



# Work-Related Traumatic Injuries and Associated Risk Factors in Iranian Metal Melting Workers, 2016

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## Abstract

**Background:** Traumatic injuries are a leading cause of death and disability in the working population, worldwide. According to estimates, by 2020, traumatic injuries will be the second cause of disability in developing countries and the third cause of death and disability across nations, worldwide.

**Objectives:** This study aimed at assessing work-related traumas and related risk factors that may contribute to the development of injuries among Iranian metal melting workers in Kashan industrial sites.

**Methods:** Data were collected by a descriptive cross-sectional study on 178 Iranian metal melting workers in five manufacturing sites of Kashan, selected as a census. The data consisted of a three-year period from 2014 to 2016. Samples were selected as the census. The study used a demographic questionnaire, accident investigation reports, and interviews with workers that had experienced traumatic injuries, to collect data.

**Results:** Overall, 58.43% of workers experienced traumatic events. The data indicated a significant association between ages, years of employment, and being a witness of an accident with work-related trauma ( $P < 0.05$ ). Workers involved in smelting operations experienced more injuries than workers at other processing units. Most Injuries affected hands and wrists. The leading causes of work-related injuries were contacting with hot objects (42.3%), fall from height (26.9%), electrical shock (1.9%), strike (18.3%), stuck (3.8%), and strain (1.9%).

**Conclusions:** These results may contribute to the nature of tasks in metal melting process, requiring the performance of hot processes and heavy manual tasks with hand tools. The results provide steps for developing prevention strategies. Metal workers involved in performing hot processes and heavy manual tasks might be considered as first targets for preventive interventions.

**Keywords:** Heavy, Industry, Injuries, Melting, Metals, Occupational, Worker, Work Related

## 1. Background

Industrialization and harsh work environments have caused increased work-related accident rates, particularly in developing nations (1). Traumatic incidents and injuries are leading causes of death and disability in the working population, worldwide. According to estimates, by 2020, traumatic injuries will be the second cause of disabilities in developing countries and the third cause of death and disability across nations worldwide. Injuries due to traumatic accidents account for 12% of diseases, involving the highest mortality rates of unintentional mortalities (2). Reports from the International Labor Organization indi-

cated that trauma attributed to one-third of work-related deaths. Additionally, 250 million work-related traumas occur annually with an average annual fatality rate of 14 per 100000 workers per year (3). Accidents result in a million work-days losses (4). An occupational accident is defined as an unplanned and unexpected incident during work, resulting in injury, illness, and death (5). In Iran, the number of occupational accidents was 15520 in 2000 and 16745 in 2003, indicating an increase of 7.67% (6). The mortality related to traumatic injuries in every 100000 population was reported as 39 cases in Iran, compared to 88 cases around the world (7).

Given the remarkable incurred social and economic costs associated with work-related traumatic injuries, efforts to better understand and provide prevention and surveillance systems have increased in recent years (8, 9). Review of the literature revealed a number of epidemiological studies on occupational trauma injuries, such as Chi et al. (10, 11), Jeong (12), Aladelusi et al. (13), Gupta et al. (14), Zimmerman et al. (15), and Bylund and Björnstig (16).

Meanwhile, previous research has indicated the high prevalence of accidents in the metal industry, which contributed to the hazardous working process. Traumatic Burning and eye injuries were common in the metal industry, mainly caused by melted fluid splash, falling in the container, falling objects, and explosion (17).

## 2. Objectives

An epidemiologic pattern of work-related trauma injuries in the Iranian metal industry has not been well-documented. In addition, reducing traumatic injuries remains significant because of serious outcomes faced by workers who sustain one. Therefore, the primary purpose of the current study was to identify work-related traumas and related risk factors that may contribute to the development of injuries among Iranian metal melting workers in Kashan industrial sites.

## 3. Methods

### 3.1. Study Design and Participants

Data were collected in a descriptive cross-sectional survey on process workers in Kashan metal melting industry. The study sample consisted of 178 workers at five manufacturing sites. Samples were selected as a census. The list of workers was provided by the human resources center of these industries. The data were collected over a three-year time period from the year 2014 to 2016.

### 3.2. Ethics

The participants received occupational safety information sheets from health offices located in the plants, explaining the scope and the purpose of the study with clear guidance to attend the survey or exit at that point. All participants were ensured about the confidentiality of the individually identifiable data.

### 3.3. Instruments and Procedure

The study applied a demographic questionnaire, accident investigation reports, and interviews with workers, who had experienced traumatic injuries to collect data. Occupational safety and health offices in the plant sites invited workers to participate in the study.

A questionnaire developed by the research team was used to collect demographic data including age, gender, marital status, height, type of employment, shift work, duration of employment, place of work, shift work, secondary job, education, smoking, job satisfaction, working hours, and training in occupational safety and health.

Work-related traumatic data were collected from accident investigation reports databases, maintained by the occupational health and safety administration of the studied sites (private section). The researchers collected data concerning the type and severity of accidents; including parts of the body injured and related risk factors.

Workers, who experienced accidents, were interviewed. All interview sessions were conducted individually. Gathering data from accident investigation reports and interview with workers was done by a postgraduate candidate in health and safety. The interviewer greeted each subject and explained the purpose of the study. Particular attention was paid to the experienced traumatic incidence, the severity of the trauma, first aids and treatment received the following incidence and duration of recovery.

### 3.4. Data Analyses

Data were analyzed by the chi-square test, *t*-test, analysis of variance, and the logistic regression model for multivariate analyses. P values of < 0.05 were considered statistically significant. Statistical analyses were performed using the SPSS Statistics for Windows, version 16.0 (SPSS Inc., Chicago, ILL., USA).

## 4. Results

Of 178 metal workers exposed directly to melting process operation, 104 workers experienced traumatic events. Participants' age was between 19 and 55. Workers were involved in various operations, including smelting process unit (46.6%), Perapersy (18.5%), maintenance (14.1%), insulating (6.7%), and tensile unit (7.3%).

Nearly one-third of all participants had some university education, 44.9% completed high school diploma, and 26.4% had an elementary and secondary education. Most of the participants had a rotatory shift work schedule

(72.5%). Nearly half of the workers reported being satisfied with their jobs (46.6%), and 83.7% were not involved in a secondary job. Most had received health and safety at work training (76.4%), and professional training related to their job procedures (73.6%). Workers with smoking habits were 12.9%. Workers with a usual working shift of eight hours made up 69.7% of the sample, while for around one-third the working schedule exceeded 12 hours.

Overall, more than half of the workers (58.4%) experienced work-related traumatic events. The data revealed that almost one-quarter of workers had suffered trauma only once and 32% between two to fifteen times.

Tables 1 and 2 present the figures and percentages in terms of work-related trauma, individual, and occupational characteristics. The data indicated a significant association between age, years of employment, and being a witness of an accident with work-related trauma ( $P < 0.05$ ). However, no statistical relationships were determined for other studied individual and occupational variables and experience of trauma.

Figure 1 shows the percentages of work-related trauma in terms of the work unit, nature of the injury event, and the body part affected. Injuries occurred in the smelting operation unit were higher than the other processing units. While burning injury due to contact with hot objects was the most frequent type of injury, most Injuries affected hands and wrists.

The mean and standard deviations of treatment duration are shown in Table 3. Those, who had received training in occupational safety and health, had a lower duration of treatment ( $P < 0.05$ ). However, individual and occupational factors were not statistically associated with duration of treatment. Table 4 presents the results of multiple regression analysis, evaluating the relationships adjusted for potential factors. Age, place of work and attendance at the accident scene significantly affected work-related traumatic injuries.

## 5. Discussion

This paper provides the epidemiologic outline of work-related traumatic injuries in the Iranian metal melting industry. Overall, the results indicated that a substantial prevalence of traumatic incidence (58.4) leads to injuries in workers involved in the metal melting process.

This study revealed that married workers had a higher risk of traumatic injuries; it could be suggested that due to their responsibility and lack of job security they exposed

themselves to increased risks. Some previous studies, including Atrkar Roshan et al. (5) indicated an increased risk of accident rate among married workers, performing the more physically demanding job tasks.

Apparently, hazardous working environments, particularly crowded and disordered equipment and machinery and harsh climatic conditions, may contribute to increased risk of injury events in smelting operations.

The current study suggests higher traumatic incidence in workers with elementary education. This is in agreement with Khanzade et al.'s study that concluded that better education resulted in higher risk perception (18).

This study indicated increases in both accident frequency and traumatic injury rates among rotating shift workers, which may be related to chronic fatigue and deteriorated concentration on tasks (19).

In the current study, workers, who were more satisfied with their job, were more likely to suffer traumatic injuries. A previous study found that people with higher levels of job satisfaction are more likely to take risky jobs (20).

The current finding showed that although occupational safety and health training did not decrease the rates of traumatic incidence, yet it might contribute to the decreased severity of suffered injury and rehabilitation period. Previous studies suggested that inexperienced workers were exposed to high risks of accidents (10-12).

The present study indicated workers aged between 19 and 35 years had an increased risk of work-related traumatic injury, which is in agreement with the results of workplace injury rate among workers in the Iranian Aluminum production industry (21). Another occupational injury study demonstrated higher injury incidence rates among workers aged 21 to 30 (13). Other studies have reported elevated occupational injury rates among younger workers (14, 15, 22). These analyses show that young workers experienced more work-related traumatic injuries. Associated factors may include performing high-risk activities among younger workers (7, 13, 14, 21). Additionally, this study showed an increased risk of traumatic injuries among workers with more than 11 years of employment, probably due to ignoring workplace safety regulations and procedures.

Meanwhile, observing accidents on-site had made workers less vulnerable, probably due to reflective actions leading to obeying of safety rules and protecting against injury incidence (23). In another study from the United States, the severity of hand injuries, especially the fingers, after the strains of the legs and back, was the most severe disability (22). In Italy, 40% of workers had carpal tunnel

**Table 1.** Demographic Characteristics of Workers in Terms of Work-Related Traumatic Injuries in Metal Melting Industry from 2014 to 2016

Individual Characteristics	Without Trauma <sup>a</sup>	With Trauma <sup>a</sup>	Total <sup>a</sup>	OR (95% CI)	P Values
<b>Marital status</b>				1.398 (0.642, 3.039)	0.39
Single	15 (20.3)	16 (15.4)	31 (17.4)		
Married	59 (79.7)	88 (84.6)	147 (82.6)		
<b>Smoking</b>				0.890 (0.363, 2.178)	0.79
Yes	9 (12.2)	14 (13.5)	23 (12.9)		
No	65 (87.8)	90 (86.5)	155 (87.1)		
<b>Secondary job</b>				1.385 (0.623, 3.576)	0.42
Yes	14 (18.9)	15 (14.4)	29 (16.3)		
No	60 (81.1)	89 (85.6)	149 (83.7)		
<b>Education</b>					0.50
Primary school	5 (6.8)	6 (5.8)	11 (6.2)	-	
Junior school	14 (18.9)	22 (21.2)	36 (20.2)	1.31 (0.34, 5.10)	
High school	30 (40.5)	51 (49)	81 (45.5)	1.42 (0.398, 5.04)	
Academic	25 (33.8)	25 (24)	50 (28.1)	0.833 (0.225, 3.09)	
<b>Age, y</b>				2.287 (1.234, 4.238)	0.008
19 - 34	49 (66.2)	48 (46.2)	97 (54.5)		
35 - 55	25 (33.8)	56 (53.8)	81 (45.5)		
<b>Years of employment, y</b>				2.201 (1.198, 4.045)	0.010
< 9	45 (60.8)	43 (41.3)	88 (49.4)		
> 10	29 (39.2)	61 (58.7)	90 (50.6)		

Abbreviation: OR, Odds Ratio.

<sup>a</sup>Values are expressed as No. (%).**Table 2.** Job Characteristics of Workers in Terms of Work-Related Traumatic Injuries in Metal Melting Industry from 2014 to 2016

Job Characteristics	Without Trauma <sup>a</sup>	With Trauma <sup>a</sup>	Total <sup>a</sup>	OR (95% CI)	P Values
<b>Shift work schedule</b>				1.036 (0.522, 2.056)	0.91
Morning	19 (25.7)	26 (25)	45 (25.3)		
Rotational	55 (74.3)	78 (75)	133 (74.7)		
<b>Job satisfaction</b>					0.08
Never	6 (8.1)	4 (3.8)	10 (5.6)	-	
low	1 (1.4)	8 (7.7)	9 (5.1)	12 (1.05, 136.7)	
Medium	28 (37.8)	48 (46.2)	76 (42.7)	2.57 (0.668, 0.99)	
High	39 (52.7)	44 (42.3)	83 (46.6)	1.69 (0.445, 6.44)	
<b>Safety and health training</b>				0.724 (0.361, 1.453)	0.36
Yes	54 (73)	82 (78.8)	136 (76.4)		
No	20 (27)	22 (21.2)	42 (23.6)		
<b>Job training</b>				1.203 (0.607, 2.380)	0.59
Yes	56 (75.5)	75 (72.1)	131 (73.6)		
No	18 (24.3)	29 (27.9)	47 (26.4)		
<b>Working hours schedules</b>				0.680 (0.357, 1.296)	0.32
8 hours	48 (64.9)	77 (74.1)	125 (70.7)		
12 hours	26 (35)	27 (26)	53 (30.2)		
<b>Witnessing incidence</b>				2.071 (1.129, 3.797)	0.018
Yes	33 (44.6)	65 (62.5)	98 (55.1)		
No	41 (55.4)	39 (37.5)	80 (44.9)		

Abbreviation: OR, Odds Ratio.

<sup>a</sup>Values are expressed as No. (%).

syndrome, and 32% had Tigger Finger (24).

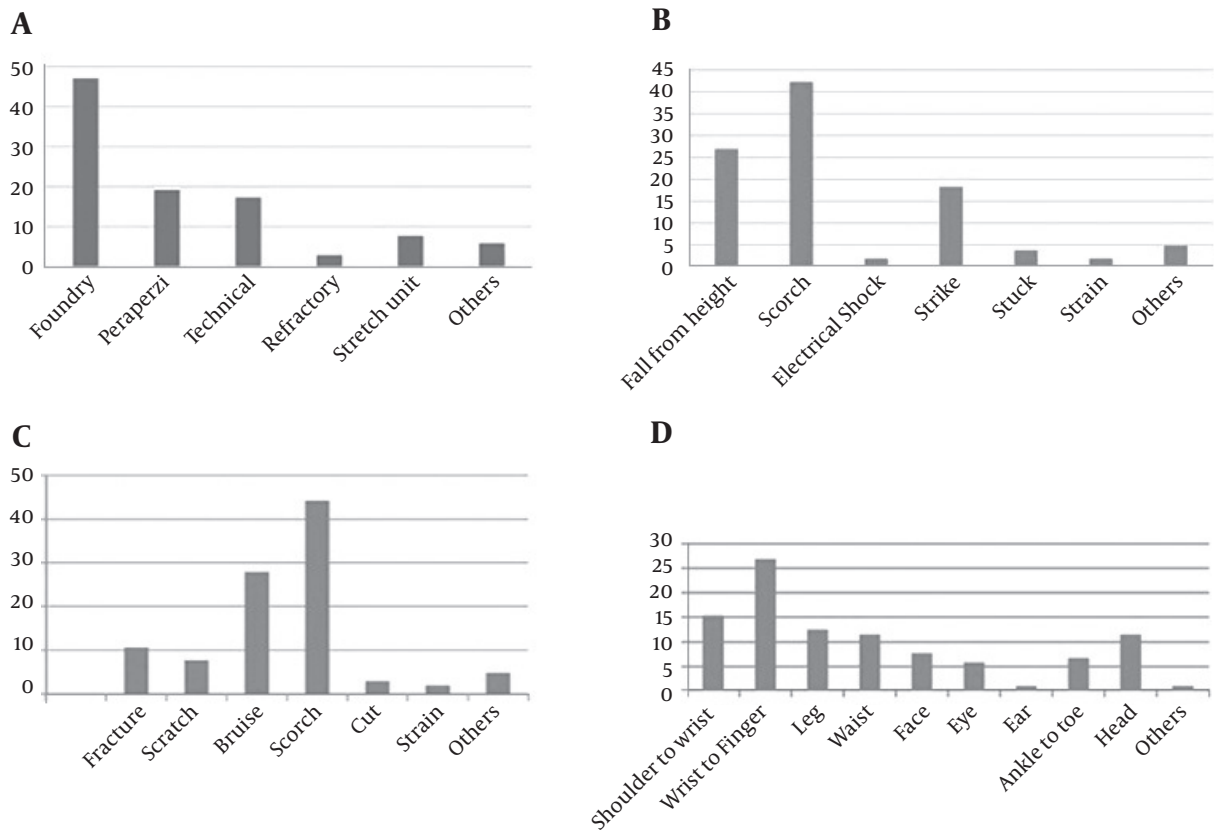
The current study revealed the hands and wrists as the

**Table 3.** Mean and Standard Deviation of Treatment Duration by Individual and Job Characteristics (2014 - 2016)

Variable	Days of Hospitalization, Mean $\pm$ SD	P Value
<b>Marital status</b>		0.70
Single	1.37 $\pm$ 2.55	
Married	1.85 $\pm$ 4.84	
<b>Smoking</b>		0.31
Yes	2.92 $\pm$ 6.45	
No	1.60 $\pm$ 4.21	
<b>Second job</b>		0.82
Yes	1.53 $\pm$ 3.81	
No	1.82 $\pm$ 4.69	
<b>Education</b>		0.43
Primary school	1.16 $\pm$ 1.32	
Junior school	0.86 $\pm$ 1.12	
High school	2.52 $\pm$ 6.23	
Academic	1.20 $\pm$ 2.12	
<b>Age, y</b>		0.48
19 - 34	1.43 $\pm$ 3.85	
35 - 55	2.07 $\pm$ 5.10	
<b>Years of employment, y</b>		0.50
< 9	1.41 $\pm$ 4.60	
> 10	2.03 $\pm$ 4.90	
<b>Safety training</b>		0.04
Yes	1.41 $\pm$ 3.87	
No	3.13 $\pm$ 6.46	
<b>Job training</b>		0.0
Yes	1.02 $\pm$ 2.03	
No	3.72 $\pm$ 7.76	
<b>Shift work</b>		0.26
Morning	2.65 $\pm$ 6.85	
Rotational	1.48 $\pm$ 3.50	
<b>Job Satisfaction</b>		0.29
Never	0.0 $\pm$ 0.0	
low	0.87 $\pm$ 1.35	
Average	1.11 $\pm$ 2.44	
High	2.68 $\pm$ 6.18	
<b>Working hours</b>		0.09
8 hours	1.32 $\pm$ 2.95	
12 hours	3.00 $\pm$ 7.28	
<b>Witnessing incidence</b>		0.29
Yes	1.41 $\pm$ 3.34	
No	2.38 $\pm$ 6.08	

**Table 4.** Associations of Work-Related Traumatic Injuries with Risk Factors. Logistic Regression Model in the Period from 2014 to 2016.

Variables	Regression Parameters				
	B	SD	Wald	EXP (B)	P Value
Age	0.062	0.026	5.73	1.06	0.017
Technical work unit	1.33	0.63	4.44	3.81	0.035
Refractory work unit	-1.45	0.73	3.94	0.23	0.047
Witnessing incidence	0.67	0.33	4.23	1.97	< ss0.000



**Figure 1.** Frequency of traumatic work-related injuries among metal melting workers from 2014 to 2016; (A, work unit; B, incidence type; C, injury type; D, injured body part)

most prevalent body sites affected following traumatic injuries, which is similar to the results reported by Muhamadfam (21) and Bylund and Björnstig (16). Also, in a study that investigated occupational injuries in an emergency trauma unit, falling was 25 percent the most (25).

The current results also indicated that burning was the most frequent traumatic injuries followed by fall-related incidence. These results may contribute to the nature of tasks in metal melting process, requiring the performance of hot processes and heavy manual tasks with hand tools.

The current findings are important because they described the extent of traumatic injuries occurring in metal melting processing plants and at-risk workers in terms of demographic and occupational characteristics. These results provide the first steps for the development of prevention strategies.

One limitation of the current study was that the authors had limited information on factors, such as exposure to physical work conditions, safety and health practices, and use of personal protective equipment. Although

this study provides an epidemiologic description of work-related injuries in metal melting industry, yet it does not provide data on the whole scope of traumatic injuries at workplaces. Future studies should consider the above factors, which may lead to effective prevention strategies.

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