Health Profile of Corporate Mineworkers and Communities Living Near Corporate Gold Mining Operations in Mankayan, Benguet (Final report of an environmental and occupational health hazard assessment)*

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Abstract

This study focused on the health profile of corporate mineworkers and residents of communities adjacent to the large-scale gold mining operations of the Lepanto Consolidated Mining Company (LCMCo or Lepanto) in the municipality of Mankayan, Benguet Province. The research has two components, namely, environmental health hazard assessment and occupational health hazard assessment. The first focused on the residents of three communities, looking at the routes of exposure to mine drainage among the residents as well as the most prevalent symptoms reported in relation to this exposure. This part revealed that residents in the community nearest Lepanto's Mill Outlet exhibited more health symptoms, and that the differences in the prevalence of symptoms between this community and the others were significant. This result is associated to the fact that elevated levels of cyanide, lead, and mercury were found in the water samples at the company's mill outlets and tailings dams.

A second phase to the first focus involved the analysis and comparison of blood samples from residents who were exposed to mine drainage with controls living downstream who had little or no exposure to

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mine drainage. This study showed a positive linear correlation between the hours of exposure to mine drainage and the subjects' hemoglobin, blood cyanide and lead levels. Statistically significant differences in the blood levels of copper, cyanide and lead between the subjects and controls were also found. The subjects had higher levels of these chemicals in their blood as compared to the controls. On the other hand, the subjects had lower levels of serum creatinine compared to the controls. These blood test results indicate the possible chemicals responsible for the symptoms originally reported in the preliminary phase. Cyanide is pinpointed as possibly playing a prominent role.

The research's second focus, i.e., the assessment of the occupational health hazard among the corporate mineworkers, found out, in turn, that the most prevalent injuries were lacerations (43.18%), crushing injuries (17.05%), bruises (14.77%) and fractures (13.64%) usually involving rock or timber fall. Twenty percent (20%) of these cases required hospitalization. Most prevalent among the work-associated symptoms reported were: phlegm production (79.55%), joint pain (78.41%), eye irritation (67.05%), headache (55.68%), dyspnea (48.86%) and dizziness (36.36%). Most prevalent abnormal physical findings were hypertension (28.41%) and perforated eardrum (19.32%).

Keywords: *mining effects, corporate/ large-scale mining, environmental health, occupational health, cyanide*

INTRODUCTION

This study looks at the health concern of the mine workers and the residents of communities living near the operations of the Lepanto Consolidated Mining Company (LCMCo or Lepanto) in the municipality of Mankayan, Benguet Province. Lepanto has been mining in the Mankayan area since 1936, using the tributaries of the Abra River as part of its mine waste disposal system.

The Abra River originates from Mt. Data in Mountain Province and flows through Mankayan, Benguet and onwards to Ilocos Sur and Abra. The communities living along the Abra River complained of decreased agricultural and fishing yield, loss of plant life, death of domestic animals and various health complaints which they attribute to the operations of LCMCo. It is these complaints, particularly those

concerning health, which this study hoped to document and validate. These constitute the first focus of the study.

The second focus are the occupational hazards faced by the corporate mineworkers. Although mining accounts for only 1% of the global workforce, it is responsible for up to 5% of fatal accidents at work (15,000 per year or 40 each day).[1] These figures generated interest for the investigation and recording of work-associated injuries and symptoms among the mineworkers of Lepanto, as no studies and formal reports are yet available on these matters.

General Objective:

In the period of two (2) years, this research project aimed to describe the health profile of communities living adjacent to large-scale gold mining operations as well as that of corporate mineworkers.

Specific Objectives:

1. To determine the prevalence of symptoms attributed to acid mine drainage among residents of exposed communities.
2. To correlate these symptoms with existing heavy metal content in the mine drainage flow to downstream rivers.
3. To determine blood levels of selected heavy metals among residents of exposed communities.
4. To determine the prevalence of work-related symptoms among corporate mineworkers.
5. To relate these symptoms with existing occupational hazards in the mine site.

METHODOLOGY

Environmental Hazard Assessment

The first phase of this study focused on fulfilling the first two specific objectives. Data for this preliminary phase were gathered from questionnaire-guided interviews of residents in the three (3) communities of: Sitio Paalaban, Barangay Paco, Mankayan, Benguet; Sitio Batbato, Barangay Cabitin, Mankayan, Benguet; and Sitio Camay, Barangay Comillas North, Cervantes, Ilocos Sur.

A total of 788 residents from Paalaban, Cabitin and Camay were included in this study.

At the time of the household survey in Paalaban (May 2003), three serial water samples (Day 1-6:00 pm, Day 2-6:00 am and 6:00 pm) were taken simultaneously in four sites (Spring located upstream from Lepanto, Lepanto Carbon-in-Pulp Mill Outlet, Mine Tailings Dam 5A, and downstream after merging of Baguyos and Apaoan Rivers). A spot water sample was also taken from the Lepanto Carbon-in-Pulp Mill Outlet on 12 June 2003 (1:00 am) to validate the claims of residents and mineworkers that levels of toxic chemicals in mine drainage rises when the mill site is flushed out prior to shut down during holidays.

Because of budget limitations, it was deemed more cost-effective if measurements of blood levels of toxic chemicals among the residents be undertaken after preliminary analysis of environmental measurements and the symptoms survey were analyzed. This way, biological monitoring could be more focused in terms of subjects and chemicals to be tested.

The residents of Paalaban are most at risk for developing symptoms related to these elevated levels of toxic chemicals since they live nearest the company mill outlet. The differences in prevalence of symptoms between those living nearer the mine drainage (Lower Paalaban) as compared to those living farther away (Upper Paalaban) is the strongest indicator of a positive association between exposure to mine drainage and the development of symptoms.

The second phase of the study aimed to carry out the third objective of this research, i.e., to determine the blood levels of selected heavy metals among residents of the exposed communities. To do this, 15 residents of Paalaban were chosen as subjects. The inclusion criteria for choosing the 15 subjects were those who:

- Had lived in Lower Paalaban for at least five years
- Go to the river (1 meter from the water or less) and stay at least a total of 12 hours per week
- Are 15 years old and above

Residents who have been doing a day's work immersed in the river (as small-scale miner) in the 48 hours immediately prior to blood

sampling were prioritized. The residents who were currently employed as Lepanto workers were excluded.

In turn, 15 residents of Cervantes Proper, Ilocos Sur were chosen as controls to be compared with the subjects from Paalaban. (Cervantes Proper is located 10 kilometers. downstream from Paalaban and is not adjacent to the river.) These controls were matched for sex and age (plus or minus five years) with the subjects in Paalaban. In addition, the controls had to fulfill the following criteria:

- Lived in Cervantes Proper for at least five years
- Had not been to the river in the past seven days
- Does not usually spend more than two hours per week in the river
- 15 years old and above
- NOT currently employed as a Lepanto worker
- Preferably NON-smoker

For both subjects and controls, blood extraction for the measurement of blood levels of cyanide, lead and copper were done.[2] Other parameters measured were complete blood count (including hemoglobin, hematocrit, white blood cell and differential counts), SGOT/ SGPT, serum creatinine and blood urea nitrogen.

Blood cyanide[3] was measured using spectrophotometry/ Natelson colorimetric method. Blood copper[4] was measured also using atomic absorption spectrophotometry. Blood lead levels[5] were measured using anodic stripping voltametry. Complete blood count, SGOT/SGPT,[6] serum creatinine and blood urea nitrogen were also measured.

Occupational Hazard Assessment

Questionnaire-guided interviews with physical examination were also conducted among corporate mineworkers who were contacted through the Lepanto Employees Union. (The questionnaire used was modified from the US Mines Safety and Health Administration.[7]) A focus-group discussion on the process of mining has previously been conducted among the Union officers. A walk-through of the corporate premises, except the mine tunnels, allowed by Lepanto in October 2002 also added information for analysis of the results.

We were able to interview 88 workers (representing five percent of the total workforce), six of whom are retired employees of Lepanto.

The mean age of the workers is 42.5 years (standard deviation 9.25), with the youngest being 19 and the oldest being 57. It is notable that the majority of workers trace their ethnic origin to provinces outside of Mankayan. A few come from as far as Visayas and Mindanao.

Majority of the workers (88.64%) are married. The average number of children is five per worker. Majority (28.41%) graduated from high school.

The workers had been with Lepanto for an average of 10 years, the shortest length of service being 1.5 months and the longest being 27 years. Majority (88.64%) have permanent status.

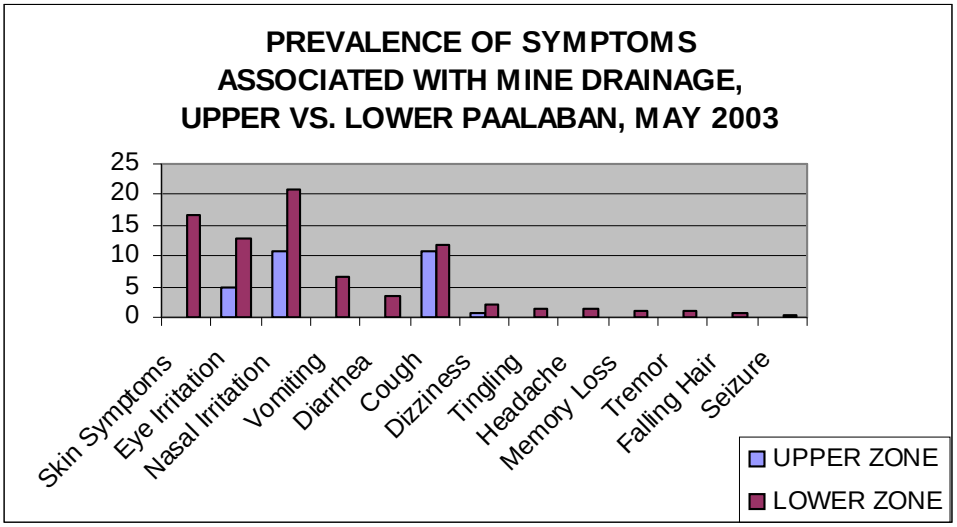
Seventy (70) of the workers interviewed are directly involved in underground mining (includes Mine Development, Mine Services, Mine Production, Mine Mechanical, Geological Mine Engineering). Others are part of the Mill (where crushing of ore and chemical extraction of gold is done), Drilling, Inventory Management, Construction (above ground) and Security. Six respondents were retired.

RESULTS AND DISCUSSION

Environmental Hazard Assessment

The residents of the three communities included in the preliminary phase of this study reported the following routes of exposure to mine drainage: inhalation, immersion and non-intentional ingestion. Cough (48.5%), nasal irritation (31.6%), skin symptoms such as rash, pruritus and burning sensation (31.6%), eye irritation (16.5%) and vomiting (10.5%) were the most prevalent symptoms reported in relation to exposure to mine drainage.

For Paalaban (the community nearest Lepanto's Mill Outlet), prevalence of symptoms for Upper and Lower Paalaban were compared to see if there was any correlation with geographical proximity to the site of mine drainage. Upper Paalaban occupies approximately the highest third of the community (around 915 to 1,030 masl). Lower Paalaban represents the houses located on the lower 2/ 3 of the mountain. More symptoms were reported among those in Lower than in Upper Paalaban.



Upon statistical analysis using phi coefficient for 2x2 tables, it was found that the differences in prevalence of skin symptoms, eye irritation, nasal irritation and vomiting between Upper and Lower Paalaban were significant at alpha=0.05.

We found that levels of cyanide were elevated at the CIP Mill Outlet and at Tailings Dam 5A. Lead and mercury levels were elevated at the CIP Mill Outlet and at Tailings Dam 5A during the spot sample taken during the June 12 holiday. These levels were compared with two standards: the Philippine Department of Environment and Natural Resources (DENR) standards for industrial effluents[8] and the United States Environmental Protection Agency's "National Recommended Water Quality Criteria".

The subjects from Paalaban chosen for blood testing had a mean age of 41.07 years (ranging from 21.00 to 55.00 years, with a standard deviation of 9.46). Eight were male while seven were female. The mean distance of the subjects' residences from the river was 89.40 meters (ranging from 10.00 to 107.50 meters, with a standard deviation of 24.92). Their mean number of hours of exposure to the river (defined as approaching the river a distance of one meter or less) was 25.00 hours per week (ranging from 2.00 to 70.00 hours, with a standard deviation of 18.96).

The controls from Cervantes had a mean age of 42.33 years (ranging from 21.00 to 55.00, with a standard deviation of 9.12). As defined in the inclusion criteria, they spent less than two hours per week near the river. In fact, all of them hardly went near the river.

Both the subjects and controls claimed to have eaten cooked cassava only occasionally (approximately once a week when it was in season). All of the subjects were farmers who used urea and/or ammonia-containing fertilizers. The controls were mostly government employees who had no/little exposure to farm-related chemicals.

There were three significant associations found in the subjects with regard to the exposure hours per week at 0.05 level of significance, using the Pearson correlation:

- Blood cyanide level and exposure hours per week were found to have a significant positive linear association (p-value=0.027). This means that as the exposure hours per week increased the blood cyanide level also tended to increase in a linear manner.
- Blood lead level and exposure hours per week were found to have a significant positive linear association (p-value=0.015). This means that as the exposure hours per week increased the blood lead level also tended to increase in a linear manner.
- Hemoglobin level and exposure hours per week were found to have a significant positive linear association (p-value=0.000). This means that as the exposure hours per week increased the hemoglobin level also tended to increase in a linear manner.

The correlation between the other blood test results and the exposure hours per week were not statistically significant in the subjects from Paalaban at level of significance=0.05.

Using the T-test to compare the subjects with the controls,

- There is sufficient evidence to conclude that the mean blood copper level between the subjects and the control are significantly different at 0.05 level of significance (p-value=0.000). In fact, the subjects have a higher mean blood copper level compared to the controls.

- There is sufficient evidence to conclude that the mean creatinine level between the subjects and the control are significantly different at 0.05 level of significance (p-value=0.000). In fact, the subjects have a lower mean creatinine level compared to the controls.

There is no sufficient evidence to conclude that the mean hemoglobin level between the subjects and the controls are significantly different at 0.05 level of significance (p-value=0.518). So, we say that the 2 groups have equal mean hemoglobin levels.

Using the Mann-Whitney test:

- There is sufficient evidence to conclude that the median blood cyanide level of the subjects and the control are significantly different at 0.05 level of significance (p-value=0.011). In fact, the subjects have a higher median blood cyanide level compared to the controls. The controls have a constant value for the blood cyanide level (negative).

- There is sufficient evidence to conclude that the median blood lead level of the subjects and the control are significantly different at 0.05 level of significance (p-value=0.000). In fact, the subjects have a higher median blood lead level compared to the controls.

There is no sufficient evidence to conclude that the median Hematocrit level of the subjects and the control are significantly different at 0.05 level of significance (p-value=0.567). The subjects and controls have equal median Hematocrit level.

There is no sufficient evidence to conclude that the median SGOT level of the subjects and the control are significantly different at 0.05 level of significance (p-value=0.148). So we say that the subjects and controls have equal median SGOT level.

There is no sufficient evidence to conclude that the median SGPT level of the subjects and the control are significantly different at 0.05 level of significance (p-value=0.267). So we say that the subjects and controls have equal median SGPT level.

In summary, this study has shown a positive linear correlation between the hours of exposure to mine drainage and the subjects' hemoglobin, blood cyanide and lead levels. Statistically significant differences in the blood levels of copper, cyanide and lead between the subjects and controls were also found. The subjects had higher levels of these chemicals in their blood as compared to the controls. On the other hand, the subjects had lower levels of serum creatinine compared to the controls.

The preliminary symptom survey preceding the blood tests showed a positive association between exposure to mine drainage (as indicated by proximity) and the development of various symptoms. These blood tests results, in addition to the documentation of chemicals present in the mine drainage, now indicate the possible chemicals responsible for the symptoms reported.

Given that a blood level of cyanide above 0.5 mcg/dL was found in one exposed subject and that the blood cyanide level of the subjects were significantly higher than the controls, it can be theorized that cyanide plays a prominent role in the symptomatology of the exposed subjects.[9] (Smoking did not seem to contribute much to elevating the cyanide levels in this particular study as all the controls registered negative levels of cyanide regardless of whether they smoked or not.)

"In humans and animals exposed to cyanide by any route, the cyanide anion rapidly binds to enzymes and other proteins that contain ferric iron, resulting in inactivation and loss of function. The high toxicity of cyanide is related to its affinity for the ferric iron of cytochrome c oxidase, which is a key enzyme in the use of oxygen by mitochondria. The rapid cell death that occurs on exposure to cyanide is related to the cessation of cellular respiration. In addition, cyanide also binds the iron of hemoglobin, with the concomitant reduction in the oxygen-carrying capacity of the blood."[10] It can be theorized that the positive relation between hemoglobin levels and hours of exposure to mine drainage found in our subjects indicates a compensatory mechanism for the reduction in the oxygen-carrying capacity of the subjects' hemoglobin. However we were unable to find any studies on chronic exposure to cyanide to corroborate this hypothesis.

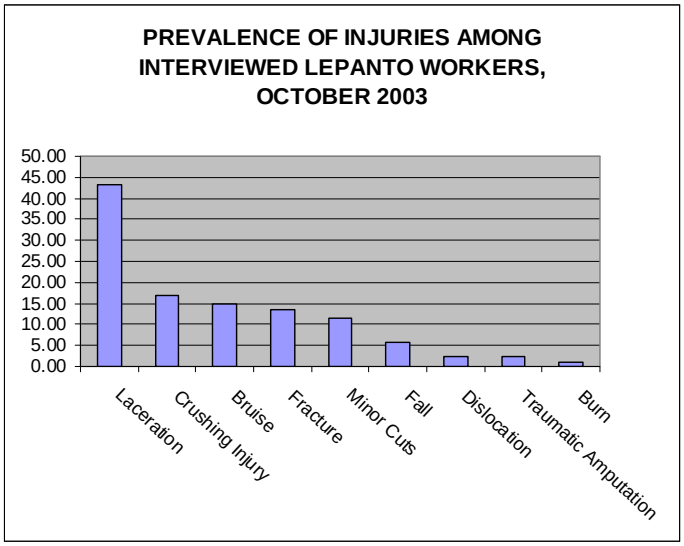
	N	Minimum		Maximum		Mean		Std. Deviation		Variance	
		Subjects	Controls	Subjects	Controls	Subjects	Controls	Subjects	Controls	Subjects	Controls
COPPER mcg/dL	15	3.7	1.8	6.5	4.2	4.69	2.74	0.7	0.69	0.5	0.47
LEAD mcg/dL	15	1.6	1	15.4	5	6.13	2.33	4.12	1.24	16.98	1.54
CYANIDE Mcg/mL	15	0.09	0.09	0.61	0.09	0.16	0.09	0.13	0	0.02	0
HEMATOCRIT g/L	15	0.3	0.3	0.5	0.4	0.41	0.39	0.05	0.03	0	0
HEMOGLOBIN g/L	15	81	95	199	151	137.67	132.6	25.71	15.33	661.1	235.11
CREATININE mg/dL	14	0.4	0.9	1.1	1.5	0.76	1.21	0.19	0.18	0.04	0.03
SGOT/ AST IU/L	15	19.4	21	40	76.9	28.72	37.87	6.1	16.44	37.16	270.38
SGPT/ ALT IU/L	15	21	18.1	52.9	128.5	31.89	44.35	9.17	28.26	84.16	798.44

Studies on the relation between creatinine levels and cyanide indicate that an increased serum creatinine level is expected among those chronically exposed to cyanide. A study of rabbits fed a cyanide-containing diet by Okolie and Osagie for ten months showed such a result.[11] In this study, serum creatinine among the exposed was actually lower than in the controls.

The possibility of complex toxidromes resulting from the chronic exposure to many heavy metals and chemicals at the same cannot be discounted. Thus, simple one-to-one correspondence of symptoms/ toxidromes with chemical exposure is difficult to pinpoint.

Occupational Hazard Assessment

Among the 88 workers included in this survey, only 23 have not suffered from any accidents. Prevalence of injuries are as follows:



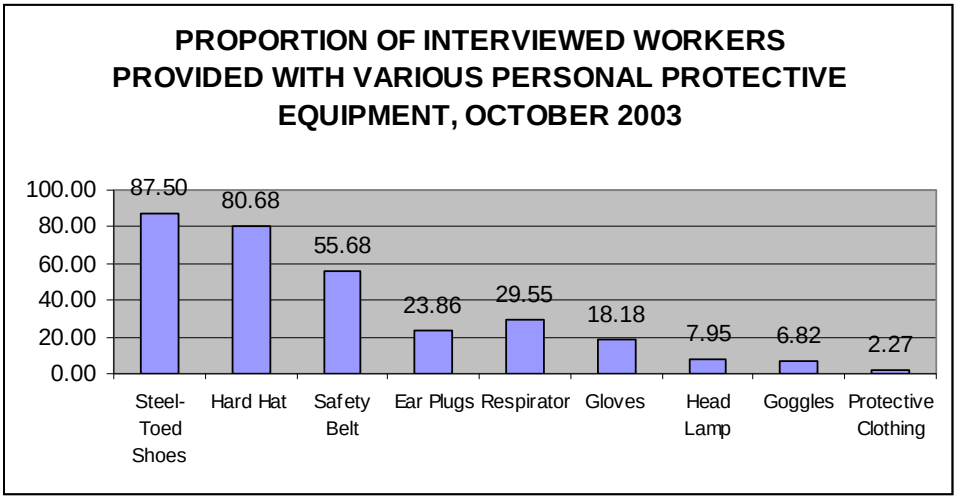
The interviewed mineworkers attributed their injuries to the following causes:

Cause of Injury	Frequency	Rate
Rock/ Timber Fall	44.00	44.90
Tool Involved	15.00	15.31
Machine Involved	8.00	8.16
Load Involved	4.00	4.08
Vehicle Involved	4.00	4.08
Slippery Surface	1.00	1.02
Not Specified	22.00	22.45
TOTAL	98.00	100.00

Twenty percent (20.41%) of injuries required hospitalization, 14.29% required suturing. It has been mentioned by some that supervisors try to convince them not to report their injuries so that these are not included in official records. Others who are confined in the hospital or at home are asked to sign the time-in record so that no lost-time is reported. There is also a perception among the workers that not all information about their illnesses is revealed to them at the company

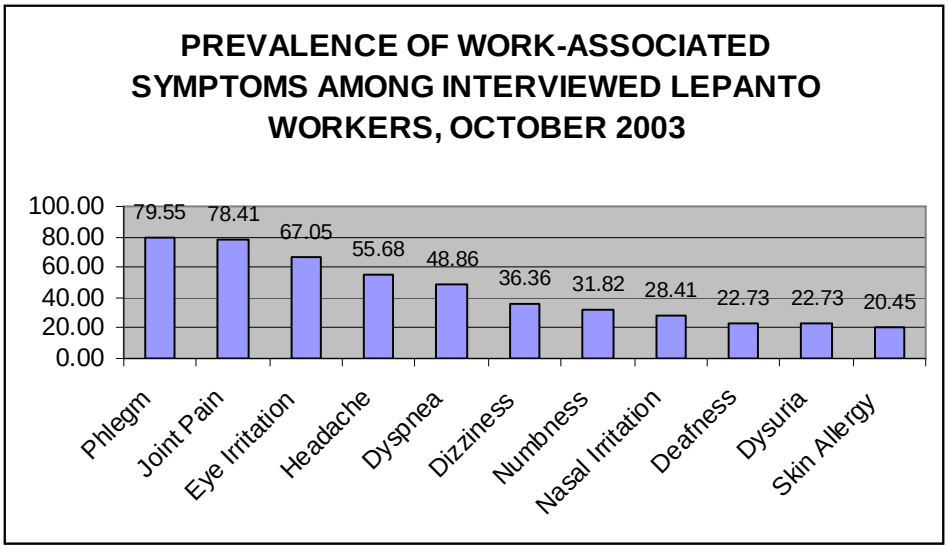
hospital. Many prefer to have their x-ray and laboratory examinations done outside the company even if they have to pay for these themselves.

In terms of personal protective equipment, reported use is as follows:

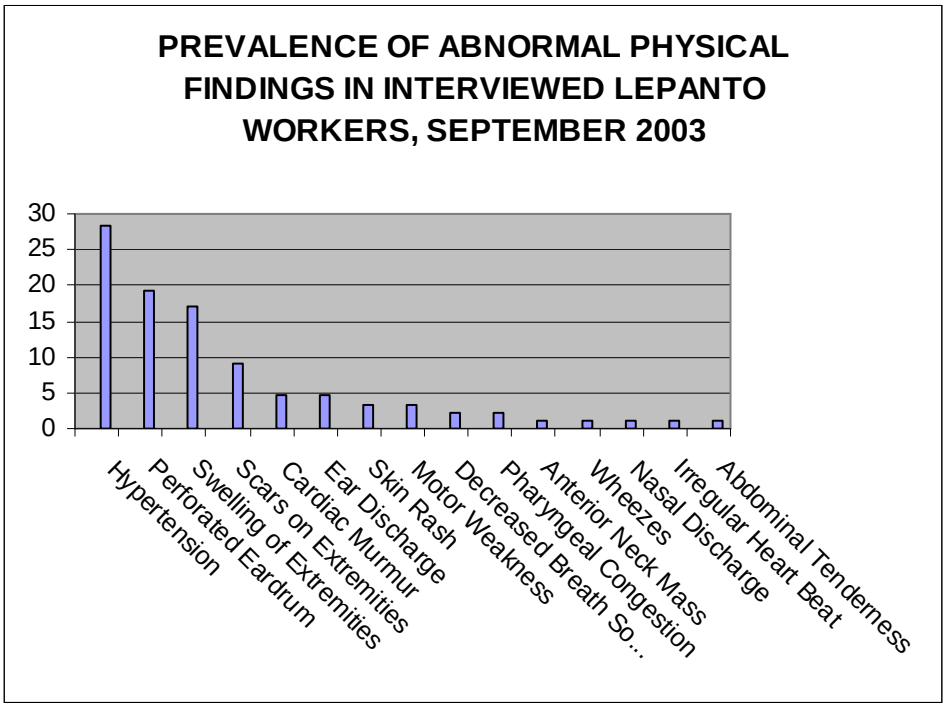


Workers reported that it is the workers' responsibility to ask for replacement of worn-out equipment such as ear plugs. Oftentimes, these are out-of-stock and the worker had to keep returning to the supplies office. Respirators lack cartridge replacements. Workers improvise by using a towel or cloth to cover their nose and mouth from dust. No reflective clothing are provided for those working in smelting; their rubber boots cannot protect against accidental spillage of molten metal. There is also a perception among the workers that distribution of PPE is selective. For example, only the LHD operator is given a respirator when all the other miners around him are exposed to the same amount of dust and diesel fumes.

The most prevalent work-associated symptoms reported by the workers were the following:



The most prevalent physical findings are the following:



Mining accounted for 30,000 disabling injuries in the US in 1988 (or an injury rate of 4.9 per 100,000 or 0.49%). According to the US Bureau of Labor Statistics, in general, sprains and strains account for 45% of cases, fractures 12%, cuts, lacerations and punctures 11% and contusions, crushes and bruises 10%.[12]

This study found an injury rate of 73.87% among the corporate mineworkers studied. The most prevalent injuries were lacerations (43.18%), crushing injuries (17.05%), bruises (14.77%) and fractures (13.64%). Twenty percent (20%) of these cases required hospitalization.

A 1997 study of underground gold mining in Itogon, Benguet reported being hit by falling objects as the leading type of accident, followed by suffocation from chemical fumes, crushing injuries involving the fingers, foreign body in the eye, fractures and dislocations of bones, accidental fall, electrocution, punctured wounds, pinning by slabs/ lumber/ mine car, accidental finger amputation, accidental blindness and being buried during an erosion or rockslide.[13] In our study, rock and timber fall was also identified as the leading cause of injury, followed by accidents involving a machine or a tool.

Most prevalent among the work-associated symptoms reported by the mineworkers were: phlegm production (79.55%), joint pain (78.41%), eye irritation (67.05%), headache (55.68%), dyspnea (48.86%) and dizziness (36.36%). Most prevalent abnormal physical findings were hypertension (21.43%) and perforated eardrum (19.32%).

The above findings were related with the hazards identified by the mineworkers during focus group discussions. A description of specific hazards per job title was obtained from interviews of the mineworkers. However only the more prominent hazards are mentioned here:

Dust, fumes and other inhaled particles

Among the most prevalent symptoms reported by the mineworkers are phlegm production (79.55%) and dyspnea (48.86%). They described their phlegm as becoming black in color after exposure to mine dust and fumes from blasting.

Present evidence now indicates that all dust exposures sufficiently intense to be reported by those exposed should be viewed with suspicion. Not only organic and inorganic dusts have been related to chronic obstructive pulmonary disease (COPD), but poorly characterized dusts (with or without chemicals, fumes and vapors) as well.[14]

The mineworkers complained in particular about the fumes coming from the diesel engines of the trucks (LPT/ LHD) they now use inside the enclosed mine tunnels. Exposure to diesel particulate matter is associated with increased rates of death and disease. As early as 1989, the International Agency for Research on Cancer pronounced that "diesel engine exhaust is probably carcinogenic to humans".[15]

Other inhaled particles

Cross-sectional studies of South African gold miners traced the work-relatedness of chronic airflow limitation independent of silicosis. Emphysema (assessed at autopsy) has also been related to years of exposure to high-dust occupations among South African gold miners.[16] It is also assumed that 100% of workers in metal mining are exposed to silica dust.

However, the development of pneumoconiosis is hard to detect through symptom survey and physical examination alone. These need to be documented through a series of chest x-ray and pulmonary function testing.

Noise

The US National Institute for Occupational Safety and Health (NIOSH) has identified noise-induced hearing loss as one of the top 10 work-related diseases and injuries in mining, with two-thirds of new cases being preventable.

The workers in LCMCo report the rock drill machine, blasting, the hoist mechanism and the crusher machines as the primary sources of noise. The need to use light signals or sign language or to shout is an indication that noise levels are above 85-90 dB most of the time. NIOSH requires hearing protection at the exposure limit of 90dBA over an 8-hour period.[17] The Philippines has similar standards.

The high prevalence of ruptured eardrum (19.32%) and ear discharge (4.55%) during the physical examination must be further investigated in relation to this. Some of these cases of ruptured eardrum may be related to dynamite blasting underground. While a number of these cases have been documented to be chronic otitis media which started in childhood, the dampness and dusty environment in the mine tunnels may also be contributory to the frequent occurrence of respiratory tract infection leading to bouts of otitis media.

Heat

Workers report conditions of extreme heat underground. Frequent heat exhaustion has been reported at Level 700. Surface workers, such as the worker in charge of mixing lime with the mine tailings, are also exposed to heat.

Vibration

Hand-arm vibration comes from operating equipment such as chain saws, chipping hammers, grinders, jackhammers and hand drills. It is also called “dead hand” or “vibration white finger”. The condition involves blanching, numbness and tingling of the fingers. Its pathophysiology is related to ischemia of the small blood vessels supplying the fingers brought about by the prolonged operation of hand-held machinery.[18]

Thirty-one percent (31.82%) of workers complained of such numbness. One LCMCo worker complained about his hands becoming numb after holding the rock drilling machine for several hours. The welder also reports developing numbness of the hands at the end of his workday. The rule-of-thumb in occupational health is to have ten minutes of rest for every hour of work. But workers at LCMCo have to hold the drilling machine for 2-3 hours at a time. They can only rest during breaktime.

Ergonomic stresses such as heavy lifting and/or prolonged awkward positions

Work-related musculoskeletal disorders is the term refering to disorders involving the nerves, tendons, muscles and support structures which may be caused or made worse by the work place. At

LCMCo, 78.41% of workers reported joint pains, usually associated with lifting heavy objects at work. Physical examination also showed 17% with swelling of the extremities.

While hypertension is the most common physical finding, the prevalence rate of 28.41% among the mineworkers is only slightly higher than that obtained by the Food and Nutrition Research Institute in the Cordillera Administrative Region (CAR).[19]

Special note must also be made regarding the inconsistent supply and use of personal protective equipment.

CONCLUSIONS

The presence of toxic levels of lead, mercury and cyanide has been documented at the outlet of the corporate mill site and at Mine Tailings Dam 5A. Residents of the three communities surveyed reported exposure to mine drainage through inhalation, immersion and ingestion. The symptoms reported are compatible with the toxic effects of lead, mercury and cyanide. A statistically significant association between proximity of residence to the mine drainage site and prevalence of symptoms was found in Upper and Lower Paalaban.

A positive linear correlation between the hours of exposure to mine drainage and the Paalaban residents' hemoglobin, blood cyanide and lead levels has been established. Statistically significant differences in the blood levels of copper, cyanide and lead between the subjects and controls were also found. These subjects had higher levels of these chemicals in their blood as compared to the controls. On the other hand, the subjects had lower levels of serum creatinine compared to the controls.

The occupational hazard assessment found that among the corporate mineworkers studied, the most prevalent injuries were lacerations (43.18%), crushing injuries (17.05%), bruises (14.77%) and fractures (13.64%) usually involving rock or timber fall. Twenty percent (20%) of these cases required hospitalization. Personal protective equipment were inconsistently supplied and used.

Most prevalent among the work-associated symptoms reported by the mineworkers were: phlegm production (79.55%), joint pain (78.41%), eye irritation (67.05%), headache (55.68%), dyspnea (48.86%) and dizziness (36.36%). Most prevalent abnormal physical findings were hypertension (21.43%) and perforated eardrum (19.32%). These were related with the physical, chemical and ergonomic hazards identified at the corporate mining operations.

RECOMMENDATIONS

The following recommendations are put forward:

1. Applying the precautionary principle, steps have to be taken to protect the residents living along the Abra River, especially those within the 10-20 kilometers downstream from the Lepanto Mill Outlet, from any further exposure to cyanide and heavy metals.

2. Institute a surveillance system in the area in order to continue to document all acute and chronic health effects of mine drainage exposure. This surveillance system may take the form of a cohort study.

3. Consider the testing of other biomarkers for exposure such as urine thiocyanates (for chronic cyanide poisoning) and testing of arsenic levels from the hair and nails of residents living along the river.

4. Conduct on-site quantification of hazards such as noise, heat, etc.

5. Conduct further studies focusing on worker's pulmonary health, including x-rays and pulmonary function testing.

6. Feedback the results of this study to the company, the workers' union and concerned government agencies for proper action.

ACKNOWLEDGMENTS

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END NOTES

[1] www.ilo.org/public/english/dialogue/sector/sectors/mining/safety.htm

[2] While elevated levels of arsenic, cadmium and mercury had previously been documented in the water and/or soil downstream from the corporate mining operations, blood levels of these heavy metals were not tested because of laboratory limitations at the time of the study.

[3] Minimum detectable level for cyanide = 0.10 mcg/mL, done at the Department of Pharmacology, University of the Philippines College of Medicine; toxicity considered at 0.5 mcg/mL and above (for smokers).

[4] Done by CHEMPRO Analytical Services Laboratories, Inc. The National Poison Control and Information Service at the Philippine General Hospital sets the toxicity action level for copper at 100 ug/dL.

[5] Detectable level for lead = 1.4-65 mcg/dL, done by Healix Foundation, Inc.; toxicity considered at 40 mcg/dL and above (for females) and 50 mcg/dL and above (for males).

[6] Done at the Pathology Department, Saint Louis University, Hospital of the Sacred Heart, Baguio City

[7] Department of Labor-Mines Safety and Health Administration, Guidelines for Medical Surveillance and Biological Monitoring for Miners Exposed to Arsenic, Cadmium, Lead and Mercury, United States of America.

[8] Department of Environment and Natural Resources, Administrative Order No. 35 (Revised Effluent Regulations os 1990, Revising and Amending the Effluent Regulations of 1982), Philippines

[9] Josephine Aries Dulay, MS En.E. of Saint Louis University reported in “Abra

River System: Water Quality Monitoring" (unpublished work) cyanide levels of 0.776 (October 2004) and 0.43 (February 2005) at the Lepanto CIP Mill Outlet, and 0.98 (October 2004) and 0.436 (February 2005) at the Baguyos Bridge. [The cited paper is published as the first article in this volume.– Editor].

[10] Toxicological Profile for Cyanide (Draft), US Department of Health and Human Services, Public Health Service Agency for Toxic Substances and Disease Registry, September 2004.

[11] N. P. Okolie and A.U. Osagie, Liver and kidney lesions and associated enzyme changes induced in rabbits by chronic cyanide exposure, Food Chemistry Toxicology, vol. 37: 7, pp.745-50, July 1999.

[12] Rom, William, editor, Environmental and Occupational Medicine, 3rd edition, Philadelphia, USA, 1998.

[13] Underground Gold Mining in Itogon, Benguet: Implications and Impact of OHS-Hazards and Environmental Protection Liabilities on Workers, Communities and Ecosystems, Institute for Occupational Health and Safety Develoment, 1997, unpublished work.

[14] Rom, William, editor, Environmental and Occupational Medicine, 3rd edition, Philadelphia, USA, 1998.

[15] US Mining Safety and Health Administration, Practical Ways to Reduce Exposure to Diesel Exhaust in Mining—A Toolbox, www.msha.gov

[16] Ibid, p. 579.

[17] Mining Safety and Health Administration, New Standards Add Protections for Miners Exposed to Noise, News Release, United States of America, September 1999.

[18] Ibid.

[19] Food and Nutrition Research Institute, Department of Science and Technology, Philippine Nutrition Facts and Figures, Philippines, April 2001.

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