SHORT REPORT

Occupational injuries and fatalities in copper mining in Zambia

Prudence Michelo1,2, Magne Bråtveit1 and Bente E. Moen1

Background The metal mining industry employs ~15% of formally employed workers in Zambia, but there is little information about the magnitude of occupational injuries among the miners.

Aims To determine the frequency rates of occupational injuries and fatalities among copper miners in Zambia.

Methods A retrospective study of occupational injuries and fatalities at one of the largest copper mining companies in Zambia was undertaken for the period January 2005 to May 2007. Information on injuries and fatalities was obtained from the electronic accident survey database of the company. Analysis was restricted to fatalities and those injuries that had prompted medical attention and at least 1 day of absence from work. Annual injury and fatality frequency rates (injuries per 1000 employee years and fatalities per 100 000 employee years, respectively) were calculated.

Results In the selected period, 165 injuries and 20 fatalities were recorded. The underground department had the highest frequency rates of fatalities (111/100 000 employee years) and injuries (5.5/1000 employee years). The most common cause of fatal injuries was fall of rock in the underground mines. The most frequent mechanism of injury was handling of tools and materials, and the most commonly injured body parts were the hands and fingers.

Conclusions The fatality rate is high compared to reported values from the metalliferous mining industry in developed countries, strongly suggesting that measures should be taken to reduce risks, particularly at underground sites.

Key words Metal mining; mining accidents; occupational injuries and fatalities.

Introduction

The metal mining industry employs ~15% of formally occupied workers in Zambia and accounts for 8% of the gross domestic product and 84% of the export earnings [1]. The number of miners is increasing with the opening of new mines and expansion of existing mining operations. Studies conducted in other countries have shown high rates of occupational injuries and fatalities in the mining industry [2–4], but there is little information about the magnitude of injuries among miners in Zambia. Higher rates of occupational injuries and fatalities have been reported for low-income countries in Africa and Asia compared to Europe and America [3,5]. The aim of this study was to determine the frequency rates of occupational injuries and fatalities among copper miners in Zambia.

Methods

A retrospective study of occupational injuries and fatalities at one of the largest copper mining companies in Zambia was undertaken for the period January 2005 to May 2007. The current owners operated the company during the entire study period. The company employs ~15 000 workers at four locations, has an annual production of 200 000 tons of processed copper and is sectioned into underground (two locations), open pit/construction (two locations), metal processing (three locations), engineering and corporate departments. The number of employees at the end of 2005, 2006 and May 2007 and information on injuries and fatalities were obtained from the electronic accident database kept at the Occupational Safety, Health, Environment and Quality unit. Information on injuries and fatalities was based on the accounts of injured workers, co-workers and qualified medical personnel and was recorded by safety officers.
Analysis was restricted to fatalities and those injuries that had prompted medical attention and at least 1 day of absence from work.

Annual injury and fatality frequency rates for January 2005 to May 2007 were calculated as follows:

i. Annual injury frequency rate = mean annual number of injuries × 1000/weighted mean annual number of workers.

ii. Annual fatality frequency rate = mean annual number of fatal injuries × 100 000/weighted mean annual number of workers.

The mean annual numbers of injuries or fatalities were calculated by dividing the total number of injuries or fatalities, respectively, by 2.42 (2 years 5 months). Weighted mean annual number of workers took into account annual variations in the number of workers, i.e. by letting the 5 months of 2007 weigh 5/12 of a full year.

Ethical clearance was obtained from the Regional Medical Research Committee in Western Norway and the University of Zambia Research Ethics Committee.

**Results**

For the selected period, the database contained 165 injuries and 20 fatalities. The frequency rate of injuries was highest for the underground department (5.5/1000 employee years), followed by processing (5.3/1000 employee years) and engineering (5.0/1000 employee years) (Table 1). The rate ratio was significantly higher in underground compared to open pit/construction (1.7; 95% CI: 1.1–2.8), but not for underground compared to processing or engineering, respectively. The underground department had a frequency rate of fatalities of 111/100 000 employee years.

The most common mechanism of injury was handling of tools and materials (Table 2), and the most frequently injured body parts were the hands and fingers (38%). The most frequent cause of fatal injuries was ‘fall of rock’ in the underground mines.

**Discussion**

For underground copper mining, we found a fatality frequency rate of 111/100 000 employee years, which is higher than estimated from reports for year 2007 in underground metalliferous mining in USA (64/100 000 employee years) and Australia (25/100 000 employee years) and for underground/surface metalliferous mining in South Africa (50/100 000 employee years) and Canada (17/100 000 employee years) [6,7]. The overall fatality rate found in our study is lower than reported for mining in Zimbabwe (83/100 000 in 1995), Kenya (80/100 000 in 1973), Zambia (71/100 000 in 1973) and in South African gold mines (107/100 000 in 1973) [8]. While fatality and injury frequency rates have been declining in high-income countries, they still remain high or even increase in low-income countries [5]. In our study, workers in the underground departments had a higher injury frequency rate than workers in the open pits, probably related to hazardous manual tasks in confined spaces with high temperature and poor illumination at underground sites. Analogous differences between underground and surface miners have been reported in the South African gold mining industry and in metalliferous mining in USA and Australia [6,7,9].

While fall of rocks was the most common cause of fatalities in our study, handling of materials and tools such as pneumatic drills, jumpers, jacks and hammers was the most frequently reported mechanism of injuries. The large size and weight of these tools may increase the likelihood of them slipping and dropping. In a study from the USA, 54% of incidents were related to material handling, 23% to machinery and hand tools, 16% to slip or fall of person, 10% to roof falls and 8% to powered haulage [10].

**Table 1.** Number of occupational injuries and fatalities and their respective annual frequency rates in a Zambian copper mine from January 2005 to May 2007

<table>
<thead>
<tr>
<th>Departments</th>
<th>Underground</th>
<th>Engineering</th>
<th>Processing</th>
<th>Open pit/construction</th>
<th>Corporate</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of workers (weighted annual mean)</td>
<td>6338</td>
<td>826</td>
<td>3617</td>
<td>2601</td>
<td>542</td>
<td>13 924</td>
</tr>
<tr>
<td>Number of injuries (2 years 5 months)</td>
<td>85</td>
<td>10</td>
<td>46</td>
<td>20</td>
<td>542</td>
<td>4</td>
</tr>
<tr>
<td>Annual injury frequency rate&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.5</td>
<td>5.0</td>
<td>5.3</td>
<td>3.2</td>
<td>3.1</td>
<td>4.9</td>
</tr>
<tr>
<td>Number of fatalities (2 years 5 months)</td>
<td>17</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>Annual fatality frequency rate&lt;sup&gt;b&lt;/sup&gt;</td>
<td>111</td>
<td><em>c</em></td>
<td><em>c</em></td>
<td><em>c</em></td>
<td><em>c</em></td>
<td>59</td>
</tr>
</tbody>
</table>

<sup>a</sup>Injury frequency rate = (mean annual number of injuries/weighted mean workforce) × 1000.

<sup>b</sup>Fatality frequency rate = (mean annual number of fatalities/weighted mean workforce) × 100 000.

<sup>c</sup>Not calculated due to low number of fatalities.
Comparison of occupational injuries and fatalities across countries is difficult since information and reporting systems are not standardized. Furthermore, a global estimate of occupational accidents has strongly indicated that the number of accidents is under-reported, especially in developing countries [5]. Studies from different countries have shown that if accurate recording systems exist, the ratio between fatal and non-fatal accidents with at least 3 days sick leave is relatively constant and ratios of between 1/526 and 1/1000 have been estimated for Sub-Saharan Africa [5]. When comparing our data with such estimated ratios, and by assuming that fatal injuries are more likely to have been reported, the number of non-fatal injuries in the present study might be under-reported, indicating that the reporting system needs to be evaluated. In addition, the much higher ratio of fatal to non-fatal injuries in underground work compared to other production departments may also indicate variability in reporting practice between departments. Nevertheless, the high-fatality frequency rates strongly suggest that measures should be taken to reduce the risk, particularly at underground sites.

Table 2. Number of occupational injuries and fatalities stratified by mechanism in a Zambian copper mine from January 2005 to May 2007

<table>
<thead>
<tr>
<th>Mechanism of Injury</th>
<th>Injuries (n)</th>
<th>Fatalities (n)</th>
<th>Corporate Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underground Engineering Process</td>
<td>19</td>
<td>2</td>
<td>21 (11)</td>
</tr>
<tr>
<td>Open pit/Construction</td>
<td>15 (10)</td>
<td>1</td>
<td>16 (10)</td>
</tr>
<tr>
<td>Powered haulage equipment and machinery such as drills, scrapers etc.</td>
<td>4</td>
<td>0</td>
<td>4 (2)</td>
</tr>
<tr>
<td>Powered locomotives, shovels, dumpers, Greg and man cars etc.</td>
<td>0</td>
<td>0</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Falling, rolling objectsc</td>
<td>17 (11)</td>
<td>1</td>
<td>18 (11)</td>
</tr>
<tr>
<td>Chemical burns</td>
<td>7</td>
<td>0</td>
<td>7 (4)</td>
</tr>
<tr>
<td>Otherd</td>
<td>2</td>
<td>1</td>
<td>3 (2)</td>
</tr>
</tbody>
</table>

Key points
- The fatality frequency rate in copper mining in Zambia was high, particularly at underground sites.
- Measures should be taken to reduce the risk of accidents and to evaluate the reporting systems of occupational injuries.

Funding
Norwegian State Education Loan Fund (Lånekassen) and Norwegian Programme for Development, Research and Education (NUFU).

Acknowledgements
We are grateful to the management and workers at the mining company for all help during the fieldwork of the study.

Conflicts of interest
None declared.

References


