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Research Article

Work Related Injuries and Some Associated Risk Factors among Workers in Iron and Steel Industry

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Abstract: Workers employed in iron and steel industries are at greater risk for nonfatal injuries due to very complex nature of production processes, material handling and other related functions of iron and steel making. The present cross-sectional descriptive study was carried out between Jul 2013 and Dec 2014 to assess the magnitude of injuries and some associated risk factors among 200 workers in Iron and Steel Industry in Nanded City (Maharashtra-India). History of work related injuries, associated risk factors and use of PPE was obtained as per the predesigned and pretested questionnaire and supplemented by clinical examination and by reviewing medical records. Data was analyzed by using Open Epi 3.03 version. 51.5% workers belonged to continuously exposed group (RMS, SMS, QCD) while 48.5% to intermittently exposed group (MAIN and ADMIN). Mean age of the workers was 35.26±8.66 years. Injury prevalence rate in this industry was found to be 61.50%. History of injury was present in 68.93% workers in continuously exposed group and 53.61% workers in intermittently exposed group. The most frequently injured body parts were hands (45%), lower limb (7.5%) and both lower and upper limb (7.5%). Most frequent type of injury reported were superficial injuries followed by burns and laceration. Significant statistical association was found between injury and continuously exposed departments, addiction of alcohol and exposure to heat. The study demonstrated a high rate of work related injuries. The industry should display safety information at appropriate places, provide training and promote and enforce use of PPE among workers.
Keywords: Work related injuries, Work related hazards, Personal protective equipments, Iron and steel industry

INTRODUCTION

All occupational environments have a certain degree of work related hazards and each working environment is unique in the nature and degree of hazards it poses to workers [1].

In the steel and iron industry hazards are inherent because of giant plants, massive equipments and movement of large masses of materials. Workers are exposed to high level of noise, temperatures up to 1,800°C, vibration, toxic or corrosive substances, respirable air-borne contaminants, chemical hazards including vapours and fumes etc. and a heavy load of occupational injuries [2]. Metal chips and welding arc rays are identified as causes of eye injury in steel industry. Ocular injuries vary from mild to severe which could threaten vision [3].

Occupational injuries are one of the most important health problems in iron and steel industries. Every year about 2.2 million people die from unintentional injuries at work and work related diseases in this world [4].

In developing countries the workplace fatal injury rates are found to be 3-4 times higher than the developed ones [5].

Workers employed in iron and steel industries are at greater risk for nonfatal injuries and illnesses due to very complex nature of production processes, material handling and other related functions of iron and steel making [6].

WHO has reported that there are 100 million occupational injuries in India that cause 0.1 million deaths. It has been estimated that 17 million occupational nonfatal injuries (17% of the world) and 45000 fatal injuries (45% of the total deaths due to occupational injuries in world) occur each year in India [7, 8].

Health at work and healthy workforce are amongst the most valuable assets of community and country. Healthy work environment contributes positively to the economic growth of any nation through improved productivity, quality of product, work motivation, satisfaction of job and overall quality of the workers life and society [9].

Therefore the present study was carried out to assess the magnitude of injuries and their associated risk factors among the workers in Iron and Steel Industry in Nanded City (Maharashtra-India)

MATERIALS AND METHODS

The present cross-sectional descriptive study was carried out in an Iron and steel Industry in MIDC area of Nanded city of Maharashtra (India) between Jul 2013 and Dec 2014.

Present study included all 200 workers, both administrative and working staff of this iron and steel industry since all these staff members were working in the same campus.

To begin with the study, necessary permission was taken from general manager of the industry and cooperation was assured by him. The purpose of the study was explained to the workers. Repeated visits were given to industry and rapport was developed.

Industry has 5 sections where the different procedures were carried out.

- Rolling mill section (RMS): In this section solid material from SMS section is passed through hot rolling mill.
- Steel melting section (SMS): In this section continuous casting of molten metal with complete stream shrouding is done
- Quality control Department (QCD): Here product is inspected, metallurgically tested and then put in the peeling bed of sulfuric acid to remove rust and clear the small holes.
- Maintenance department (MAINT): All materials including mechanical and electrical machineries are kept here and handled by store boy and electrician.
- Administrative department (ADMNS): All administrative function of a factory is done here.

For analysis and internal comparison Steel melting section, Rolling mill section and Quality control section were taken together as continuously exposed group and Maintenance and Administrative section as intermittently exposed group.

Ethical clearance was obtained from Institutional ethical committee. Informed verbal consent was obtained from each participant after the researcher provided a clear explanation of the study purpose. Confidentiality of the data was maintained throughout the study period.

A pretested and structured questionnaire was used to collect socio demographic, behavioural characteristics and work related injuries among the workers in last one year. Clinical examination was done to identify affected body parts and types of injuries. Medical records were also reviewed. Information was also gathered about their occupation, its type, section of work, etc.

They were also asked about the various protective equipment (PPE) available in the industry, whether they were using them or not, if not then what were the reasons and about their replenishment.

Statistical Analysis

Data was entered into excel sheet and analyzed by using Open Epi 3.03 version. Chi square test was applied to find out the significance. Percentage, mean and standard deviation were also calculated.

RESULTS

There were total of 200 workers, all males, working in the industry as permanent employee. Out of them 33(16.50%) were in Steel Melting Section, 45 (22.50%) in Rolling Mill Section, 25 (12.50%) in Quality control section, 81 (40.50%) in maintenance and 16 (08.00%) in administrative department. Out of 200 workers 103 (51.50%) workers belong to the continuously exposed group i.e. Rolling Mill Section, Steel melting Section and Quality Control Department while 97 (48.50%) belong to intermittently exposed group i.e. Maintenance and Administrative Department (Table 1).

Out of 200 workers, 75 (37.50%) belonged to the age group of 30-39 years, and only 03 (01.50%) to age of 60 years. Youngest worker among them was 20 years of age and eldest of 60 years of age who belong to Rolling Mill Section. Mean age of the workers was 35.26±8.66 years.

Table 2 shows the section wise distribution of workers according to the history of injury in last one year. It had been observed that out of 200 workers, 123(61.50%) workers had history of work related injuries in last one year resulting into the prevalence rate of 61.50%. It was found that in continuously exposed group (SMS, RMS and QCD Department) 68.93% of the workers had history of injury while in intermittently exposed group (MAIN and ADMNS department) 53.61% of the workers had history of injury. The difference between the history of injury among continuously exposed group and intermittently exposed group was found to be significant (x^2=4.954 df-1, p-value-.0260).

Table1: Age wise distributions of workers in various sections

Age in years	Continuously exposed group			Intermittently exposed group		Total (200)
	SMS (33)	RMS (45)	QCD (25)	MAINT (81)	ADMNS (16)	
20-29	13(39.39)	10(22.22)	04(16.00)	32(39.50)	01(06.25)	60(30.00)
30-39	14(42.42)	12(26.67)	15(60.00)	27(33.33)	07(43.75)	75(37.50)
40-49	04(12.12)	19(42.22)	05(20.00)	16(19.75)	05(31.25)	49(24.50)
50-59	02(06.06)	02(04.44)	01(04.00)	05(06.71)	03(18.75)	13(06.50)
60	00(00.00)	02(04.44)	00(00.00)	01(01.23)	00(00.00)	03(01.50)
Mean ±S.D.	33.18±7.78	37.71±9.45	35.56±6.53	33.49±8.57	40.44±8.07	35.26±8.66

Table 2: Section wise distribution of workers according H/O injury in last one year

History of injury	Continuously exposed group			Intermittently exposed group		Total	p-value
	SMS	RMS	QCD	MAIN	ADMNS		
Yes	16(48.48)	36(80.00)	19(76.00)	50(61.71)	2(12.50)	123(61.50)	.0260
No	17(51.51)	09(20.00)	06(24.00)	31(38.27)	14(87.50)	77(38.50)	

Table 3: Section wise distribution of workers according to type of injury

Type of injury	Continuously exposed group			Intermittently exposed group		Total (200)
	SMS(33)	RMS(45)	QCD(25)	MAIN(81)	ADMNS(16)	
Superficial	11(33.33)	33(73.33)	15(60.00)	42(51.85)	02(12.50)	103(51.50)
Burns	04(12.12)	00(00.00)	00(0.00)	00(00.00)	00(00.00)	04(02.00)
Lacerations	01(00.00)	03(06.67)	04(04.00)	08(04.94)	00(00.00)	16(04.00)

It had been found that out of 200 workers, 103 (51.50%) workers had superficial injuries, 04 (02.00%) had injuries due to burns and 16 (04.00%) had lacerations. All the 04 burn cases had occurred in steel melting section (Table 3).

From table 4 it had been observed that among 200 workers the commonest site were limbs 116 (58.00%), among them hands were involved in 90 (45.00%) workers. Lower limbs were involved in 13 (07.50%) workers and both upper and lower limbs in 13(07.50%) workers. Injury to eye and head occurred in 8 (04.0%) and 3 (1.5%) workers respectively.

History of hand injury was maximum in workers working in RMS (60.00%) followed by QCD (56.00%), Maintenance (45.68%), SMS (33.33%) and Administration (06.25 %).

Table 4: Section wise distribution of workers according site of injury

Site of injury	continuously exposed group			Intermittently exposed group		Total
	SMS(33)	RMS(45)	QCD(25)	MAIN(81)	ADMNS(16)	
Hands	11(33.33)	27(60.00)	14(56.00)	37(45.68)	01(06.25)	90(45.00)
Lower Limbs	02(06.06)	05(11.11)	00(00.00)	05(06.17)	01(06.25)	13(07.50)
Both Upper & Lower Limbs	03(09.09)	04(8.89)	02(08.00)	04(04.94)	00(00.00)	13(07.50)
Eye	00(00.00)	00(00.00)	03(12.00)	05(06.17)	00(00.00)	08(04.00)
Head	00(00.00)	00(00.00)	00(00.00)	03(03.70)	00(00.00)	03(01.50)

Table 5: Section wise distribution of workers according to type of protective devices they are using

Protective devices	Continuously exposed group			Intermittently exposed group		Total
	SMS(33)	RMS(45)	QCD(25)	MAIN(81)	ADMNS(16)	
Safety shoes	31(93.94)	41(91.11)	22(88.00)	71(87.65)	7(43.75)	172(86.00)
Helmet	15(45.45)	24(53.33)	11(44.00)	26(32.10)	03(18.75)	79(39.50)
Gloves	17(51.52)	28(62.22)	10(40.00)	23(28.40)	04(25.00)	82(41.00)
Mask	00(0.00)	00(0.00)	02(8.00)	04(4.94)	00(00.00)	06(03.00)
Safety belt	00(0.00)	00(0.00)	00(0.00)	01(1.23)	00(00.00)	01(00.50)
Goggles	00(0.00)	00(0.00)	01(4.00)	08(9.88)	01(06.25)	10(05.00)

Table 5 shows the type of protective devices used by the workers in various sections. Out of 200 workers, 172(86.00%) were using safety shoes. Helmet was used by 79 (39.50%) workers. 82 (41.00%) workers were using gloves. Mask and goggles were used by 06 (03.00%) and 10(05.00%) workers respectively. One worker (0.50%) was using safety belt.

Safety Shoes were used most commonly by the workers of SMS i.e. 93.94% followed by RMS i.e.

91.11%, QCD i.e. 88.00%, MAIN i.e.87.65% and least commonly by the workers of administrative department i.e.43.75%.

In table 6 various reasons for not using the protective devices had been mentioned. Out of 200 workers, 24 (12.00%) said that devices were not available for them, 23 (11.50%) said that they do not consider necessary to use the protective device during their work, 22 (11.00%) said that they do not require protective device in their work while 16(08.00%) were not comfortable with using the device.

Regarding training for the use of protective devices out of 200 workers, 94 (47.00%) said that they got the training for the use of personal protective devices while 106 (53.00%) denied of any training for the use of personal protective equipments.

The Table 8 shows the relationship between the use of protective devices and the occurrence of injury among the workers.

It had been observed that out of 57 (52.63%) workers who were not using the personal protective device (PPE) 30(52.63%) had history of injury. It was also observed that out of 143 workers who were using PPE, 93 (65.03%) had history of injury. No significant difference was found between non use of PPE and occurrence of injuries (X^2=7181, df-1, p= .3968).

Table 9 shows that out of 104 workers who were addicted for alcohol, 73 (59.34%) gave history of work related injuries. While out of 96 workers who did not drink alcohol, 50 (40.66%) had history of injuries. The relationship between addiction and injury was found to be significant that more people with addiction had more history of injur (x^2= 6.914, df=1,p-value .0086).

In this industry out of 127 workers exposed to high temperature, 98 (77.17%) had history of injured while out of 73 workers who were not exposed to heat 26 (64.38%) gave history of injury in industry. The association between history of heat exposure and history of injury was significant (x^2=33.97, df=1, p-value <.0001).

Table 6: Reasons for not using protective devices by workers of various sections

Reasons	Continuously exposed group			intermittently exposed group		Total
	SMS(33)	RMS(45)	QCD(25)	MAINT(81)	ADMNS(16)	
Not available	05(15.15)	05(11.11)	03(12.00)	11(13.58)	00(00.00)	24(12.00)
Not consider necessary	04(12.12)	07(15.56)	05(20.00)	08(09.88)	01(6.25)	23(11.50)
Not comfortable	04(12.12)	01(02.22)	04(16.00)	07(08.64)	00(00.00)	16(08.00)
Not required	00(0.00)	02(04.44)	01(04.00)	11(13.58)	08(50.00)	22(11.00)
Careless	00(0.00)	00(00.00)	00(00.00)	00(00.00)	01(06.25)	01(00.50)

Table 7: Training of the workers in various sections for using protective devices

Training	Continuously exposed group			Intermittently exposed group		Total
	SMS	RMS	QCD	MAINT	ADMNS	
Yes	16(48.48)	28(62.22)	14(56.00)	26(32.10)	10(62.50)	94(47.00)
No	17(51.52)	17(37.78)	11(44.00)	55(67.90)	6(37.50)	106(53.00)

Table 8: Relation between use protective devices and occurrence of injury

Protective device	Injured	Not injured	Total	p-value
Using	93(65.03)	50(34.97)	143(71.50)	.3968
Not Using	30(52.63)	27(47.37)	57(28.50)	
Total	123	77	200(100.0)	

Table 9: Relation between alcohol addiction and occurrence of injury among workers

	Addicted	Not addicted	Total	p-value
Injured	73(59.34)	50(40.66)	123(61.5)	.0086
Not Injured	31(40.25)	46(59.75)	77(38.5)	
Total	104	96	200	

Table 10: Relation between injury and heat exposure among the workers of various sections

Injured	Exposed To Heat	Not Exposed to Heat	Total	p-value
Yes	98(77.17)	26(35.62)	124(62.00)	<.0001
No	29(22.83)	47(64.38)	76(38.00)	
Total	127	73	200	

DISCUSSION

In the present study injury prevalence rate in iron and steel industry was found to be 61.50%. It is higher than that is reported by Mazaheri *et al*. [10] which might be due to variation in work place, technology and environmental conditions. The most frequently injured body parts in this study were hands (45%) , lower limb (7-5%) and both lower and upper limb (7.5%). Most frequent type of injury reported were superficial injuries followed by burns and laceration. This may be due to more involvement of these particular body parts while work, exposure to unguarded machines, tools and instruments, hot metals and chemicals. 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 28.5% 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 Iran10 and Brazil [11] reported similar findings and reasons. In the present study, no statistical significant relation was found between injuries and non use of PPE. This might be due to irregular use of these PPE or its improper use in these workers. It is also found that workers who had habit of alcohol drinking were more likely to be injured than workers who did not drink alcohol. Alcohol drinking can increase the risk of injury through engaging in risk taking behaviour or reducing the perception and response off to hazards. It is also found that direct heat might cause burn injuries while indirectly it may lead to exhaustion and poor concentration leading to more injuries among the workers. Similar findings were also observed by Bezroy *et al*. [12] and Tsawatsupa *et al*. [13].

This needs to impart health education about proper and consistent use of PPE, avoidance of work while under influence of alcohol and to follow safety rules while working in such work places.

CONCLUSION

The study demonstrated a high rate of work related injuries. The industry should display safety information at appropriate places, provide training and promote and enforce use of PPE among workers. The industries should established occupational health and safety programs.

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