ORIGINAL ARTICLE

OCCUPATIONAL INJURIES AMONG WORKERS IN IRON AND STEEL INDUSTRIES IN BISHOFTU TOWN, OROMIA REGIONAL STATE, ETHIOPIA: A CROSS-SECTIONAL STUDY

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ABSTRACT

Occupational injury in most developing countries including Ethiopia is becoming a public health problem. Assessment of occupational injuries and associated risk factors were the aim of this paper. The study was conducted in Bishoftu town, Oromia Regional State, Ethiopia which is located about 47 km south east from the capital Addis Ababa. Institution based cross-sectional study was conducted among 443 workers from November to December, 2015. Working sections were stratified to select workers. Multivariable logistic regression analysis was used to identify the associated risk factors. Occupational injury was 384 per 1000 exposed workers per year. Working nights shifts, working more than 48 hours per week, safety training, workers with sleeping disorder, job satisfaction and use of Personal Protective Equipment were predictors of occupational injury. Iron and steel manufacturing industry has significant public health problem. Emphasis should be given to minimize injury.

Keywords: *Occupational injury, Ethiopia, Iron and Steel Industry, Health and Safety Training*

BACKGROUND

An occupational injury is any physical injury condition sustained on a worker in connection with the performance of his or her work in the industry. Employed people in industries spend at least one third of a day at work which have a strong effect on their health and safety due to work and work-related injuries [1]. These occupational injuries pose a major public health and developmental problems which result in a serious health, social, and economic consequences on workers and their employers[2,3].

The risk of occupational diseases and injuries has become by far the most prevalent and major health problem. According to the International Labour Organization, approximately 2.3 million people die from accidents and diseases related to work each year[4]. The workplace fatal injury rates are 3–4 times higher in developing countries than the developed ones. Compensation, work time loss, production interruption, training and retraining, medical expenses and social assistance accounts for 5% of the global gross national product (GNP). In Africa, where traditional hazards, such as workplace dusts and noise levels have not been dealt adequately, in-

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troduction of new technologies, chemical substances and materials have led to new and extra increased burden of occupational injuries[5,6]. In developing countries having 60% of the global workforce with 80% employed in heavy and dangerous work, only 5–15% of them have access to occupational health service[7]. Unregulated exposures to chemical and physical hazards, beginning work in childhood, poverty, hunger, and scarce workplace health and safety resources contribute to high incidences of occupational injuries. These injuries along with occupational health remained a neglected public health problem, received little attention, remained low at the national priorities list and had low commitment level in developing countries [8,9].

Historically, steel industries continued to be dangerous. Employed workers in basic steel industries are at greater risk for non-fatal injuries and illnesses due to very complex nature of production processes, material handling and other related functions of iron and steel making [10].

Ethiopia has been a member state of International Labor Organization and signed conventions related to health and safety of factory workers since 1923. However, the national occupational safety and health policy is not issued though it is required by the country as a result of ratifying occupational safety and health convention no. 155/1981[11].

Study carried out in Thailand reported that there were 189,621 cases of occupational injuries. Of this number, 607 were deaths, 20 cases of disability, and 48,078 cases of over 3 days lost from work. Results from US study showed rate of 75 per 1000 exposed workers per year [12,13].

Studies that are available on industrial injuries indicated that work related injuries occur with great frequency and much greater severity in developing countries. The injury rate among small-scale industrial workers in Zimbabwe was 131 per 1000 exposed workers per year [14]. The injury rate in Nigerian factories was 22 per 1000 exposed workers per year[15].

Limited studies in the field of occupational health hazards have indicated that the magnitude of occupational injury is grave in Ethiopia[16]. Since there is poor Epidemiological information regarding the present status on the prevalence and factors affecting work-related injury among industrial workers, it is crucial to add some knowledge to the prevalence and determinants of work-related injuries among these workers [17,18]. The main aim of this study is therefore, to assess the prevalence of occupational injuries and factors affecting injury among iron and steel factories workers in Bishoftu town, Oromia Regional State, Ethiopia. The results of the study may be valuable for policy makers to formulate injury prevention programs in order to inform, plan, implement and evaluate health promotion policies and strategies in the iron and steel industries nationwide.

METHODS

Study Setting and design: The study was conducted in Bishoftu town, Oromia Regional State, Ethiopia which is located about 47 km south east from the capital Addis Ababa. The total population of Bishoftu town is 181,413. The industries selected for

the study were Abyssinia Integrated Steel PLC, Metal and Engineering Corporation Steel Processing, C&E Brothers Steel Factory PLC and Steely RMI PLC. All four of them are in Bishoftu town. There are a total of 2,872 workers in the industries.

Institution based cross sectional study was conducted to assess the prevalence and factors of occupational injuries in workers engaged in iron and steel manufacturing industries in Bishoftu town from November to December, 2015.

All workers employed in four iron and steel factories in Bishoftu town were source population while the factories they were employed in were study units. Employees who were only directly engaged in the production process in the selected industries irrespective of sex and age were included in the study as they are more exposed to injuries. Employees that did not have direct involvement in the production process, such as administrative staff, were not included in the study because by virtue of their occupation they are not exposed to occupational health and safety hazards. Besides, and workers having less than a year experience were excluded from the study.

Sample Size and Sampling Procedure: The sample size was calculated using sample size determination formula for single population proportion with 48.9% based on prevalence of the study conducted on Magnitude and Factors of Occupational Injury among Workers in Large Scale Metal Manufacturing Industries in Ethiopia, 5% the margin of error (d), 95% degree of confidence level ($Z\alpha/2 = 1.96$), and 10% non- response rate to maximize the sample size. The calculated sample size (n = 443) was allocated by probability proportional to size of each selected iron and steel Factories. Then production workers in four iron and steel industries were first stratified by its organizational department, then the sample size was proportionally allocated to each section, finally workers were selected from employees list in each section using simple random sampling.

Data Collection Procedure: A pretested and structured questionnaire was used to collect socio-demographic, behavioural characteristics and occupational injuries among workers in the last twelve months by interviewing (the selected) production workers from all four iron and steel industries in Bishoftu town, Oromia Regional State, Ethiopia. Data collection was done at industries, which was prepared by the principal investigator and managers of the industries prior to data collection.

One male Bachelor Science in Environmental health, 2 male and 3 female Diploma nurses who had experiences in data collection were trained to collect data. Data collectors reported and discussed their daily data collection activities to take immediate corrections, checked completeness until the end of data collection and rearranged the code for data entry. Principal investigator supervised the data collection process and checked completeness and consistency. Data was collected from November 15, 2015 to December 15, 2015.

Statistical Analysis: The data was edited, cleaned and coded, then entered and analyzed using SPSS version 20. Bivariate analysis was performed to find associations between independent and dependent variable using odds ratio and variable that had significant association up to p-value ($p < 0.2$) was entered to multivariate analyses. Hosmer and Lemshow goodness of test was checked to assure the model fitness. Finally, independent variables that had p-

RESULTS

A total of 443 workers take consent and participated in the study with a response rate of 100%. Out of 443 respondents, from where data gathered, majority of them, 432 (97.5%), were males while the rest, 11 (2.5%), were females. From all respondents 308 (69.5%) were 18–29 years old, while 129 (29.1%) were30-44 years of age. They were 18–58 years old with the mean age of 27.47 ± 6.32. Nearly all the respondents, 432 (97.5%), were permanent workers, whereas very few, 11 (2.5%), were temporary workers. Of all the workers 234 (52.8%) were in basic production section, 142 (32.1%) in foundry/melting section, 67 (15.1%) in maintenance **(Table 1).**

Occupational injury characteristics: From the total of respondents 38.4% (33.4, 42.7) reported that they had experienced work-related injury in the previous 12 months providing an overall prevalence of 384 injuries per 1000 exposed workers per year. A total of 97 (57.1%) of the injured respondents faced physical injury once, 36 (21.2%) twice and 37 (21.8%) three times and more. Most affected body parts with their prevalence rate were Lower arms 66 (25.8%), Lower legs 43(16.8%), Fingers 39 (15.2%), Upper arms 20 (7.8%) and Eyes 18 (7%) **(Figure 1).**

Table 1: Socio-Demographic Characteristics of the workers at Bishoftu city Iron and Steel fac-

Variables	Frequency (n=443)	Percent
Sex		
Male	432	97.5
Female	11	2.5
Age in (yrs.)		
18-29	308	69.5
30-44	129	29.1
≥45	6	1.4
Religion		
Orthodox	250	56
Protestant	133	30
Catholic	17	3.8
Muslim	43	9.7
Educational status		
Illiterate	29	6.5
Can read and write	42	9.5
Primary school (1-8)	154	34.8
Secondary school (9-12)	144	32.5
Certificate and above	74	16.7
Marital status		
Married	197	44.5
Divorced	14	3.3
Separated	7	1.6
Single	222	50.1
Widowed	3	0.7
Employment Status		
Permanent	432	97.5
Temporary	11	2.5
Job category		
Maintenance	67	15.1
Basic production	234	52.8
Foundry	142	32.1
Service Duration (yrs.)		
≤5	421	95.0
>5	22	5.0
Salary (Month)		
≤1560	235	53.0
>1560	208	47.0
Number of dependents		
No	125	28.2
1-2	217	49
≥3	101	22.8
Residence		
Urban	394	88.9
Rural	49	11.1

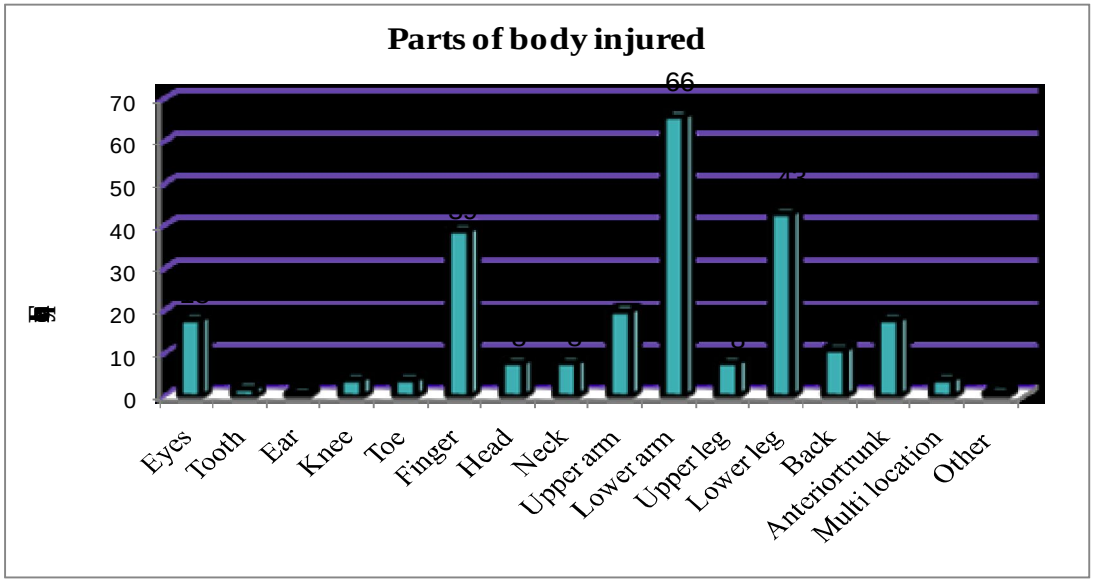

Figure 1: *Injured body parts of the workers at Bishoftu city Iron and Steel factory, 2016:*

In terms of type of injury, burn occurred on 100 (43.5%) workers and abrasions on 51 (22.2%) **(Figure 2).** The commonest causes of work related injuries were hot metal contact 52 (23.4%), fire explosion 50 (22.5%), splintering objects 38 (17.1%) and machinery 32 (14.4%). About 65 (38.8%) injuries were occurred in the evening and about 46 (27.1%) in the afternoon. Regarding the day of injury, 20.6% of the workers injured on Saturday followed by Friday (18.8%) even though many workers (25.3%) did not remember the exact day of injury. Only 70 (41.25%) of the injured received medical treatment, whereas more than half 100 (58.8%) didn't have the opportunity. 127 (74.7%) of injured respondents lost their job within 1-30 days and 5 (2.9%) lost from job for 31-60 days **(Table 2).**

Working Environment and Behavioural Characteristics: Majority of workers 290 (65.5%), work for less than or equal to 48 hours and 153 (34.5%) of workers reported that they worked more than 48 hours per week. Most of the workers 358 (80.8%) worked at night shift for 3.25-3.75 days per week and 20 (4.5%) of them worked at night shift for 1- 3 days per week.

Out of 443 respondents 313 (70.7%) used Personal Protective Equipment (PPE) while 130 (29.3%) did not use while performing their job **(Figure 3).** The distribution of PPE: Gloves, Respirators, Helmet, Overalls, Goggles, Face shield and Boots among 313 PPE user respondents is shown in Figure 3.

The main reasons mentioned by the respondents for not using PPE were lack of PPE, 122 (93.8%), lack of safety and health education, 30 (23.1%), and not comfortable to use 31 (23.8%) **(Table 3).** Number of night shifts at work, work place regular supervision, safety training, drinking alcohol, chewing Khat, sleeping disorder, job satisfaction and use of PPE were statistically significant in bivariate analysis.

The result of multivariable logistic regression analysis: The prevalence of occupational injury among iron and steel factory workers were significantly associated with number of night shifts per

week, hours worked per week, safety training, sleeping disorder, job satisfaction and use of PPE. Those workers worked for 3.25-3.75 days per week at night shift were 2.14 times more likely to be injured than those workers didn't work at night shift [AOR: 2.14, 95% CI: (1.01, 4.51)]. However, no statistically significant association was found between workers worked for 1-3 days per week at night shift [AOR: 1.43, 95% CI: (0.36, 5.69)]. In addition, those workers who used to work ≤48 hours/week had less occupational injuries than those who used to work >48hours/week [AOR: 0.52, 95% CI: (0.300, 0.902)]. Also, workers who did not took safety training were 3.89 times more likely to have injury than those who took safety training [AOR: 3.89, 95% CI: (2.284, 6.612)].

Workers with sleeping disorder were 1.83 times [AOR: 1.83, 95% CI: (1.048, 3.186)] more likely to experience injury than workers without sleeping disorder. Job satisfaction showed statistically significant association with occupational injury; workers who didn't have job satisfaction were 2.12 times more likely to face injury compared to workers satisfied with their job [AOR: 2.12, 95% CI: (1.305, 3.460)]. Finally use of PPE shows significant association with occupational injuries. That is, workers reported not using PPE were 3.929 times more likely to be injured than their counterparts [AOR: 3.93, 95% CI: (2.270, 6.801)] (Table 4).

Table 2: Occupational injury characteristics of the workers at Bishoftu city Iron and steel factory, 2016

Variables	Frequency	Percent
Causes of Injury		
Machinery	32	14.42
Hit by falling objects	13	5.86
Electricity	1	0.45
Splintering objects	38	17.12
Hand tools	5	2.25
Fire and explosion	50	22.52
Hot metal contact	52	23.42
Falls	5	2.25
Collision with objects	17	7.66
Lifting heavy objects	8	3.60
Other	1	0.45
Time of Injury		
In the morning	23	13.5
In the afternoon	46	27.1
In the evening	65	38.2
In the midnight	36	21.2
Day of Injury		
Monday	5	2.9
Tuesday	13	7.6
Wednesday	18	10.6
Thursday	24	14.1
Friday	32	18.8
Saturday	35	20.6
Not remember	43	25.3
Hospitalized		
Yes	70	41.2
No	100	58.8
No. of days lost due to occupational injury in the last 12 month		
No	34	20
1-30	127	74.7
31-60	5	2.9
>61	4	2.4

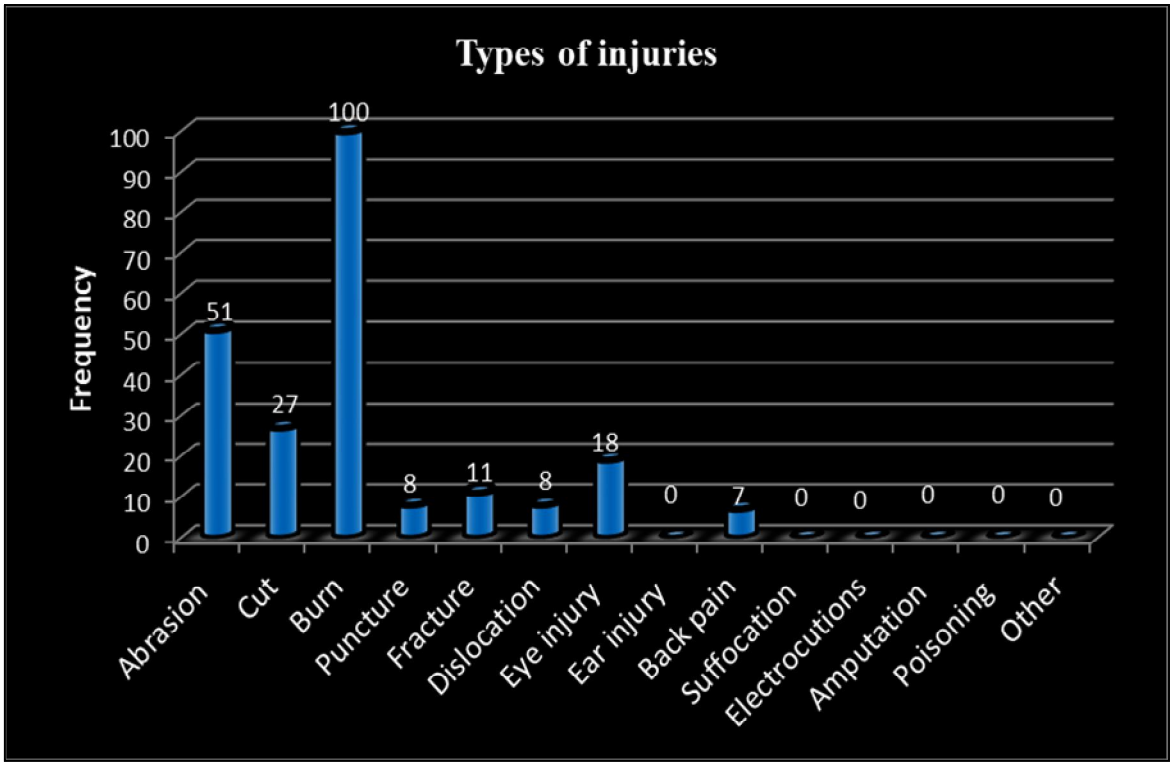

Figure 2: *Types of injuries of the workers at Bishoftu city Iron and Steel factory, 2016*

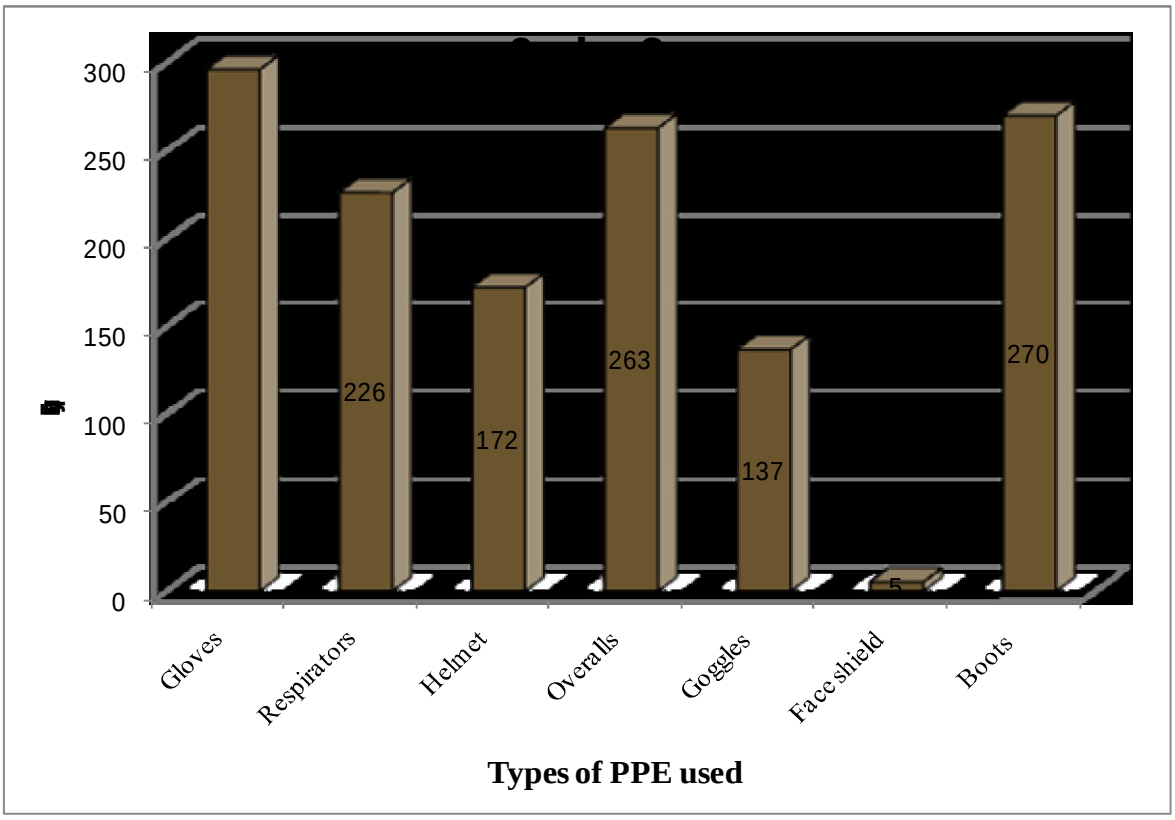

Figure 3: *Proportion of PPE used the workers at Bishoftu city Iron and Steel factory March, 2016*

Table 3: Working Environment and Behavioral Characteristics of the workers at Bishoftu city Iron and Steel factory, 2016

Variables	Frequency	Percent
Work place regular supervision		
Yes	362	81.7
No	81	18.3
Safety Training		
Yes	198	44.7
No	245	55.3
Drinking Alcohol		
Yes	125	28.2
No	318	71.8
Chewing Khat		
Yes	27	6.1
No	416	93.9
Smoking Cigarettes		
Yes	25	5.6
No	418	94.4
Sleeping Disorder		
Yes	98	22.1
No	345	77.9
Job Satisfaction		
Yes	264	59.6
No	179	40.4
Reasons for none use of PPE		
Lack of PPE	122	93.8
Lack of safety training	30	23.1
Not comfortable to use	31	23.8
Decrease work performance	6	1.4
Other	3	0.7

Table 4: Summary of the stepwise logistic regression analysis of the relative effect of work environment and behavioural factors on the prevalence of occupational injuries, Bishoftu City, 2016

	occupational Injury		Crude OR	Adjusted OR
	Yes	No	(95% CI)	(95% CI)
Job category				
Maintenance	30(44.8)	37(55.2)	1	1
Basic production	77(32.9)	157(67.1)	0.605(0.348, 1.052)	0.592(0.296, 1.182)
Foundry	63(44.4)	79(79.6)	0.984(0.548, 1.764)	0.853(0.407, 1.787)
No of night shift/week				
No	16(24.6)	49(75.4)	1	1
1-3	6(30.0)	14(70)	1.32(0.432, 3.984)	1.427(0.358, 5.696)
3.25-3.75	148(41.3)	210(58.7)	2.158(1.182, 3.942)*	2.138(1.014, 4.507)*
Hours worked /Week				
≤48	119(24.4)	171(59.0)	1	1
>48	51(33.3)	102(66.7)	0.718(0.477, 1.082)	0.520(0.300, 0.902)*
Work place regular supervision				
Yes	120(33.1)	242(66.9)	1	1
No	50(61.7)	31(38.3)	3.253(1.976, 5.355)***	1.093(0.581, 2.057)
Safety Training				
Yes	34(17.2)	164(82.8)	1	1
No	136(55.5)	109(44.5)	6.018(3.849, 9.411)***	3.886(2.284, 6.612)***
Drinking Alcohol				
Yes	57(46.0))	67(54.0)	1.528(1.003, 2.33)*	1.553(0.917, 2.63)
No	113(35.8)	203(64.2)	1	1
Chewing Khat				
Yes	15(57.7)	11(42.3)	2.279(1.021, 5.087)*	2.002(0.755, 5.311)
No	155(37.4)	259(62.6)	1	1
Sleeping Disorder				
Yes	57(58.8)	40(41.2)	2.900(1.826, 4.607)***	1.828(1.048, 3.186)*
No	113(32.9)	230(67.1)	1	1
Job Satisfaction				
Yes	67(25.4)	197(74.6)	1	1
No	103(57.5)	76(42.5)	3.985(2.656, 5.979)***	2.124(1.305, 3.460)**
Use of PPE				
Yes	85(27.2)	228(72.8)	1	1
No	85(66.9)	42(33.1)	5.429(3.476, 8.478)***	3.929(2.270, 6.801)***

DISCUSSION

In this study injury prevalence rate in iron and steel industry was found to be 384 workers per 1000 per year. A study conducted in Small and medium sized manufacturing industries in Gondar, a study conducted in iron and steel industries and a study conducted in large scale metal manufacturing industries showed the prevalence rate 335, 333 and 489 workers per 1000 exposed workers per year respectively[13,17,19]. A study in Japan showed the magnitude of occupational injuries of 385 workers per 1000 per year in small and medium sized manufacturing industries[20].

Regarding to severity which was measured by hospitalization/staying on bed and days away from work, the most severe condition was found to be hospitalization or stayed at home bed, 70 (41.2%), with 127 (74.7%) of injured respondents lost their job 1-30 days due to injury[13,18,19].

The most frequently injured body parts in this study were Lower arms (25.8%), lower limb (16.8%), Fingers (15.2) and upper arms (7.8%). Most frequent type of injury reported were burn followed by abrasions and cut. This may be due to more involvement of these particular body parts while working, exposure to hot metals, fire explosions, splintering objects and machineries. Further human failure such as lack of complying with safety rules is also responsible for such high prevalence of injuries in iron and steel industry. About 29.3% workers were found to be not using PPE which may be another reason for such body parts injuries. Studies carried out in steel companies in Iran, Brazil and studies carried out in iron and steel industries in Ethiopia reported similar findings and reasons[8,9,17,19].

Many Researches showed that several factors were related to the occurrence, severity, and types of injury. Socio-demographic factors, working environment variables, worker's behaviour and organizational factors are the possible risk factors for workers to be injured in workplace of manufacturing industries including iron and steel manufacturing industries[13,17,18,20–23] .

Sex of the worker showed significant association with magnitude of occupational injury when adjusted for all variables. However this study showed that sex is not significantly associated with occupational injuries [13,20,22,24]. This is because there are only 11 (2.5%) female workers from 443 study subject.

Some findings showed that age is significantly associated with magnitude of occupational injuries in which all showed the younger the age group the greater injury rate [13,18,20,25]. However, this study showed that age is not significantly associated with occupational injury. This could be because almost all of the workers were at young age in this study. Educational status was not also significantly associated with magnitude of occupational injuries when adjusted all variables of interest. This is not also consistent with the study[22,24]. This implied that education may not a guarantee for not being injured but safe practice.

Regarding the work environment factors, hours worked per week were showed significant association with occupational injury. This is consistent with other studies done in Ethiopia[13,18]. Similarly, numbers of night worked per week also showed significant association with occupational injury. This result also correlates with other studies [20,22]. Safety and health training showed significant association with

occupational injury. It is consistent with other findings [13,18]. The occurrence of occupational injury was significantly related to sleeping disorder. That is, sleep disorder affects the ability to maintain wakefulness, concentration, ability in assessing or watching the work environment and working conditions and performing duties and health status. Most occupational health and safety studies conducted in developing and developed countries strongly agree with this report[3,13,20,25,25].

An increasing number of studies have considered job satisfaction and use PPE as pervasive and influential factors in the occurrence of work-related injuries in the work environment [13,18,24,25].

It shows that the important of health and safety education about proper and consistent use of PPE, and work-related injury decreased with job satisfaction. This study has the following limitations. The study was a one-year cross-sectional study. The possibility of recall biases resulting in under or over reporting and misreporting of events are likely. Study participants might have also perceived that responding as injured could bring benefits and failed to report socially sensitive information.

CONCLUSION

The present study showed that occupational injury was common among iron and steel industries and were associated with preventable and modifiable factors such as Number of night shifts per week, hours worked per week, safety training, sleeping disorder, job satisfaction and use of PPE. Occupational health service coverage in Iron and Steel industry should get attention from government to design strategy needed for the prevention and control of occupational injuries.

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Competing interests: The author(s) declare that they have no competing any competing interests.

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