

Fatal and Non-Fatal Work Related Injuries Among Workers of Iranian Aluminum and Copper Industries Between 2003 and 2011

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Received: 28 Dec. 2015, Revised: 30 Jan. 2016, Accepted: 8 Feb. 2016

ABSTRACT

One-third of globally, injuries to the adults in the world were related to workers and work situations. The aim of the present study was determining of work-related injuries rate among workers at two main metal industries (aluminum and Cooper industries) and independent predictors of fatal work-related injuries among them.

Present cross-sectional study was assessed fatal and not fatal work-related injuries among 11172 workers into two groups of Iranian metal industries between April 2003 and September 2011. Information was obtained from the electronic registry of work-related injuries to the health & environment office of Iranian Mines and mining Industries Development and Renovation Organization of the Iranian industrial ministry. Binary logistic regression was used for determining predictors of fatal work-related injuries.

During the study period, 55 workers of metal companies had been dyed and mortality rate among study workers was 1.7% and 3282 work-related injuries were reported. Mortality rate in study workers had significant association with injury location ($P \leq 0.00$), worker's age ($P \leq 0.00$) and not significant association with worker's shift ($P \geq 0.44$), educational level ($P \geq 0.46$), injury type ($P \geq 0.65$) and work experience ($P \leq 0.07$). In linear regression model analysis only age of workers was independent mortality predictors among study workers.

Based on our findings work-related injuries in mentioned industries in this study setting are high, and a comprehensive injury prevention program seems to be essential.

Keywords: Aluminum; Copper; Fatal; Injuries; Workers, Occupational Medicine

INTRODUCTION

According to the International Labor Organization (ILO) approximately two million, people die while at work every year [1]. One-third of globally, injuries to the adults in the world were related to workers and work situations [2]. Metal industry's works have been high physical demanded, and workers are exposed to heavy cutting and hammering work duties in noisy workplaces with awkward body position. Some stressors such as heat or humidity, welding fumes can deteriorate since their workplace performance [3]. Usually, they experience an ache or pain in their musculoskeletal system and diagnosed as musculoskeletal disorders [4]. Exposing to high electricity and magnetic field with working in the noisy workplace with poor illumination with a variety of chemical agents is threatening workers in metal industries [5, 6]. Occupational injuries are one of the

major concerns in noted industries, and metal industries had a high mortality rate.

Some of the previous studies have shown that accidents are more common in male workers in comparison with their female coworkers [7-9]. Furthermore, it had shown that younger workers had more accidents and injuries in comparison with their older colleagues [10] On the other hand; some studies have reported that older workers are more prone to accidents because of their declining mental and physical capacities [11, 12]. In Iran, almost all of the workers in these industries are male and based on our knowledge; there is no available data about age and other demographic factors.

According to the above background, assessment of work-related injuries can help health care professionals for better therapeutic services and health policy makers for designing better preventive strategic programs for reducing work-related injury

rate among metal industries. The aim of the present study was determining of work-related injuries rate among workers at two main metal industries (aluminum and Cooper industries) and independent predictors of fatal work-related injuries among them.

MATERIALS AND METHODS

Present cross-sectional study was assessed fatal and not fatal work-related injuries among 5964 workers from two groups of Iranian metal industries (Aluminum and Copper) between April 2003 and September 2011. The study was approved by the ethics committee of Iran University of medical sciences. Information on injuries and fatalities was obtained from the electronic registry of work-related injuries to the health & environment office of Iranian Mines and mining Industries Development and Renovation Organization (IMIDRO) organization of the Iranian industrial ministry. For the purpose of evaluating and determining the overall strategies and policies, executing the projects relating to the construction and the renovation of metal-related industries, extraction and processing of mineral products as well as executing exploration projects, the Iranian Mines and Mining Industries Development & Renovation Organization (IMIDRO) was established and officially registered. The injury and the circumstances surrounding the event were documented by safety inspectors who have received training in reporting and documenting injury events. In the registry system, injuries were considered that need medical attention. Severe accidents in our study were defined as any work-related injuries, which cause at least one day of absence from work and medical examination. In this registry system, work-related injuries were monitored in 5964 workers from three aluminum industries and 5208 workers of three copper industries were reported.

For each work-related injury, demographic and work related data and injury data entered in electronic form. The injury-related variables included accident causes (unsafe act and unsafe condition or both of them), injury types (contusion or trauma, falling, electrical shock or lesions, toxicity, other types), accident consequences (death; limb amputation; rupture, laceration, fracture, penetration and contusion; burning, electrical shock or lesions, toxicity, and other outcomes), a body part involved (head and neck; chest and abdomen; upper limbs, lower limbs, spine, multiorgan and other parts) .

Statistical analysis

We transported data from the data bank into the SPSS 16.0 software. Analysis conducted on fatal and non-fatal occupational injuries. In the invariable analysis, we compared injury consequences between workers with fatal and non-fatal injuries according to their

age, work experience? Educational level, injury type, causes and location were analyzed with chip-square test. All of p-values less than 0.05 were assuming as significant results. For determining predictors of fatal work-related injuries, binary logistic regression was used. Consequences of injuries were divided into the fatal and non fatal variable and were entered into the regression model. All of other demographic and injury-related variables were entered into the model as independent variables. Variables that were remained into the model were known as independent predictors of mortality in work-related injuries.

RESULTS

In the present study, 5964 workers of Aluminum and 5208 workers of Copper industries were monitored and finally during the study period, 3282 injuries (43.5% of all injuries) were reported as work-related injuries to workers of noted industries. Workers who had between 20 and 39 years old had the highest frequency of work-related injuries. Workers with less than five-year job experiences in comparison with other workers (more than five years work experience) had the highest frequency of injury. Workers with undergraduate education degree consisted of more than 50% of all injuries involved workers. Unsafe work (67.6%) was the highest cause of injury to study workers in comparison with safe condition and both. Physical (61.3%) and thermal (0.2%) traumas were the highest courses of injuries. During the study period, 55 workers of metal companies had been dyed and mortality rate among study workers was 1.7%. More details of frequency of work related accident outcomes among study workers were shown in Table 1.

Table1. Frequency of work related accident outcomes among study workers

Accident outcome	Number	Frequency
Death	55	1.7
Amputation of limbs	41	1.2
Physical injuries	917	27.9
Eye foreign body legions	2175	66.4
Burning	25	0.8
Electrical lesions	8	0.2
Toxicity	11	0.3
Others	50	1.5
Total	3282	100

In an invariable analysis mortality rates in study workers had significant association with injury location ($P \leq 0.001$), worker's age ($P \leq 0.001$) and non-significant association with worker's shift ($P \geq 0.44$), educational level ($P \geq 0.46$), injury type ($P \geq 0.65$) and work experience ($P \leq 0.07$). Details of comparisons were presented in table 2.

Table 2. comparison study variables between death and live study workers

Study variables	Death workers	Alive workers	P-value
Educational level	Under graduate	27	0.46
	Diploma	21	
	Post graduate	7	
Accident type	Physical trauma	34	0.66
	Falling	15	
	Thermal trauma	6	
	Electrical trauma	0	
Accident location	Toxicity	0	0.00
	Other	0	
	Head and neck	24	
	Eye	4	
	lesions		
	Chest and abdomen	2	
	Upper limbs	0	
	Lower limbs	1	
	Spine	23	
	Multiple organ	2	
Workers shift	Other	0	0.28
	Morning	31	
	Afternoon	9	
	Night	8	
	Non shift work	7	
Age	Younger than 20 years	2	0.00
	20-29 years	11	
	30-39 years	21	
	40-49 years	13	
	50-59 years	7	
	Older than 60 years	1	
		9	
Work history	Less than 5 years	32	0.07
	6-10 years	8	
	11-15 years	9	
	16-20 years	4	
	21-25 years	0	
	More than 25 years	2	
		30	

In linear regression model analysis for covering impacts of confounding variables after entering all of study variables into the model, only age of workers

has remained into the model and known as independent mortality predictors among study workers. Table 3 showed complete results of regression analysis in studying workers.

DISCUSSION

Findings of our study showed that during eight-year study period, injuries were occurred in 3282 workers and consisted of more than 40% of all work-related injuries. Finally, 55 workers had been dyed and in regression analysis, only age of workers was an independent predictor of mortality.

Workers of large and basic industries in the world had major problems with work-related injuries, and these injuries could lead to economic and even social and familial consequences. The International Labor Organization (ILO) in the latest report estimated that annually 2.2 million workers had been died from work-related injuries and disorders [13]. Non-fatal injuries in developed and industry's countries (such as USA) lost nearly to 4% of Gross Domestic Products and workers in the USA as a sample at least left three their work days [14]. There are between 10% and 20% percent increase in rate work-related injuries in developing countries in comparison with developed countries [15]. In the developed and advanced countries, we had annually 5.5 deaths per each 100000 worker and in contrast. This rate in Latin America was 13.5 per 100000. In Republic of Korea even this rate was reached to the 34 per 100000 workers at the highest fatality rate among industries [16].

Workers in the present study had different conditions in comparison with workers of above studies, and we performed our study only on workers of aluminum and copper industries, and we cannot exactly compare above papers with study findings. In the overall, fatality rate in the present study was higher than other reports. This higher rate might be due to epidemiological causes such as study case sampling method and including only workers of specific industries into the study. Other reasons for this discrepancy were due to this fact that many occupational injuries don't report in many occupational settings. We in our practice have seen many work-related injuries that had not been reported. In some other industries like agriculture, there is estimation about the magnitude of this underestimation [17]. But in our setting and this industry, we don't have any estimation. However, definitely this number is an underestimation of the true situation. So, the magnitude of this problem is greater and requires more attention.

Table 3. results of regression analysis in study workers

Variable	Beta	Standard Error	Significances	95.0% C.I.for EXP(B)	
				upper	lower
Constant	6.88	0.84	0.00	-	-
Level of education	-0.32	0.21	0.13	0.49	1.09
Accident type	0.18	0.16	0.27	0.86	1.65
Accident location	-	0.1	0.21	0.73	1.07
	0.124				
Work history	0.22	0.13	0.1	0.96	1.62
Accident shift	-0.17	0.13	0.21	0.65	1.09
Age	-0.74	0.17	0.00	0.34	0.66

Aluminum and Copper industries are stressful and highly physical demanded works with awkward body position [3]. Findings of the present study showed that although the rate of work-related injuries in thing contributed to this difference and can be preventable with proper preventive strategies. Unsafe act in studying workers was the highest cause of injury and according to that work-related education for workers about their work, machines and work environments can help them to better their work-related duties and then work-related injuries will be reduced.

Young workers (less than 40 years) had the highest frequency of work-related injuries in comparison with old workers. The magnitudes of severe impacts of work-related injuries on young workers were greater. Previous studies confirmed that young workers are at higher injury risk [18-21]. And most of the noted injuries in young workers were preventable, and this fact induces our ethical duty for control of them. In the present study, the fatal and non-fatal injuries rate for young workers was significantly higher than old workers. Generally young workers consist of more than 80% of workers, and these statistics had been confounding effect on this association. Similar studies reported that although the injury rate for young workers is often higher, the incidence of fatal injuries (i.e., more serious injuries) is more often reported being lower or the same among young workers [22]. In one population-based study in Ontario, researchers found that work-related charters and situations for young workers were one of the major contributing factors to the risk of injury experienced [20].

Several studies have shown that inexperienced workers have the greatest risk of fatal occupational injury due to the effects of subcontracted work, labor turnover and short-term employment [23, 24]. In this study, the finding that most of the fatal accidents occurred during the first year of employment was consistent with previous findings [8]. 58.2% of all mortalities were occurred in workers with occupational history of lower than 5 years. In the present study in contrast to study of Lin *et al.* [8] falling was not the leading cause of fatal occupational injuries. However, still falling had a great percentage

of causes (27.3% all fatal injuries; It seems that although falling in study setting and in these industries, is not the leading cause of death, it needs a special attention. Numerous studies of occupational fall-related accidents have been published in many other countries [24, 25] Possible preventive interventions include the use of proper personal protective equipment (safety nets, handrails, safety belts and reins), employee training in fall-related prevention, and management efforts to encourage workers to improve their own risk assessment [11, 23] Work-related mortality in workers was happened due to two major reasons: (1) workplace injury and injuries due to handling with work machines and unsafe acts or conditions and (2) mortality due to work related disorders such as asbestosis, silicosis and cancers. In this study, we only assessed workplace-related injuries and assessment of second cause of work-related mortality need to a cohort study with suitable follow-up duration.

Our study had some limitations; we had not any data about occupational exposure and this limitation, we couldn't talk about accident risk factors and the relation between severity of accidents and occupational exposures. Also lack of information about workers stresses. Family conflict and financial status as important risk factors for the accident will be another shortage.

CONCLUSION

Preventive measures with more focus on younger workers, could help to decrease the rate of accidents. Based on our findings, work-related injuries in mentioned industries in our setting are high, and a comprehensive injury prevention program seems to be essential. Also more detailed studies with a focus on our shortages are necessary. Finally, the occupational physician could make workers more aware of the risks and encourage them to improve their living and working conditions, during the medical examinations. It seems that IMIDRO as an organization that determines the safety policies of its sub group industries could have a more important role in this area.

ETHICAL ISSUES

The study was approved by the ethics committee of Iran University of medical sciences.

CONFLICT OF INTEREST

Authors of the manuscript did not have conflict of interest.

AUTHORS' CONTRIBUTION

Authors contribute on this study as following items:
Elaheh Kabir-Mokamelkhan: Study design and revision
Mashallah Aghilinejad: Study design and revision
Amir Bahrami Ahmadi: Study statistical analysis and reviewing the final version of manuscript.
Mohammad Kazem Nouri: Data coordinator and data mining
Mohammad Hassan Nassiri Kashani: Drafting the manuscript
Seyed Ali Mousavi: Collecting and revising the data

FUNDING/SUPPORTING

Autors did not find any extra supporting from any source.

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