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PREVALENCE AND CORRELATES OF LUNG FUNCTION IMPAIRMENT AMONG OPEN-PIT MINERS AT NCHANGA IN ZAMBIA

BY

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER OF PUBLIC HEALTH (MPH)

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Prevalence and correlates of lung function impairment among open-pit miners at Nchanga in Zambia

By

Chisambi N.S. Laima

2012

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I Chisambi N.S. Laima, declare that this Dissertation represents my own work and that all the sources I have quoted have been indicated and acknowledged by means of complete references. I further declare that this Dissertation has not previously been submitted for Degree, Diploma or other qualifications at this or other Universities. It has been prepared in accordance to the guidelines for Master of Public Health Dissertation of the University of Zambia.

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I have read this dissertation and approved it for examination

Prof. S. Siziya

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I, **Prof. S. Siziya,** having read and submitted this dissertation, I am satisfied that this is the original work of the author under whose name it is being presented. I confirm that the work has been completed satisfactorily and is hereby for presentation to the examiners.

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CERTIFICATE OF APPROVAL

The University of Zambia approves this Dissertation of **Chisambi N. S. Laima** in partial fulfilment of the requirement for the award of the Master of Public Health Degree by the University of Zambia.

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Examiner I

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Examiner II

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Examiner III

Head of Department

Signature ....Date: ....

DEDICATION

It is with great pleasure that I dedicate this study to my beautiful mother, Grace Ntenda Nampemba Laima and my late father Charles Nechi Laima.

To my God who is faithful not that my parents are above him no way.

To my brother and sister, who have always supported and encouraged me.

To my Sweetheart Mwanda Kilimuna, Thank you for being a part of my life.

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LIST OF ACRONYMS

FEV	-	Forced Expiratory Volume
FEV_1	-	Forced Expiratory Volume in 1 second
FVC	-	Forced Vital Capacity
PPE	-	Personal Protective Equipment
WHO	-	World Health Organization
NICS	-	Newly Industrialized Countries
COPD	-	Chronic Obstructive Pulmonary Disease
ICORD	-	International Conference on Respiratory Pulmonary Diseases
IBU	-	Integrated Business Unit
PI	-	Principal Investigator

DEFINITION OF TERMS

Mining The extraction (removal) of valuable minerals or other geological materials from the earth.

Spirometry The measurement of how quickly air can be expelled from the Lungs.

Forced Expiratory

Volume in 1 second The volume of air that the patient is able to exhale in the first second of forced expiration.

Forced Vital

Capacity The total volume of air that the patient can forcibly exhale in one breath.

Lung Function refers to how well Lungs put oxygen into and removes Carbon dioxide from the blood or an FEV_1/FVC ratio of greater than 70% (the ratio of forced expiratory volume in one second to forced vital capacity that is greater than 70%).

Lung Function

Impairment An FEV_1/FVC ratio of less than 70% (the ratio of forced expiratory volume in one second to forced vital capacity that is less than 70%) or the distortion or weakening of the Lungs ability to put oxygen into and remove carbon dioxide from the blood.

Personal Protective

Equipment This is the protective clothing, helmets, goggles, or other garment designed to protect the wearer's body from injury by blunt impacts, electrical hazards, heat, chemicals, and infection, for job-related occupational safety and health purposes.

Mineral Dust Is the term used to indicate atmospheric aerosols originated from the suspension of minerals constituting the soil being composed of various oxides and carbonates.

Exposure The act of subjecting or an instance of being subjected to an action or an influence (mineral dust).

Open-Cast Mining Also known as Open-Pit mining and Open-Cut mining, refers to a method of extracting rock or minerals from an Open-Pit or burrow.

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ABSTRACT

Background

Mining operations contaminate the environment by emitting sizable quantities of dust particles or chemical emissions into the air which singly or in combination cause respiratory impairment if inhaled at adequate concentrations and over a long enough period of time.

Studies in African countries, like Zambia, have shown that precautionary measures against dust inhalation at mineral extraction sites are generally poor or nonexistent. In Zambia, mining regulations do not have crystalline silica exposure limits. Many miners are therefore exposed to the harmful effects of silica dust which includes respiratory complications.

This study was undertaken to determine the prevalence and correlates of impaired lung function among open-pit miners and also to add information to the body of knowledge on the relationship between mere exposure to dust measured by length of service in the mine and lung function impairment.

Materials and Methods

A cross-sectional study was conducted at the Nchanga open-pit mine in Chingola, Zambia. Informed consent to participate in the study was sought from each open-pit miner that was selected by stratified sampling method. Consenting open-pit miners were interviewed to get information on socio-demographic characteristics, respiratory symptoms, smoking, and also personal protective equipment. Further, the respondents also had their lung function measured using a spirobank G spirometer. The research was cleared by the biomedical ethics committee of the University of Zambia, school of medicine, Zambia. Data were entered, managed and analysed using EPI-DATA and SPSS (version 17) for windows.

Results

The response proportion to participate in the study was 93.9% (N=122). Most of the participants were of age 45-54. The prevalence rate of Lung function impairment was 27% (Severe; 4 (3.3%), Moderate; 5 (4.1%), and Mild 24 (19.7%)).

It was found that the respondents who had cough first thing in morning (morning cough) were 3.44 times (CI=1.10, 10.70) more likely to have had lung function impairment than those who did not cough first thing in morning. Also, respondents who had chest tightness in the past year were 2.37 times (CI=1.22, 4.62) more likely to have had lung function impairment than those who did not have chest tightness in the past year.

Conclusion/Recommendation

No association was observed between duration of employment and lung function impairment hence the hypothesis did not hold and was rejected. Only morning cough and chest tightness were found to be significantly associated to lung function impairment and hence the correlates.

It is therefore, recommended that respiratory symptom evaluation including spirometry be performed at least every year or so in order to check for the development of significant pulmonary symptoms. This may necessitate early intervention which may lead to reduced prevalence.

CHAPTER 1

1.1 INTRODUCTION/BACKGROUND

Mining operations are known to contaminate air with dust particles or chemical emissions. All mining along with limestone processing emit sizable quantities of dust particles. Airborne dust from mines turn up from sources like exposed pits, ore along with discarded piles together with concentrated storage areas, ore crushing, open ore vehicles in addition to haulage roads. These sources could cause impacts to the quality of air alone which can impact the ones living in close proximity to the mine, and employees. It is particularly of worry if dust consists of elevated levels of metals (Tompkins 2010). In humans, high exposure to metals (copper) may cause injury to red blood cells and lungs, as well as damage to liver and pancreatic functions (ZCCM 2005: 26-27). Air pollution therefore can be due to gases (carbon monoxide, nitrogen dioxide, sulphur dioxide, benzene and ozone) or particulates (dust). These can singly or in combination cause respiratory impairment (lung function impairment) if inhaled at adequate concentrations and over a long enough period of time (Tanimowo 2000).

Several million people are at present employed throughout the world in the extraction of coal and other minerals. Consequently, this number of workers is potentially exposed to the harmful effects of respirable mineral dusts. The most important health effects associated with the inhalation of these dusts (Silica, coal) are fibrotic reactions in the lung (pneumoconioses). In their advanced stage, these conditions are associated with impairment of breathing capacity, disability, and premature deaths (Schuler 1986).

Spirometry is the most commonly performed lung function test (Schuler 1986). It is the measurement of the air moving in and out of the lungs during various respiratory manoeuvres. It allows one to determine how much air can be inhaled and exhaled, and how fast. The most important measures (values) for spirometry are the forced vital capacity (FVC), the forced expiratory volume in 1 second ($FEV_{1)}$, and the FEV_1 expressed as a percentage of the FVC (FEV_1/FVC ratio) (Al-Ashkar et al. 2003; Kaplan et al. 2010). Spirometry indicates the presence of an abnormality if any of the following are recorded: FVC <80% predicted normal, FEV_1<80% predicted normal and FEV_1/FVC ratio <70%. It indicates an obstructive disorder (airways are obstructed e.g asthma) if the FVC is normal or reduced, FEV_1 is reduced (<80% predicted normal) and FEV_1/FVC ratio <70%. It indicates a restrictive disorder (lung volume is reduced e.g fibrosing alveolitis) if FVC is reduced (<80%

predicted normal), FEV_1 is reduced (<80% predicted normal) and FEV_1/FVC ratio is normal (>70%) (Bellany 2005; Kaplan et al 2010).

Studies in the different regions of the world including; Asia, Africa and South America have shown that the incidence of pneumoconiosis may be increasing rather than decreasing (WHO, 2007). Further, in other studies done in different parts of the African region including; Nigeria, South Africa, and Ghana it has been shown that occupational respiratory diseases are caused by inhalation of toxic dust and chemicals and that precautionary measures against inhalation of dust at rock crushing and mineral extraction sites are still generally poor or nonexistent (Osim et al. 2004). Occupational health has received limited attention in the southern African region. Much of the published data in this region is from South Africa. Research on occupational illnesses and the pursuit for improved occupational health have largely been reported from high and middle income nations. Data from low income nations are often unavailable and when they do, are incomplete, unreliable or generally describe poor occupational health situations among workers (Muula et al. 2010).

A study carried out to assess the burden of occupational illnesses and associated factors in the Zambian workforce showed that the prevalence of work-related illness (chest infections at 17% of the overall proportions) was high in Zambia, and associated with significant levels of absence from work (Muula et al. 2010). In Zambia, Copper is still the main export and foreign exchange earner. The main sources of air pollution on the Copperbelt are the mining industry, burning of bush and firewood among other sources (ZCCM 2005: 30-31).

According to the Copper-Tour (2001), it was stated that copper mining and processing has a significant effect on the health and well being of the people working in the mines and in the surrounding environment of the copperbelt. It was further stated that the mining and processing of copper ore involves the production of silica particles that causes a number of respiratory illnesses such as Asthma, tuberculosis, and skin diseases. In the same article, it was stated that between January and June 1996, 21,743 miners were screened for chest ailments at the Occupational Health and Research Bureau and it was found that many of the miners suffered from silicosis or pneumoconiosis which is an incurable disease. As it has already been stated in Schuler (1986), this condition in its advanced stages may result in impaired breathing.

In Zambia, there is no information on the prevalence of lung function among miners. It was important therefore, to investigate the respiratory health effects of Mineral dust exposure on open-pit miners.

1.2 STATEMENT OF THE PROBLEM

Literature shows that Occupational airborne particulates are an important cause of death and disability worldwide (Driscoll et al. 2005; WHO 2010). The WHO report on occupational health for all stated that 68-157 million new cases of occupational disease may be caused by various exposures at work (WHO 2010). Despite this status, studies done globally and regionally show that the levels of lung function impairment which can be attributed to mineral dust exposure are still of concern (Osim et al 2004; Tanimowo 2000; WHO 2007).

In Africa, studies have shown that air pollution from different sources adversely affects people's respiratory health (Tanimowo 1995, Tanimowo 1998; Mengesha et al. 1998). Despite these facts, respiratory impairment from different pollution sources is still a major but highly neglected problem on the African continent (Taninowo 2000).

In South Africa, studies have shown that there are high levels of occupational disease due to dust exposures (Murray et al. 2011; Sluis-Cremer et al. 1967). Industrial hygiene and dust control measures are still poor in the developing countries which include Zambia (Osim et al. 2004). In a report by Simpere (2010), working conditions in some mines in Zambia have been described as difficult and this has been attributed mainly to little or no ventilation whilst dusty operations are taking place. Many of the miners working in such environments usually complained of leg pain and respiratory problems.

It was also stated in the article by Simpere, that levels of silica in the air exceeded rates authorized by the United States of America regulations ($0.1mg/m^3$). This means that emission controls were insufficient and that the miners were exposed to greater risks of lung diseases, especially silicosis. Classical symptoms associated with such exposures include lung infections, coughs, eye irritation and also other respiratory complications (Simpere, 2010). A study by Muula et al. (2010) showed that the prevalence of work-related illness in Zambia is high.

Although substantial progress has been made in the control of occupational health hazard, there remains room for further risk reduction (WHO 2007). Since mining remains an important industrial sector in many parts of the world including Zambia, it was of significance that this study be conducted in order to determine the prevalence of lung function impairment among the miners.

1.3 JUSTIFICATION FOR THE STUDY

According to WHO (2010), only 5-10% of workers in developing countries and 20-50% of workers in industrialized countries (with few exceptions) have access to occupational health services in spite of an evident need virtually at each place of work. The need for occupational health services is particularly acute in the developing and newly industrialized countries (NICS). Such services if organized appropriately and effectively for all workers, would contribute positively not only to workers' health, but also to overall socio-economic development, productivity, environmental health and well-being of countries, communities, families and dependants. Also the control of unnecessary costs from sickness, absenteeism and work disability, as well as costs of health care and social security can be effectively managed with the help of occupational health (WHO 2010). Furthermore, approximately 8 out of 10 of the world's workers live in these countries (WHO 2010).

Various documented reports worldwide account for the need for information relevant to help with health-based limits for dust control in the various work places (Schuler, 1986; WHO 1980; WHO 1981; WHO 1982; WHO 1983). As already stated, dust control measures in developing countries are poor. In a study by Hnizdo et al. (2003), it was shown that chronic levels of silica dust that do not cause disabling silicosis may cause the development of chronic bronchitis, emphysema, and/or small airways disease that can lead to airflow obstruction, even in the absence of radiological silicosis (Hnizdo et al. 2003).

In a study by Pritchard (1989), it was shown that pulmonary clearance becomes impaired after exposure to high dust concentration. It was concluded in this study that impairment of pulmonary clearance may affect all materials and species if dust is deposited in the lung at sufficient rates (Pritchard, 1989).

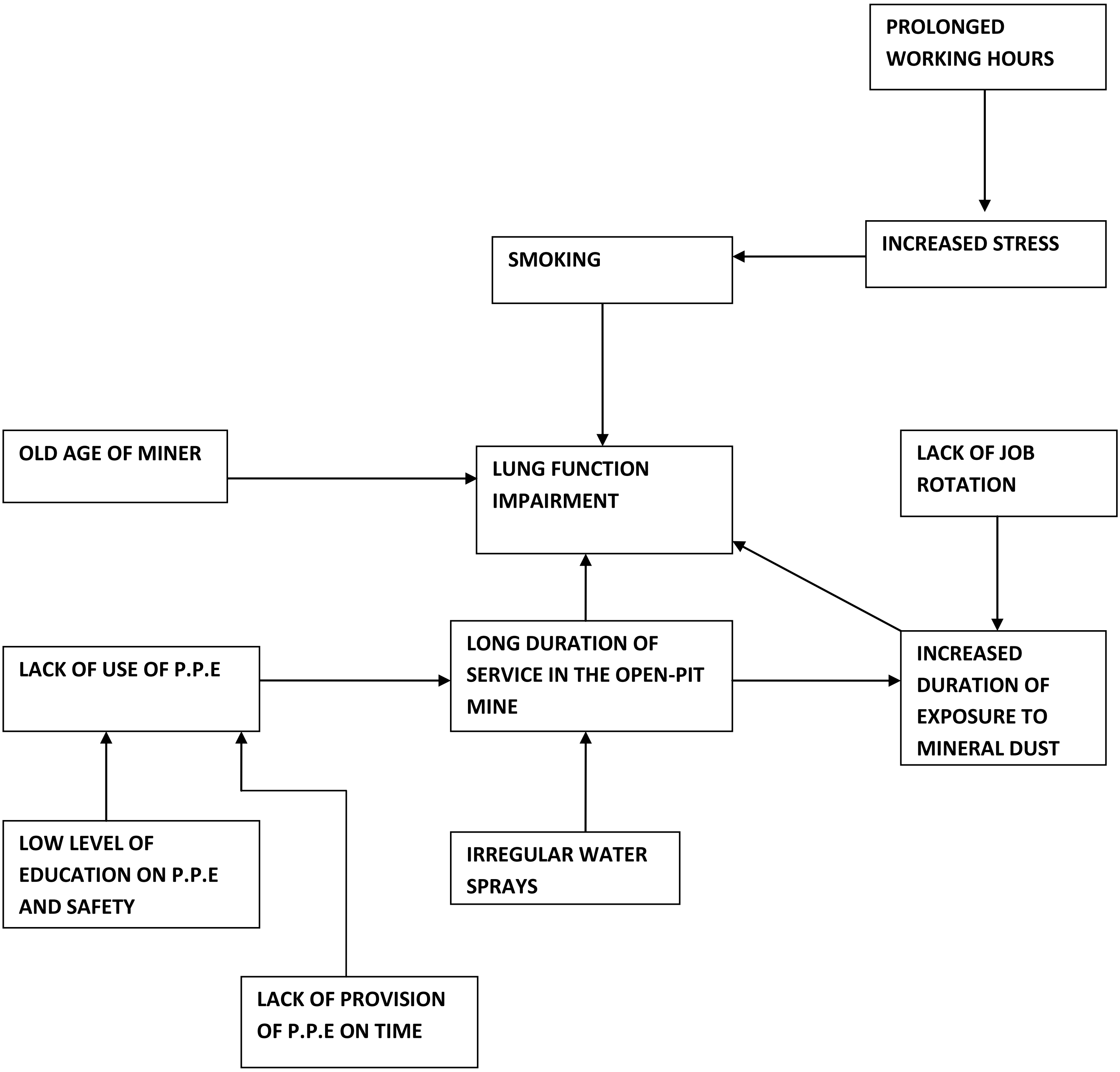
In a study by Hayumbu et al. (2008), it was noted that silica exposure and silicosis morbidity levels have been poorly studied among nearly half a million miners that have been employed in the copper industry since large-scale Zambian copper mining started in the early 1930s. It was further stated that control of silicosis as implemented in Zambia, using the methods of monitoring dust in mines and annual pneumoconiosis screening of miners has gaps. It was concluded from this study that weak dust monitoring exists in the Zambian mines and this may increase the risk of non malignant respiratory disease in many miners. This report by Hayumbu also pointed out that the Zambian mining regulations do not have crystalline silica exposure limits and that this should be changed in order to increase the protective dust protecting workers (Hayumbu et al. 2008).

Currently there is insufficient documented information on air quality/levels of air pollution or respirable dust content in ambient air for the Nchanga mine as evidenced from the Environmental Council of Zambia database. Also, no information on such issues as the adherence to wearing personal protective equipment, dust control, smoking behaviour among miners and how it relates to impairment of lung function was come across among other issues. It is therefore not certain whether the amount of dust is alarming or not and if it were, to state if any association exists between dust exposure and prevalence of lung function impairment in open-pit miners.

The principal investigator after having worked in a mining environment noticed that the air appeared to be quite dust-laden and further no study on lung function impairment in the open-pit mine has been done in Zambia with focus on such variables as P.P.E, duration of service e.t.c. Although some studies have been done with focus on the smelter and its effects on children living in close proximity and lung function in adults and also mining in general, some gaps still exist.

It was important therefore, to conduct this study in order to determine the prevalence and correlates of impaired lung function among open-pit miners using selected variables (PPE, duration of employment, educational level, age and also smoking). In this study, the relationship between mere exposure to dust measured by length of duration of employment in the mine and Lung function impairment was studied to determine if any associations existed. Further, the study was conducted to add information to the body of knowledge on the same subject in Zambia. The problem analysis diagram that depicted the factors that could have been associated with lung function impairment occurrence in the miners was as outlined in figure 1;

FIGURE 1: PROBLEM ANALYSIS DIAGRAM



Prevalence of lung function impairment in open-pit miners was studied using some selected variables such as duration of service in the open-pit mine, age of miner, lack of use of P.P.E, and also smoking as shown in the analysis diagram above.

1.4 RESEARCH QUESTIONS

i. What was the prevalence of respiratory symptoms at the Nchanga Open-pit?
ii. What was the prevalence of occupational lung disease in the Nchanga Open-pit?
iii. What was the most commonly reported respiratory symptoms?
iv. What were the factors associated with impairment in lung function?

1.5 GENERAL OBJECTIVE

i. To determine the prevalence and correlates of lung function impairment

1.6 SPECIFIC OBJECTIVES

i. To determine the prevalence of lung function impairment
ii. To determine whether duration of service was associated with lung function impairment.
iii. To determine if there was a relationship between Personal protective equipment and lung function impairment.
iv. To determine if educational level of the miner was associated with occurrence of lung function impairment.

1.7 HYPOTHESIS

Long duration of service in the open-pit mine was associated with the occurrence of lung function impairment.

CHAPTER TWO: LITERATURE REVIEW

2.1 Prevalence of Lung function Impairment

Studies in a large open pit mine in Mexico for determining prevalence of lung function impairment showed that a substantial percentage of miners had adverse respiratory symptoms including shortness of breath (46%), wheezing (12%), coughing (12%), and elevated sputum production (10%). Further, obstructive patterns were found in 23% of miners and 3% had significant lung function impairment due to dust exposure *(*Zubieta et al. 2009).

About 45% of the world's population and 58% of the population over 10 years of age belong to the global workforce. Their work sustains the economic and material basis of society, which is critically dependent on their working capacity. Thus, occupational health and well-being of working people are of utmost importance for overall socio-economic and sustainable development.

The workplace is a hazardous environment; occupational health and safety hazards are common in many economic sectors and affect large numbers of workers. Approximately 30-50% of workers report hazardous physical, chemical or biological exposures or overload of unreasonably heavy physical work or ergonomic factors that may be hazardous to health and to working capacity. Many individuals spend one-third of their adult life in such hazardous work environments. About 120 million occupational accidents with 200,000 fatalities are estimated to occur annually and some 68-157 million new cases of occupational disease may be caused by various exposures at work. Most of such morbidity is in principal preventable with the help of the modern occupational health approach. Many of these cases of occupational disease however, go under diagnosed and under reported and preventive actions are not undertaken (WHO 2010; WHO 2011). This means that the average risk of accidents is 42 per 1000 workers with the risk of fatality at 8.3/100 000. It should be noted that the estimation of occupational disease rates is difficult because of the shortage of data and variation in the definition of an occupational disease in different countries (WHO 2011).

In a study to determine the global burden of non-malignant respiratory disease due to occupational airborne exposures by, it was concluded that occupational airborne particulates are an important cause of death and disability worldwide (Driscoll et al. 2005). In an article on the elimination of silicosis in 2005, it was noted at the 10^{th} ICORD (International

Conference on Occupational Respiratory Diseases) that such conferences provide an excellent forum for deliberations on best practices for prevention and control of occupational respiratory hazards. However, efforts are still needed to prevent Silicosis as it persists worldwide just like other respiratory illnesses (WHO 2007).

In another study by Donoghue, 2004 on occupational health hazards in mining: overview, it was noted that mining remains an important industrial sector in many parts of the world and although substantial progress has been made in the control of occupational health hazards, there remains room for further risk reduction. This applies particularly to traumatic injury hazards, ergonomic hazards and noise. It was reported in another study that vigilance is also required to ensure exposures to coal dust and crystalline silica remain effectively controlled whenever such control prevails in a work environment (Driscoll et al. 2005).

2.2 Factors associated with occurrence of Lung function impairment

In a study by Saab (2010), a non-comprehensive list of medical conditions that may result in respiratory impairment was given and it included: allergies, asthma, chemical sensitivity (MCS), chronic obstructive pulmonary disease, cystic fibrosis, environmental illness (EI), fragrance sensitivity, lung cancer, pulmonary sarcodoisis, tuberculosis, emphysema, pulmonary hypertension, latex allergy and AIDS related lung disease. For the purposes of this research dissertation and topic of interest, Lung function impairment that resulted from dust or was associated with other mining exposures including related exposures was discussed as follows;

2.2.1 Dust exposure and respiratory symptoms

A WHO report showed that the incidence of pneumoconiosis in Asia, Africa and South America might be increasing, rather than decreasing. Although most of the reports are not verifiable statistically (because of the difficulties in obtaining systematically gathered and relevant data), such accounts do underline the need for the widest possible dissemination of information relevant to the establishment of health-based limits for dust control (Schuler 1986).

The rapid expansion of mining and mineral extraction industries in developing countries (which includes Zambia) is placing tens of thousands of new workers at risk each year. In many cases, dust control measures are not adequate; the concentrations of respirable dust are likely to be much higher and medical surveillance less effective than in countries with longer histories of industrial development (Schuler 1986).

In a study by Osim et al. (2004) to determine the lung function status as well as respiratory and other associated symptoms of Nigerian men and women chronically exposed to dust generated from the granite rock crushing industries (in Old Netim in Akampa local government area of Cross River State) showed that chronic exposure to dust does impair lung function and causes some respiratory and non-respiratory symptoms in men and women.

In the same study by Osim et al. (2004) in Nigeria, it was further stated that there are 50 million occupational respiratory diseases caused by inhalation of toxic dust and chemicals, which are allergenic and carcinogenic agents. A lot of dust and gases are generated in rock crushing and mining industries. Precautionary measures against inhalation of dust at the rock crushing sites are generally poor or nonexistent owing to lack of resources by the management of the industries and ignorance of the rock crushers.

It has been shown that in the rural and urban areas of Africa where industries are situated high prevalence of respiratory symptoms and reduced lung function exist. For example, Tanimowo in his study demonstrated a high frequency of occurrence of cough alone, cough with sputum, morning phlegm, nasal catarrh, chest pain and reduced lung function among the residents of Bacita; Kwana state, Nigeria sequel to their exposure to air pollution from the process of sugar production. In Eastern Africa studying the respiratory effects of dust in different sections of Cement, Yarn and Cigarette factories found a higher prevalence of chronic cough, Chronic bronchitis and Bronchial Asthma among the workers than controls. Also, Rees et al. (1994) found an uncontrolled dust hazard in all nine (9) foundries surveyed in South Africa in a period of 9 years. (Tanimowo 2000). Other studies in South Africa have shown that occupational exposure to dust is associated with increased prevalence of respiratory symptoms (Sluis-Cremer et al. 1967; Wiles et al. 1977).

A study done in Ghana however by Burge et al. (2007) did not show any deleterious effects on FEV_1 and let alone respiratory function due to silica exposure. This could be attributed to the fact that the study did not directly relate impairment to measured personal total inhalable and respirable dust exposures. In another study done among South African Gold miners, it was found that despite a healthy worker effect, lung function loss was demonstrable whether due to silicosis, tuberculosis and lung function impairment because of silica dust exposure (Ehrlich et al, 2009).

The copperbelt province in Zambia is known for good evidence of industrial pollution. Constant coughing characterises the general population due to vast amounts of toxic materials that miners inhale as they dig copper ore (Palekelo, 1997). Hayumbu et al. (2008) showed that some mines in Zambia had miners exposed to dust limits which were above the calculated U.S. Occupational safety and health administrative permissible limit. The P.I did not however come across any readings for Nchanga mine specifically as already stated.

In a study by Siziya (2005), it was shown that there were associations between Lung function impairment and some selected respiratory symptoms. For Asthma, it was found to be less common in the population of cement workers. Similar results were found for wheezing and cough. For shortness of breath, the prevalence was the same in both the exposed and unexposed persons. For phlegm, however, the results showed that exposed persons had a higher rate of it than the unexposed persons.

In a study by Noor et al. (2000), it was reported that three respiratory symptoms were significantly higher among cement workers. These were morning cough (in 6% of controls vs. 25% of cement workers), morning phlegm (11% vs. 24%) and chest tightness (6% vs. 19%). Overall, this study showed that there was a higher prevalence of chronic respiratory symptoms and reduced pulmonary function in cement workers compared to the controls.

In a study by Al-Neaimi et al. (2001), it was reported that a higher percentage of the exposed workers reported recurrent and prolonged cough (30%), phlegm (25%), wheeze (8%), dyspnoea (21%), bronchitis (13%), sinusitis (27%), shortness of breath (8%) and bronchial asthma (6%) as compared to the unexposed worker who had prevalences of these symptoms as; 10, 5, 3, 5, 4, 11, 4 and 3% respectively. Similarly, Zubieta et al (2009) reported that a substantial percentage of miners reported significant respiratory symptoms i.e. Dyspnoea (which was also stated shortness of breath) 46%, Chronic Cough 12%, Chronic bronchitis 10% and wheeze 12%. It was further stated that the exposure of dust was of importance in causing respiratory symptoms though the data set was too small to determine associations between work place exposure and lung function impairment. Mamuya et al. (2007) reported a prevalence of shortness of breath (34.5%) that was comparable to Zubieta et al. (2009) although the rate of wheeze (8.1%) reported in the same study was lower than Zubieta et al. (2009).

A study by Zambia consolidated copper mines on air quality with focus on particulates from the smelter suggested that there were strong correlations between ambient particulate matter levels and increase in Lower respiratory symptoms and reduced lung function in children as well as chronic obstructive pulmonary disease and reduced lung function in adults. In addition, that due to the activities of mining-agriculture industry, the air quality especially around smelters and such industries was dust-laden (ZCCM 2005: 23-31).

2.2.2 Socio-demographic

In a study by Siziya (2005), it was shown that there were associations between Lung function impairment and some social demographic characteristics such as age, height and also sex. Izycki et al. (1979) stated that prevalence of bronchitis was reported to incresase with duration of work in exposure to cement dust. This was not the case in the study conducted by Siziya (2005).

In a study conducted in Nigeria by Osim et al. (2004), it was found that length of service was noted to be a predisposing risk factor for the occurrence of impaired breathing. Similar studies done in South Africa and few other developing countries showed an exposure-response relationship and also that job types and exposure to dust were significant predictors of lung function impairment (Gomes et al. 2001).

In the study by Siziya (2005), sex was found to be significantly associated with lung function impairment while height was found to be not associated with phlegm or lung function impairment itself.

Muula et al. (2010) reported that lower education level was positively associated with having suffered from occupational illness. It was further stated by Muula et al. (2010), that respondents with more education were less likely to suffer from illness compared to respondents with little or no education. Like Muula et al. (2010), Sabitu et al. (2000) reported that only 20% of those who had no formal education were aware of occupational hazards and safety measures compared to 77.6% among those who had primary education and 85% among those who had secondary education (Sabitu et al. 2009). People with education are more knowledgeable to avoid harmful exposures, and as a result may be less likely to fall ill. Educated workers may also be employed in more skilled but less hazardous jobs, and as result may be less likely to suffer from occupational illnesses (Muula et al. 2010). Concerning educational level and its association to occupational illnesses, Muula et al. (2010) reported that older age was positively associated with having suffered from occupational illness.

In a study by Nandi et al. (2009), it was reported that about 10% of the miners were illiterate. It was further reported that the literacy rate was poor among the miners; 42% were either illiterate or had only been educated up to primary school level as compared to 7% among the controls. It was not stated however if the variable educational level was associated to Lung function impairment in any way. It was however stated that among the measures to use for control of the work place environment in order to help reduce morbidity among miners, health education was a priority.

In a study by Al-Neaimi et al. (2001), it was reported that the differences in the ventilatory function between the exposed smokers and non-exposed smokers and the un-exposed smokers and non-smokers did not achieve statistical significance even after adjusting for age, BMI(Body Mass Index) and smoking. It was therefore concluded from this study that adverse respiratory health effects (increased frequency of respiratory symptoms and decreased ventilatory function) observed among cement workers could not be explained by age, BMI and smoking, and were probably caused by exposure to cement dust.

2.2.3 Smoking

The smoking of tobacco and its products has been recognized as a cause of respiratory impairment in Africa for a long time. In the1980s, the World Health Organisation tried to focus on this subject (WHO 1980), but more recent studies showed that cigarette smoking was actually on the increase on the continent (WHO 1985; Yach 1996) with attendant increase in respiratory morbidity (Tanimowo, 2000).

In a study by Hnizdo et al. (1990), it was shown that severe lung impairment could be prevented through the elimination of tobacco smoking. It was concluded in this study that tobacco smoke was found to potentiate the effect of dust on respiratory impairment.

There was also association shown between lung function impairment and smoking including some social demographic characteristics such as age, height and also sex (Siziya, 2005).

Studies from South Africa also demonstrated the continued deterioration in respiratory health from cigarette smoking, whether the smoking is active or passive (Ehrlich et al. 1996; Reddy et al. 1996; Richards et al. 1996). Theron et al. (1994) reported that cigarette smoking causes pulmonary dysfunction among other effects. Furthermore, cigarette smoking has been blamed for the increased incidence of lung cancer in southern and eastern Africa (Ball 1992).

2.2.4 PPE

In the study by Al-Neaimi et al. (2001), it was reported that the use of appropriate personal protective equipment, if available at the worksite, could protect cement workers from adverse respiratory health effects. For a variety of reasons, industrial workers in rapidly developing countries do not adequately protect themselves through personal protective equipment. It was further stated in this study that the use of proper PPE while at work and the reduction or elimination of smoking by the exposed workers would help to protect them from developing more severe chronic respiratory diseases in future.

In a study by Nandi et al. (2009), it was reported and stated that among the measures for the control of the workplace environment, use of personal protective equipment would help reduce morbidity amongst the miners.

CHAPTER THREE: METHODOLOGY

3.1 STUDY DESIGN

The study was a cross sectional study.

3.2 STUDY SITE

The study was conducted in Chingola, which is a city in Zambia's Copperbelt province, the country's mining region, with a population of 210,073 according to the 2010 Census (Central Statistical Office, 2010). It is the home of Nchanga Open-pit mine which was the actual study site and it is the second largest open cast mine in the world. The interviews with the respondents were conducted at the Nchanga Open-pit mine in Chingola (400km North of Lusaka). Nchanga open pit mine workings lie in an arc 11km long around the west and north of the town as shown on the map on Appendix 5. At present, mining is concentrated on the main Nchanga pit, with satellite planned for future extensions, as economics and processing technological developments unfold. Together they are termed generically as the Nchanga open pits (Map data, 2010).

3.3 STUDY POPULATION

The target population consisted of open-pit miners at the Nchanga IBU (Integrated Business Unit) under Konkola Copper Mines Plc who were measured for lung function impairment. There were 178 miners on the sampling frame who were eligible to take part in the study based on the inclusion criteria of the study. These employees were divided into three strata based on their job category.

3.3.1 INCLUSION CRITERIA

- Miners who were 18 years of age and above who would have worked in the Open-pit and in the production area or actual pit for at least 3 years were invited to participate in the study.

3.3.2 EXCLUSION CRITERIA

- Miners less than 18 years of age who would have worked in the Open-pit for less than 3 years and are not in the actual production area were not invited to take part in the study.
- Females (who are too few workers) were also not invited to take part in the study.

3.4 SAMPLE SIZE AND SELECTION

There were a total 178 miners working in the actual pit or production area. Using the formulae;

$n=Z^2 PQ/d^2$; where P=50%, α=5%, and non-response rate of 5%.

$n=1.96^2 *0.5*(1-0.5)/0.05^2$

n=384.16 (for an infinite population)

Adjusting sample to finite population of 178

s=n/[1+(n/population)]

s=384.16/[1+(384.16/178)]

s=121.51 (Adjusting for 5% non-response rate)

s=121.51/0.95

s=128.42 (The sample size is 128.42)

A sample size was calculated using the formula shown above. The calculations gave a minimum sample size of 384 for an infinitely large population size. This sample size was adjusted to a finite population which in this case was 178 and this resulted in a new size of 121.51. After adjusting for a 5% non-response rate, the sample size of 121.5 increased to a sample size value of 128.42. This was adjusted to give a round figure of a 130 miners.

Stratified sampling by section was used to select these miners from the target population. The population of 178 miners was divided into strata (by job types) and then simple random sampling proportional to the population size was carried out in each stratum to select the 129 miners. The first stratum (Heavy equipment operators) had 48 miners; the second stratum (multi-heavy equipment operators) had 38 miners while the last strata (Senior Multi-Heavy equipment operators and also shift bosses) had 78 miners.

3.5 DATA COLLECTION

Data was collected over a period of 5 weeks starting from the first week of November to the first week of December, 2011. The data collection tools were a structured interview questionnaire and a spirobank G spirometer.

A list of the employees in the Open-pit's production area was collected from the mine captain in charge of training. This was used as a sampling frame on which stratified sampling by section was done. Structured questionnaires (Appendix 5) were used to obtain data from the participants. The P.I interviewed the participants either before or after their daily (morning, afternoon or night) shifts began to get information on Socio-demographic characteristics, respiratory symptoms, smoking and also PPE. Interviewing only took place after informed consent was obtained from the participants. The participants were given an information sheet which they read and questions were clarified if they had any. The participants kept the information sheet which had contact details for the P.I, the supervisor and also the chairperson of the Research Ethics committee. Afterwards, the data collection using a structured interview questionnaire was done. The questionnaire had closed ended questions only.

With the help of a trained spirometry technician, lung function testing was done using a spirobank G spirometer. This was also only done after informed consent was done also. The reference normal value that was used for spirometry testing was that of a normal person as per physiological standard where FEV_1 /FVC% was 80 per cent (Guyton 2006: 526-527). It should be noted at this point that the standard reference values had been calibrated into the spirometer before use. The participants were guided on the correct posture to take when doing the breathing maneuvers to ensure maximum effort from the participant when they forcefully expired. Further, they were given instructions of how to breathe into the instrument that is; they were asked to expire in the absence of the instrument and then if it was done correctly into the instrument. Up to three (3) maneuvers were done on each participant. Three readings of the lung function test were collected and at a later stage, the mean of these three readings was calculated and recorded. The variables that were collected were the FVC and $FEV_{1.}$ The FEV_1/ FVC% was categorized as <40=Severe, 40-54=Moderate, 55-70=Mild, >70=Normal (Mannino (2001) and Siziya et al. (2005)). Any average lung function readings that were in the categories Severe, Moderate and Mild were considered to be impaired lung function. The participants were given the option to request for their results otherwise, they were with held. For the participants who had impaired lung function according to the criteria indicated above and had requested for their results, a letter containing the study results was prepared for them and they were instructed to take the spirometry results to their health care provider within the next 30 days.

A Spiro bank G spirometer that had been used before (Siziya 2005; Siziya et al. 2005) was used to measure the lung function as indicated above hence no pre-testing of the tool was done. The questionnaire however was pre-tested both by self administration as well as on 10 randomly selected miners in order to check and assess the understanding and flow of questions (these miners were not part of the Open-pit department). The flow and understanding seemed ok hence no changes were made to the questionnaire. The need not to change anything in the questionnaire was also enhanced by the fact that most questions were adapted from the U.S Department of Labor, Occupational Safety and Health Administration Respiratory questionnaire which had been used before. Further, most of the questions in the questionnaire were similar to those used by Siziya et al (2005). With the reasoning explained above, it was concluded therefore that the spirometer would be effective enough to measure the lung function capability of the participants and give acceptable readings. It was further concluded that the questionnaire would be easy to follow and therefore it was maintained as already stated.

3.6 VARIABLES OF THE STUDY

Independent variables

- Age of miner
- Duration of service in the open-pit mine
- Level of education of the miner
- Smoking and
- Lack of use of P.P.E
- Other variables are appearing in the problem analysis diagram but not selected for further investigation.

Dependant variable

- Lung function impairment

3.7 ETHICAL CONSIDERATION

Ethical clearance for conducting the study was obtained in writing from the Biomedical Research Ethics committee on the 25 October, 2011 (Assurance No. FWA 00000338, IRB 00001131 of IORG 0000774, Ref: 004-06-11). An informed consent form was prepared according to the Research Ethics Committee guidelines; this was issued to the participants in order to guarantee voluntary participation, confidentiality, benefits and maintenance of privacy of all participants in the research. In addition, permission to conduct the research was also obtained in writing from the Konkola Copper Mines Plc open-pit management.

Voluntary participation and the right to withdraw from the study at anytime were emphasized. In order to ensure confidentiality, no names were recorded. The purpose and procedures of the study were explained to the participants. Time was given to them to ask questions or clarify anything. The information sheet was given to the participants to keep while the consent form was retained by the P.I. It should be noted that both the consent form and information sheet had contact details well written out. All the participants gave consent by signing and none used a thumb print. The data that was collected has been kept safely and will only be discarded after a period of about 5 years.

The participants were given the option to request for their results otherwise, they were with held. For the participants who had impaired lung function according to the criteria indicated above and had requested for their results, a letter containing the study results was prepared for them and they were instructed to take the spirometry results to their health care provider within the next 30 days. At the end of the data collection process, the participants were thanked and the questionnaires and signed consent forms were taken and kept safely by the P.I.

Precautionary measures in using the spirometer included the following; only one mouth piece was used by one participant to avoid cross infection and also because the survey was synonymous. The P.I and trained technician wore appropriate P.P.E in order to protect themselves from any cross infection while the spirometry testing was being carried out.

Finally, the results of the study will be disseminated by way of a presentation at the University Of Zambia School of medicine, by publication in a suitable scientific Journal, and also giving a project report on the same to the KCM management. If also the study participants require the detailed findings, they will be given to them via email. It should be noted that the findings will be presented in writing, tables etc, to facilitate understanding.

4.0 DATA PROCESSING AND ANALYSIS

Following data collection, the structured interview questionnaires were sorted out and edited for internal consistency, legibility and completeness every day after returning from the field. Data was entered twice using the Epi-Data software. The P.I entered the data in both cases. The data entry program had checks that had the legal range for each field as well as skip patterns if questions were not applicable. The data entered into Epi-Data software were compared using the validate option in order to validate the records. The records that differed were rechecked and corrections were made after counter checking the appropriate questionnaires. The final data set was exported to Statistical package for social sciences (SPSS) version 17 for the purposes of defining variables, labels and also values. It should be noted that the completeness of questionnaires was checked while in the field.

Transformation of continuous variables into categorical variables was done in order to make the data analysis process easier. Some of the transformations which took place include the following; Age and duration of employment were transformed into more than two categories initially i.e. Age was grouped into three categories which include; 25-34, 35-44 and 45-54. These categories were then reduced into dichotomous ones having the values '1'and '2' (where 1 represented 25-39 while 2 represented 40-45) in order to avoid small cells in Chi-square analysis. These dichotomous categories were maintained as values '1'and '2'and not transformed/recoded into values '1'and '0' for the purposes of multivariate analysis using Logistic regression (Backward stepwise logistic regression). Duration of employment had the values of dichotomous variables '1' and '2' (where 1 represented short duration of employment while 2 represented long duration of employment). This variable like age was not transformed into values '1'and '0' but it maintained values '1' and '2'. Educational level initially had four categories ranging from 1 up to 4 (where 1 represented a lack of education, 2 represented primary education, 3 represented secondary education while 4 represented tertiary education) but it was changed to assume the value of dichotomous variables '1'and '2' as Lower education and Upper education respectively . The recoding into Lower and Upper education was done due to the fact that all the respondents in the study had an education and also for the purposes of Logistic regression analysis. The variable education was also not recoded into the values ‘1’and ‘0’. Other variables that were not recorded into values ‘1’and ‘0’ but maintained values ‘1’and ‘2’ (where 1 represented the response yes while 2 represented the response no) were smoking, PPE, and also respiratory symptoms. As for the dependent variable Lung function impairment, it was transformed from having four categories (where 1 represented severe, 2 represented moderate, 3 represented mild while 4 represented normal) into a dichotomous variable by placing the categories severe, moderate and mild under one value (1 to represent impairment) while normal was under the other value (0 to represent the value normal). All this was done for the purposes of Logistic regression as stated above. Data analysis was done using the SPSS version 17.

Data analysis included running frequencies and generating appropriate tables. The Chi-square test and Logistic regression analysis were used to determine associations between variables. If more than 20% of the cells had an expected frequency of <5, categories that were similar by the P.Is judgment were combined in order to validate the results of Chi-square testing. It was observed however, that after combining the similar categories, the percentages improved and the results were recorded accordingly.

As stated above, the dependent variable was re-coded into values ‘1’and ‘0’ (1 represented Impairment while 0 represented Normal) while all the independent variables maintained values of ‘1’ and ‘2’ (yes coded as 1, no coded as 2) for the purposes of Logistic regression. Since the dependent variable was binary, Logistic regression was used to try and determine which independent variables would be significantly associated with the dependent variable (lung function impairment). The independent variables included; Age, Educational level, Employment duration, PPE, Cough, Phlegm, Wheezing, Shortness of breath, and also Chest tightness. All these variables were re-coded accordingly as already indicated above. For all the analysis that was carried out, the statistical significance was achieved only when the P-value was less than 0.05 ($P< 0.05$).

5.0 RESULTS

5.1 Description of Sample

Of the 130 men that were selected to be interviewed, 122 (93.9%) participated in the study while 8(6.15%) refused to take in the study for various reasons like ill health (2), just refusal (2), leave (1), resignation (1), and sudden shift changes (2). Of the 122 respondents, 34 (27.9%) were Heavy Equipment operators, 37 (30.3%) were Multi-Heavy Equipment operators while 51 (41.8%) were Senior-Multi Heavy Equipment operators.

5.1.1 Socio-demographic characteristics

Out of the 122 participants who were interviewed, most (94.3 %) of them were married. In terms of age, the majority (58.2%) of the respondents were in the age group 45-54 years. As for the duration of employment/Service, most (87.8%) of the respondents reported that they had worked for a Longer duration (6 years and above). For the Educational level however, most (87.7%) of the respondents reported to have completed Secondary school education. These results are shown in table 1.

TABLE 1: Sample description

	Frequency	Percent
Age Group		
25-34	22	18
35-44	29	23.8
45-54	71	58.2
Marital Status		
Single	6	4.9
Married	115	94.3
Separated/Divorced/ Widowed	1	0.8
Duration of Employment		
Short (3-5 years)	15	12.3
Long (>6 years)	107	87.7
Educational level		
Primary	2	1.6
Secondary	107	87.7
Tertiary	13	10.7

5.1.2 Smoking

Of the 122 respondents, 91.8% were non- smokers and 8.2% were smokers. Of the 31 respondents who were Ex-smokers, 71% said that they had not smoked for at least 10 years, 25.8 % said they had not smoked for 5 to 9 years while 3.2% said they had no smoked for a year.

5.1.3 Cough

When asked if they usually get a cough first thing in the morning, 4.1% out of 122 respondents said they did. The respondents were further asked if they usually cough during the day or at night, 5.7% of the 122 respondents stated that they did.

5.1.4 Phlegm

Respondents were asked if they usually bring up phlegm from the chest. Out of the 122 respondents, 18.9% said they did while 81.1% said that they did not. The respondents were further asked how long they had had trouble with phlegm. Out of the 18.9% who did bring up phlegm from the chest, 2% said they had had trouble with it for less than a month while 91.3% said that they had had trouble with it for more than a month.

5.1.5 Wheezing

Of the 122 respondents who were asked whether their chests ever sounded wheezy when they had a cold, 15.6% said their chests did sound wheezy while 84.4% said they did not. The respondents were further asked for how long they had had trouble with wheezing. Of the 15.6% who said their chests were wheezing, 14.3% said they had had trouble for less than a month while 85.7% said that they had had trouble for more than a month.

5.1.6 Shortness of Breath

Out of the 122 respondents who were asked whether they had had trouble with shortness of breath when walking on the level or up a slight hill, 12.3% said they did while 87.7% said that they did not.

5.1.7 Chest tightness

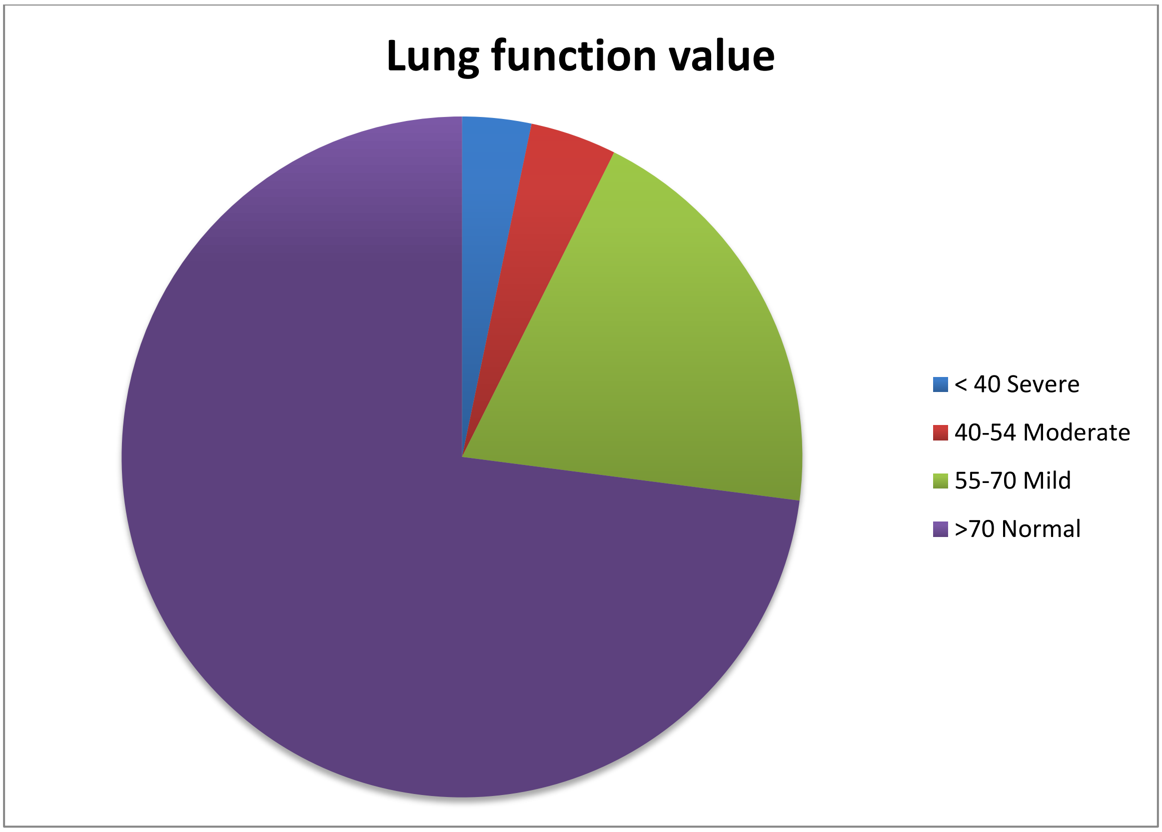
Respondents were asked if their chests ever felt tight. Of the 122 respondents, only 1.6% said they did while 98.4% said that they did not. When further asked if they had experienced chest tightness in the past year, only 9% said that they did while 91% said that they did not experience any chest tightness.

5.1.8 PPE

Of the 122 respondents who were asked whether they wear PPE, 98.4% said that they did wear their hard hats, 88.5% said that they did wear their Safety goggles, another 88.5% said that they did wear Respirators while 97.5% said that they did wear their Work suits. Respondents were also asked if they wore PPE in the hot weather. Two thirds (68.9%) of the respondents said that they did while one third (31.1%) said that they did not. When further asked how often they did wear PPE, 0.8% said that they wore PPE once while 37.7% said that they wore PPE sometimes and 61.5% said that they wore PPE all the time.

5.1.9 Lung function value FEV1/FVC percent

Of the 122 respondents who were measured for Lung function, 3.3% had severe lung function, 4.1% had Moderate lung function, and 19.7% had Mild Lung function while 73% were normal. This implies that 27% had impaired lung function while 73% were normal. These findings are shown in the pie chart.



5.2 Associations among variables of the study

The following results have been presented in two parts i.e. the findings from the Chi-square test and lastly findings from the Logistic Regression which was used as Multivariate analysis.

Socio-demographic factors associated with lung function impairment

Table 2 shows the associations of socio-demographic factors with lung function impairment. Among the respondents who had lung function impairment, 27.3% were of age 25-39 years while 31.5% of the participants who had normal lung function were in the same age group. The association between age and lung function impairment was not statistically significant (P-value 0.655).

TABLE 2	SOCIO-DEMOGRAPHIC FACTORS ASSOCIATED WITH LUNG FUNCTION IMPAIRMENT		
	LUNG FUNCTION IMPAIRMENT		
	Impairment n (%)	Normal n (%)	P-Value
Age	Total=33	Total=89	
25-39	9 (27.3)	28 (31.5)	
40-54	24 (72.7)	61 (68.5)	0.655
Educational Level	Total=33	Total=89	
Lower	29 (87.9)	80 (89.9)	
Upper	4 (12.1)	9 (10.1)	0.747
Duration of Employment	Total=33	Total=89	
3-5 Years	5 (15.0)	10 (11.2)	0.547
6 and above Years	28 (85.0)	79 (88.8)	

The table further shows that among the respondents who had lung function impairment, 87.9% had lower education while 89.9% of the participants who had normal lung function were in the same category of lower education. The association between educational level and lung function impairment was not statistically significant (P-value 0.747). It is also shown in the table that among the respondents who had lung function impairment, 15% worked for a shorter duration of employment while 11.2% of the participants who had normal lung function were in the same category of shorter duration of employment. The association between duration of employment and lung function impairment was not statistically significant (P-value 0.547).

PPE

Associations of PPE factors with lung function impairment are shown in Table 3. Among the respondents who had lung function impairment, 100% wore hard hats while 97.8% of the respondents who had normal lung function were also in the same category that wore hard hats. The association between hard hat and lung function impairment was not statistically significant (P-Value 1.000). The table further shows that among the respondents who had lung function impairment, 85% wore safety goggles while 89.9% of the respondents who had normal lung function were in the same category that wore safety goggles. The association between safety goggles and lung function impairment was not statistically significant (P-Value 0.520). It is also shown in the same table that among the respondents who had lung function impairment, 84.9% used a respirator while 89.9% of the respondents who had normal lung function also wore their respirators. The association between respirator and lung function impairment was not statistically significant (P-Value 0.520). The table also shows that among the respondents who had lung function impairment, 97% wore work suits while 98% of the participants who had normal lung function also wore work suits. The association between work suit and lung function impairment was not statistically significant (P-Value 1.000). It is further shown that among the respondents who had lung function impairment, 72.7% wore their PPE in the summer while 67.4% of the respondents who had normal lung function were also in the category that wore PPE in the summer. The association between wearing PPE in the summer and lung function impairment was not statistically significant (P-Value 0.574). Concerning frequency of wearing PPE, among those who had lung function impairment, 0% wore PPE once while 1.1% of the respondents who had normal lung function also wore PPE once. The association between frequency of wearing PPE and lung function impairment was also not statistically significant (P-Value 0.765).

TABLE 3	PPE ASSOCIATED WITH LUNG FUNCTION IMPAIRMENT		
	LUNG FUNCTION IMPAIRMENT Impairment n (%)	Normal n (%)	P-Value
PPE			
Hard hat	Total=33	Total=89	
Yes	33 (100)	87 (98.0)	
No	0 (0)	2 (2.0)	1.000
Safety goggles	Total=33	Total=89	
Yes	28 (22.9)	80 (65.6)	
No	5 (4)	9 (7.4)	0.520
Respirator	Total=33	Total=89	
Yes	28 (85.0)	80 (89.9)	
No	5 (15.0)	9 (10.1)	0.520
Work suit	Total=33	Total=89	
Yes	32 (97.0)	87 (98.0)	
No	1 (3.0)	2 (2.0)	1.000
Wearing PPE in the summer	Total=33	Total=89	
Yes	24 (72.7)	60 (67.4)	
No	9 (27.3)	29 (32.6)	0.574
Frequency of using PPE	Total=33	Total=89	
Once	0 (0)	1 (1.1)	
Sometimes	12 (36.4)	34 (38.2)	
All the time	21 (63.6)	54 (60.7)	0.765

Table 4 shows the associations between respiratory symptoms, smoking and lung function impairment. Among the respondents who had lung function impairment, 9.1% were smokers while 7.9% of the participants who had normal lung function were also smokers. The association between smoking and lung function impairment was not statistically significant (P-value 1.000). Concerning morning cough, it is shown in the table that among the respondents who had lung function impairment, 12.1% coughed first thing in the morning while 1.1% of the respondents who had normal lung function were in the same category of those that had morning cough. The association between morning cough and lung function impairment was statistically significant (P-value 0.019). Also, among the respondents who had lung function impairment, 9.1% coughed during the day or night while 4.5% of the respondents who had normal lung function were also in the category that coughed during the day or night. The association between cough during the day or night and lung function impairment was not statistically significant (P-Value 0.387). Further, among the respondents who had lung function impairment, 3% had chest tightness while 1.1% of the respondents who had normal lung function were in the same category of those that had chest tightness. The association between chest tightness and lung function impairment was not statistically significant (P-Value 0.469). It is also shown in the table that among respondents who had lung function impairment, 21.2% had chest tightness in the past year while 4.5% of the respondents who had normal lung function were also in the category of those that had chest tightness in the past year. The association between chest tightness in the past and lung function impairment was statistically significant (P-value 0.009). The table also shows that among the respondents who had lung function impairment, 24.2% produced phlegm while 16.9% of the respondents who had normal lung function also produced phlegm. The association between phlegm and lung function impairment was not statistically significant (P-value 0.526). It is further shown in the table that among the respondents who had lung function impairment, 15.2% had wheezing chests while 15.7% of the respondents who had normal lung function were in the same category that had wheezing chests. The association between wheeze and lung function impairment was not statistically significant (0.938). The table also shows that among the respondents who had lung function impairment, 6.1% had shortness of breath while 14.6% of the participants who had normal lung function were also in the category that had shortness of breath. The association between shortness of breath and lung function impairment was not statistically significant (P-value 0.351).

TABLE 4	SYMPTOMS (INCLUDING SMOKING) ASSOCIATED WITH LUNG FUNCTION IMPAIRMENT		
	LUNG FUNCTION IMPAIRMENT		
	Impairment n (%)	Normal n (%)	P-Value
Smoking	Total=33	Total=89	
Yes	3 (9.1)	7 (7.9)	
No	30 (90.9)	82 (92.1)	1.000
Coughing 1st thing in the morning	Total=33	Total=89	
Yes	4 (12.1)	1 (1.1)	
No	29 (87.9)	88 (98.9)	0.019
Coughing during the day or night	Total=33	Total=89	
Yes	3 (9.1)	4 (4.5)	
No	30 (90.9)	85 (95.5)	0.387
Phlegm	Total=33	Total=89	
Yes	8 (24.2)	15 (16.9)	
No	25 (75.8)	74 (83.1)	0.526
Years had trouble with Phlegm	Total=8	Total=15	
< Month	0 (0)	2 (13.3)	
> Month	8 (100)	13 (86.7)	0.351
Wheezing	Total=33	Total=89	
Yes	5 (15.2)	14 (15.7)	
No	28 (84.8)	75 (84.3)	0.938
Shortness of Breath	Total=33	Total=89	
Yes	2 (6.1)	13 (14.6)	
No	31 (93.9)	76 (85.4)	0.351
Chest tightness	Total=33	Total=89	
Yes	1 (3.0)	1 (1.1)	
No	32 (97.0)	88 (98.9)	0.469
Chest tightness in the past	Total=33	Total=89	
Yes	7 (21.2)	4 (4.5)	
No	26 (78.8)	85 (95.5)	0.009

In multivariate analysis, the adjusted odds ratios showed that there were no statistically significant relationships between socio-demographic factors, PPE factors, smoking and the dependent variable lung function impairment. The respiratory symptoms were also not statistically significantly associated with lung function impairment with an exception of morning cough and past chest tightness as elaborated in the subsequent section.

5.3 Factors associated with Lung function Impairment in multivariate analysis

Factors that were independently associated with lung function impairment are shown in Table 5. Participants who coughed first thing in the morning (morning cough) were 3.44 (95% CI [1.10, 10.70]) times more likely to have lung function impairment compared to participants who did not cough the first thing in the morning. Compared to participants who did not have chest tightness in the previous year, those who had chest tightness in the previous year were 2.37 (95% CI [1.22, 4.62]) times more likely to have lung function impairment.

TABLE 5: Factors associated with Lung function impairment

Factor	**Adjusted Odds ratio**	**95% Confidence Interval**
Coughs first thing in the morning		
Yes	3.44	1.10, 10.70
No	1	
Had chest tightness in the past		
Yes	2.37	1.22, 4.62
No	1	

6.0 DISCUSSION

This was a study to determine the prevalence and correlates of lung function impairment among Open-pit miners of one of the oldest and largest Open-pit mines in Zambia. The prevalence of impaired lung function among the miners was 27% (3.3% had severe lung function, 4.1% had moderate, and 19.7% had mild lung function impairment). The prevalence rates of respiratory symptoms were as follows; cough (9.8%), phlegm (18.9%), wheeze (15.6%), shortness of breath (12.3%) and chest tightness (10.6%). Only morning cough and chest tightness were independently associated with lung function impairment.

Results on the prevalence of lung function impairment are comparable to those reported in Mexico, where prevalence of obstructive pattern was 23% and significant impairment was 3% (Zubieta et al. 2009). Prevalence rates of cough (9.8%), and wheeze (15.6%) found in the present study is comparable to those reported in Mexico of cough (12%) and wheeze (12%) (Zubieta et al. 2009). While, the prevalence rates of phlegm (18.9%) in the present study is higher than that reported in Mexico (10%), the prevalence of shortness of breath (12.3%) in the current study is lower than that reported in Mexico (46%) (Zubieta et al. 2009). The prevalence of shortness of breath reported in Mexico (46%) is however, comparable to that reported amongst miners in Tanzania (34.5%) (Mamuya et al. 2007). The prevalence rate of wheeze (8.1%) reported in Tanzania is lower than that reported both in Mexico (12%) and in the current study (15.6%). These different findings may be due to the differences in the sources of dust in the different study sites.

As already stated above, morning cough and chest tightness were independently associated with lung function impairment. The association specifically of cough and chest tightness on one hand and the occurrence of lung function impairment on the other have not been reported in the literature. But, the results of cough and chest tightness and the occurrence of lung function impairment observed in the current study are comparable to those reported by Noor et al. (2000) (despite being dust of different source (cement)) and Sluis-Cremer et al. (1967). It was reported that respiratory symptoms were significantly higher and also more common among exposed workers than controls. These were morning cough (in 6% of controls vs. 25% of cement workers), morning phlegm (11% vs. 24%) and chest tightness (6% vs. 19%) and also chronic cough and phlegm (44.4% in miners vs. 26.2% in non-miners) respectively (Noor et al. 2000; Sluis-Cremer et al. 1967). The findings of the current study were however contradicting those found by Siziya (2005) who reported that there were no significant differences in the prevalence of cough between exposed (23%) and un-exposed (19.4%) persons.

In the current study, there was no significant relationship between phlegm, wheeze and shortness of breath on one hand and the lung function impairment on the other. The findings on wheeze in the current study are comparable to Siziya (2005) who found no association between the study area and wheezing. Also, Al-Neaimi et al. (2001) reported that there was a higher percentage of exposed workers (8%) reporting wheeze than un-exposed (3%) workers. Concerning phlegm, Siziya (2005) showed that exposed persons (27.7%) had a higher rate of Phlegm than non-exposed persons (4.2%).

Although, the relationship between reduced lung function and high prevalence of respiratory symptoms has been shown in the literature (Osim et al. 2004), the relationship may not necessarily be causal. Studies in South Africa have shown that occupational exposure to dust is associated with increased prevalence of respiratory symptoms (Sluis-Cremer et al. 1967; Wiles et al. 1977). Perhaps the respiratory symptoms observed in this study may have been as a result of work place/occupational (mineral dust) exposures. The findings by Osim et al. (2004) are similar to those reported by Tanimowo (2000). It was stated by Tanimowo (2000) that due to a high exposure of dust, residents of the area surrounding the cane plant showed a high frequency of occurrence of respiratory symptoms and reduced lung function. It was further stated that in eastern Africa in cement, yarn, and cigarette factories, the respiratory effects of dust on exposed workers resulted in higher prevalence of respiratory symptoms (Tanimowo 2000).

Length of service was not associated with the occurrence of lung function impairment in the current study. The findings by Siziya (2005) concur with those from the current study as no association was observed between length of service and lung function impairment. Findings by Osim et al. (2004) and Izycki et al. (1979) were contradictory to those of the current study as it was reported that length of service was a predisposing risk factor for the occurrence of impaired breathing and also that the prevalence of respiratory symptoms increased with the duration of work in the exposure to dust respectively. These contradictory findings may be due to the differences in length of employment between the study sites. A significant association between length of service and lung function impairment in the current study would have been achieved if perhaps the measuring of the amount of dust emitted in the workplace was a factor for lung function impairment unlike focussing on the mere exposure to dust measured as length of employment. Another possible explanation for the insignificant findings could be that despite Open-pit mining being a dusty operation, most of the miners worked in enclosed compartments when carrying out production operations in the pit. Other explanations could be that some of the miners had a non-continuous long duration of working in the pit due to job terminations then re-hiring at unfixed interval, contracts, and also job losses in general. It can be stated further that the study was not powered to determine an association between duration of employment and lung function impairment.

PPE was not significantly associated with occurrence of lung function impairment in the current study. Nandi et al. (2009) and Al-Neaimi et al. (2001) stated that among the measures for the control of the workplace environment, use of PPE would help reduce morbidity amongst the miners. None of these studies stated explicitly if PPE was associated with lung function impairment or the occurrence of respiratory symptoms.

It was found that smoking was not associated with the occurrence of lung function impairment in the current study. These findings are similar to those reported by Siziya (2005) who stated that there was no association between smoking and some of the social demographic variables/characteristics such as age, height and sex. Contradictory findings were reported by Hnizdo et al. (1990) who found that severe lung function impairment could be prevented through the elimination of tobacco smoking. The smoking of tobacco and its products has been recognized as a cause of respiratory impairment in Africa for a long time. In the1980s, the World Health Organisation tried to focus on this subject (WHO 1980: 127-130), but more recent studies showed that cigarette smoking was actually on the increase on the continent (WHO 1985; Yach 1996) with resulting increase in respiratory morbidity (Tanimowo 2000). Studies from South Africa also demonstrated the continued deterioration in respiratory health from cigarette smoking, whether the smoking is active or passive (Ehrlich et al. 1996; Reddy et al. 1996; Richards et al. 1996). Theron et al. (1994) reported that cigarette smoking causes pulmonary dysfunction among other effects. Furthermore, cigarette smoking has been blamed for the increased incidence of lung cancer in southern and eastern Africa (Ball 1992). Although smoking was not found to be associated with lung function impairment in the current study, but the literature above shows clearly that it leads to respiratory impairment.

In the current study, educational level was not significantly associated with lung function impairment. Unlike the findings in the current study, Sabitu et al. (2000) reported that only

20% of those who had no formal education were aware of occupational hazards and safety measures compared to 77.6% among those who had primary education and 85% among those who had secondary education (Sabitu et al. 2009). People with education are more knowledgeable to avoid harmful exposures, and as a result may be less likely to fall ill. Educated workers may also be employed in more skilled but less hazardous jobs, and as result may be less likely to suffer from occupational illnesses (Muula et al. 2010). A study by Nandi et al. (2009) reported that among the measures to use for control of the work environment in order to help reduce morbidity among miners, health education was a priority. It was also further stated in the same study that literacy rates were generally poor among the miners. It has been shown in the literature above that educational level and avoidance of occupational hazards are positively associated although this was not the case in the current study.

Age was found not be associated with lung function impairment in the current study. The findings by Siziya (2005) and Al-Neaimi et al. (2001) are similar to those of the current study in that age was found not to be associated with impaired lung function.

6. 11 Limitations of the study

6.11.1 Design

This study was able to establish some associations between some independent variables and the dependent variable. It should be noted however that for most of the variables selected for the study, no associations were seen to occur with the dependent variable. By design the current study was conducted as a cross-sectional study and therefore it could not establish causality and temporal sequence. In order to establish causality however, research in form of longitudinal studies would have to be conducted. If this was to be done, instead of focussing on mere exposure measured by the duration of employment, it is suggested that instead, dust sampling should be done in order to establish the relationship between ambient dust breathed in by the participants and the occurrence of impaired lung function.

For variables such as PPE (which includes frequency of use), questions on the behaviours and attitudes towards the same would be more appropriate as opposed to questions phrased in a quantitative manner. It is further suggested that using qualitative methods of collecting data as opposed to quantitative methods would best explore the possible associations that may exist among the variables of the study unlike the case in this current study.

6.11.2 Sample and Data collection

The inclusion of all the respondents in the study would have been a better option unlike sampling from the already small population size. However, this would have meant that standard errors would not have been computed in the current study.

It should be noted that despite the fact that use of structured questionnaires offered an opportunity for clarifying questions to the interviewee, but it also had some important limitations or disadvantages. The physical presence of the P.I. during the data collection process may have influenced some responses and hence introduced some bias in the study. For instance, some of the participants if not most seemed to be worried about losing their jobs depending on the outcome of the study results. They all suspected that the results would be given to their superiors and hence they would later on end up being fired. Despite informed consent being given, this may not have still cleared the doubt in the minds of the respondents. This could have caused respondents to give responses (far from the true result) they perceived would protect them and increase their job security. Perhaps this could be reason for the lack of information on chronic bronchitis and also chronic asthma in the current study among the Nchanga Open-pit miners. These miners could have feared failing to have their mining certificates renewed based on this survey's findings.

The response rate was at 93.9%. It should be noted that the extent to which the non-responses may have influenced the results was not assessed.

7.0 Conclusion

A high prevalence of lung function impairment was observed in this workforce of miners. Early detection of impaired lung function could be made using morning cough and past chest tightness.

8.0 Recommendations

i. Measures for reduced dust exposure in the workplace should be introduced by management (Overall for Nchanga Integrated Business Unit (IBU) and also the Open-pit) and existing ones enhanced in order to help reduce respiratory symptoms.

ii. The management (Overall for Nchanga IBU) should also ensure that they include to their annual medical check-ups for staff, spirometry testing (currently not included at Nchanga mine) and also respiratory symptom evaluation to look for development of significant pulmonary symptoms which may necessitate early intervention and perhaps the reduced prevalence of lung function impairment.

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10.0 APPENDICES

APPENDIX 1: GANTT CHART

Task to be performed	**March 2010**	**April 2011**	**May 2011**	**June 2011**	**August 2011**	**September 2011**	**October 2011**	**November 2011**
Proposal development	→	→						
Presentation to graduate forum			→					
Submission to the REC				→	→			
Data collection						→	→	
Data Analysis							→	
Report writing							→	→
Submission of 1st draft								→
Submission of 2nd draft								→
Dissemination of Results								→

APPENDIX 2: BUDGET AND JUSTIFICATION

Budget and Justification

Item	Unit cost (ZMK)	Quantity	Total
1.Stationary			
a)Flash disk	350 000	1	350 000
b)Bond paper	30 000	4	120 000
c)Toner for printer	800 000	1	800 000
d)Pencils/pens	1 500	5	7 500
e)Eraser	5 000	3	15 000
f)Note books	10 000	4	40 000
g)Correction Fluid	17 000	1	17 000
h)Stapler	12 000	1	12000
i)Staples	10 000	1	10 000
j)Folders	15 000	4	60 000
i)Bag for questionnaires	150 000	1	150000
Sub total			**1,581,500**
2.Personnel			
a) Transport allowance	100 000	2trips	200 000
b) Research Technician	350 000	7days	2450000
c) Ethics committee	250 000		250 000
Sub total			**2,900,000**
3.Researcher			
a)Researchers transport to Chingola	100 000	3 trips	300 000
b)Researchers accommodation in Chingola	1000 000	2 months	2000 000

4.Spirometer Mouth pieces	1000 000	1000pieces	2000 000
Sub total			**4,300,000**
5.Secretarial services a)Research proposal photocopying b) Research proposal binding c) Summary photocopying d)Photocopying questionnaires e)Research report photocopying f)Research report binding	15 000 10 000 5 000 1000 20 000 10 000	5copies 5copies 25Copies 180copies 5copies 5copies	75000 50 000 125 000 180 000 100 000 50 000
Subtotal			**580,000**
Communication facilities			400 000
Total			**9,761,500**
Contingency fund 10%			**976,150**
Grand total			**10,737,650**

After careful consideration of the travelling, lodging, data collection costs and analysis, the budget outlined above was drawn up.

APPENDIX 3: PARTICIPANTS INFORMATION SHEET

INFORMATION FOR PARTICIPANTS

Dear participant

I am a student at the University of Zambia with the department of Community Medicine who is carrying out a study to determine how big the problem of breathing is if it does exist and what may cause it among open-pit miners like yourself here at Nchanga Open-Pit mine..

Procedures

This study is measurement and questionnaire based and the questions that will be asked are with regard to Lung function (breathing) and respiratory symptoms. A spirometer will be used to measure your Lung function. This procedure requires that you take in a deep breath and breathe into the machine which will give readings about the compliance of your lungs. This procedure will take about 30 minutes of your time.

Voluntary participation

Before you decide whether or not you should participate in this study, I would like to explain to you about voluntary participation, the risks and benefits involved, what is expected of you and also what you should expect

Your participation in the study and giving consent is voluntary and therefore, you are free to withdraw from the study at any time you wish to do so. You have a right to seek any clarification from the researcher whenever you wish to do so. Withdraw from the study will be of no consequence.

Benefits and risks

Some of the benefits of taking part in the study are:

I. You will be given an opportunity to know if you have impaired Lung function or not.
II. The study shall assist in establishing whether duration of employment influences Lung function impairment, so that appropriate recommendations can be made to the employer on your behalf.

There is no risk involved in this research however, you may feel light headed after forced expiration into the spirometer but it is not harmful. Should you however feel light headed, testing will be stopped and you will be observed for about an hour. The option to continue with the study will be given after full recovery but it will be of no consequence if you do not wish to continue. There is no monetary gain but refreshments will be given.

Confidentiality

Please note that all the information gathered will be highly confidential and privacy will be maintained at all times. The research information will be disseminated to the relevant authority but no such information will lead directly to you, as anonymity will be maintained.

The Lung function results will be given to you on request and you will be referred to the mine clinic for further investigation if found to have impaired lung function. Otherwise, they will be withheld.

If you agree to participate in this study, you will be asked to sign the consent form provided with this information sheet.

If you wish to seek any clarification, please contact the following:-

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Tel.no. 0211 256067

APPENDIX: 4

INFORMED CONSENT

The purpose of this study has been explained to me and I understand the purpose itself, benefits, risks and confidentiality of the study.

I further understand that: If I agree to take part in the study, I can withdraw at any time without having to give an explanation and that taking part in this study is purely voluntary.

I hereby consent to participate.

Date this .... day 2011

Signature/Thumb print ....

(Participant)

If you wish to seek any clarification, please contact the following:-

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APPENDIX 5: QUESTIONNAIRE

Lung function Impairment Interview Questionnaire for open-pit Miners

Questionnaire Number .... [| | |]

Date of Interview.. [| | | | |]

Day Month Year

Instructions

-Where boxes are given, enter details except for in the coding box.

-Where options are given, tick (√) once where applicable.

	Respondent's Identification	code
	Identification number...	
	Age of Respondent .... [|]	[ ]
	Sex of Participant: 1.Female [ ] 2. Male [ ]	
	Duration of Employment .... [|]	
	Job type (state name)..	
	Study site (Specify name)..	
	Interviewers Identification	
	Interviewer's Name	

QN		
	Now, I would like to ask you a few questions about yourself. Please Feel free to answer the questions. Your responses will help with the Improvement of the health of miners in the country, especially in your Field.	
	A.BACKGROUND INFORMATION	
Q1.	Are you in a marriage relationship, single, separated, divorced or widowed? 1. Single [ ] 2. Married [ ] 3. Separated/Divorced/widowed [ ]	☐
Q2.	Have you ever attended school? ……………………………… yes: 1. [ ] or 2. No [ ]	☐
Q3.	If yes, what is your highest level of education? 1. No Formal education …………………… [ ] 2. Primary……………………………………… [ ] 3. Secondary…………………………………… [ ] 4. Tertiary……………………………………… [ ]	☐
	B.RESPIRATORY SYMPTOMS, SMOKING AND ASTHMA	
	The following questions I am going to ask relate to respiratory symptoms. Please respond when asked.	
Q4A.	Do you smoke? (record yes if regular smoker up to one month ago of cigarettes, Cigar) Record "no" if participant has never smoked as much as one cigarette a day. Yes: 1 [ ] or 2 [ ]	
B.	If yes, for how many years? ☐☐	
C.	If cigarettes, how many cigarettes per day? ☐☐	

D.	If an ex smoker (cigarettes, cigar), how long since you stopped smoki-ng? 1. 0-1 years............................[ ] 2. 1-4 years........................... [ ] 3. 5-9 years............................[ ] 4. 10+ years ....[ ]	
Q5A.	Do you usually cough first thing in the morning? If yes: 1. [ ] or 2 No [ ] (Count a cough with first smoke or on "first going out of doors." Exclude clearing the throat or a single cough.)	
B.	Do you usually cough during the day or at night? If yes: 1. [ ] or 2 No [ ] (Ignore an occasional cough.)	
C.	If "Yes" to either question (5A-B): Do you cough like this on most days for as much as three months a year? If yes: 1. [ ] or 2 No [ ]	
Q6A.	Do you usually bring up phlegm from your chest? 1. yes: [ ] or 2 No[ ] (Count phlegm with the first smoke or on first going out-of-doors. Exclude phlegm from the nose. Count swallowed phlegm) [If no, skip to 6C.]	
B.	Do you usually bring up phlegm like this as much as twice a day, 4 or more days out of the week? 1. yes: [ ] or 2 No[ ]	
C.	Do you usually bring up phlegm at all on getting up or first thing in the morning? If yes: 1. [ ] or 2 No [ ]	

	If yes to any of the above (6a, b, c, or d), answer the following: if no to all, check does not apply and skip to 7a	
D.	Do you bring up phlegm like this on most days for 3 consecutive months or more during the year?	
	If yes: 1. [ ] or No 2 [ ]	[ ]
E.	For how many years have you had trouble with phlegm?	
	Number of years? [ ][ ]	
Q7.	Does your chest ever sound wheezy or whistling:	
A.	When you have a cold?	
	If yes: 1. [ ] or 2 No [ ]	[ ]
B.	Occasionally apart from colds?	
	If yes: 1 [ ] or 2 No [ ]	[ ]
C.	Most days or nights?	
	If yes: 1. [ ] or 2 No [ ]	[ ]
	If yes to 7a, b or c	
D.	For how many years has this been present?	
	Number of years? [ ][ ]	
E.	Have you ever had an ATTACK of wheezing that has made you feel short of breath?	
	If yes: 1. [ ] or 2 No [ ]	[ ]
Q8A.	Are you troubled by shortness of breath when hurrying on the level or walking up a slight hill?	
	If yes: 1. [ ] or 2 No [ ]	[ ]
	If yes to 8a:	
B.	Do you have to walk slower than people of your age on level due to	

	breathlessness?	
	If yes: 1. [ ] or No 2 [ ]	
C.	Do you ever have to stop for breath when walking on your own pace on the level?	
	If yes: 1. [ ] or 2 No [ ]	
Q9A.	Does your chest ever feel tight or your breathing become difficult?	
	If yes: 1. [ ] or 2 No [ ]	
B.	Is your chest tight or your breathing difficult on any particular day of the Week? (After a week or 10 days from the mine)	
	If yes: 1 [ ] or 2 No [ ]	
	(Ask if No to question 9a)	
C.	In the past year, has your chest ever been tight or your breathing difficult?	
	If yes: 1. [ ] or 2 No [ ]	
10A.	Have you ever had asthma?	
	If yes: 1. [ ] or 2 No [ ]	
B.	If "yes", when did it begin?	
C.	Did you have asthma before going work in the mines?	
	If yes: 1 [ ] or 2 No [ ]	
	C. PERSONAL PROTECTIVE EQUIPMENT	
	I am now going to ask questions on personal protective equipment. Kindly respond when asked.	
Q11A.	Do you wear your hard hat when you are in the mine?	
	If yes: 1 [ ] or 2 No [ ]	
B.	Do you wear safety goggles when in the mine?	

If yes: 1. [ ] or 2 No [ ]

C. Do you wear a respirator when in the mine area?

If yes: 1. [ ] or 2 No [ ]

D. Do you wear your work suit every time you are in the mine?

If yes: 1. [ ] or No 2 [ ]

E. When it is hot (summer), do you wear your P.P.E?

If yes: 1 [ ] or 2 No [ ]

If "No", specify which P.P.E? ....

F. In the last one month, how often did you use your P.P.E?

1. Once..........................[ ]
2. Sometimes................[ ]
3. All the time................ [ ]

D. MEASUREMENT OF LUNG FUNCTION

I am now going to measure your lung function. Kindly follow the Instructions you will be given on how to breathe into the Spirometer.

Q12. The Lung function value FEV1/FVC% is

1 = <40 Severe .... [ ]

2 = 40-54 Moderate.. [ ]

3 = 55-70 Mild .... [ ]

4 = > 70 Normal .... [ ]

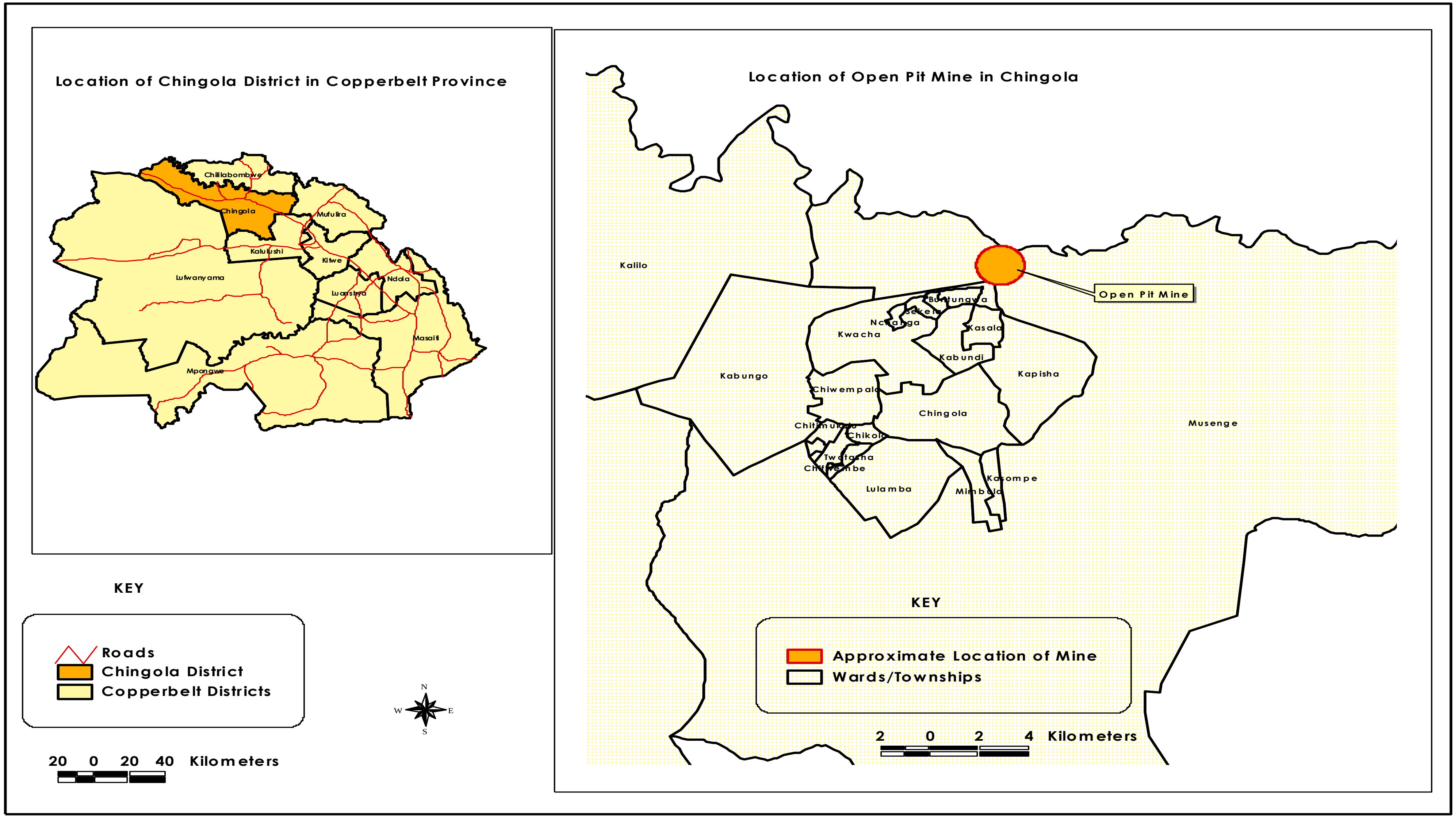
Any comments or questions you would like to say or ask me about my Interview with you today?

....

....

(Interviewer please thank respondent for the interviews and time)

APPENDIX 6: MAP OF CHINGOLA SHOWING THE LOCATION OF THE NCHANGA OEN-PIT MINE



Konkola Copper Mines plc

29 August 2011

MPH Coordinator
The University of Zambia
School of Medicine
Department of Community Medicine
P.O Box 50110
LUSAKA

Dear Sir/Madam

RE: CHANGES TO THE PERMISSION LETTER TO COLLECT RESEARCH DATA FROM KCM

Reference is being made to your letter dated August 5, 2011 in which you were seeking permission to carry out a research in Konkola Copper Mines.

Please note that approval has to be sought with Ethic Committee before Konkola Copper Mines can consider granting permission for you to conduct the research with the company.

Yours Faithfully,

Joshua Mulinga
Manager Learning & Development

cc: File

Private Bag KCM (C) 2000 Fern Avenue Chingola, Zambia
Tel: +260 2 351052, Fax: +260 2 351020
Incorporated in the Republic of Zambia. Reg. No. 43628

Konkola Copper Mines plc

30 May 2011

MPH Coordinator
The University of Zambia
School of Medicine
Department of Community Medicine
P.O Box 50110
LUSAKA

Dear Sir/Madam

RE: PERMISSION TO COLLECT RESEARCH DATA FROM KCM

Reference is being made to your letter dated 10 May 2011 in which you requested for permission on behalf of Ms Chisambi to collect data from Konkola Copper Mines (KCM) in connection with her Masters Programme. We wish to inform you that your request has been acceded to and that KCM Management expects a copy of the research findings from the study.

Yours Faithfully,

Joshua Mtinga
Manager Learning & Development

cc: File

Private Bag KCM (C) 2000 Fern Avenue Chingola, Zambia
Tel: +260 2 351052, Fax: +260 2 351020
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THE UNIVERSITY OF ZAMBIA

BIOMEDICAL RESEARCH ETHICS COMMITTEE

Telephone: 260-1-256067
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Assurance No. FWA00000338
IRB00001131 of IORG0000774

Ridgeway Campus
P.O. Box 50110
Lusaka, Zambia

25 October, 2011.

Your Ref: 004-06-11.

Ms Chisambi Laima,
School of Medicine,
Department of Public Health,
Lusaka.

Dear Ms. Laima,

RE: RE-SUBMITTED RESEARCH PROPOSAL: **"PREVALENCE AND CORRELATES OF LUNG FUNCTION IMPAIRMENT AMONG OPEN-PIT MINERS AT NCHANGA OPEN-PIT MINE"**

The above-mentioned research proposal was re-submitted to the Biomedical Research Ethics Committee with recommended changes on 21st October, 2011. The proposal is approved.

CONDITIONS:

- This approval is based strictly on your submitted proposal. Should there be need for you to modify or change the study design or methodology, you will need to seek clearance from the Research Ethics Committee.
- If you have need for further clarification please consult this office. Please note that it is mandatory that you submit a detailed progress report of your study to this Committee every six months and a final copy of your report at the end of the study.
- Any serious adverse events must be reported at once to this Committee.
- Please note that when your approval expires you may need to request for renewal. The request should be accompanied by a Progress Report (Progress Report Forms can be obtained from the Secretariat).
- **Ensure that a final copy of the results is submitted to this Committee.**

Yours sincerely,

Dr. J.C Munthali
CHAIRPERSON

Date of approval: 25 October, 2011 **Date of expiry:** 24 October, 2012