authors declared no conflicts of interest.

## Declaration of Generative Artificial Intelligence in Scientific Writing

No generative artificial intelligence tools were used in the preparation or writing of this manuscript.

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