FACTA UNIVERSITATIS
Series: **Working and Living Environmental Protection** Vol. 2, N^{o} 5, 2005, pp. 477 - 484

OCCUPATIONAL INJURIES IN METALIC ORE MINING

UDC 613.6:622.861

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Summary. *The aim of this study is to examine the factors that contribute to occupational injuries in metallic ore mining. The number of injuries was highest on Monday, in January, between 8 a.m. and 10 am and between 4 pm and 6pm. Most of the injuries occurred in first and second shifts. Most of the injuries involved employees with less than one year of experience in their job. The number of occupational injuries is inversely related to age and worker education levels. The leading causes of injuries were being struck by objects or being pressed. Upper and lower extremities were the body parts most often affected. Contusions, lacerations and closed fractures were the most frequent injury types. These results are important for the control and prevention of occupational injuries.*

Key words: *Occupational injury, miners, metallic ore mining*

INTRODUCTION

Traumatic occupational injuries are one of the 21 priority areas identified under the National Occupational Research Agenda, because the associated economic costs are high, costing the nation more than AIDS and as much as cancer and heart disease [1,2,3]. Intrajob workload, psychosocial factors and organizational factors are potential risks for work related injuries [4]. Machinery-related incidents were the second leading cause of traumatic occupational fatalities in the United States [5].

Miners are exposed to numerous hazards in the workplace, such as electrical hazards, flooding, explosive agents, the risk of asphyxia, face and roof collapses, noise, vibrations, exposure to dust and in some cases, poor illumination and ventilation. It is then no wonder that the mining industry is one of the most hazardous industries in the greatest number of countries [6,7]. Limited information is available on a national level regarding the incidence of mining injuries in our country.

Received October 11, 2005

AIM

The purpose of this study is to estimate the number of and average annual injury rate, to describe the circumstances of the injuries in the period between 1994 and 2002 in metallic ore mining. The study seeks to examine the factors that contribute to occupational injuries in metallic ore mining.

MATERIALS AND METHODS

This paper presents a descriptive analysis of occupational injuries involving in metallic ore mining over a nine year period. An injury was defined as occupational if it occurred while working for compensation, on or off the employer's premises, while arriving or leaving work, on a break if on the employer's premises or working as a volunteer. All injuries, which have resulted in at least one day's absence from work after the day of the injury, formed the basis of the analyses. When the injury occurs, data is entered by the management representatives of the safety department and the plant's medical staff. The data set includes information on employee characteristics (e.g. sex, age, education, hours, working experience), characteristics of the workplace and event (e.g. location, date and time of injury), description of the injury (injury type and body part injured) and outcome (lost days, days on which employees reported to work but were assigned light or alternative duties). All injuries analyzed must have met one or more of the following conditions: it required medical treatment brought loss of consciousness, restriction of work or motion, transfer to another job or it resulted in death. The circumstances of each incident were reviewed using variables in the database, including the narrative description of "how the injury occurred", the nature of the injury, the injured worker's job title, and recommendations to prevent future occurrences. External causes of the injury in the database were based on codes from the International Classification of Diseases [8], excluding only suicide and medical misadventure. Injuries were classified in terms of the general environment in which they occur, the general mechanisms of injury (motor vehicle collisions, falls etc.), or the contributing behavior of the human factor. For the annual injury rate calculation, the number of injuries was divided by the average number of employed workers in that year and multiplied by 100.

RESULTS

There were 642 work related traumatic injuries (5 fatal and 637 non fatal) for the period 1994-2002 that occurred in metallic ore mining. The highest average annual injury rates were in 2000 (6.01/100) and 2002 (5.51/100), and the lowest rate were in 2001 (2.84/100) and 1996 (3.6/100) (Table 1). These injuries numbered 567 in total that occurred in the workplace, 52 that occurred on the road while working and 23 that occurred during journeys to and from work, mostly on the road (Table 2). The most common location of the fatal incidents were underground workplaces (80%). The most common cause of deaths underground was a result of wall or roof collapse (100%). The number of injuries was highest on Monday (Table 3). Distribution of injuries according to the months of the year showed four peaks: in January, February, September and May (Table 4). Most of the injuries occurred during the

first and second shifts (Table 5). About one third of the injuries (28.8%) involved employees with less than one year of experience in their job (Table 6). theistribution of injuries according to the age of the injured workers shows that the most injuries happened to workers under the age of 20. The number of injuries decreased with the age of the victims (Table7). The number of occupational injuries is inversely related to worker education levels (Table 8). The greatest number of injuries occurred between 8 a.m. and 10 a.m. (12.3%), and between 4 and 6 p.m. (11.4%). Less than eight percent of the injuries occurred between 6 p.m. and 6 a.m. (Table 9). The leading causes of injuries during the examined period were being struck or pressed by objects (Table10). Upper and lower extremities were the most frequently affected body parts (Table11). Contusions, lacerations and closed fractures were the most frequent injury types (Table 12).

Table 1. The number and average annual rate (per 100 workers) of occupational traumatic injuries for the period 1994-2002 in metallic ore mining

Years	Number	Average annual rate
1994	69	4.5
1995	96	6.1
1996	67	3.6
1997	75	4.4
1998	80	4.8
1999	58	4.1
2000	93	6.0
2001	41	2.8
2002	63	5.5
Total	642	

Table 2. The distribution of injuries according to the type of location of the accident

Location	Number	Percent
Injuries at the workplace	567	88.3
Injuries in traffic at work	52	8.1
Commuting injuries	23	3.6
Total	642	100.0

Table 3. The distribution of injuries according to the day of the week

Day of the Week	Number	Percent
Monday	151	23.5
Tuesday	115	17.9
Wednesday	89	13.8
Thursday	83	12.9
Friday	90	14.0
Saturday	51	7.9
Sunday	63	9.8
Total	642	100.0

Table 4. The distribution of injuries according to the month of the year

Month	Number	Percent
January	69	10.7
February	68	10.6
March	51	7.9
April	52	8.1
May	67	10.4
June	53	8.2
July	49	7.6
August	40	6.2
September	68	10.6
October	42	6.5
November	41	6.4
December	42	6.5
Total	642	100.0

Table 5. The distribution of injuries according to shift

Shift	Number	Percent
First	314	48.9
Second	232	36.1
Third	96	14.9
Total	642	100.0

Table 6. The distribution of injuries according to the work experience of the injured workers

Work experience(Years)	Number	Percent
Less than 1	185	28.8
1-9	121	18.8
10-19	104	16.2
20-29	135	21.0
30-39	97	15.1
Total	642	100.0

Table 7. The distribution of injuries according to the age of the injured workers

Age (Years)	Number	Percent
Under 20	126	19.6
20-29	119	18.5
30-39	118	18.4
40-49	109	16.9
50-59	97	15.1
Over 60	73	11.4
Total	642	100.0

Table 8. The distribution of injuries according to the education level of the victims

Education Level	Number	Percent
Primary School	287	44.7
Secondary School	218	33.9
High School	98	15.3
College Level	39	6.1
Total	642	100.0

Table 9. The distribution of injuries according to the time of day

Hour of the day	Number	Percent
00-02	31	4.8
02-04	34	5.3
04-06	49	7.6
06-08	71	11.1
08-10	79	12.3
10-12	64	9.9
12-14	62	9.7
14-16	54	8.4
16-18	73	11.4
18-20	47	7.3
20-22	43	6.7
22-24	35	5.5
Total	642	100.0

Table 10. Causes of the injuries

Cause	Number	Percent
Fall from height	22	3.4
Fall on some level	95	14.8
Pressed by mechanical equipment or other objects	187	29.1
Traffic accidents	21	3.3
Struck by flying or falling objects	169	26.3
Collision	118	18.4
Electrocution	15	2.3
Eruption or explosion	8	1.2
Poisoning	7	1.1
Total	642	100.0

Table 11. The classification of injuries according to the injured part of the body

Part of the body	Number	Percent
Head	58	9.0
Eye	47	7.3
Neck	41	6.4
Internal organs	45	7.0
Upper extremities	224	34.9
Lower extremities	195	30.4
Multiple locations	32	4.9
Total	642	100.0

Table 12. The classification of injuries according to the type of injury

Type of injury	Number	Percent
Contusions	273	42.5
Lacerations	87	13.6
Closed fractures	79	12.3
Open fractures	33	5.1
Sprains/Strains	63	9.8
Ruptures and tears of joints and ligaments	55	8.6
Ruptures and tears of internal organs	5	0.8
Burns	43	6.7
Poisoning by gases	4	0.6
Total	642	100.0

DISCUSSION

To understand the risk factors of occupational injuries and to develop prevention and control strategies, it is essential to know about and learn from past occupational injuries. Here we report on the epidemiology of occupational injuries occurring in metallic ore mining from 1994 to 2002. The injury certificate data identified 642 metal ore workers who were injured in occupational accidents over the examined period. The circumstances of these 642 injuries provide valuable information that can be used to prevent occupational injuries in metallic ore mining. Because of the multiple factors that contribute to most of the injury causing events, epidemiologic methods offer a useful approach for identifying risk factors that contribute to injuries. Epidemiological methods are valuable for identifying key risk factors for work related injuries and assessing their magnitude. Over a period of nine years, the average annual rate of occupational accidents has not gone through a significant decrease, despite some of the structural, technological changes and organizational transformations. The most common location of injuries was in the workplaces. The most common location of fatal incidents was underground, and the most common cause of deaths was wall or roof collapse. Similarly, a South African study of mining fatalities found that cave-ins of earth and other material were the most common cause of fatal injuries in an underground environment [7]. Transport to and from the mine accounted for many of the mining injuries. Therefore, transport is part of the sphere of activities over which occupational health and safety obligation should be seen to extend.

Most injuries occurred on Monday and Thursday, and there were peaks in the injury rate in May, September, January and February. These results are similar to the results obtained by other authors [9]. The circumstances and number of injuries varied across shifts, probably because the first and second are typically production shifts while the third concentrates primarily on maintenance activities. One third of the workers had one or more occupational injuries in their first year of employment. These results are similar to those of other authors [10]. A lack of work experience can be a contributing factor in the development of occupational injuries. The relevant training that new workers received and timely accurate education are needed to prevent occupational injuries [11]. Efforts to prevent occupational injuries among new workers will benefit from actions of the employers, regulatory agencies, the community at large, and young workers themselves. Employers can develop safety training programs that address the young workers' potential lack of experience and skills in recognizing and responding to hazards. School work programs have traditionally been focused on high skill jobs rather than the types of workplaces where youths are more likely to gain employment. The requirements for becoming a skilled worker include meeting physical requirements for vision, hearing and coordination, participating in industrial vehicle training, and passing a test of knowledge and ability for the job. As part of every employee's safety training, each employee should be made aware of the hazards associated with that job. Safe working practices and rules should be clearly explained to workers and enforced when appropriate. It would be useful to help supervisors know and understand the safety rules they are responsible for enforcing. Safety talks are part of the ongoing safety.

One of the key findings in this study indicates that the injury rate is highest among the youngest workers. More than 55% of the injuries involved workers who were 40 or younger. The risk of occupational injuries is inversely related to a worker's age and education level, which is in accordance with the data obtained from various kinds of literature

[10, 12, 13, 14]. Young workers may be at an increased risk for injuries in the workplace because they are often new to the job, inexperienced, commonly unaware of their legal rights as workers. Compared with older workers, young workers tend to move in and out of the workforce and are usually employed in part time, low paying jobs [15]. Youth employment also tends to be seasonal, peaking during the summer months [16,17]. The seasonal and sporadic nature of youth employment, along with frequent job changes, make it difficult for young workers to obtain the sustained mentoring and experience needed to perform their job safely. It has been well established that age is associated with employee work well-being and job satisfaction in particular [18]. In general, older workers tend to be better adjusted to work, as reflected in their job satisfaction. Older workers could be more knowledgeable and experienced, displaying more positive attitudes to safety, and possibly more committed to work and willing to comply with safety regulations than younger workers.

The time of day when the injuries occurred revealed a peak between 6am –10am and between 4pm-6pm. However, the peak injury times for mining are similar to the peak injury times from a study of work injuries and time of day at an industrial worksite [19] and for the peak incident time in the forest industry [20]. These peaks in incident frequency for a particular time of day may simply reflect a higher number of persons working at those times rather than changing circumstances during the day. The peaks in incident times could also be the result of different operations being performed at different times of the day, or might be due to changes in worker behavior. Without the information concerning the number of workers employed at particular times of the day or the information regarding the exact operations performed at different periods throughout the day, it is difficult to comment on the effects of the time of day on the incidence of mining injuries [21].

The most common causes of injury was being struck or pressed by objects. Upper and lower extremities were the most frequently affected body parts. Contusions, lacerations and closed fractures were the most frequent injury types. These findings are similar to the results of the other authors [10,13].

CONCLUSION

It should be acknowledged that the metallic ore mining industry presents one of the more hazardous industries around. The ongoing national collection of data regarding both fatal and nonfatal injuries in the mining industry has been advocated. Prevention oriented software for surveillance and disability management must generate case level measures of the magnitude and severity of the occupational injuries. In conjunction with an explicit case definition, screening criteria for case follow-up, and guidelines for medical, disability and health and safety management, software can play a significant role in prevention. Everything that has been mentioned is important for the control and prevention of occupational injuries in metallic ore mining.

REFERENCES

1. NIOSH. National Occupational Research Agenda. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. DHHS (NIOSH) Publication 1996; 96: 115-125.

2. NIOSH. National Occupational Research Agenda Update. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. DHHS (NIOSH) Publication 1997; 97: 138-147.
3. Leigh PJ, Markowitz SB, Fahs M, Shin C, Landrigan PJ. Occupational injury and Illness in the United States: estimates of costs, morbidity, and mortality. Arch Intern Med 1997; 157: 1557-1568.
4. Simpson CL, Severson RK. Risk of injury in African American hospital workers. J Occup Environ Med 2000; 42(10): 1035-1040.
5. Pratt SG, Kisner SM, Helmkamp JC. Machinery related occupational fatalities in the United States, 1980 to 1989. J Occup and Environ Med 1996; 38(1): 70-76.
6. Bennett J., Passmore D. Corelates of coal mine accidents and injuries: a literature review. Accid Ann Prev 1994; 16(1): 37-45.
7. Leger J. Trends and causes of fatalities in South African mines. Safety Sci 1991; 14: 169-185.
8. WHO. International Classification of Diseases: Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death. Tenth revision, Geneva, Switzerland, 1997.
9. Ivens UI, Lassen JH, Kaltoft BS, Skov T. Injuries among domestic waste collectors. Am J Ind Med 1998; 33(2): 182-189.
10. Barreto SM, Swerdlow AJ, Schoemaker MJ, Smith PG. Predictors of first nonfatal occupational injury following employment in a Brazilian steelworks. Scand J Work Environ Health 2000; 26(6): 523-528.
11. Brandt VA, Moon S, Ehlers J, Methner MM, Struttmann T. Exposure to endosulfan in farmers: two case studies. Am J Ind Med 2001; 39(6): 643-649.
12. Bull N, Riise T, Moen BE. Compensation for occupational injury and disease in Norway: ranking of job groups. J Occup Environ Med 2000; 42(6): 621-628.
13. Bull N, Riise T, Moen BE. Occupational injuries to fisheries workers in Norway reported to insurance companies from 1991 to 1996. Occup Med 2001; 51(5): 299-304.
14. Crandall CS, Fullerton L, Olson L, Sklar DP, Zumwalt R. Farm-related injury mortality in New Mexico, 1980-91. Accid Anal Prev 1997; 29(2): 257-261.
15. Castilo DN, Davis L, Wegman DH. Young workers. Occup Med 1999; 14: 519-536.
16. Rubenstein H, Sternbach MR, Pollack SH. Protecting the health and safety of working teenagers. Am Fam Physician 1999; 60(2): 575-580.
17. Dunn KA, Runyan CW, Cohen LR, Schulman MD. Teens at work: a statewide study of jobs, hazards, and injuries. J Adolesc Health 1998; 22(1):26-28.
18. Siu OL, Phillips DR, Leung TW. Safety climate and safety performance among construction workers in Hong Kong: the role of psychological strains as mediators. Accid Ann Prev 2003; 958: 1-8.
19. Webb G, Redman S, Sanson Fisher R. Work injury experience at an industrial worksite. Journal of Occup Health and Safety-Australia and New Zealand 1992; 8(2): 143-153.
20. Driscoll T, Ansari G, Harrison J, Fromer M, Ruck E. Traumatic work related fatalities in forestry and sawmill workers in Australia. Occup Environ med 1995; 51: 612-616.
21. Williamson A, Feyer A. Causes of accidents and time of day. Work and Stress 1995; 9(2): 158-164.

POVREDE NA RADU U RUDNICIMA RUDE METALA

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Cilj rada je istraživanje faktora koji mogu doprineti pojavi povreda na radu u rudnicima rude metala. Najveći broj povreda se događa Ponedeljkom, između 8 i 10 sati i između 16 i 18 sati, tokom meseca Januara i u vreme prve i druge radne smene. Najčešće se povređuju radnici sa radnim iskustvom manjim od godinu dana. Broj povreda na radu je obrnuto proporcionalan starosti i školskoj spremi radnika. Najčešći uzroci povreda su udari ili nagnječenja predmetima. Povredama su najčešće zahvaćeni gornji i donji ekstremiteti. Nagnječenja, razderne rane i zatvorene frakture su najčešće vrste povreda. Ovi rezultati mogu naći svoju primenu u procesu kontrole i prevencije povreda na radu.

Ključne reči: *Povrede na radu, rudari, rudnici rude metala*