Electronic Journal of General Medicine
2023, 20(1), em432
e-ISSN: 2516-3507
https://www.ejgm.co.uk/

MODESTUM

Original Article

OPEN ACCESS

Fire burns matter: A case-control study of severe accidental burns in pediatric patients

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Citation: Rojas-Contreras C, De la Cruz-Ku G, Eyzaguirre-Sandoval ME, Chambergo-Michilot D, Torres-Roman JS. Fire burns matter: A case-control study of severe accidental burns in pediatric patients. Electron J Gen Med. 2023;20(1):em432. https://doi.org/10.29333/ejgm/12650

ARTICLE INFO

Received: 16 May 2022

Accepted: 15 Oct. 2022

ABSTRACT

Objective: We aimed to identify factors associated with severe accidental burns in patients ≤12 years old.

Materials and methods: We conducted a matched case-control study, in which we retrospectively reviewed the medical records of children treated in a single institution from 2014-2016. We classified the cases (patients with severe burns) and controls (patients with non-severe burns) according to the criteria of the American Burn Association. We used multivariate conditional logistic regression analysis to identify the relationship between the etiology of burns and their severity.

Results: We reviewed 180 cases and 90 controls. The most common etiology of burns was boiling water in both cases (65.6%) and controls (83.3%). Most burns occurred inside the home (84.1%) and in the afternoon (37.4%). Multivariate analysis identified that severe burns were mainly due to exposure to fire (odds ratio [OR]: 3.22, 95% confidence interval [CI]: 1.53-6.81). Similarly, these patients were more likely to live in a rural area (OR: 2.96, 95% CI: 1.17-6.19).

Conclusions: In pediatric patients ≤12 years of age severe accidental burns are more likely to be caused by fire compared to boiling water. Public health interventions should focus on populations located in rural areas.

Keywords: burns, pediatrics, risk factors, Peru, fire

INTRODUCTION

Burns remain a global public health problem. The epidemiology of burns varies among countries [1-3]. For example, the incidence of burns in Kenya is 27.9 per 100,000 population-years [4] while the prevalence in South Korea decreased from 12.2% to 9.2% over a 10-year period [5]. On the other hand, burns are the third most common cause of unintentional death in the pediatric population [6]. The prevalence of burns in children under five years of age is 9.9%, with an incidence of 42 cases per 1,000 person-years [7]. In Peru, there are approximately 15,000 cases of pediatric burns annually [8].

Several studies have identified that low socio-economic status, young mothers, poor parental education, overcrowding, lack of water supply, children under five years of age, and female gender are factors related to increased risk of burns in the pediatric population [4, 5, 9-11]. In addition, hot water burn is the most common etiology, followed by fire, hot surfaces, and electricity [10, 12]. However, few studies address the importance of the etiology in the severity of accidental burns in Latin American pediatric patients [13-15]. Thus, there is a lack of information on the etiology that increases the probability of severe accidental burns. Therefore, the objective of this study was to determine the most frequent etiologies of severe accidental burns in pediatric patients in Peru.

MATERIALS AND METHODS

Study Design and Population

A matched case-control study was designed. We retrospectively reviewed all the medical records of patients treated in a burn unit at a national pediatric reference institute during the period from 2014 to 2016. We identified the records based on the International Code of Diseases 10 (ICD-10): "Burns and corrosion (T20-T32)." The cases were pediatric patients ≤12 years old with severe accidental burns, while the controls were pediatric patients (≤12 years old) with non-severe accidental burns. Both groups were diagnosed and treated at the institute. The health care center, where the study was conducted is a highly specialized health facility which cares for a higher proportion of severe burns compared to non-severe burns, therefore two cases per one control were selected.

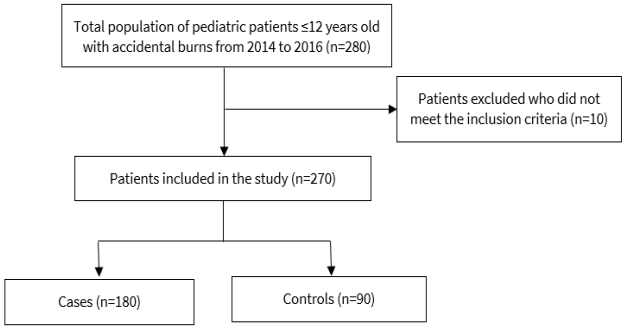

Figure 1. Flowchart of patient selection (Source: Authors' own elaboration)

The cases were matched by age, sex, household income, and place of residence. These variables were selected because according to the literature, they are consistent risk factors for burns [4, 5, 10, 16]. Patients that were not under the care of their parents or those with physical or mental incapacity were excluded. The sample included patients who met the inclusion criteria and for whom all the medical were available. Of a total of 280 records initially identified, 270 medical records met these criteria (180 cases and 90 controls) (**Figure 1**).

Variables

Burns were classified according to the revised American Burn Association (ABA) burn injury severity grading which classifies burns into superficial or epidermal burns, partial-thickness (superficial or deep), and full-thickness [17]. Severe burns were classified according to the following criteria of the ABA:

1) patient <10 years old, with >20% of total body surface area (TBSA) involved, with superficial and deep partial burns,
2) patient ≥10 years, >25% of TBSA, with superficial and/or deep partial burns,
3) full thickness burns, >10% of TBSA,
4) burns involving critical areas (hands, face, feet, perineum, groin area, or major joints),
5) electrical and inhalation burns, and
6) circumferential burn.

Patients without these criteria were classified as non-severe burns based on a previous study [5]. At the time of the burn accident, the minimum wage in Peru was 750 Peruvian Soles (PEN) [18], therefore, we dichotomized the household income variable as <750 PEN or ≥750 PEN. Education level was defined as the highest educational level attained and was classified as primary school (up to 6 years of education), secondary school (up to 11 years of education), and university or higher (13 or more years of education).

Statistical Analysis

First, a descriptive analysis of demographic variables and burn characteristics was performed. Qualitative variables are expressed as frequencies and percentages, while the quantitative variables are shown with the mean and standard deviation. Bivariate analysis used the chi-square test and Student's t-test for qualitative and quantitative variables, respectively. We carried out the matching process with the "exact" and "nearest" methods; however, the "nearest" method provided the best standard mean difference between the paired variables, and therefore, we used the latter in the subsequent analyses.

We performed a univariate conditional logistic regression analysis with the following variables: age group (≤5 years vs. >5 years), gender, household income (<750 PEN vs. ≥750 PEN), place of residence, and etiology of the burns. Next, we included these variables in a multivariate conditional logistic regression model to identify the probabilities that patients with severe burns had been exposed to a specific etiology. Four important variables had missing values in the medical records (the educational level of the father and mother, and the place and time of the accident); therefore, when the missing values were greater than 2.5%, they were not included in the matching process or in the multivariate analysis to avoid loss of statistical power. We reported our results with crude and adjusted odds ratios (OR) and its 95% confidence interval (95% CI). A p value <0.05 was considered statistically significant. All analyses were carried out using the R 3.5 program.

RESULTS

Socio-demographic, Family, and Housing Characteristics of Burned Patients

We analyzed a total of 270 medical records of 180 patients with severe burns and 90 with non-severe burns. Most of the patients were from an urban area, followed by marginal urban and rural areas. The mean age was 3.30±2.66 years and 80.7% were less than five years old. The average family income was 827±454.59 PEN, with 54.8% having an income above the minimum wage. Most of the houses were made of cement and had electric lighting (**Table 1**).

Table 1. Socio-demographic characteristics of the pediatric population included in the study

Variables	NSBs (n=90) n (%)	SBs (n=180) n (%)	P (n=270) n (%)	Percentage (%)
Sex				0.630
Female	56 (62.2)	105 (58.3)	109 (40.4)	
Male	34 (37.8)	75 (41.7)	161 (59.6)	
Age group				1.000
>5 years	17 (18.9)	35 (19.4)	52 (19.3)	
≤5 years	73 (81.1)	145 (80.6)	218 (80.7)	
Household economic income: Mean (SD)	830.67 (356.39)	825.28 (497.38)	827.08 (436.51)	0.927
Household economic income				0.762
≥750 PEN	51 (56.7)	97 (53.9)	148 (54.8)	
<750 PEN	39 (43.3)	83 (46.1)	122 (45.2)	
Place of residence				0.037*
Urban area	50 (55.6)	78 (43.3)	128 (47.4)	
Urban-marginal area	29 (32.2)	57 (31.7)	86 (31.9)	
Rural area	11 (12.2)	45 (25.0)	56 (20.7)	

Table 1 (Continued). Socio-demographic characteristics of the pediatric population included in the study

Variables	NSBs (n=90) n (%)	SBs (n=180) n (%)	Pop (n=270) n (%)	Percentage (%)
Father's mean age (SD)	33.28 (8.48)	33.77 (9.47)	33.61 (9.17)	0.690
Father's educational level				0.058
Without education	5 (5.6)	16 (8.9)	21 (7.8)	
Primary	18 (20.0)	64 (35.6)	82 (30.4)	
Secondary	51 (56.7)	74 (41.1)	125 (46.3)	
Higher	8 (8.9)	14 (7.8)	22 (8.1)	
Missing values	8 (8.9)	12 (6.7)	20 (7.4)	
Maternal age: Mean (SD)	29.45 (6.74)	29.72 (7.31)	29.63 (7.11)	0.772
Mother's educational level				0.257
Without education	6 (6.7)	19 (10.6)	25 (9.3)	
Primary	28 (31.1)	72 (40.0)	100 (37.0)	
Secondary	50 (55.6)	75 (41.7)	125 (46.3)	
Higher	5 (5.6)	11 (6.1)	16 (5.9)	
Missing values	1 (1.1)	3 (1.7)	4 (1.5)	
Home building material				0.297
Concrete	54 (60.0)	82 (45.6)	136 (50.4)	
Adobe	15 (16.7)	44 (24.5)	59 (31.9)	
Wood	18 (20.0)	44 (24.4)	62 (23.0)	
Quincha	3 (3.3)	6 (3.3)	9 (3.3)	
Missing values	0 (0.0)	4 (2.2)	4 (1.5)	
Electric light				0.059
Yes	85 (94.4)	152 (84.4)	237 (67.8)	
No	4 (4.4)	24 (13.3)	28 (10.4)	
Missing values	1 (1.1)	4 (2.2)	5 (1.8)	
Burn etiology				0.004*
Boiling water	75 (83.3)	118 (65.6)	193 (81.5)	81.5
Fire	15 (16.7)	62 (34.4)	77 (28.5)	28.5

Note. NSBs: Non-severe burns; SBs: Severe burns; Pop: Population; SD: Standard deviation; PEN: Peruvian soles; & *Statistically significant

Table 2. Characteristics of burns in the study population

Variables	Pop (n=270)	P (%)
Burn etiology		
Boiling water	193	81.5
Fire	77	28.5
Site of accident		
Home	227	84.1
Outside the home	22	8.2
Missing values	21	7.8
Time of the accident		
Morning	92	34.1
Afternoon	101	37.4
Evening	57	21.1
Missing values	20	7.4
Burn degree		
Superficial/deep partial thickness	188	69.6
Full thickness	82	30.4
Critical areas (n=153)		
Face	69	45.1
Hands	39	25.5
Groin	17	11.1
Face and hands	11	7.2
Foot	11	7.2
Hands and feet	5	3.3
Eyes	1	0.6

Note. Pop: Population & P: Percentage

The mean age of the fathers and mothers was 33.61±9.14 and 29.63±7.11 years, respectively. Only a minority of parents had no education, while the majority reached a maximum grade of primary education (**Table 1**).

Table 1 describes the characteristics of the cases and controls. The distribution of age, sex, household income and household construction material was similar in both groups. In addition, age of the parents and their respective educational level also presented a similar distribution in the two groups. However, severely burned patients had a higher frequency of fire burns (34.4% vs. 16.7%, p=0.004) and living in rural areas (25% vs. 12.2%, p=0.037) (**Table 1**).

Burn Characteristics and Risk Factors

Table 2 describes the characteristics of the burns. In general, hot water was the most frequent etiology of burns (81.5%), occurring more frequently inside the house and during the afternoon or morning hours (**Table 2**). Full thickness burns were presented by 30.4% of the population. Burns in critical body areas were presented by 153 (56.7%) patients, with the face (45.1%), hands (25.5%), and groin (11.1%) being the most affected body parts (**Table 2**).

Univariate and multivariate conditional logistic regression identified fire burns (OR=3.22, 95% CI: 1.53-6.81) and residence in rural areas (OR=2.61, 95% CI:1.24-5.52, p=0.012) as factors related to severe accidental burns in the pediatric population (**Table 3**).

DISCUSSION

Main Fndings

The present study analyzed the relationship between the etiology of burns and their severity in the pediatric population in Peru. It was found that severe accidental burns in pediatric patients are more likely to be caused by fire and in patients living in rural areas.

Comparison with Other Studies

Fire is one of the most common etiologies of burns. It was reported that this cause was the second most frequent (38%)

Table 3. Univariate and multivariate conditional logistic regression analysis of risk factors for severe accidental burns in the pediatric population

Variables	Univariate analysis			Multivariate analysis		
	OR	95% CI	p-value	OR	95% CI	p-value
Sex						
Female	1	-	-	1	-	-
Male	0.85	0.51-1.43	0.540	0.83	0.48-1.42	0.489
Age						
>5 years	1	-	-	1	-	-
≤5 years	0.97	0.51-1.84	0.913	1.85	0.84-4.10	0.130
Household economic income						
≥750 PEN	1	-	-	1	-	-
<750 PEN	1.12	0.67-1.86	0.666	0.82	0.46-1.47	0.505
Place of residence						
Urban area	1	-	-	1	-	-
Urban-marginal area	1.26	0.71-2.23	0.429	1.26	0.70-2.26	0.445
Rural area	**2.61**	**1.24-5.52**	**0.012***	**2.69**	**1.17-6.19**	**0.020***
Burn etiology						
Boiling water	1	-	-	1	-	-
Fire	**2.62**	**1.39-4.93**	**0.003***	**3.22**	**1.53-6.81**	**0.002***

[19]. Similarly, a multicenter study identified fire as the second leading cause of burns in the pediatric population [20]. Previous studies identified fire in severe events but did not establish an association with burn severity. For instance, it was reported that fire caused 96% of full thickness burns in a pediatric population [21]. Similarly, a study in a rural area found that 88% of fatal burns were due to fire compared to 8% caused by hot liquids [3]. It was shown that in a Latin American population fire was the first cause of death in the age group of 0-4 years, the second cause in the 5-14-year-old group, and severely burned patients were 3.22 times more likely to be exposed to fire burns [22].

In our study, we identified that living in rural areas was another factor in addition to fire burns. In fact, previous studies identified that living in rural areas is associated with burns [4, 5, 10], largely because people in this environment have greater contact with fire and flammable objects, thereby predisposing them to burn accidents [20].

The majority of our population presented burns from boiling water inside the home, similar to other studies, in which more than 90% of burns were reported to occur at home [23-25]. However, these studies reported that 26-44% of burns were caused by boiling water, while in our population boiling water caused approximately 80% of burns.

Cultural differences in our population, such as the use of boiling water in food preparation, are likely to result in a high frequency of boiling water as an etiology of burns. Indeed, most of the burns in our population occurred in the kitchen. Although this data could not be found in the medical records, three additional conditions support our reasoning: 84.1% of the burns occurred inside the home; 80.7% of patients were ≤5 years of age, during this age, the pediatric population generally remains under parental care; and lastly, 34.1% of the burns occurred in the morning and 37.4% in the afternoon. Food is usually prepared and eaten during these times of the day, and thus, exposure to hot water by this population in the kitchen is feasible.

Limitations

One of the limitations of our study is the lack of information on certain variables, such as the educational level of the father and mother, the place of the accident and the time of the burn. Therefore, we were unable to match the population or perform a multivariate analysis including the education of the parents. Additionally, it was not possible to quantify the exact place within the house, where the accident occurred. This variable was measured in previous studies [3, 20] and can help proposing health education interventions with greater certainty. Moreover, data was not available to differentiate between superficial and deep partial thickness burns.

The novelty of the analyses performed was based on the matched variables known as risk factors for burns, which allowed controlling the confounding effect of these variables and increase the efficiency of the study. On the other hand, our study used two cases for each control, making the prevalence of cases in the population high. This limits the capacity of exposure (fire burns) to be interpreted as a risk factor. Finally, this study was carried out in a specialized institution, and thus, extrapolation of the data to the population with minor burns was not possible.

CONCLUSION

In conclusion, the present matched case-control study showed that severe burns in pediatric patients (≤12 years) are more likely to be caused by fire and among children that more frequently live in rural areas. Hence, rural areas should be given more focus regarding burn prevention programs, including community education on risk factors and measures to prevent burns, especially in pediatric patients.

Author contributions: CR-C, GDC-K, & MEE-S: participated in the conception and design of the article, analysis and interpretation of the information, writing and critical review of the article, and approval of the final version; **GDC-K & MEE-S:** participated in the collection of information; **DC-M:** participated in the writing of the article; & JST-R: provided advice and administrative guidance in the protocol approval process. All authors have agreed with the results and conclusions.

Funding: No funding source is reported for this study.

Ethical statement: This study was approved by the Institutional Review Committee the National Reference Institute, where the study was conducted (Code: 33-2015) and was registered in the Office for Human Research Projections with the codes IORG0008796 and IRB00010509 and accredited by the National Institute of Health from Peru with the code RCEI-228.

Declaration of interest: No conflict of interest is declared by authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

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