

## The Investigation of Factors Related to Total Body Surface Area and Burn Degree in under 5-year-old Children of Kermanshah, Iran: Using Ordinal Regression

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### Abstract

#### Background

The prevalence of burn in children is more than other age groups. This study aimed to "investigate the factors associated with the burn degree and total body surface area (TBSA) in under five-year-old children of Kermanshah".

**Materials and Methods:** We studied under five-year-old children hospitalized in the burn center of Imam Khomeini hospital in Kermanshah, Iran, from September 2014 until March 2016 for 18 months. Required information extracted by trained staff based on existing data. Researcher-made checklist was used to obtain information. The ordinal regression has been applied to evaluate factors related to TBSA and burn degree in children.

**Results:** In general, 262 children were input of the study so that 226 cases (86.3%) were in under two-year-old group. The majority of cases were boys by 66.8% (175 cases). Hot liquid was the most reported cause of burns by 68.7% of all cases. Most of the burn incidents (43.1%) with high burn degree occurred at 7 am to 2 pm. Girls were exposed to higher burn degrees more than boys. Factors such as being boy (odds ratio [OR] =2.83), less than 2 years old age (OR=4.91) significantly increased TBSA. Also, living in rural (OR=5.17) and delay of treatment (OR=41.35) significantly increased burn degree.

#### Conclusion

To reduce the incidence and complications of burns in children, interventions should be considered to change the environmental and individual factors.

**Key Words:** Burn degree, Children, Iran, TBSA, Ordinal regression.

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## 1- INTRODUCTION

Burn is one of the most important accidents involving human health due to severe complications and high mortality rates (1). It is also considered as one of the main causes of disability and mortality in the world (2, 3). About 2.5 million people are suffered from burns annually in the United States (US) of America. 200,000 and 100,000 of these cases are needed outpatient treatment and hospitalization, respectively (4).

Annually, 3,000 children are died because of burns (5). Burns are the third cause of death by incidents after car accidents and drownings in the US (1). Burns in the Middle East is also a major health concern that one-third of its victims are children aged 0-5 years old (6) and among the Middle East countries, Iran is one of the countries that is a population of kids, it's more that, according to the studies of the population most at risk for accidents (7-9). A study conducted in Tehran (in 2003) showed that the highest burn rate belonged to under five-year-old children (10).

Burns and its severe complications had destructive consequences in children because of their curiosity, reaction, high activity and lack of experience in understanding the common risks (11, 12). Burns cause prolonged pain, physical and psychological problems for children and their families (13, 14). Furthermore, it requires more hospital care and costs in comparison with other physical injuries (15, 16). According to studies, there are several factors affecting the severity and mechanism of burn such as the energy source used in the home and workplace, lifestyle, and the level of social, economic and cultural of society (17, 18). Most of the accidental and preventable burns occur in the first decade of life (19). The statistical data of at-risk people are required to plan and develop solutions and policies for the prevention of burns. It

is worth mentioning that the relevant data in this regard is low and incomplete. There is also no study on the investigation of the factors related to the degree and percent of burns in children. Therefore, this study aimed to evaluate factors related to burn degree and total body surface area (TBSA) in under five-year-old children of Kermanshah.

## 2- MATERIALS AND METHODS

### 2-1. Study design and population

In this cross-sectional design based on existing data, we studied under five-year-old children referred to the burn emergency ward of Imam Khomeini hospital in Kermanshah city, Iran, from September 2014 until March 2016 for 18 months. Burn center of Imam Khomeini hospital was the only referral center for patients with burns in Kermanshah province. Patients with 3rd-degree, 2nd-degree and 1st-degree burns at the level above 15% burns are hospitalized in this burn center; [First-degree or epidermal burns: these burns involve only the epidermis; Second-degree or partial-thickness burns: includes upper layers or extend into the reticular layers of the dermis; Third-degree or full-thickness burns: involves all layers of the dermis (20)]. This project was approved by Research Committee of Kermanshah University of Medical Sciences.

### 2-2. Methods

Information of burned children was collected from their parents or caregivers in the burn center routinely; in this study, required information such as age, gender, burn degree, burns percentage, location 1 (rural or urban), location 2 (the provincial capital or city), transfer type to the center, incident time, interval time from incident to burn center, exposure time to burn agent, burned body area, burn history, burn agent, incident location and economic situation, had

extracted based on a researcher-made checklist. Some of the variables classified in different groups; the variable of age divided into two groups including under two-year-old and three to five-year-old children, respectively. Furthermore, body areas of the burn categorized into three groups: upper area of the body (abdomen, chest, back, loin, hands, neck, and head), the lower area of the body (hips, thighs, and feet), and combined (combination of upper and lower areas). The location of the incident considered the kitchen and other places (including the living room, bedroom, garden and outdoors). TBSA of burn divided into three categories of less than 25 percent, 25 to 50 percent and more than 50 percent. It should be mentioned that only three patients had burns over 75 percent. Finally, burn agents classified in three of groups including group I (including hot liquids such as boiling water, tea, coffee, soup), group II (including gas, oil and petroleum products), and group III (including other burn agents). The economic situation data with 69.1 percent missing were excluded from the study.

### 2-3. Data Analyses

In data analysis section, a univariate analysis is performed first. Then, the variables with *p*-value less than 2.0 were selected. These selected variables were inputs of the ordinal regression test.

According to this test, 1st-degree burn and less than 25% TBSA considered as reference for the analysis of burn degree and TBSA, respectively. Alpha level error of 0.05 was also considered as the cutoff point for statistical significance. SPSS version 16.0 applied for all data analysis in this study.

## 3- RESULTS

This study aimed to evaluate factors related to burn degree and TBSA in under five-year-old children of Kermanshah.

From September 2014 until March 2016, 262 under five-year-old children were hospitalized in the burn center. According to two different age groups in this study, 226 (86.3%) and 36 (13.7%) children were in under two-year-old and three to five-year-old groups, respectively. There were 175 (66.8%) boys and 87 (33.2%) girls.

Results showed that 49.2% of burn cases were from urban regions and 50.8% of them were from rural regions. The residence for 32.6% of children was provincial capital and 67.6% were the cities of the province, respectively. It was worth mentioning that only 35.5% of children have been transferred to the burn center by ambulance of medical emergency.

Most of the burn incidents (43.1%) occurred from 7 am to 1:59 pm. About 45% of cases were treated less than 5 minutes after the burn incident. About 26% of burn cases had the exposure time with the burning agent for more than 5 seconds. Hot liquid was the most reported cause of burns by 68.7% of all cases. More than 75% of burn cases were on the lower area of the body. About 20% of children had a history of burns. Moreover, 38.2% of burns occurred in the kitchen. **Table.1** shows the results of univariate analysis for factors measured in under five-year-old children in Kermanshah.

The results of univariate analysis based on the chi-square test showed that *p*-value was less than 0.2 for the relationship between variables with burn degree. The results also showed that only two variables (transfer type and burn history) didn't have the *p*-value less than 0.2 for the relationship with TBSA (**Table.1**).

The results of ordinal regression showed that gender, location (urban or rural), incident time, interval time from incident to burn center and exposure time to burn agent had a statistically significant

relationship with the burn degree. Furthermore, the odds for high degrees of burns was as follows: in boys was more than girls, in rural regions was more than urban regions, the burns occurred at 7 am to 2 pm hours more than other times, more than 5 minutes treatment after the time of the incident was higher in comparison with less than 5 minutes treatment and the exposure time for more than 5 seconds was higher in comparison with 2 seconds or less. **Table.2** shows factors affecting burn degree in under five-year-old children of Kermanshah based on ordinal regression. The results of univariate regression with factors related to the percentage of burn area showed that gender, residence (urban and rural), age, interval time from incident to burn center and the place of burn occurrence had a significant relationship with TBSA. Higher values of TBSA reported as follows: for boys more than girls, in rural regions less than urban regions, in under two-year-old group more than three to five-year-old group, for interval time of 10 minutes less than five minutes and in the kitchen less than other places. (More details in **Table.3**) (*please see the tables in the end of paper*).

#### 4- DISCUSSION

This study was aimed to evaluate factors associated with burn degree and TBSA of burns in under five-year-old children of Kermanshah. In this study, boys had the majority of burn cases (66.8%). The relationship of gender with burn degree and TBSA was statistically significant ( $p < 0.05$ ).

Sakallıoğlu et al. (21) showed that girls had more burn incidents, but Sowemimo et al. (22) and Rafiei et al. (23) showed that the average burns in boys were more than girls. The frequency of rural (50.8%), and urban (49.2%) regions for residence was approximately equal; the residence had a

statistically significant relationship with burn degree and TBSA. Higher degrees of burn (2<sup>nd</sup> and 3<sup>rd</sup> level) reported in urban areas and the most TBSA (above 50%) occurred in rural areas. This was inconsistent with the study of Sakathogla et al. (21) conducted in Turkey, that reported the relationship between TBSA and residence was statistically significant and mean TBSA was higher for rural areas in Turkey. In our study 35.5% of burn cases were transferred to the medical center by ambulance. Amir Alavi et al. (24) reported that only 18 burn cases (13%) used the medical emergency ambulance for transferring to the medical center. It can be concluded from this that people called emergency center more in case of burn incidents in Kermanshah. In current study, 86.3% of burn cases were under two-year-old children. Burn degree and TBSA for this age group were higher than 3 to 5-year-old children. Therefore, there was a statistically significant relationship between age with burn degree and TBSA. Balseven et al. (25) also showed that burns in under three-year-old children in Turkey were more common, as well as, the risk of this age was reported in several studies (26, 27).

The majority of burn cases (43.1%) occurred during the time period of 7 am to 2 pm in our study. Time of burn incidents had a significant relationship with the burn degree and TBSA. In a study conducted in Taiwan (3), the most burn cases were reported in meal times (19.7% at 11 am to 1 pm and 35% at 5 pm to 8 pm). Rafiei et al. (23), also reported that burn cases were almost at about lunch time and dinner time by 31% and 36%, respectively. Our results showed that more than a third of burn cases occur in the kitchen. This was inconsistent with a study conducted in Pakistan (28). They also reported that kitchen was the place of burn incidents for

a third of burn cases. There also several studies indicated that the kitchen was the most reported place for children burns (3, 24). As mentioned before, hot liquids (by 68.7%) was the most common cause of burns in children. Our results like other studies (3, 12, 29), also showed the most common cause of burns in children was hot liquid. Therefore, burn agent had a statistically significant relationship with TBSA and burn degree ( $p < 0.05$ ). Extent and severity of burns by hot liquid were more than other agents which were inconsistent with Balseven et al. (25). However, Tarim et al. (30) reported that electrical burns had higher extent and severity in comparison with other agents. Ansari et al. (31) in a study on burn agents by TBSA showed that self-immolation and electrical burn had higher extent and severity. The interval time from incident to the treatment in most burn cases (45.4%) was less than or equal to 5 minutes. Furthermore, interval time had a statistically significant relationship with the burn degree and TBSA.

Most of the burn cases (97.7%) with high TBSA (more than 50%) were reported for interval time of fewer than 5 minutes. Interval time of longer than 10 minutes was for the most cases (81.3%) with high burn degree (3<sup>rd</sup> degree). It should be noted that this issue was not mentioned in any previous studies. Exposure time with burn agent had a statistically significant relationship with the burn degree and TBSA. Increasing the exposure time with burn agents led to higher severity and extent of burns. About 20.2% of burn cases had burn history. The relationship between burn history and burn degree was statistically significant. Burn history had a preventive role so that cases with burn history were exposed to the burn fewer. There was not a significant relationship between burn history and TBSA. In our study, 76% of burns occurred in the lower

areas of the body. The relationship of the burned areas of the body and burn degree was statistically significant. Burn degree in the lower areas of the body was higher. Furthermore, the burned area of body had a significant relationship with TBSA so that the most reported TBSA over 50% (with a frequency of 97.7%) was in the lower areas of the body. Sakallıoğlu et al. (21), also showed that the majority of burn cases (62.7%) were at lower areas of the body. Since regression analysis method had not been used in this field, the results of the analysis will be individually discussed. Our study showed that gender had a statistically significant relationship with burn degree and TBSA so that the odds of burns in girls was higher than boys while the odds of higher burn percentage was higher in boys. The reason of these differences can be explained by considering this point that boys and girls are interested in different kinds of toys. Incidents and exposure to risk factors for boys and girls are different because girls and boys tend to imitate the activities of their own mothers and fathers, respectively. In our result residence (urban or rural) had a significant relationship with burn degree and TBSA. Odds of higher burn degrees and TBSA were increased in rural and urban regions, respectively. This can be explained by cultural differences and lifestyles in urban and rural regions. In our study time of burn incident had a significant relationship with burn degree. However, there was no a meaningful relationship with the time of burn incident and TBSA. The most reported time of burn incident was from 7 am to 2 pm; considering that mothers are cooking and doing housework at this time, the level of care and attention to children is low. Therefore, it is logical that children are exposed to risk factors of burns such as hot fluid in this time. The relationship between age and TBSA was statistically significant. Odds of higher TBSA was increased for

under two-year-old children in comparison with 3 to 5-year-old children. Children under 2 years old usually crawl or quadruped walk, so they are exposed to more risks and their reactions and perceptions of risk are lower. The interval time from burn incident to treatment had a statistically significant relationship with burn degree and TBSA. The odds of higher burn degrees for the time of longer 5 minutes was more than under 5 minutes. Furthermore, interval time of under 10 minutes led to lower TBSA. According to these results, the burn cases with the higher burned surface were brought earlier to medical centers while the burn degree is not visible to the person like the burned surface.

The relationship between exposure time to burn agent and burn degree was statistically significant, but it was not significant for TBSA. The higher odds of burns were for exposure time of more than 5 seconds in comparison with the exposure time of fewer than 2 seconds. Higher exposure time to burn agent led to higher burn degrees, but it did not lead to higher values of TBSA. There was a significant relationship between the incident location and TBSA. However, a significant relationship between incident location and burn degree not observed in our study. Odds of higher TBSA in the kitchen was less than other places.

This implies that other places had the burn agents with higher TBSA and burn degree. Khorasani et al.(32), also stated that the flame of fire had greater consequences than other burn agents.

#### **4-1. Strengths and weaknesses of the study**

One of the weaknesses of this study was the type of cross-sectional by using available data. Furthermore, some variables had missed such as the variable of economic situation excluded from the study because of high missing. On the

other hand, the same article that has been worked on factors related to total body surface area and burn degree in under 5-year-old children was not found to be compared in conclusion section. The main strength of this study was the use of ordinal regression to examine variables related to burn degree and TBSA in under five-year-old children for the first time.

#### **5- CONCLUSIONS**

There were variables which had a statistically significant relationship with severity and extent of burns such as gender, residence, age, interval time from incident to the treatment, the location of the incident and exposure time to burn agents. Therefore, it can be concluded that many factors affecting the severity and extent of burns in children should be considered to reduce the risk of burns as well as reduce the severity and extent of burns in children with the need for comprehensive consideration at the level of individual and environmental variables.

**6- CONFLICT OF INTEREST:** None.

#### **7- ACKNOWLEDGMENTS**

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**Table-1:** The Factors Related to Total Body Surface Area and Burn Degree in under 5-year-old Children of Kermanshah based on univariate analysis (2014-2016).

Variables		Burn Degree: Number (percent)				TBSA: Number (percent)			
		1 <sup>st</sup> Degree	2 <sup>nd</sup> Degree	3 <sup>rd</sup> Degree	P-value	≤ 25%	25-50%	>50%	P-value
Gender	Male	92 (60.5)	48 (77.4)	35 (72.9)	0.036	136 (78.2)	31 (68.9)	8 (18.6)	<0.001
	Female	60 (39.5)	14 (22.6)	13 (27.1)		38 (21.8)	14 (31.1)	35 (81.4)	
Residence1	Urban	54 (35.50)	42 (67.7)	33 (68.8)	<0.001	95 (54.6)	30 (66.7)	4 (9.3)	<0.001
	Rural	98 (64.5)	20 (32.3)	15 (31.3)		79 (45.4)	15 (33.3)	39 (90.7)	
Residence2	Provincial capital	57 (37.5)	13 (21)	15 (31.3)	0.063	72 (41.4)	12 (26.7)	1 (2.3)	<0.001
	City	95 (62.5)	49 (79)	33 (68.8)		102 (58.6)	33 (73.3)	42 (97.7)	
Age	≤ 2 year	145 (95.4)	52 (83.9)	29 (60.4)	<0.001	162 (93.1)	26 (57.8)	38 (88.4)	<0.001
	3-5 year	7 (4.6)	10 (16.1)	19 (39.6)		12 (6.9)	19 (42.2)	5 (11.6)	
Transfer Type	Ambulances	58 (38.2)	14 (22.6)	21 (43.8)	0.040	57 (32.8)	16 (35.6)	20 (46.5)	0.241
	other	94 (61.8)	48 (77.4)	27 (56.30)		117 (67.2)	29 (64.4)	23 (53.5)	
Event time, minute	7-13.59	71 (46.7)	28 (45.2)	14 (29.2)	<0.001	82 (47.1)	15 (33.3)	16 (37.2)	<0.001
	14- 21.59	26 (17.1)	14 (22.6)	26 (54.2)		26 (14.9)	22 (48.9)	18 (41.9)	
	22- 6.59	55 (36.2)	20 (32.3)	8 (16.7)		66 (37.9)	8 (17.8)	9 (20.9)	
Intervaltime of the event to treatment,	≤ 5	84 (55.3)	26 (41.9)	9 (18.8)	<0.001	67 (38.5)	10 (22.2)	42 (97.7)	<0.001
	5.1-10	68 (44.7)	12 (19.4)	0		79 (45.4)	0	1 (2.3)	

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minute	>10.1	0	24 (38.7)	39 (81.3)		28 (16.1)	35 (77.8)	0	
Exposure time to burn agent	≤ 2Second	74 (48.7)	20 (32.3)	2 (4.2)	<0.001	81 (46.6)	4 (8.9)	11 (25.6)	<0.001
	2.1-5 Second	58 (36.8)	29 (46.8)	13 (27.1)		66 (37.9)	16 (35.6)	16 (37.2)	
	>5.1 Second	22 (14.5)	13 (21)	33 (68.8)		27 (15.5)	25 (55.6)	16 (37.2)	
Burn agent	Scald	118 (77.6)	32 (51.6)	30 (62.5)	0.002	116 (66.7)	28 (62.2)	36 (83.7)	0.028
	Oil, gas, petroleum	21 (13.8)	18 (29)	8(16.7)		37 (21.3)	6 (13.3)	4 (9.3)	
	Other	13 (8.6)	12 (19.4)	10 (20.8)		21 (12.1)	11 (24.4)	3 (7)	
Burned area of body	Upper	7 (4.6)	9 (14.5)	6 (12.5)	<0.001	12 (6.9)	9 (20)	1 (2.3)	<0.001
	Lower	145 (95.4)	40 (64.5)	14 (29.2)		150 (86.2)	7 (15.6)	42 (97.7)	
	Combined	0	13 (21)	28 (58.3)		12 (6.9)	29 (64.4)	0	
History of burn	Yes	38 (25)	12 (19.4)	3 (6.3)	0.018	39 (22.4)	6 (13.3)	8 (18.6)	0.385
	No	114 (75)	50 (80.6)	45 (93.8)		135 (77.6)	39 (86.7)	35 (81.4)	
Burn event location	Kitchen	47 (30.9)	29 (46.8)	24 (50)	0.017	44 (25.3)	26 (57.8)	30 (69.8)	<0.001
	Other	105 (69.1)	33 (53.2)	24 (50)		130 (74.7)	19 (42.2)	13 (30.2)	

TBSA:Total Body Surface Area.

**Table-2:** The Factors Affecting on Burn Degree in Under Five-Year-Old Children of Kermanshah (2014-2016) based on ordinal regression.

Variables		B	OR (95% CI)	P-value
Sex	Female	-*		
	Male	-1.282	0.277 (0.112-0.686)	0.005
Residence 1	Urban	-		
	Rural	1.644	5.176 (2.378-11.269)	0<0.001
Residence 2	Provincial capital	-		
	City	-6.51	0.522 (0.242-1.126)	0.097
Age	3-5	-		
	≤ 2	0.108	1.114 (0.427-3.414)	0.723
Transfer Type	Ambulances			
	other	0.103	1.108 (0.549-2.234)	0.774
Event time, minute	24-6.59	-		
	7-13.59	0.989	2.689 (1.175-6.147)	0.019
	14-23.59	0.031	1.032 (0.397-2.675)	0.950
Interval time of the event to treatment, minute	< 5	-		
	5.1-10	4.778	118.866 (26.735-528.477)	0<0.001
	>10	3.722	41.347 (11.382-150.355)	0<0.001
Exposure time to burn agent, second	> 5.1	-		

Relationship between Aggressive Behaviors and Counseling with Family Members among Children

	2.1-5	-0.764	0.466 (0.196-1.110)	0.085
	≤ 2	-1.362	0.256 (0.0840-0.781)	0.017
Burn agent	Other	-		
	Oil, gas and petroleum	-1.042	0.353 (0.108-1.154)	0.085
	Scald	0.744	2.104 (0.747-5.936)	0.159
Burned area of body	Combined	-		
	Lower	0.991	2.694 (0.810-8.962)	0.106
	Upper	1.277	3.586 (0.941-13.667)	0.061
History of burn	No	-		
	Yes	0.093	1.097 (0.467-0.387)	0.831
Burn event location	Other	-		
	Kitchen	-0.091	0.913 (0.455-1.831)	0.797

B: Regression coefficient; OR: Odds ratio; 95% CI: 95% Confidence interval; \*Items marked with (-) are the reference groups.

**Table-3:** The Factors Affecting on Total Body Surface Area (TBSA) in Under Five-Year-Old Children of Kermanshah (2014-216) based on Ordinal Regression.

Variables		B	OR (95% CI)	P-value
Gender	Female	-*		
	Male	1.041	2.832 (1.315 - 6.098)	0.008
Residence1	Urban	-		
	Rural	-0.932	0.394 (0.182 - 0.851)	0.018
Residence 2	Provincial capital	-		
	City	-0.496	0.609 (0.243 - 1.524)	0.289
Age, year	3-5	-		
	≥ 2	1.592	4.914 (2.024 - 11.929)	0<0.001
Incident time, minute	24 to 6.59	-		
	7 to 13.59	-0.113	0.893 (0.390 - 2.044)	0.789
	14 to 23.59	-0.738	0.478 (0.197- 1.164)	0.104
Interval time of the event to treatment, minute	< 5	-		
	5.1 to 10	1.577	4.840 (0.476- 47.134)	0.184
	> 10	-2.076	0.125 (0.038 - 0.414)	0<0.001
Exposure time to burn agent, second	> 5.1	-		
	2.1 to 5	-0.497	0.608 (0.249 - 1.486)	0.276

Relationship between Aggressive Behaviors and Counseling with Family Members among Children

	≥ 2	.929	2.532 (0.140 - 1.112)	0.078
Burn agent	Other	-		
	Oil, gas and petroleum	0.865	2.375 (0.718 - 7.854)	0.276
	Scald	0.072	1.075 (0.427- 2.705)	0.878
Burned area of body	Combined	-		
	Lower limb	1.151	3.161 (0.970 - 10.299)	0.056
	Upper limb	0.751	2.119 (0.602- 7.463)	0.243
Burn event location	Other	-		
	Kitchen	-1.295	0.274 (0.138-0.544)	0<0.001

B: Regression coefficient; OR: Odds ratio; 95% CI: 95% Confidence interval; \*Items marked with (-) are the reference groups.