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TRAUMATIC WORK-RELATED FATALITIES INVOLVING MINING IN AUSTRALIA, 1989-1992

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Abstract - Work-related traumatic mining fatalities in Australia were studied as part of a larger study of all work-related traumatic fatalities from 1989-1992. Preliminary results from this investigation indicate 162 cases met the study definitions of deaths related to mining. Travelling for work purposes, obtaining minerals, sands or coal and performing maintenance tasks were the most common activities being performed at the time of the fatal injury. Being hit by falling objects, often during a face or roof collapse in an underground mine, was the most common mechanism of fatal injury. Unstable terrain, poor work practice, equipment or machinery problems and a lack of safe operating procedures or inappropriate safe operating procedures were the most common contributing factors to the fatal incidents. It is recommended that there be emphasis on the development of and adherence to safe operating procedures. A national collection of detailed information regarding OHS performance in the mining industry would aid in the monitoring of OHS performance in this industry.

INTRODUCTION

The mining industry presents occupational hazards that are more diverse and more extreme than most other industries. 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, exposure to dust and in some cases, poor illumination and ventilation.

Limited information is available on a national basis regarding the incidence and circumstances of mining fatalities in Australia. National compensation statistics provide an insight into the number of mining fatalities that occur. However, these statistics do have shortcomings.

Australian mining fatalities have been addressed in several commissioned reports and inquiries which have either been conducted on a jurisdictional level and do not give a national perspective (Torlach, 1990; Kelly and White, 1991; Mines Department, 1992) or which have not addressed the causal factors relating to the incidents (Australian Mining Industry Council, 1994; Minerals Council of Australia, 1995).

The mining inspectorate in each jurisdiction will generally investigate fatalities that occur in the mining industry. These detailed, investigative reports usually form part of the coronial investigation, but are not compiled in an aggregated form for dissemination.

Previously, the most comprehensive study of traumatic work-related fatalities in Australia was conducted by Harrison et al (1989) for the 1982-1984 calendar period. Data from the 1982-1984 period indicated that miners, mineral prospectors and quarrymen had a fatality incidence of 63.2 per 100,000 person years compared to the entire Australian workforce which had a fatality incidence of 8.1 per 100,000 person years

(Mitchell et al., in press). A second work-related fatalities study covering the years 1989-1992 has been undertaken by the National Occupational Health and Safety Commission. One of its aims is to provide comparable information to the first national fatalities study.

The aim of this paper is to describe the types and circumstances of traumatic work-related fatalities among miners and related personnel working on mine sites in Australia during the years 1989-1992 with specific emphasis on the factors that contributed to the occurrence of the fatal incident. Where possible comparisons will be made with information concerning work-related mining fatalities from the 1982-1984 period.

Method

Traumatic fatalities relating to individuals involved in mining and/ or who worked in the mining industry were studied as part of a larger investigation of deaths attributable to work-related injury that occurred in Australia during the years 1989-1992.

A list was obtained of all deaths that occurred in the study period and which had been assigned International Classification of Diseases, Revision 9 (ICD9) codes corresponding to External Causes of Death, excluding only suicide and medical misadventure. Research officers examined the files and collected detailed information on deaths that met the study definitions of work-relatedness. Cases were then coded by a central coding team.

The Employed Civilian Labour Force included persons who worked for pay, profit, or payment-in-kind in a job, business or on a farm (including employees, employers and self-employed persons) and persons who worked for 15 hours or more per week without pay in a family business or on a farm. Occupation coding was performed using Australia Occupational Classification System (ASCO: ABS, 1986). Industry was coded using the Australian Standard Industrial Classification (ASIC: ABS, 1985).

Deaths related to mining were defined as fatal injuries that occurred to any individual who at the time of the incident was involved in mining work or who was employed in the mining industry. Persons who suffered fatal injuries, who did not work in the mining industry, but who were performing work tasks on a mine site, were also included. Bystanders to mining work were included in the analysis (n=6). Individuals who were commuting to and from work at the time of the fatal incident who were employed in the mining industry were not included in the analysis (n=12). A total of 162 persons from the 1989-1992 period met the study definitions.

Fatality rates were calculated for individuals working in the mining industry (ASIC 1111 to 1620). The denominator data was calculated from the means of the relevant estimates of the 16 Employed Civilian Labour Force surveys that were undertaken during the 1989-1992 period. Ninety-five percent confidence intervals were calculated assuming a Poisson distribution (Armitage & Berry, 1987). The confidence intervals do not take into account the sample variance associated with the 16 Employed Civilian Labour Force surveys and therefore are somewhat narrower than the true confidence intervals.

Contributing factors were defined as factors that contributed to the incident occurring or made its outcome more severe than it would otherwise have been. It should be noted that in the majority of incidents it was possible to identify several factors that contributed to the fatal outcome, rather than the fatal event being attributed to a single factor.

Results

There were 162 work-related traumatic fatalities for the period 1989 to 1992 that occurred to miners working in the mining industry or to persons working on a mine site, but who were not employed in the mining industry. Persons working in the mining industry, not including commuting deaths, had a fatality incidence rate of 35.9 per 100,000 person-years (Table 1).

Table 1 Frequency and incidence rate of work-related traumatic death of persons employed in the mining industry during 1989-1992 (by industry, excluding commuters)

Industry Group	Fatality [1] frequency	Employed [2] persons	Fatality [3] incidence	95% CI [4]
Industry				
Mining (ASIC 1111-1620)	134	93,257	35.9	29.8-42.0
Industry Subdivisions				
Metallic minerals (ASIC 1111-1129)	69	37,495	46.0	35.8-58.2
Coal (ASIC 1201-1202)	29	28,380	25.5	17.1-36.7
Other mining[5] (ASIC 1300,1501-1505)	23	3,890	147.8	93.7-221.8
Construction materials (ASIC 1401-1404)	7	6,185	28.3	11.4-58.3
Services to mining (ASIC 1611-1620)	6	13,407	11.2	4.1-24.4

1 Frequency for the four years of the study.
2 Mean of the 16 Labour Force Surveys for the years 1989-1992.
3 Deaths per 100,000 person-years.
4 95% Confidence interval.
5 Includes oil and gas (ASIC 1300) and non-metallic minerals (ASIC 1501-1505).

Of the 162 fatalities, 82% of persons were working in the mining industry at the time of the fatal incident (ASIC 1100-1620) and the remaining persons were working in other or unknown industries. Successful workers' compensation claims were paid in response to the deaths of 69% of individuals who were working on the mine site at the time of the fatal incident.

The average age of the fatally injured workers was 35 years (sd 11.55) and all workers, bar three, were male.

The individuals who received fatal injuries were plant and machinery operators and drivers (40%), labourers and related workers (34%), tradespersons (15%), para-professionals (4%), professionals (4%), managers and administrators (3%), with 1% having other or unknown occupations.

Individuals who were employed working with metallic minerals (43%) and individuals working in the coal industry (18%) had a high frequency of fatalities. Interestingly, 15% of the fatally injured workers were not employed in the mining industry.

The 162 deaths occurred in 144 separate incidents. Seven persons were killed in the same incident in a motor vehicle accident when travelling for work purposes. Six persons were killed when an underground mine shaft flooded. Three workers were killed when a roof collapsed in an underground mine. Three workers were killed when a sudden outburst of a combination of carbon dioxide and methane gases occurred and they were overcome by the gas. Two workers were killed in a helicopter crash when they were performing a geological survey. Two persons were killed in a sand slide at a quarry and two persons were killed when struck by a falling concrete block while they were being lifted in a hoist up a mine rise bore hole. All other incidents involved only one death.

The fatal incidents occurred in a number of different locations. Forty-three percent of incidents occurred underground, most commonly as a result of a wall or roof collapse; 26% in open cut mines and quarries; 10% on an unspecified mine or quarry; 6% on other mines or quarries; 9% on a public roadway while the deceased person was travelling for work purposes; and 7% in other and unknown locations.

The most common activity at the time of the fatal incident was transportation for work purposes (22%), (transportation included: air transport, transport around the mine site and transport on public roadways).

Other common activities at the time of the fatal incident included obtaining minerals, sands, or coal (19%); workers involved in performing maintenance (14%); workers involved in earth moving or digging (9%); workers performing construction activities (7%); workers escaping a hazard (6%); and workers who were moving goods (4%).

The type of mechanism that resulted in the fatal injury varied. The most frequent mechanism involved the worker being hit by falling objects (28%), for instance the collapse of a mine face or roof; being fatally injured in vehicle incidents (19%), usually while travelling around the mine site or while driving vehicles in a quarry or in an open pit; falling from a height (15%) and being hit by moving objects, such as underground vehicles or moving machinery (8%).

In 6% of deaths mine gases played a role, including one incident where three workers were asphyxiated by carbon dioxide and methane gases.

Of the 162 fatally injured workers, multiple injuries were the most common cause of death (25%). The majority of other fatalities resulted from head and neck injuries (24%), mechanical asphyxia (17%), chest injuries (14%) and drowning (6%).

Blood alcohol content (BAC) was not recorded for 24% of workers involved in fatal incidents. For the individuals for whom data were available, 5% had a BAC of 0.001% to 0.05% and 6% had a BAC of 0.05% or greater. All of the remaining workers (66%) had a nil BAC reading.

In 5% of cases it was not clear if the individual was performing shiftwork. Of the remaining cases, 37% were working shiftwork.

The frequency of fatal incidents varied with the time of day showing a major peak between 0800 and 1000 hrs and lesser peaks in the afternoon.

Main factors that contributed to the fatal incident

Physical and/ or environmental factors contributed to the fatal incident in 54% of fatal incidents. The most common physical/ environmental factor that contributed to the fatal incident was unstable, uneven or slippery terrain (35%).

Behavioural factors, specifically improper work practices, contributed to 44% of the fatal incidents. Improper work practice refers to a work practice that deliberately deviates from the normal safe system of work.

Factors pertinent to the organisation contributed to 44% of the fatal incidents. The most common organisational contributing factor was a lack of official safe operating procedures or inappropriate safe operating procedures, which contributed to 28% of the fatal incidents.

Thirty-three percent of fatalities involved equipment or machinery problems, with the most common equipment or machinery problem being faulty equipment or machinery (12%).

There are several systems available for describing human error in occupational accident research. ‘Human error’ in this paper has been used to describe ‘skill-based errors’ only. Other forms of error, such as ‘rule-based errors’ and ‘knowledge-based errors’ have been classified as ‘improper work practice’ and as ‘inexperience and/or lack of training’, respectively. Human errors were found to contribute to 10% of the fatal incidents.

The non-use of personal protective equipment contributed to 13% of the fatalities.

Inexperience or lack of skill was thought to contribute to 9% of the fatal incidents.

In 3% of fatal incidents the high blood alcohol content of the deceased definitely contributed to the fatal incident occurring.

Fatigue experienced by the worker contributed to 3% of fatal incidents.

Several of the fatal incidents involved other personnel contributing to the incident occurring. Another person was identified as having contributed to the incident if the action, or lack of action, of another person

directly led to the fatal incident occurring and/ or worsened its consequences for the deceased. However, if the other person was a passive participant (for example, driving a mine truck correctly when the deceased ran in front and was struck by the truck) then they were not deemed to have contributed. In 14% of incidents another person contributed to the fatal incident.

Discussion

The fatality incidence for the mining industry for the 1989-1992 period was 35.9 per 100,000 person years. This incidence rate is an increase from the 1982-1984 period fatality incidence rate of 26.9 per 100,000 person years (Mitchell et al., in press).

The results from this investigation of work-related fatalities involving mining show that the majority of persons fatally injured on mine sites were plant and machinery operators and drivers (40%) and labourer and related workers (34%). The majority of persons involved in a fatal incident were working in the mining industry (82%). Information from the first national work-related fatality study, 1982-1984 (WRFS1) indicated that 60% of fatally injured persons were employed in the mining industry.

The most common location of the fatal incident was underground (43%). This proportion compares similarly with WRFS1 where 46% of mining fatalities occurred underground and where the most common cause of deaths underground was as a result of a wall or roof collapse (34%). Similarly, a study of mining fatalities in Western Australian found that individuals working underground had a higher number of fatalities when compared to surface workers and that the majority of the underground fatalities occurring as a result of rock falls (Mines Department, 1992).

Transportation for work purposes (22%), along with obtaining minerals, sands or coal (19%) were the most common activities at the time of the fatal incident. In WRFS1, transport for work purposes accounted for many of the mining deaths (30%). The nature of many mining activities necessitates a lot of travel and travel with known special risks such as general aviation, remote and unsurfaced roads. Therefore, it appears that some individuals working in the mining industry are exposed to transport hazards arising directly from their work.

Mine gases did not play a major role in the deaths from WRFS1, with only one incident (1%) involving a worker being asphyxiated by methane gas. Findings from the second work-related fatalities study suggests that mine gases played a role in 6% of deaths

The most common cause of death was multiple injuries (25%), which compares similarly with WRFS1 where multiple injuries were the cause of death of 30% of workers.

The time of day that the fatal incident occurred revealed a morning peak between 0800 and 1000 hrs and smaller peaks in the afternoon. Data from WRFS1 concerning the time of day of the fatal incident found a mid-morning peak at 1000 hrs and smaller peaks in the early afternoon. It is not clear if these peaks in incident frequency for a particular time of day may be reflecting a higher number of persons working at those times rather than changing incidence 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 behaviour. It is also possible that the apparent afternoon peaks in both studies may reflect random variation. Without information concerning the number of individuals employed and the operations performed at particular times of the day it is difficult to comment on the possible effects of time of day on the incidence of mining fatalities.

The factors that contributed to the occurrence of the fatal incident were remarkably similar for the 1989-1992 period and WRFS1.

The most common physical/ environmental factor that contributed to the fatal incident was unstable, uneven or slippery terrain (35%) which compared similarly with WRFS1 where 38% of incidents involved problems with terrain.

Inappropriate work practices were found to contribute to 44% of fatal incidents in the current study and 40% of fatal incidents in WRFS1. This does not mean that the individual worker should be blamed for the incident. Rather, it indicates that a deliberate act by the worker, which the worker knew to be unsafe,

contributed to the incident. It is then necessary to examine why there was a defect in the work standards of the organisation that allowed unsafe behaviour to arise in the workplace.

A lack of safe operating procedures or inadequate safe operating procedures contributed to around 28% of the fatalities in this study and to 21% of the fatalities in WRFS1. A study of fatal incidents in the Western Australian mining industry also found that inadequate work standards contributed to more than half of the fatal incidents that were analysed (Mines Department, 1992).

Equipment or machinery problems contributed to many of the fatal incidents in WRFS1 (22%) and this investigation of mining fatalities found 33% involved faulty equipment or machinery.

Inexperienced workers were found to contribute to 9% of fatal incidents both in this study and in WRFS1.

The identification of the factors that contributed to a fatal incident is dependent on a number of elements, including the type and quality of the data available; and the training and philosophy of the data recorders (for example, police, coroners, occupational health and safety inspectors); and of the data coders. Nevertheless, we have attempted to identify the main contributing factors, without implying that they are the root cause nor that they are the only factors which may be identified.

There were 103 mining-related deaths over a three year period in WRFS1 and 162 mining-related deaths over a four year period identified from the current study. The data suggest an increase in mining fatalities between the 1982-1984 and the 1989-1992 periods. The assessment of factors that contributed to the fatal incident indicates that mining incidents are occurring in similar circumstances during both time periods.

Detailed information was generally available concerning each mining fatality for the current study. However, several areas where more information would have been beneficial when assessing the contributing factors to the fatal incident were: relevant training the worker received; blood alcohol levels at the time of fatal incident; relevant organisational factors such as current safe work procedures; and information regarding shift type/ overtime work and the possible contribution of fatigue.

It should be acknowledged that the mining industry presents occupational hazards that are more diverse and more extreme than most other industries and as a result exceptional efforts are required of the mining industry if the risk excess is to be reduced.

The national collection of detailed information regarding OHS performance in the mining industry which includes relevant information concerning the worker and the factors that contributed to both non-fatal injuries and fatal incidents would be beneficial for injury prevention. This information could be used to help develop appropriate prevention strategies which would contribute to the improvement of safety in the mining industry.

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