Research Paper

Investigating the Work-related Accidents in Iran: Analyzing and Comparing the Factors Associated With the Duration of Absence From Work

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Citation Gholamizadeh K, Tapak L, Mohammadfam I, Soltanzadeh A. Investigating the Work-related Accidents in Iran: Analyzing and Comparing the Factors Associated With the Duration of Absence From Work. Iranian Rehabilitation Journal. 2022; 20(4):589-600. http://dx.doi.org/10.32598/irj.20.4.1739.1

http://dx.doi.org/10.32598/irj.20.4.1739.1

Article info:
Received: 12 Feb 2022
Accepted: 19 Mar 2022
Available Online: 01 Dec 2022

Keywords:
Work, Accident, Industrial safety, Occupational injuries

ABSTRACT

Objectives: Work-related accidents as one of the most prominent indicators of safety and health in the industry play an undeniable role in developing and improving the quality of industrial health management. Therefore, their accurate analysis on a large scale is essential. To provide controlling solutions, we aimed to investigate the causes of occupational accidents in Iran for 10 years (2007-2017).

Methods: At first, the reports of 10-year work-related accidents were taken from the Social Security Organization, then classified, and entered into SPSS software, version 18.0. Analyses were performed in two stages. Descriptive analyses were initially performed and then multivariate Cox regression was implemented to determine the significance of the effects of the identified factors. Accordingly, six parameters including the cause of the occurrence, gender, type of insurance, time of the accident, marital status, and type of accident were extracted as the effective factors. Next, the effect of each parameter was examined using multivariate Cox regression with a 95% confidence interval.

Results: The findings showed that falls and slips (18.3%) and physical strikes (14.6%) were the most common causes of accidents, and carelessness (61.9%) and equipment density (21.1%) had the strongest impact on accidents. Accidents had the highest incidence rate from 9 AM to noon (34.77%). The findings also showed that accident location (P<0.001), cause of the accident (P<0.001), type of insurance (P<0.001), and age (P<0.001) had significant effects on the duration of absence from work. Moreover, the findings demonstrated that the mental condition of workers and workplace design/layout had the strongest impacts on the rate of accidents.

Discussion: to control and reduce the risk of occupational accidents, appropriate working situations should be provided.

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Highlights

• The mental condition of workers as well as the design and layout of the workplace have the greatest impact on the rate of occupational accidents.

• The "accident location", "cause of accident", "type of insurance", and "age" had a significant effect on "number of absenteeism days from workplace" (NADW).

• The "carelessness" and "equipment density" had the greatest impact on accidents.

• The "falls and slips" and "physical strike" were the most common causes of accidents.

Plain Language Summary

Every year we see workers having accidents in factories and at the workplace. These accidents must be carefully investigated as they can cause physical injuries, amputations, and even death. The reason for this investigation is to find out the causes of the accidents and measures to reduce the number of accidents. Workers are among the most toiling groups in society. They make the economies of the countries flourish. The same situation exists in Iran. This study showed that workers' carelessness greatly affects the occurrence of accidents. In addition, the findings showed that workers' mental state and workplace design/layout had the strongest impact on the rate of accidents. Therefore, to control and reduce the risk of occupational accidents, the provision of appropriate working conditions should be considered. It is also interesting to know that we have the highest number of accidents in Iran between 9:00 AM and noon. Therefore, we conclude that the inspections of safety engineers should be done focusing on this 3-h period.

1. Introduction

Today, industries must protect their employees' health and safety as one of their daily management activities at work [1]. Many parameters can affect employees' health and the rate of accidents, the identification of which is difficult but essential [2]. The importance of this problem is well known in many countries, and the national estimates of occupational injuries and illnesses have been taken into account due to their high costs [3]. An essential requirement for occupational health promotion and injury prevention is the availability of reliable and accurate information about occupational injuries [4]. Prevention requires knowledge to help identify the causes of occupational accidents and their consequences [5]. Pain and disability are the main results of injuries caused by accidents in the workplace and have a great potential to affect workers' lives [6]. Accidents can impose economic and psychological burdens on managers, workers, and the whole of society.

According to the International Labor Organization, about 2.3 million men and women suffer from work-related accidents and illnesses every year with approximately 360000 fatal accidents and 1.95 million deaths [7]. Statistics show that approximately 337 million accidents occur annually in the workplace [8]. It is also economically estimated that about 4% of annual GDP or $1.25 trillion is the direct and indirect cost of work-related accidents and diseases such as lost time, workers' compensation, production disruptions, and so on [9]. According to Eurostat (the statistical office of the European Union), in the European Union, more than 5700 people die each year due to work-related accidents [10]. On the other hand, every year, 3.2% of workers in the EU-27 suffer from work-related accidents, which number about 7 million workers [11].

According to what was said, the need to control and reduce the risk of occurrence and severity of work-related accidents has become increasingly apparent [12]. The inability to identify and prevent hazards in the workplace and the limited resources required to identify and eliminate hazards have led to a failure in achieving 'zero accidents' while many regional and national goals have been set in this regard. Thus, simultaneous attention to both active and passive approaches seems necessary [13].

One of the basic steps in the event investigation process is to find the underlying causes of accidents. Therefore, the analysis of accidents by providing the possibility of determining the types and causes of accidents as well as a platform for designing and implementing corrective

actions can help management choose the optimal measures appropriate for the relevant organizational conditions [14]. This endower will be only possible by using appropriate approaches [15]. Given the importance of this issue, it is necessary to identify and investigate factors affecting occupational accidents with appropriate statistical procedures. By so doing, their effects can be evaluated by identifying the mentioned factors and extracting statistical data from reputable authorities.

Previous studies have been conducted on the effects of various individual and organizational factors on the occurrence rate of accidents in various industries. For example, Jabbari et al. [16] used the CRA technique to investigate severe occupational accidents. Li et al. [17] also examined the relationship between economic development and occupational accident rates. On the other hand, Lopez et al. [18] studied the effects of work shift time on occupational accidents. In their study, Varonen et al. [19] examined the impact of organizational safety conditions on occupational accidents. Cheng et al. [20] investigated occupational accidents in the construction industry in Taiwan using CART and data mining techniques. Regarding the effects of individual factors, Villanueva et al. [21] examined the relevant factors in their study. On the other hand, Lin et al. [22] examined the relationship between variables of age and gender and occupational accidents. Hale et al. [23] used the HFACS (The Human Factors Analysis and Classification System) method in their study to determine the root causes of occupational accidents.

As for small industries, Cheng et al. [2] used analyses of variance to investigate the causes of occupational accidents. In the field of unsafe behavior, Khosravi et al. [24] examined the interactions between unsafe behaviors and the occurrence of occupational accidents through a multifaceted review of previous studies. Despite these valuable studies, no comprehensive study has been conducted considering the statistical population of the country by using a powerful analytical method to investigate the factors affecting work-related accidents. Therefore, we aimed to comprehensively investigate the causes of occupational accidents happening for 10 years in Iran using advanced statistical methods.

2. Materials and Methods

The general stages of this study are shown in Figure 1. This study was performed in two main phases. The first phase was dedicated to collecting and classifying data related to occupational accidents, and the second phase was to studying extracted parameters descriptively and analytically.

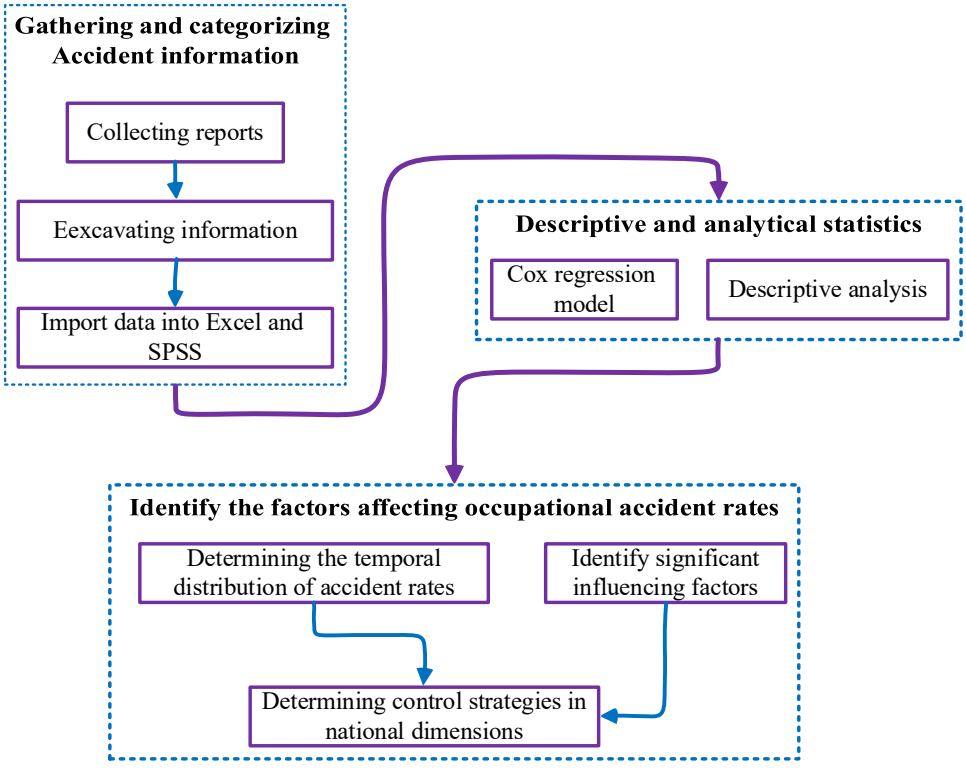

Figure 1. The main study steps

Collecting data

In this step, the data on insured workers' accidents were collected from all industries in Iran from 2007 to 2017. To do so, the reports of 191897 documented occupational accidents were collected from the Social Security Organization of Iran. Specialized data were then collected from the reports. The extracted data included age, gender, marital status, and the following variables:

Duration of absence from work (DAFW): The length of time a worker is absent from the workplace due to an accident. This parameter includes the hospitalization (if the worker is admitted to the hospital) and the duration of rest at home.

Insurance: Workers in Iran are covered by different types of insurance depending on the type of job. Freelance insurance, construction workers' insurance, driver insurance, and compulsory insurance are different types of insurance in Iran.

Reason for the accident (ROA): Naturally, every accident that occurs in the workplace has one or more causes that are specified in the accident report forms (or details) by an or more occupational health expert(s) in the industry. For example, carelessness, insufficient lighting, and so on.

Location of accident (LOA): Occupational accidents occur in one of the following places: inside the workplace, outside the workplace (for work-related reasons), or on the way to and from work.

Type of accident (TOA): In general, workers are exposed to different hazards depending on the type of industry and tasks they perform. Therefore, depending on the type of hazards and tasks, different accidents can occur, for example, electric shock, falling from a height, and so on.

Descriptive and analytical study

Initially, a descriptive analysis was conducted on the collected accident data. In this analysis, the number and percentage of each category related to the extracted factors were determined. Also, time-based analyses were conducted on accident data. Because the data collected were time-varying (occupational accident data collected from 2007 to 2017, and certainly the data for each year were different from last year's), a method is needed to examine that kind of data. As in the present study, DAFW was the outcome of interest, and it was subjected to censoring (not all of the subjects were recovered, instead some of them died or were disabled for life); the multivariate Cox regression was used to identify factors associated with the DAFW (in other words, the length of time absent from work). Hence, we considered the length of rest (in days) as the duration from the accident date to the full improvement date and considered full improvements as the status and others as censored. The Cox model is a semi-parametric regression method that is used to investigate the association between several variables and the time-to-event response. This model assumes that the effects of each variable on the hazard function are constant over time. The hazard ratio (HR) is used as the effect size and it is calculated by the exponent of the regression coefficient [25].

In this model, the criterion for measuring the effects is HR, which is the ratio of the hazard rate to the conditions described at two levels of one variable [26]. This method has been used in other similar studies. For example, Nieuwenhuijsen et al. [27] used Cox regression to compare influencing parameters related to the prediction of sickness absence for patients. In another study, Brage et al. [28] compared the effects of gender on musculoskeletal-related long-term sickness absence using multivariate Cox regression. The data were analyzed using SPSS software, version 18.0 at a 95% confidence level [29].

3. Results

The results of descriptive analysis

The findings extracted from the incident report are presented in Table 1. Findings show that the highest number of accidents occurred in men (97.9%). Occupational accidents in married workers were about three times (77.5%) of the single workers (22.5%). About two-thirds of accidents (66.5%) occurred in the morning shift and about a quarter (26.4%) occurred in the evening shift. Moreover, 94.8% of accidents occur within the workplace. Findings also showed that carelessness (61.9%) and equipment congestion (21.1%) were the most common causes of occupational accidents. On the other hand, poor ventilation (0.1%), poor lighting (0.2%), and dangerous clothing (0.4%) had the weakest effects on accidents. The most common accidents were 'falls and slips' (18.3%) and 'physical injuries' (14.6%). On the other hand, 'gas poisoning' (33 accidents) and 'asphyxia' (30 accidents) were also very rare. The results also showed that the average number of DAFW in the studied accidents was 1.57 days (with a standard deviation=156.6); 98.9% of workers involved in accidents were covered by compulsory labor

insurance. Besides, 92.6% of the workers injured in the accident completely recovered during their treatment period. Findings also showed a mortality rate of 0.5% in occupational accidents. The results of the time-based analysis are shown in Figure 2. These findings revealed that most occupational accidents occurred between 9:00 AM and 10:00 PM (10.16%), 10:00 AM to 11:00 PM (12.95%), and 11:00 AM to 12:00 PM (11.66%). Also, the rate of accidents between 03:00 PM and 05:00 PM (15.5%) increased significantly.

Table 1. Descriptive analysis of the worker population involved with accident (N=191897)

Variables		No. (%)
Gender	Male	187834(97.9)
	Female	4063(2.1)
Marital status	Single	43185(22.5)
	Married	148713(77.5)
Shift Time	Morning	127685(66.5)
	Afternoon	50628(26.4)
	Night	13216(6.9)
Location of the accident	Inside workplace	181980(94.8)
	Outside workplace	8137(4.2)
	In transport to the workplace	1781(0.9)
Reason of accident	Unprotected items	8665(4.5)
	Defective equipment	6619(3.4)
	Carelessness	118871(61.9)
	Incomplete light	374(0.2)
	Undesirable ventilation	233(0.1)
	Dangerous clothes	726(0.4)
	Lack of information	2992(1.6)
	Equipment congestion	40486(21.1)
	Lack of education	1039(0.5)
	No protective equipment	384(0.2)
	Violation of regulations	3090(1.6)
	Other causes	8419(4.4)
Type of insurance	Compulsory insurance	189865(98.9)
	Drivers' insurance	1019(0.5)
	Free Occupational Insurance	11(5.7E-5)
	Construction Workers Insurance	770(0.4)

Variables		No. (%)
Type of accident	Falling objects	14633(7.6)
	Falling and slipping	35107(18.3)
	Strike	27966(14.6)
	Stuck between objects	15652(8.2)
	Entering objects in the eye	1744(0.9)
	Entering bodies in the body	1554(0.8)
	Displacement accident	9502(5.0)
	Burn	5452(2.8)
	Burning substances accident	1147(0.6)
	Explosions and fires	1042(0.5)
	Rubble Shedding	943(0.5)
	Accident with vehicle	5808(3.0)
	Injury and amputation	21844(11.4)
	Fractures of the skins	21524(11.2)
	Accidents with different objects	4181(2.2)
	Machine tools accidents	10266(5.3)
	Hand tools accidents	4367(2.3)
	Electrocution	1307(0.7)
	Other events	5267(2.7)
	Not stated	2529(1.3)
	Choking	30(1.5e-5)
	Gas poisoning	33(1.7e-5)
Accident's outcomes	Complete disability	1648(0.9)
	Disability (33% and 66%)	2742(1.4)
	Disability less than 33%	8757(4.6)
	Full recovery	177784(92.6)
	Death	967(0.5)

	No.	Min	Max	Mean	Median	Variance	SD	Interquartile Range
Days of rest	191898	0	841	1.57	30.00	15952.04	126.30	45.00

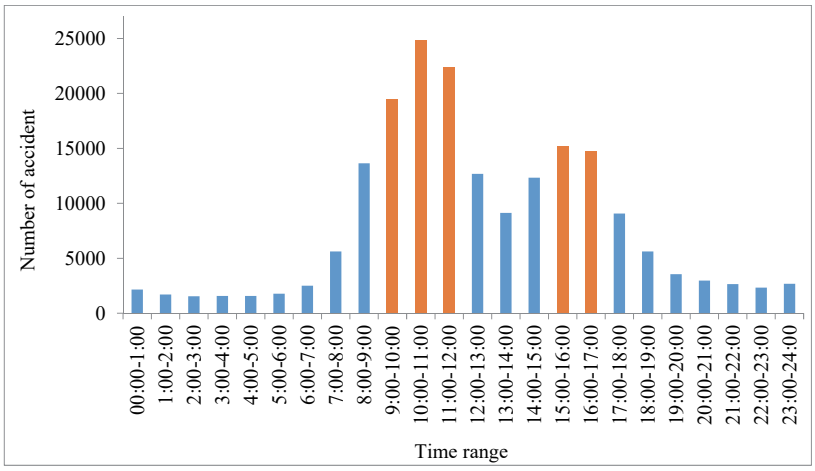

Figure 2. The rate of events at different times

Analytical analysis findings

The results of Cox regression are presented in Table 2. According to the adjusted results, 'presence at work' (Hazard ratio [HR]: 1.322, 95% CI: 1.256, 1.391) and 'presence outside the workplace' (HR: 1.132, 95% CI: 1,071, 1.198) had significant effects on DAFW compared with "Commute to the workplace". On the other hand, unprotected equipment (HR: 1.074, 95% CI: 1.041, 1.109), carelessness (HR: 1.095, 95% CI 1.070, 1.121), inappropriate clothing (HR: 1.139, 95% CI: 1.054, 1.231), lack of information (HR: 1.055, 95% CI: 1.010, 1.103), 'equipment congestion (HR: 1.079, 95% CI: 1.052, 1.106), and breach of the regulation (HR: 1.077, 95% CI: 1.031, 1.124) had significant effects compared with "other reasons" regarding the DAFW. Compulsory insurance (HR: 1.152, 95% CI: 1.068, 1.242) and drivers' insurance (HR: 0.863, 95% CI: 0.780, 0.955) also had significant effects on the DAFW compared with construction worker insurance. Furthermore, unlike gender and marital status (no significant effect), age (HR: 0.998, 95% CI: 0.997, 0.997) had significant effects on DAFW. In addition, the overall results showed that accident location ($P<0.001$), cause of the accident ($P<0.001$), type of insurance ($P<0.001$), and age ($P<0.001$) significantly influenced DAFW. The proportional hazard assumption was checked for all variables in the model using scaled Schoenfeld residuals. All P values greater than 0.05 indicate that the proportionality assumption has not been violated.

4. Discussion

The study aimed to investigate the causes of work-related accidents occurring in Iranian industries in 10 years (2007-2017). In the first phase of the study, the parameters affecting the occurrence of work-related accidents were identified, and in the second phase, the effects of these parameters were investigated using Cox regression.

The findings showed that psychological and ergonomic factors were the main causes of work-related accidents. This finding was consistent with the study of Khosravi et al. [24] in which personal and organizational factors were identified as the major parameters affecting work-related accidents. Various studies have proven the significant effects of the layout design of hardware and equipment on work-related accidents. The findings of this study were in line with the findings of Hale et al.'s study [30] as well as Azadeh et al. [31] who investigated the effect of workplace layout on work-related accidents in the construction industry. Besides, the findings of the study revealed that few accidents were caused by physical and chemical factors in the workplace. Of note, this limited number cannot be a good reason for the low impact of these factors as many studies have proven the effects of such factors on work-related accidents. For example, we can talk about the high impact of proper ventilation systems in preventing gas poisoning in the industry. Yamano et al. [32] investigated methyl bromide poisoning in the workplace. Likewise, Kaga et al. [33] investigated hydrogen sulfide gas poisoning in the workplace, emphasizing that the role of the ventilation system in this type of poisoning is undeniable.

On the other hand, strict legal requirements and regular monitoring of occupational health experts in workshops and industries in Iran have led to a significant upgrade of lighting systems, so, naturally, the number of accidents caused by improper lighting systems is low. These rules also comply with the safety rules for working with per-

Table 2. The association of various factors with DAFW using adjusted (Multivariate) Cox regression model

Variables		HR	HR (CI=95%)		P
			Lower	Upper	
Gender	Female	-	-	-	-
	Male	1.016	0.948	1.050	0.328
Marital status	Single	-	-	-	-
	Married	0.993	0.982	1.004	0.213
Shift time	Night	-	-	-	
	Morning	0.997	0.978	1.015	0.718
	Afternoon	0.998	0.978	1.018	0.828
Location of the accident	Commute to workplace	-	-	-	
	In workplace	1.322	1.256	1.391	0.000*
	Out of workplace	1.132	1.071	1.198	0.000*
Reason of accident	Other reasons	-	-	-	
	Unprotected items	1.074	1.041	1.109	0.000*
	Defective equipment	1.028	0.994	1.064	0.112
	Carelessness	1.095	1.070	1.121	0.000*
	Incomplete light	1.035	0.928	1.154	0.538
	Undesirable ventilation	1.003	0.874	1.152	0.961
	Dangerous clothes	1.139	1.054	1.231	0.001*
	Lack of information	1.055	1.010	1.103	0.016*
	Equipment congestion	1.079	1.052	1.106	0.000*
	Lack of education	1.045	0.977	1.118	0.199
	No protective equipment	1.021	0.916	1.139	0.702
	Violation of regulations	1.077	1.031	1.124	0.001*
	Age	0.998	0.997	0.998	0.000*
Type of insurance	Construction worker insurance	-	-	-	
	Drivers' insurance	0.863	0.780	0.955	0.004*
	Free Occupational Insurance	0.907	0.450	1.821	0.784

Variables		HR	HR (CI= 95%)		P
			Lower	Upper	
Type of accident	Gas poisoning	-	-	-	
	Falling objects	1.298	0.862	1.954	0.211
	Falling and slipping	1.241	0.824	1.867	0.301
	Multiplication	1.378	0.916	2.074	0.124
	Stuck between objects	1.226	0.814	1.845	0.329
	Entering objects in the eye	1.154	0.764	1.742	0.496
	Entering bodies in the body	1.281	0.894	1.934	0.234
	Displacement accident	1.299	0.862	1.955	0.211
	Burn	1.227	0.815	1.849	0.327
	Burning substances accident	1.246	0.825	1.883	0.296
	Explosions and fires	0.991	0.655	1.499	0.965
	Rubble Shedding	1.123	0.742	1.699	0.584
	Accident with vehicle	0.953	0.652	1.480	0.934
	Injury and amputation	1.159	0.770	1.745	0.497
	Fractures of the skins	1.267	0.842	1.908	0.256
	Accident with different objects	1.260	0.836	1.898	0.269
	Machine Tools Accidents	1.207	0.801	1.817	0.367
	Hand Tools Accidents	1.327	0.881	1.999	0.176
	Electrocution	0.927	0.613	1.401	0.719
	Other events	1.204	0.800	1.814	0.373
	Not stated	1.135	0.753	1.711	0.546
	Choking	1.040	0.584	1.854	0.894

sonal protective equipment, so the low number of accidents due to non-use (or improper use) of this equipment can be justified. A closer look at Cox regression findings and these findings suggests that failure to use or improper use of personal protective equipment will definitely lead to a significant increase in work-related accidents.

The findings demonstrated that a high percentage of work-related accidents occurred from 9 AM to noon. This period is the time with maximum power in most industries. This finding agrees with the results of Wojtczak et al.'s study [34] reporting that an increase in the level of industrial activity can raise the occurrence rate of accidents. On the other hand, the findings of the study

showed a reincrease in the rate of accidents in the last hours of the morning shift, which was due to the sudden increase related to lunchtime as regarded by Lopez et al. [18] and Mohammadfam et al. [35] as an influential factor on the accident rate. Also, the findings of this study were very close and consistent with the findings of Richter et al.'s study [36] showing that more than half of work-related accidents (66%) occur in the first half of the morning shift.

It was also observed that violation of safety and health regulations in the workplace, as one of the main principles of safety culture in the organization, had a moderate effect on the DAFW. This finding is consistent with the findings of studies by Mokarrami et al. [37] and Morrow et al. [38] who showed the relationship between safety culture and work-related accidents as a negative relationship. On the other hand, various studies have reported the significant impact of practical and theoretical training as well as documentation and access to information resources on the level of safety in various process and non-process industries as one of the main effective parameters [39-44]. Accordingly, the findings of this study showed that the lack of work, safety, and equipment information are the influential factors that have a significant effect on the DAFW, which is in line with Silva et al.'s [45] findings on the relationship between information cycle and safety level. Also, in agreement with the study of Alizadeh et al. [46], there was no significant relationship between workers' marital status and accident rates and DAFW. It is noteworthy that this study was conducted in a very large statistical community. The findings of this study can be used as a guide in future research. The large statistical community helped increase the accuracy of the findings.

5. Conclusion

The findings of this study revealed that the mental condition of workers as well as the design and layout of the workplace have the strongest effects on the rate of work-related accidents. Therefore, to control and reduce the risk of work-related accidents, providing appropriate working conditions should be considered more than before. These conditions should cover the ergonomic, organizational, and safety aspects of the workplace. The findings also showed that Cox regression has the potential to analyze and investigate work-related accidents. The findings of this study can be used as a powerful practical guide in national macro-planning to reduce the rate of work-related accidents.

The present study has some limitations. The data used in the present study were obtained from the Social Security Organization. This organization only records the accidents of insured workers and employees, while a significant number of the workers in various organizations are uninsured. Most of them are generally daily workers, seasonal workers, or migrant workers. So, the main limitation of this study is the inability to consider the accidents of uninsured workers and employees. Lack of access to the database of the Ministry of Labor, the most comprehensive database of work-related accidents in Iran, has been another limitation of the present study. Another limitation of this study was the non-provision of data from 2017 to 2022 by the Social Security Organization because of organizational reasons. On the other hand, the strength of this study was the existence of 10-year accident data in all process and non-process industries, so that it well reflects the status of the accident rate. The authors suggest that future studies could be conducted using data from the Ministry of Labor, the Social Security Organization, and forensics.

Ethical Considerations

Compliance with ethical guidelines

This study had no ethical limitations. The received data were approved by the Social Security Organization. No names of industries, provinces of Iran, or workers affected by the accidents have been received or reported.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Authors' contributions

Conceptualization, Study design, Writing original and revised manuscript: Kamran Gholamizadeh; Data analysis: Leili Tapak; Supervision, Data collection, Funding acquisition and resources: Iraj Mohammadfam; Verifying, Review: Ahmad Soltanzadeh.

Conflict of interest

The authors declared no conflict of interest.

Acknowledgments

This study was conducted at Hamadan University of Medical Sciences. We hereby thank the Social Security Administration for their sincere cooperation.

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