ASSOCIATIONS OF LIMESTONE DUST AND OCCURRENCE OF RESPIRATORY CONDITIONS AMONG STONE CRUSHERS IN LUSAKA, ZAMBIA

By

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DECLARATION

I, **MWANAMAKWA SAMANYAMA,** do hereby declare that this dissertation represents my own work and that it has not previously been submitted for a degree at this or any other university

Signature..

(Student)

Date..16/07/2009..........

CERTIFICATE OF COMPLETION OF THE DISSERTATION

I, **MWANAMAKWA SAMANYAMA,** do hereby certify that this dissertation is the product of my own work and it has not been submitted in part or whole to another university.

Signature.. Date. 16/07/2009

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CERTIFICATE OF APPROVAL

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Examiner III

ABSTRACT

The study looked at the associations of limestone dust and occurrence of respiratory conditions among the stone crushers in Lusaka, Zambia. There have been some reports that inhalation of limestone dust might cause respiratory conditions such as cough, phlegm production, breathlessness and chest tightness and abnormal lung function [10, 11, 15].

The study was a Cross Sectional Comparative Study involving 200 exposed (stone crushers) and 200 unexposed participants to limestone dust aged between 16 and 59 years living in Misisi Compound.

Convenience and Systematic Random Sampling techniques were used to select study participants. A structured interview schedule (respiratory questionnaire) and portable spirometer (manual winspiro) were used to collect data on the respiratory conditions and Lung function impairment among participants.

The study findings showed that more participants exposed to limestone dust reported having cough, phlegm production, chest tightness, and breathlessness for a period ranging from three months to one year as compared to unexposed participants (cough 77.0% vs 24.5%; phlegm production 69.5% vs 17.5%; chest tightness 61.5 % vs 14.5% and breathlessness 20.5% vs 3.5%).

More participants with the history of smoking in the exposed group reported having combination of respiratory conditions than participants in unexposed group (combination of two respiratory conditions 78.0% vs 25.0%; combination of three

respiratory conditions 63.7% vs 25.0% and combination of four respiratory conditions 23.1% vs 6.3%).

Significantly, more exposed participants (73.3%) had abnormal lung function in comparison to unexposed participants (50.9%). Similarly, more exposed participants with combination of respiratory conditions had abnormal lung function than unexposed participants (combination of two respiratory conditions 71.2% vs 18.2%; combination of three respiratory conditions 56.2% vs 10.9% and combination of four respiratory conditions 18.5% vs 3.6%).

In conclusion, there was high prevalence of respiratory conditions and abnormal lung function among exposed participants in comparison to unexposed participants. The findings could be attributed to exposed participants' continuous exposure to limestone dust without protective measures for at least six months. Smoking also facilitated the occurrence of respiratory conditions and abnormal lung function among exposed participants.

Dedicated to my wife – Alice and Children; Mbuyoti, Tumelo and Limpo.

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ACRONYMS

Al_2O_3	Aluminum oxide
BMI	Body Mass Index
$CaCO_3$	Calcium carbonate
CaO	Calcium oxide
CI	Confidence Interval
ECZ	Environmental Council of Zambia
FEF	Forced Expiratory Flow
FEFR	Forced Expiratory Flow Rate
FeO_3	Ferric oxide
FEV	Forced Expiratory Volume
FVC	Forced Vital Capacity
GPPF	Graduate Proposal Presentation Forum
IMF	International Monetary Fund
K_2O	Potassium Oxide
MgO	Magnesium oxide
Na_2O	Sodium oxide
OR	Odds Ratio
PEFR	Peak Expiratory Flow Rate
PPF	Preoperative Pulmonary Function
SiO_2	Silicon dioxide
UAE	United Arab Emirate
UNZA	University of Zambia
USAID	United States Agency for International Development
VC	Vital Capacity

ZNS	Zambia National Service

CHAPTER 1

1.0. Introduction

Limestones are calcareous sedimentary rocks formed at the bottom of lakes and seas with accumulation of shells, bones and other calcium rich materials and are preserved as fossils. Over thousands and millions of years, layer after layer is built up adding weight. The heat and pressure caused chemical reaction at the bottom and the sediment turned into solid stones called limestone rocks. Gradually limestone rocks had been pushed above the water due to movements of the earth's crust (plate tectonics). Limestones are composed of calcium carbonate in form of mineral calcite. Limestone might be classified according to the impurities they contain such as: dolomite limestone, which contains substantial amounts of magnesium carbonate; argillaceous limestone, with high contents of clay; siliceous limestone which contains sand or quartz and marble. The dust contains chemicals such as; Calcium Carbonate ($CaCO_3$), Silicon Dioxide (SiO_2), Aluminium Oxide (Al_2O_3), Ferric Oxide (Fe_2O_3), Magnesium Oxide (MgO), Calcium Oxide (CaO), Sodium Oxide (Na_2O) and Potassium Oxide (K_2O) [1, 2].

Limestone rocks deposits are widespread on the world's five continents; America, Europe, Asia, Australia and Africa. [3, 4, 5].

1.1. Limestone rocks in Zambia

Most limestone rocks deposits in Zambia are found in central parts of the country in the area from Lusaka via Kapiri Mposhi and also from Kitwe to Solwezi in North Western Province. In the eastern part of Zambia, limestone rocks are found in Lundazi, Chipata and Petauke areas. Only a few small occurrences of limestone rocks are known in Northern and Luapula provinces. The main carbonate resources (limestones) in Northern Province are Nkombwa Hills, which is 25 km from Isoka. Limestone rocks in Luapula Province are found near Matanda and Bukanda approximately 70 km from Mansa. There are only few sizeable deposits of limestone rocks found in the western part of Zambia. These limestones are gray or white in colour with various texture and compositions [6, 7].

1.2. Extraction of limestone rocks by small scale miners in Zambia

There are limited bushes (shrubs and soils) covering limestone rocks and are easily removed using machetes, axes, shovels and hoes. The exposed loose rocks are removed using crow bars, sledge hammers and picks. If the rock fails to break, fire is set on it and when it cools, it cracks, making it easy to be broken up. The broken up rocks are loaded in wheelbarrows and taken to crushing sites. At the crushing sites, large pieces of rocks are reduced to less than 10cm size using sledge hammers. These rock pieces could further be broken down into rock chips which are less than 10mm in size [7].

Additionally, limestone rocks, dolomites (hard rocks) are extracted on large scale by drilling and blasting using dynamites. Soft limestone rocks are extracted by using rippers fixed to bulldozers. Blocks of limestone rocks are taken to hammer mills where they are crushed into different sizes as required.

1.3. Uses of limestone rocks

Limestone has a variety of uses ranging from construction, making of steel, lime, cement to chemicals as discussed below.

Limestone has been used directly in buildings as load bearing walls and also in facades. Crushed limestone which is also called aggregate is used as a filler in concrete, base in road construction and filler in asphalt.

Limestone is used in making steel. The limestone is mixed with iron ore and coke, a form of coal and melted in the furnace. Calcium oxide combines with the impurities, mostly silicon dioxide in the iron ore to form a material called slag (calcium silicate). The slag floats on top of molten metal because it is lighter. Then the molten iron sinks to the bottom of the furnace.

Limestone is converted into lime by heating limestone rock to about 800 degrees Celsius. Lime is used to adjust pH in chemical processes, water treatment, and adjusting soil pH.

Cement is made by heating a mixture of silica, clay, and limestone to about 1500 degrees Celsius. The cooled mass is then crushed and some gypsum is added. When mixed with water, sand and gravel, complex reactions results in a very strong hardened material called concrete.

Heated limestone and in some cases combined with salt is used to make common products such as paper, glass, paint, varnish, soap and detergents. Finely grounded limestones are used to control coal mine dust, collect sulphur dioxide from power plant exhaust, sweeten soils, and in making fertilizer and stock feeds [1,3, 4, 8] .

CHAPTER 2

2.1. Literature review

From the literature reviewed, few studies have been done focusing on the occurrence of respiratory symptoms and exposure to limestone dust as compared to cement dust. Limestone is the major component of cement with a mixture of small amount of gypsum. Both limestone and cement dusts contain chemical components such as calcium carbonate, silicon dioxide and calcium oxide responsible for causing respiratory problems. Silicon dioxide and calcium oxide dust are more likely to cause respiratory conditions than calcium carbonate. The respiratory conditions include asthma with symptoms of wheezing, chest tightness, cough, phlegm production and shortness of breath [2, 9, 10].

Another element contained in limestone dust responsible for causing respiratory problems is crystalline silica. Silica accounts for 1 to 10 percent of limestone rock. When silica enters the lungs, it acts as an irritant and obstructs the ease with which air can be taken into the lungs making it difficult for the person to breathe. Excessive exposure to respirable crystalline silica might cause acute silicosis which is characterized by shortness of breath, cough, fever, weight loss and chest pain. X-ray and clinical examinations in studies of limestone quarries workers have revealed some pulmonary changes, pharyngitis, bronchitis and emphysema [11, 12, 13].

Exposure to limestone dust or cement dust might cause irritation by mechanical abrasion or corrosive to moist mucous membranes of the nose, throat and upper respiratory system. Pre-existing respiratory and lung diseases may be aggravated by inhalation of the dust. Exposure to limestone dust at concentration exceeding the occupational exposure levels might cause bronchitis, coughing, sneezing, shortness of breath and lung impairment [14, 15] .

2.1.1 Respiratory symptoms associated with limestone dust

In Florida, it was reported that repeated exposure to limestone dust might cause shortness of breath and cough [15]. Equally, the United Arab Emirates (UAE) study found that there was a higher percentage of workers exposed to cement dust having prolonged cough, wheeze, dyspnoea as compared to unexposed workers. The increased frequency of respiratory symptoms among cement workers could not be explained by age, Body Mass Index (BMI) and smoking, but were probably due to exposure to cement dust [16].

In 1998, a study was carried out among 53 Ethiopian cement workers investigating the prevalence of respiratory symptoms. It was observed that more cement workers had respiratory symptoms as compared to controls. These included: chronic coughs (30% of the cement workers verses 9% of controls); chronic bronchitis (26% versus 9%) and bronchial asthma (32% versus 8%) [17].

The respiratory health of 661 cement factory workers in Taiwan was investigated. The workers were classified into groups according to the amount respirable dust exposure. It was reported that there was an increased prevalence of one respiratory symptom (cough) in a group of workers with highest current respirable cement dust exposure of 1.24 mg/m^3 [18].

In 2000, a respiratory questionnaire was administered on 62 Malaysian cement factory workers, and 70 university students and staff (controls). It was reported that the prevalence of respiratory symptoms were significantly high among cement workers in contrast to the controls. The respiratory symptoms reported were; cough (25% of cement workers verses 6% of controls), phlegm production (14% versus 11%) and chest tightness (19% versus 6%) (11).

In 1999, the respiratory health of 425 Mexican cement factory workers was investigated. A semi-quantitative dust exposure assessment was done. Few workers aged 25 reported having respiratory symptoms. 8% of the workers aged 25 to 45 years and 16% aged above 45 years were diagnosed with bronchitis. 72% of workers aged between 25 to 44 years and 83% aged above 45 years had dyspnoea; 24% and 32 % had wheezing. It was concluded that the prevalence of respiratory problems was greatest among those with highest cumulative exposures of cement dust (19).

Similar study was done in Iran among cement workers and office workers exposed to cement dust levels of 53.4 ± 42.6 mg/m^3 and 26 ± 14.2 mg/m^3 respectively. Statistical analysis of data showed that respiratory symptoms like regular cough, phlegm production, wheezing and shortness of breath were statistical significant ($p < 0.05$) prevalent among cement workers exposed to high levels of dust (20).

The respiratory health of 280 Moroccan cement factory workers was investigated using a respiratory questionnaire. No dust exposure measurements were taken, but levels were described as being relatively high. There was a higher prevalence of respiratory symptoms among workers exposed to cement dust than unexposed workers [19] .

A study looking at cement dust and respiratory problems was carried out in four villages in Indonesia. Three villages were exposed to cement dust emission and one village was not exposed to cement dust emission. The study consists of 3,418 people. The prevalence of cough and shortness of breath was higher in people living in the exposed villages as compared to unexposed village. Cough and shortness of breath in the exposed population tended to increase with proximity to cement factories [21] .

Another study carried out in Norway found that the odds ratio for the occurrence of new respiratory symptoms (cough, chest tightness and phlegm production) was high among tunnels workers compared to heavy construction workers due to prolonged exposure to respirable dust, quartz, oil mist and nitrogen dioxide [22]. On the contrary, a Swedish study consisting of 137 dolomite workers reported that exposure to tremolite asbestos which contains carbonate like limestone was not a strong determinant of occurrence of respiratory symptoms. The occurrence of the respiratory symptoms was more associated with smoking than exposure to dust [14] .

Equally, a retrospective cohort study was conducted on respiratory health of 119 Norwegian cement factory workers and a respiratory questionnaire was administered. Current cement dust levels were available and a semi - quantitative exposure matrix was developed. The study showed no significant difference in the respiratory health of the cement workers exposed to average dust level when compared to blue-collar controls [23].

2.1.2 Common respiratory diseases associated with limestone dust

There are conflicting results about occurrence of respiratory problems and exposure to limestone and cement dusts as discussed below.

Inhalation of free crystalline silica (Silicon Dioxide) may cause silicosis. Silicon Dioxide is identified as a probable health hazard to humans. Silicosis is typically associated with long term exposure to silica. Exposure to high air concentrations of free silica can cause an acute form of silicosis that may occur within one year after exposure. Not all individuals with silicosis will exhibit symptoms of the disease. Silicosis is progressive and symptoms can appear at any time even after exposure has ceased. Symptoms of silicosis may include: difficulty breathing with or without exertion, diminished work capacity and chest expansion, reduction of lung volume and enlargement of the right part of the lung. Persons with silicosis have an increased risk of pulmonary tuberculosis infection (2, 4, 5, 12, 15).

In Florida and America it was reported that breathing limestone dust containing respirable crystalline silica might cause pneumoconiosis, a respiratory disease whose symptoms includes; cough, shortness of breath, wheezing and chest tightness (15, 25). Similarly, in Sweden it was found that prolonged inhalation of limestone and cement dust was responsible for causing severe respiratory problems such as asthma and bronchitis (14).

A study in Iran involving 88 cement workers and 80 office workers showed that more of the cement workers exposed to cement dust had various abnormalities such as emphysematous changes associated with inflammatory processes (20). A study in the United Arab Emirates found that more workers (13%) exposed to cement dust had respiratory diseases such as bronchitis compared to unexposed workers (4%). It was further reported that there was a significant association between sinusitis and exposure to cement dust [(16)]. The prevalence of chronic cough, phlegm production, wheezing and breathlessness among workers increased with period of exposure to cement dust [(23)].

2.1.3 Lung function and limestone dust

Over exposure to limestone dust containing microscopic particles of crystalline silica can cause scar-tissue formation in the lungs', which reduces the lungs' ability to extract oxygen from in breathed air [(2, 5, 10, 12)].

An Indian study showed that there was no statistically significant association between lung function and age among stone crushers exposed to limestone dust as compared to unexposed participants. There was also no statistical association between lung function and smoking among the exposed and unexposed participants [(26)]. Spiromentry results of the study in Ethiopia cement factory showed that more cement workers with the highest dust exposures had lower FEV_1, FEV and FEV_1/FVC ratio [(17)]. Similarly, studies done in Malaysian and Tanzania found that lung function was poorer among cement workers exposed with mean dust exposure of $3.2 mg/m^3$ and above. The risk of developing a notable obstructive impairment, represented by FEV_1/FVC ratio less than 0.7 was significantly increased for exposures in excess of $300 mg/m^3$ in a year [(11, 27)].

Similarly, studies carried out in Iran, Nigeria and Taiwan in cement factories found that lung function of workers exposed to cement dust worsened with the duration of employment [18, 20, 28]. Similarly, in a Tanzania study done among cement workers, it was reported that cement workers' FEV_1, FVC and PEFR decreased with years of service [27].

A study was carried out to find if cumulative exposure to dust causes accelerated decline in lung function among tunnel workers in Norway. 96 tunnel workers and a reference group of 249 heavy construction workers were examined in 1991 and re-examined in 1999. Exposure measurements were done to estimate personnel cumulative exposure to respirable dust, quartz, oil mist and nitrogen dioxide. The tunnel workers had decreased FEV_1 and that was associated with cumulative exposure to respirable dust and quartz ($p < 0.001$) [22].

On the contrary, studies done among cement workers in Jordan, Norway and Zambia (Chilanga Cement Factory) found that there was no significant association between lung function impairment and exposure to cement dust [23, 24, 29].

2.1.4 Smoking and limestone dust

Smoking has been identified to predict the occurrence of respiratory conditions and lung impairment among people exposed to limestone dust. In Florida and America, it was reported that smoking might increase the risk of developing lung disorders to persons exposed to limestone dust [15, 25]. Similar studies carried out among cement workers in Jordan, Tanzania and Malaysia indicated that heavy smokers had lower predicted values of FVC and FEV_1 than light smokers and none smokers [11, 27, 29].

Similarly, the United Arab Emirates and Indonesian studies found that smoking was significantly associated with chronic cough and bronchitis. Smokers exposed to cement dust had higher rates of respiratory symptoms and lung impairment than non-smokers [21, 30].

A cross sectional study which looked at the effect of smoking on the lung functions of workers exposed to dust and fumes was carried out in a teaching hospital in Mumbai. The study sample size was 115 people exposed to dust and fumes by means of their occupation. Types of dust included cement, cotton, silica and paper dust. Fumes included gasses, chemicals, and rubber fumes. 50.4% of the study participants were smokers. Among smokers, 24.2% were identified as ever smokers, 17.2% as current smokers, 29.3% were 'quitters', while 29.3% were nicotine dependants. Respiratory disorders were significantly higher among quitters and nicotine dependants compared to ever smokers and current smokers. Smokers had significantly more restrictive (FVC < 75% of predictive value) and ventilatory disorders than non smokers. Significantly, more smokers (46.5 %) had respiratory disorders compared to non-smokers (12.3%). The respiratory disorders increased with years of exposure to fumes or dust in both smokers and non smokers [31].

In summary, although exposure to occupational dust has long been generally associated with prevalence of respiratory conditions and impaired lung function, the associations have not been consistent partly due to differences in exposure levels and study designs.

2.2 Statement of the problem

In mid 1970s Zambia experienced economic crisis because of reduced copper prices (the country's major source of revenue) at the world market and increased oil price in the Middle East. In 1983, the Zambian government invited the IMF/World Bank to assist her with economic reforms so that she could receive foreign aid. Some of the IMF/World Bank economic reforms adopted included the removal of subsidies on food staff and fuel. Consequently, the prices of food staff and fuel went up and there was an out-cry among the people. The government was forced to rescind its decision and broke off with IMF in 1987 and the economic situation worsened [13, 32].

In 1991, when the Movement for Multi – Party Democracy (MMD) government took over office, Structural Adjustment Programmes - SAP (IMF economic reforms) were adopted. Enterprises were auctioned off to rich elites and foreign multinational corporations and many Zambians lost their jobs [33, 34].

The implementations of SAP failed to substantially revitalise the country's economy as it is one of the poorest countries in Africa and the world, ranking 166 out of 177 in the Human Development Index (HDI). According to the Human Development Report, 64 percent of the population is living in absolute poverty (less than US $1 = ZK3, 500.00 per day) and 73 percent is living below the national poverty line [35, 36, 37].

Economic crisis forced the local authorities in Zambia to abandon construction of houses on large scale in urban areas. People started building their own houses mostly in uncontrolled areas and that lead to the increase of illegal small scale quarrying in order to provide crushed stones. Most people in Lusaka who lost their jobs from government companies involved themselves in stone crushing as a way of earning a living.

Stone crushing in Lusaka is highly pronounced in areas such as Bauleni, Garden, and Misisi compounds. Apart from stone crushing causing environmental degradation (big ditches in places where limestone rocks are dug), limestone dust had an adverse effect on the health of stone crushers. The dust might cause respiratory conditions with symptoms of wheezing, chest tightness, cough, phlegm, dyspnoea and shortness of breath [(10, 11, 12, 23)].

Nevertheless, it was reported that respiratory complaints among the locals where Chilanga Cement Factory is located were higher than the national averages due to exposure to cement dust [(38)]. However, a study that was done showed no significant differences between the exposed and unexposed participants in the occurrence of respiratory conditions such as wheezing and chest tightness. There was also no association between cement dust and lung impairment [(24)].

Findings from a walk through survey, stone crushers along Kafue Road - opposite Misisi and Kalingalinga Compounds did not use protective measures against limestone dust. Stone crushers inhale limestone dust containing chemicals such as Silicon dioxide and Calcium oxide which are harmful to their respiratory systems. Therefore, the study was aimed at determining associations of occurrence of respiratory conditions among stone crushers exposed to limestone dust.

2.2.1 Justification of the study

There has been conflicting evidence in literature reviewed on occurrence of respiratory conditions among people exposed to limestone or cement dust. Some studies have attributed differences in exposure levels of dust to study designs and protective measures against dust, which were put in place in factories.

Stone crushing does not only result in environmental degradation but also serious occupational health hazard to individuals involved. The stone crushers are continuously inhaling dust from stones being crushed as they do not use facemask to protect themselves against dust as observed. The dust could increase the risk of occurrence of respiratory conditions such as cough, phlegm production, chest tightness and breathlessness [39]. Stone crushers' vulnerability to dust demands urgent recognition. It is against this background that this study was carried out.

There have never been studies done on the association of limestone dust and occurrence of respiratory conditions in Zambia hence the need to gather epidemiological evidence on the occurrence of respiratory conditions among stone crushers exposed to limestone dust.

If results of the study show that there was an association between exposure to limestone dust and occurrence of respiratory conditions, there would be need for the information to be disseminated to the health care providers and supervisors such as Environmental Council of Zambia (ECZ). There would be need to sensitise stone crushers about the dangers of crushing stones.

2.3 OBJECTIVES

2.3.1 General Objective

To determine the associations between limestone dust and occurrence of respiratory conditions among stone crushers.

2.3.2 Specific Objectives

1. To compare the prevalence of respiratory conditions between stone crushers and persons who never crushed stones before in Lusaka.
2. To compare the prevalence of lung function impairment between stone crushers and persons who are not involved in stone crushing in Lusaka.
3. To determine factors that are associated with the development of respiratory conditions among stone crushers in Lusaka.
4. To make appropriate recommendations based on findings of the investigation.

2.3.3 Study hypothesis

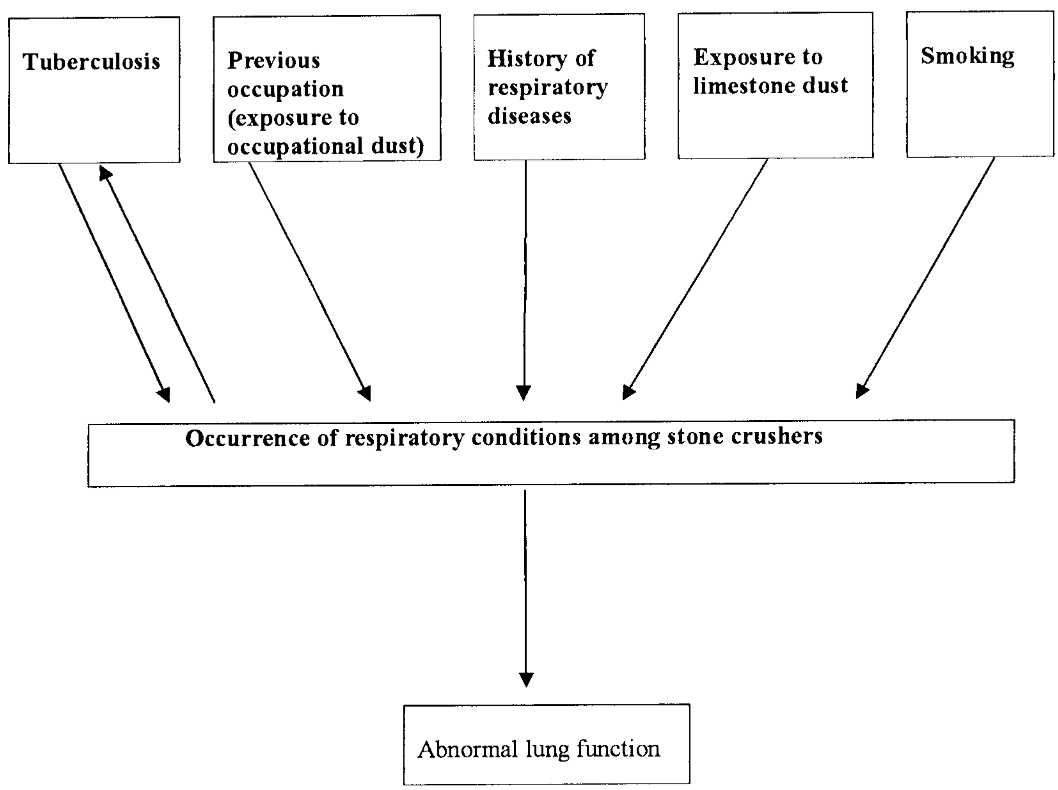
Exposure to limestone dust is not associated with an increase in the occurrence of respiratory conditions.

CHAPTER 3

3.1 Methodology

3.1.1 Conceptual framework

The variables associated with limestone dust and occurrence of respiratory conditions among the stone crushers exposed to limestone dust were conceptualised as shown below.



The presence of tuberculosis, history of respiratory diseases, smoking and exposure to limestone dust might increase the risk of occurrence of respiratory conditions among stone crushers. Previous exposure to occupational dust might predispose the stone crushers to respiratory conditions. Stone crushers with respiratory conditions are more likely to have abnormal lung function as compared to the stone crushers with no respiratory conditions [5, 12, 15].

3.1.2 Operation definitions

Definitions of words or expression that have been used in the study were as follows:

Asthma is the respiratory disease that affects the air ways (tubes) that carry air in and out of the lungs. It has symptoms such as wheezing, chest tightness, coughing, shortness of breath and facial pressure

Bronchitis is the inflammation of the bronchial tubes (air ways) that connect the trachea to the lungs. It has symptoms such as cough, phlegm production, breathlessness and wheezing.

Sinusitis is an infection of the sinus cavities caused by bacteria characterised by collection of mucus in the sinuses (lasting for atleast 3 months or more), nasal discharge, nasal congestion and coughing

Forced Vital Capacity (FVC) is the maximum volume of air exhaled, rapidly, forcefully and as completely as possible from the point of maximum inhalation.

Forced Expiratory Volume (FEV) is the amount of air a person can exhale during a forced expiration.

Forced Expiratory Flow Rate (FEFR) is the average Forced Expiratory Volume at the middle part of the FVC manoeuvre.

Peak Expiratory Flow Rate (PEFR) is the greatest flow that can be sustained for 10 milliseconds on forced expiration starting from full inflation of the lungs.

Age is the period of time (years) someone has been alive

Sex is the characteristics of being male or female.

Weight is participants' heaviness measured in kilograms.

Height is the distance of the participant from foot to head when standing measured in meters.

Smoking history refers to participants who used to smoke or are smoking.

History of respiratory diseases refers to participants who had suffered or were suffering from respiratory disease.

Previous occupation done refers to type of jobs a participant did before starting stone crushing.

Period of stone crushing is time a person had spend doing stone crushing.

Respiratory conditions:

Cough – Coughing for atleast three months.

Phlegm production – Producing phlegm for atleast three months.

Chest tightness – Experiencing some chest tightness for atleast three months.

Shortness of breath – Experiencing breathlessness for atleast three months

3.1.3 Study design

The study design used was a Cross Sectional comparative study. The study was conducted among the exposed and non-exposed populations.

3.1.4 Study areas

The study was conducted along Kafue Road – among stone crushers. The stone crushers were from Misisi Compound where the controls were selected. Misisi

Compound is one of the densely populated compounds in Lusaka. Most of the people living in there are unemployed and earn their living through stone crushing.

Inclusion criteria

- Individuals aged between 16 to 59 years participated in the study as these people are able to cooperate when administering spirometry tests to them.
- Individuals in exposed group who had been crushing stones for atleast six months.
- Individuals in unexposed (control) group who had been living in Misisi compound (control area) for atleast six months as demanded from the exposed participants i.e. having crushed stones for atleast six months.

Exclusion criteria

- Individuals below 16 and above 59 years were not allowed to participate in the study as they could have failed to co-operate in taking a deep breath and then blow all the air out quickly and forcefully through the spirometer.
- Individuals among unexposed (control) group, who had been involved in stone crushing before, were not allowed to take part in the study.

3.1.5 Sample size determination

There was no information on the prevalence of respiratory conditions among stone crushers in Zambia that could be used to determine sample size. The sample size was determined after doing a pilot study on 30 stone crushers – exposed to limestone dust along Alick Nkata Road and 30 unexposed people in Kalingalinga Compound. The pilot study found 20 percent of the stone crushers and 8 percent of the unexposed participant had combinations of four respiratory symptoms (cough, phlegm production, chest tightness and breathlessness).

The formula that was used to calculate sample size was as follows:

$$n = \frac{(P_1Q_1+P_2Q_2)}{(P_1-P_2)^2} * f(\alpha\beta)$$

Where:

n is the size sample.

P_1 is the expected proportion in the control group.

P_2 is the expected proportion in the intervention group (cases).

Q is 100 - p

α is significance level.

β is the power of the study.

$$n = \frac{[(8\% * 92\%) + (20\% * 80\%)]}{[8\% - 20\%]^2} * 10.51$$

$$= 170.49$$

The study sample size consisted of **200** stone crushers and **200** participants not exposed to limestone dust.

3.1.6 Sampling

Convenience Sampling was used to recruit stone crushers from Misisi Compound along Kafue Road. Stone crushers aged between 16 and 59 years found by research team on site were requested to take part in the study.

Unexposed (control) group were conveniently picked from Misisi Compound - in the eastern direction of a quarry company called Crushed Stones Sales Limited. The people in the eastern direction of the quarry were less exposed to dust because dust was being blown away in the western direction. Systematic Random Sampling technique was used to select people living on the edge of Misisi Compound. First participant was picked from a house selected randomly. Thereafter, a participant was picked at the interval of two houses. The oldest person who was found at the house by the research team was requested to participate in the study.

3.1.7 Variables

The variables that were considered in the study were; age, sex, previous occupation, duration of stone crushing, history of smoking, history of respiratory diseases, length of stay in the area, weight, height, cough, phlegm production, chest tightness, breathlessness, Forced Vital Capacity (FVC), Forced Expiratory Volume exhaled in the first second (FEV_1), Forced Expiratory Flow Rate (FEFR), Peak Expiratory Flow Rate (PEFR) and the ratio of FEV_1 to FVC.

3.1.8 Data collection

A structured interview schedule (respiratory questionnaire) was used to collect data from the respondents. In situation where an interviewee did not understand the question, the investigator would repeat or rephrase the question. It was also easy to create a rapport among participants through structured interview schedule.

Lung function impairment among the exposed and unexposed was assessed using a portable spirometer (manual winspiro). During examination, the technician told participants to take maximum inhalation whilst standing and forcefully exhale as much air as they could through the spirometer. The participants' lung function results i.e. FVC, FEV%, FEFR and PEFR were recorded and verified by the Medical Doctor.

Lung function was determined by dividing FVC % into FEV_I. Participants with results of 0.80 and above were considered to have normal lung function and those with results less than 0.80 had abnormal lung function [(40)].

Participants with lung function impairment would be advised to go to the nearest health centres for further medical checkups and treatment.

3.1.9 Data processing and analysis

Data was entered in a computer using Epi – Info statistical package. The questionnaires were given identification numbers from 01 to 400. The questions were coded by assigning numbers to response categories. The coded questions were entered in the computer. On data analysis, the prevalence of respiratory conditions and lung impairment among stone crushers, exposed to limestone dust and unexposed participants were compared.

Chi-square test (Yates corrected) was used to test for associations of limestone dust and occurrence of respiratory conditions between exposed and non exposed participants. The cut off point for statistical significant was set at 5% and exact Confidence Intervals were used.

3.1.10 Pre-test

A pre-test was conducted on ten stone crushers in Kalingalinga Compound to test the suitability of the questionnaire. Adjustments were made to questions not properly constructed and also the spirometer was calibrated. The interviews were conducted by the investigator with the help of the technician in administering the spirometry test.

Ten stone crushers from Kalingalinga Compound were conveniently chosen during pre-test because they had common things with the stone crushers along Kafue Road. Stone crushers in Kalingalinga Compound and along Kafue Road were; exposed to limestone dust, not using protective measures against dust and have been crushing stones for atleast six months.

During pre-testing, it was found that most of the stone crushers had difficulties in responding to the English questionnaire and the questions were translated into Nyanja.

3.1.11 Ethical consideration

Ethical clearance to do the study was sought from the University of Zambia Research Ethics Committee.

Informed consent was obtained from the participants and were assured that their responses would be confidential and used for the intended purpose. The participants were told that participation in the study was voluntary and that they had the right to withdraw from the study at any time if they felt uncomfortable.

No individual person would be identified by name and a number was used on questionnaires. Participants were given time to ask any question about the interview.

The Principal Investigator gave his contact address and phone number to the participants so that they could contact him for any clarification.

3.1.12 Limitations.

Some limitations of the study were:

a. There was lack of literature to review on studies done on the associations between limestone dust and occurrence of respiratory conditions among stone crushers. That led to the use of studies done on exposure to cement dust which has similar chemical compositions as limestone dust.

b. Measurement of limestone dust levels to which study participants were exposed was not done and chest X-ray to examine the presence of tuberculosis among participants was not done. Some studies had reported that dust levels and tuberculosis had an effect on determination of the occurrence of respiratory conditions and abnormal lung function among participants exposed to dust [20].

c. Chemical analysis of limestone dust was not done in order to find out the levels of Silicon dioxide (crystalline silica) and Calcium oxide which are highly associated with the occurrence of respiratory conditions and lung functions impairment among exposed individuals [14].

d. Convenience sampling which was used in the study has got some limitations because the sample is not an accurate representation of the population, the findings are not definitive and have to be extrapolated in order to fine tune them [41, 42].

e. Most of the study participants (65%) in un-exposed group were aged between 16 to 20 years compared to exposed participants who were evenly distributed in all age groups and this could have affected the study findings.

f. Preoperative Pulmonary Function (PPF) of the study participants was not measured.

CHAPTER 4

4.1 Research findings

4.1.1 Demographic data

The study had 200 participants (stone crushers) exposed to limestone dust of which 73% were males and 27% were females along Kafue Road from Misisi Compound. There were 200 non- exposed participants consisting of 64% males and 36% females living in Misisi Compound (see table 1).

Participants in exposed group were evenly distributed in all age groups. In contrast, most participants (65%) in unexposed group were between 15 to 20 years consisting of 35% males and 30% females (see table 2).

Table 1: Distribution of study participants exposed and unexposed to limestone dust by sex

	Group	
Sex **Males**	**Exposed *** **n (%)**	**Not-exposed #** **n (%)**
Males	146 (73.0)	128 (64.0)
Females	54 (27.0)	72 (36.0)
Total	200 (100.0)	200 (100.0)

* Stone crushers found along Kafue Road exposed to limestone dust and have been crushing stone for at least six months.

\# People living in Misisi Compound and nearby places where stones crushing was done and have never been involved in stone crushing.

Table 2: Distribution of study participants exposed and unexposed to limestone dust by age

Age Range (Years)	Group	
	Exposed n (%)	**Not-exposed** n (%)
15 - 20	17 (8.5)	131 (65.5)
21 - 25	37 (18.5)	26 (13.0)
26 - 30	50 (25.0)	15 (7.5)
31 - 35	39 (19.5)	11 (5.5)
>35	57 (28.5)	8 (8.5)
Total	200 (100.0)	200 (100.0)

4.1.2 Occurrence of respiratory conditions between exposed and unexposed participants

More participants among the exposed reported having; cough, phlegm production, chest tightness and breathlessness for a period ranging from three months to one year compared to the unexposed. Those in the exposed group were ten times more likely to have a cough compared to those in unexposed group. Similarly, phlegm production and chest tightness were more likely to occur in the exposed group than unexposed group (see table 3).

Table 3: Occurrence of respiratory conditions among study participants

	Groups			
Respiratory condition *	**Exposed n (%)**	**Non – exposed n (%)**	**P-value**	**OR (95% CI)**
Cough				
Yes	154 (77.0)	49(24.5)		
No	46(23.0)	151(75.5)	< 0.001	10.3(6.5, 16.4)
Total	200(100.0)	200(100.0)		
Phlegm				
Yes	139(69.5)	35(17.5)		
No	61(30.5)	165(82.5)	< 0.001	10.7(6.7, 17.2)
Total	200(100.0)	200(100.0)		
Chest tightness				
Yes	123(61.5)	21(14.5)		
No	77(38.5)	179(85.5)	< 0.001	13.6(8.8, 23.2)
Total	200(100.0)	200(100.0)		
Breathlessness				
Yes	41(20.5)	7(3.5)		
No	159(79.5)	193(96.5)	< 0.001	7.1(3.1, 16.3)
Total	200(100.0)	200(100.0)		

* Occurrence of respiratory condition for a period ranging from three months to one year.

4.1.3 Occurrence of combination of respiratory conditions among participants

Table 4 shows the association between limestone dust and occurrence of combination of respiratory conditions among exposed and unexposed. Participants in the exposed group were more likely to have combinations of respiratory conditions compared to those in unexposed group and these findings were statistically significant ($p < 0.001$).

Table 4: Occurrence of combination of respiratory conditions among study participants

Respiratory conditions		Groups		P-value	OR (95% CI)
		Exposed n (%)	Unexposed n (%)		
Cough + phlegm	Yes	137 (68.5)	31(15.5)	< 0.001	11.8(7.3, 19.3)
	No	63(31.5)	169(84.5)		
	Total	200(100.0)	200(100.0)		
Cough + Phlegm + Chest tightness	Yes	110(55.0)	15(7.5)	<0.001	15.1(8.3, 27.3)
	No	90(45.0)	185(92.5)		
	Total	200(100.0)	200(100.0)		
Cough + Phlegm, Chest tightness + Breathlessness	Yes	33(16.5)	4(2.0)	<0.001	9.9(3.4, 27.9)
	No	167(83.5)	196(98.0)		
	Total	200(100.0)	200(100.0)		

4.1.4 Occurrence of combination of respiratory conditions among participants by age groupings

More exposed participants in all age groups reported having combinations of two respiratory symptoms (see table 5). The results of participants who had combinations of three respiratory symptoms in all age groups were statistically significant ($p < 0.05$) except for those in age group between 31 and 35 (see table 6).

Combinations of up to 4 respiratory symptoms were statistically significant ($p = 0.001$) in age category between 15 and 20 in the study participants. More exposed participants were at risk of having the combination of 4 respiratory conditions compared to non-exposed participants. However, there was no significant difference in the combination of 4 respiratory symptoms between age categories: 21 and 25; 26 to 30; 31 to 35; and above 35 in exposed and unexposed groups (see table 7).

Table 5. Occurrence of combination of cough and phlegm production among participants by age groupings (stratified analysis)

Age (years)	Combination of cough + phlegm	Group: Exposed n (%)	Group: Non – exposed n (%)	P-value	OR (95 CI)
	Yes	9 (52.9)	18(13.7)		
15 - 20	No	8(47.1)	113(86.3)	< 0.001	7.1(2.41, 20.7)
	Total	17(100.0)	131(100.0)		
	Yes	27(73.0)	5(19.2)		
21 - 25	No	10(27.0)	21(80.8)	< 0.001	11.3 (3.4, 38.2)
	Total	37(100.0)	26(100.0)		
	Yes	37(74.0)	3(20.0)		
26 -30	No	13(26.0)	12(80.0)	0.001	11.4(2.8, 46.8)
	Total	50(100.0)	15 (100.0)		
	Yes	29(74.4)	2(18.2)		
31 -35	No	10(25.6)	9(81.8)	0.002	13.1(2.4, 70.9)
	Total	39(100.0)	11(100.0)		
	Yes	35(61.4)	3(17.6)		
>35	No	22(38.6)	14(82.4)	0.002	7.4 (1.9, 28.8)
	Total	57(100.6)	17(100.0)		

Table 6. Occurrence of combination of cough, phlegm production and chest tightness among participants by age groupings

Age (years)	Combination of cough +phlegm + chest tightness	Group Exposed n (%)	Un-exposed n (%)	P-value	OR (95 CI)
	Yes	8(47.1)	6(4.6)		
15 - 20	No	9(52.9)	125(95.4)	< 0.001	18.5 (5.3, 65.0)
	Total	17(100.0)	131(100.0)		
	Yes	21(62.0)	3(13.3)		
21 - 25	No	16(38.0)	23(86.7)	0.001	10.6(2.6, 39.5)
	Total	37(100.0)	26(100.0)		
	Yes	31(74.0)	2(20.0)		
26 -30	No	19(26.0)	13(80.0)	0.003	10.6(2.2, 52.2)
	Total	50(100.0)	15 (100.0)		
	Yes	21(53.8)	2(18.2)		
31 -35	No	18(46.2)	9(81.8)	0.080	5.4 (1.0, 27.5)
	Total	39(100.0)	11(100.0)		
	Yes	29(50.9)	2(11.8)		
>35	No	28(49.1)	15(88.2)	0.010	7.8(1.6, 37.1)
	Total	57(100.0)	17(100.0)		

Table 7. Occurrence of a combination of cough, phlegm production, chest tightness and breathlessness among participants by age groupings

AGE (Years)	Combination of cough + phlegm + chest tightness + breathlessness	GROUP Exposed n (%)	Unexposed n (%)	P-value	OR (95 CI)
	Yes	3(17.6)	1(0.8)		
15 - 20	No	14(82.4)	130(99.2)	0.001	27.9 (2.7, 28.6)
	Total	17(100.0)	131(100.0)		
	Yes	4(10.8)	2(7.7)		
21 - 25	No	33(89.2)	24(92.3)	1.000	1.5(0.2, 8.6)
	Total	37(100.0)	26(100.0)		
	Yes	6(12.0)	1(6.7)		
26 -30	No	44(88.0)	14(93.3)	0.913	1.9(0.2, 8.6)
	Total	50(100.0)	15 (100.0)		
	Yes	8(20.5)	0(0.0)		
31 -35	No	31(79.5)	11(100.0)	0.241	1.4 (1.1, 1.6)
	Total	39(100.0)	11(100.0)		
	Yes	12(21.1)	0(0.0)		
>35	No	45(78.9)	17(100.0)	0.091	1.5(1.2, 1.6)
	Total	57(100.0)	17(100.0)		

4.1.5 Occurrence of combination of respiratory conditions among participants by sex

112 females were enrolled out of which 54 and 72 females were exposed and unexposed to limestone dust respectively. There were 274 males consisting of 146 male exposed and 128 males unexposed. Significantly, more females and males exposed to limestone dust had combinations of respiratory symptoms compared to female and males not exposed (see tables 8 and 9).

Table 8. Occurrence of combination of respiratory conditions among female participants

Combination of respiratory conditions		GROUP Exposed n (%)	Unexposed n (%)	P-value	OR (95 CI)
	(Females)				
Cough + phlegm	Yes	29(53.7)	14(19.4)		
	No	25(46.3)	58(80.6)	< 0.001	4.8(2.2, 10.6)
	Total	54(100.0)	72(100.0)		
	(Females)				
Cough + Phlegm + Chest tightness	Yes	22(40.7)	6(8.3)		
	No	32(59.3)	66(91.7)	< 0.001	7.6(2.8, 20.5)
	Total	54(100.0)	72(100.0)		
Cough + Phlegm + Chest tightness + Breathlessness	**(Females)**				
	Yes	5(9.3)	1(1.4)		
	No	49(90.7)	71(98.6)	0.103	7.3(0.8, 64.0)
	Total	54(100.0)	72(100.0)		

Table 9. Combination of respiratory conditions among male participants

Combination of respiratory conditions		GROUP Exposed n (%)	Unexposed n (%)	P-value	OR (95 CI)
	(Males)				
Cough + phlegm	Yes	108(74.0)	17(13.3)		
	No	38(26.0)	111(86.7)	< 0.001	18.6(9.9, 33.4)
	Total	146(100.0)	128(100.0)		
	(Males)				
Cough + Phlegm + Chest tightness	Yes	88(60.3)	9(7.0)		
	No	58(39.7)	119(93.0)	< 0.001	20.1(9.4, 42.7)
	Total	146(100.0)	128(100.0)		
Cough + Phlegm + Chest tightness + Breathlessness	(Males)				
	Yes	28(19.2)	3(2.3)		
	No	118(80.8)	125(97.7)	< 0.001	9.9(2.9, 33.4)
	Total	146(100.0)	128(100.0)		

4.1.6 Combinations of respiratory conditions between participants who smoked exposed and not exposed to limestone dust

Participants with history of smoking in the exposed group were more likely to have a combination of respiratory conditions than smokers in unexposed group. These results were statistically significant for up to the combination of three symptoms (see table 10).

The CIs showed that exposed smoking participants were more likely to have combinations of respiratory conditions compared to non-smoking exposed participants (table 11).

Table 10. Combinations of respiratory conditions among participants who smoked

Combinations of respiratory conditions		Group: Exposed n (%)	Group: Unexposed n (%)	p-value	OR (95 CI)
Cough + phlegm	Yes	71(78.0)	4(25.0)	<0.001	10.7(3.1, 36.6)
	No	20(22.0)	12(75.0)		
	Total	91(100.0)	16(100.0)		
Cough +Phlegm + Chest tightness	Yes	58(63.7)	4(25.0)	0.009	5.3(1.6, 17.7)
	No	33(36.3)	12(75.0)		
	Total	91(100.0)	16(100.0)		
Cough + Phlegm + Chest tightness + Breathlessness	Yes	21(23.1)	1(6.3)	0.230	4.4(0.5, 36.1)
	No	70(76.9)	15(93.7)		
	Total	91(100.0)	16(100.0)		

Table 11. Combinations of respiratory conditions between smoking and non smoking participants exposed to limestone dust.

Combination of respiratory conditions		Exposed participants: Smoking n (%)	Non smoking n (%)	p-value	OR (95 CI)
Cough + phlegm	Yes	71(78.0)	66(60.6)	<0.001	2.31(1.24, 4.29)
	No	20(22.0)	43(39.4)		
	Total	91(100.0)	109(100.0)		
Cough +Phlegm + Chest tightness	Yes	58(63.7)	52(47.7)	0.067	1.93(1.09, 3.41)
	No	33(36.3)	57(52..3)		
	Total	91(100.0)	109(100.0)		
Cough + Phlegm + Chest tightness + Breathlessness	Yes	21(23.1)	18(16.5)	0.895	1.52(0.75, 3.07)
	No	70(76.9)	91(83.5)		
	Total	91(100.0)	16(100.0)		

4.1.7 Lung function and exposure to limestone dust between the exposed and unexposed participants

198 exposed and 108 unexposed participants had their lung function done. More participants in the exposed group had abnormal lung function in comparison to participants in unexposed group. Similarly, significantly more smoking participants exposed to limestone dust had abnormal lung function compared to unexposed smoking participants (see tables 12 and 13).

More males in the exposed group had abnormal lung function than males in unexposed group and the findings were significant. In contrast, there was no significant difference in the results of females in exposed group compared to those of females in the unexposed group (see table 14).

Table 12. Association between lung function and exposure to limes exposed group tone dust among the exposed and unexposed

Groups	Lung function		Total n (%)	p-value	OR (95% CI)
	Normal n (%)	Abnormal n (%)			
Exposed	52(26.3)	146(73.7)	198(100.0)	< 0.001	2.7 (1.7, 4.4)
Non - exposed	53(49.1)	55(50.9)	108(100.0)		

Table 13. Abnormal lung function among participants who smoked

Abnormal lung function	Group*		p- value	OR(95% CI)
	Exposed n(%)	Unexposed n(%)		
Yes	68(46.6)	5(9.1)		
No	78(53.4)	50(90.9)	< 0.001	8.7(3.3, 23.1)
Total	146(100.0)	55(100.0)		

*Smoking participants

Table 14. Males and females participants with abnormal lung function

Sex	Abnormal Lung function	Group		p- value	OR (95% CI)
		Exposed n (%)	Unexposed n (%)		
	Yes	108(75.0)	40(51.3)		
Males	No	36(25.0)	38(48.7)	< 0.001	2.9 (1.59, 5.10)
	Total	144(100.0)	78(100.0)		
	Yes	38(70.4)	15(50.0)		
Females	No	16(29.6)	15(50.0)	0.106	2.4 (0.94, 5.98)
	Total	54(100.0)	30(100.0)		

4.1.8. Association between occurrence of respiratory conditions and abnormal lung function among study participants

Significantly more participants exposed to limestone dust with respiratory conditions had abnormal lung function compared with unexposed participants. Equally, more exposed participants with combinations of respiratory conditions had abnormal lung function compared to unexposed participants (see tables 15 and 16).

Table 15. Association between respiratory conditions (cough, phlegm production, chest tightness and breathlessness) and abnormal lung function among the exposed and unexposed

Respiratory condition	Abnormal lung function	Groups: Exposed n (%)	Groups: Non – exposed n (%)	P-value	OR (95% CI)
	Yes	117(80.1)	15(27.3)		
Cough	*No*	29 (19.9)	40 (72.7)	< 0.001	10.8 (5.2, 22.1)
	Total	146(100.0)	55(100.0)		
	Yes	105(71.9)	12(21.8)		
Phlegm	*No*	41(28.1)	43(78.2)	< 0.001	9.2 (4.40, 19.1)
	Total	146(100.0)	55(100.0)		
	Yes	90(61.6)	9(16.4)		
Chest tightness	*No*	56(38.4)	46(83.6)	< 0.001	8.2(3.7, 18.1)
	Total	146(100.0)	55(100.0)		
	Yes	33(22.6)	4(7.3)		
Breathlessness	*No*	113(77.4)	51(92.7)	0.022	3.7(1.2, 11.1)
	Total	146(100.0)	55(100.0)		

Table 16. Association between occurrence of combination of respiratory conditions and abnormal lung function among study participants

Respiratory conditions	Abnormal lung function	Groups		P-value	OR (95% CI)
		Exposed n (%)	Unexposed n (%)		
	Yes	104(71.2)	10(18.2)		
Cough + phlegm	No	42(28.8)	45(81.8)	<0.001	11.1(5.1, 24.1)
	Total	146(100.0)	55(100.0)		
Cough + Phlegm + Chest tightness	Yes	82(56.2)	6(10.9)		
	No	64(43.8)	49(89.1)	<0.001	10.5(4.2, 26.0)
	Total	146(100.0)	55(100.0)		
Cough + Phlegm + Chest tightness + Breathlessness	Yes	27(18.5)	2(3.6)		
	No	119(81.5)	53(96.4)	0.014	6.0(1.4, 3.7)
	Total	146(100.0)	55(100.0)		

CHAPTER 5

5.1 Discussion

This section discusses the findings on occurrence of respiratory conditions among participants exposed to limestone dust compared to unexposed participants. It also discusses the occurrence of combinations of respiratory conditions and abnormal lung function among study participants with the history of smoking.

5.1.1 Occurrence of respiratory conditions (cough, phlegm production, chest tightness and breathlessness) between the exposed and unexposed participants

More participants among the exposed reported having; cough, phlegm production, chest tightness and breathlessness compared to unexposed participants because of the continuous exposure to limestone dust. Limestone dust contains calcium oxide and silicon dioxide which might have caused irritation by mechanical abrasion to the respiratory tract mucous membranes of the exposed participants [7, 28]. Similarly, studies done in United Arab Emirates, Taiwan and Morocco, found that more workers exposed to cement dust (containing limestone dust in large proportion) had respiratory conditions in contrast with unexposed workers [16, 18, 19]. On the contrary, studies carried out on cement factory workers in Norway and Zambia showed that there was no significant difference among the workers exposed to cement dust on the occurrence of respiratory symptoms as compared to unexposed workers. That possibility was due to dust reduction measures such as respirators which were in place, protecting the workers from inhaling the cement dust [23, 24].

5.1.2 Occurrence of combinations of respiratory conditions among participants

Significantly, more participants' exposed to limestone dust reported having combinations of respiratory conditions compared to unexposed participants' ($p < 0.001$). That could be attributed to prolonged exposure for at least six months and inhalation of limestone dust. Similarly, studies done in Malaysia and Nigeria have shown that workers exposed to cement dust were more likely to have occurrence of respiratory conditions compared to those in unexposed workers (11, 28).

5.1.3 Occurrence of combinations of respiratory conditions among participants by age groupings

More exposed participants in all age groups had combinations of respiratory symptoms and 80% of the results were statistically significant and 20% were not significant. These differences could not be attributed to age, repeated exposure to limestone dust and lack of protective measures from inhaling dust. A study done in United Arab Emirates also found that more workers exposed to cement dust had high prevalence of respiratory symptoms such as cough, phlegm production, wheezing, dyspnoea and breathlessness compared to unexposed workers. Those findings could not be explained either by age or smoking but also by exposure to cement dust and inhalation of dust (16).

5.1.4 Occurrence of combinations of respiratory conditions among participants by sex

Significantly, more females and males exposed to limestone dust had combinations of respiratory conditions compared to unexposed females and males. That was due to the exposed participants' repeated exposure for at least six months to crystalline silica contained in limestone dust. Similarly, in America, it was observed that excessive exposure to respirable silica dust for a long period might lead to respiratory conditions such as shortness of breath, cough and fever [5, 12, 14, 36].

5.1.5 Combinations of respiratory conditions between smoking participants exposed and not exposed to limestone dust

Participants with history of smoking in the exposed group were more likely to have a combination of respiratory conditions than smokers in unexposed group. Exposed smokers were also more likely to have combinations of respiratory conditions than exposed non-smokers. The occurrence of respiratory conditions in the exposed group was due to inhalation of limestone dust exacerbated by smoking, a confounding factor in this study. Equally, in United Arab Emirates and Jordan, it was reported that smoking was significantly associated with the occurrence of respiratory conditions among workers exposed to cement dust [29, 30].

On the contrary, the findings in another study (United Arab Emirates) showed that smoking was not significantly associated with occurrence of respiratory conditions among workers exposed to cement dust. The results were attributed to short period of exposure and availability of protective measures against dust [16].

5.1.6 Lung function and exposure to limestone dust between the exposed and unexposed participants

More participants in the exposed group had abnormal lung function in comparison to participants in unexposed group. It was also found that significantly more participants who smoked in the exposed group had abnormal lung function compared to participants who smoked in the unexposed group. The findings were due to prolonged exposure to limestone dust for at least six months without protective measures against dust. Limestone dust contains chemical components such as Calcium Oxide and Silicon Dioxide, responsible for causing respiratory problems. Similarly, it was reported that, chronic exposure limits to limestone dust at concentration exceeding occupational exposure levels, might cause lung impairment [12, 14, 36].

On the contrary, studies done in; Jordan, Norway and Zambia reported that there was no statistically significant difference in the results of workers exposed to cement dust compared to the unexposed. These results were attributed to dust reduction measures that were in place in the factories and workers had short periods of exposure to dust [16, 23, 24].

Significantly, more participants with smoking history in exposed group had abnormal lung function in contrast to smokers in unexposed group. Smoking had facilitated the occurrence of abnormal lung function among participants exposed to limestone dust. Studies carried out in United Arab Emirates and Jordan also found that smoking was associated with lung impairment among workers exposed to cement dust [29, 30]. In line with the results, studies in Florida and America, and Martin Marietta Materials indicated that smoking increased the risk of developing lung disorder for people with chronic exposure to respirable dust [2, 5, 12].

More males in the exposed group had abnormal lung function than males in unexposed group. On the contrary, there was no significant difference in the results of females in the exposed group having abnormal lung function compared to those of females in the unexposed group. The reason for differences in results could be that more exposed males were operating in areas with high levels of limestone dust, containing silicon dioxide and calcium oxide, which were highly associated with abnormal lung function as compared to exposed females. Similarly the study done in Tanzania cement factory found that workers exposed to high levels of cement dust had poor lung function [27].

5.1.7 Association between occurrence of respiratory conditions and abnormal lung function among study participants

The p - values less than 0.05 on association between occurrence combinations of respiratory conditions and abnormal lung function indicated that significantly, more participants exposed to limestone dust with respiratory conditions and combinations of respiratory conditions had abnormal lung function compared with unexposed participants. The findings could be attributed to continuous exposure to limestone dust for at least six months without protective measures from inhaling dust. Similar results were reported in Norway and Iran at cement industries that workers exposed to cement dust had increased occurrence of respiratory symptoms due to exposure to cement dust [20, 23].

CHAPTER 6

6.1 Conclusion

The occurrence of respiratory conditions (cough, phlegm production, chest tightness and breathlessness) and lung impairment were more prevalent among participants exposed to limestone dust in contrast to unexposed participants. Participants exposed to limestone dust with combinations of respiratory conditions were more likely to have abnormal lung function in contrast to unexposed participants. The findings were due to participants' (stone crushers) continuous exposure for atleast six months to limestone dust without protective measure against dust.

Smoking facilitated the occurrence of respiratory conditions and abnormal lung function among participants exposed to limestone dust compared to unexposed participant.

The hypothesis of the study which stated that ***exposure to limestone dust is not associated with an increase in the occurrence of respiratory conditions*** has been rejected because more participants exposed to limestone dust had respiratory conditions compared to unexposed participants.

6.2 Recommendations

a. Future researchers on the same study should do chemical analysis and measure the levels of limestone dust to which stone crushers are exposed.

b. Chest X-ray to examine the presence of tuberculosis and lung function of participants exposed and not exposed to limestone dust should be taken in future studies.

c. There should be biochemical and microbiology examination of exposed and unexposed participants' phlegm.

d. Stone crushers should be sensitized on the importance of using protective measures against dust in order to reduce the occurrence of respiratory conditions and abnormal lung functions.

e. The findings has shown that there is an association between exposure to limestone dust and occurrence of respiratory conditions, therefore, there is need to disseminate the information to policy makers (Ministry of Health and ECZ) so that protective measures are put in place.

f. Cross sectional studies do not produce causative factors. Need for cohort studies to be able to do so.

References

1. Lobeck, A. K. 1939. **Geomorphology.** New York: McGraw – Hill Book Co.
2. Martin Marietta Materials. 2007. **Material Safety Data Sheet** (Unpublished).
3. Hatch, F. H., A. K. Wells and M. K. Wells. 1978. **Petrology of the Sedimentary Rocks**. London: Thomas Murby and Co.
4. Strahler, A. and A Strahler 2002. **Physical Geography**. New York: John Wiley and Sons.
5. Cemstone Products Company. 2002. **Material Safety Data Sheet** (Unpublished).
6. Bailey, D. K. 1959. **Carbonates and Intrusive Limestone in the Central and Southern Provinces of Northern Rhodesia.** A Thesis submitted to London University for the Degree of Doctor of Philosophy.
7. Mitchell, C. J. and M. Mwanza. 2005. **Farmlime Manual for Small Scale production of agriculture lime.** Keyworth, Nottingham British Geological Survey.
8. Dietrich, R. V. and B. J. Skinner 1979. **Rock and Rock Minerals.** New York: John Wiley and Sons In.
9. Rasmessen, F. V., L. Borchsenius, B. Holstein and P. Solvsteen. 1977. "**Lung function and long term exposure to cement dust.**" Scandinavia Respiratory Disorder., 58 (5), 252-264.
10. Lahabra, 2002. **Material Safety Data** (Unpublished).
11. Noor, H., C.L Yap, O. Zolkepi, and M. Faridah. 2000. "**Effect of exposure to dust on lung function of cement factory workers**." Medical Journal of Malaysia., 55 (2), 51-57.

12. Dry- Packaged Fast Selling Cement Based Product. 2002. **Material Safety Data Sheet** (Unpublished).

13. Scream Manchester News. 2006. **UNZA SCREAM** (Unpublished).

14. Selden, A. L., N.P. Berg, E.A. Lundgren, G. Hillerdal, N.G. Wik, C.G. Ohlson and L.S. Bodin. 2001. "**Exposure to tremolite asbestos and respiratory health in Swedish dolomite workers.**" Journal of Occupational Environmental Medicine., 58 (10), 670-677.

15. Titan Florida. 2001. **Material Safety Data Sheet for Limestone** (Unpublished)

16. Al-Neaimi, Y.I., J. Gomes and O.L. Lloyd. 2001. "**Respiratory illness and ventilatory function among workers at a cement factory in a rapidly developing country.**" Occupational Medicine (London)., 51 (6), 367-373.

17. Mengesha, Y. and A Bekele. 1998. **"Relative chronic effects of different occupational dusts on respiratory indices and health of workers in three Ethiopian factories."** Journal of Industrial Medicine., 34: 373 - 380

18. Yang C.Y., C.C. Huang, H.F. Chiu, S.Y. Lan and Y.C. Ko. 1996. "**Effects of occupational dust exposure on the respiratory health of Portland cement workers.**" Journal of Toxicology and Environmental Health., 6:581-588.

19. Portland Cement Dust Hazard assessment document. December, 2007.

20. Meghan, M and A. Choobineh. 2007. **"Work – related Respiratory Symptoms and Ventilatory Disorders among Employees of a Cement Industry in Shiraz, Iran."** Journal of Occupational Health., 49: 273 - 278

21. Projects in Indonesia: **international Development Research Centre: Cement Dust and Respiratory Problems** (Unpublished)

22. Ulveslad, B., B. Bakke, J. Kongerud and M. B. Luud. 2001. **"Cumulative exposure to dust causes accelerated decline in lung function in tunnel workers."** Occupational Environmental Medicine., 58: 663 – 669

23. Fell, A. K., T. R. Thomassen, P. Kristennsen, T. Kristensen, T. Egeland and J. Kongrerud. 2003 **"Respiratory symptoms and ventilator function in workers exposed to Portland cement dust."** Journal of Occupation and Environmental Medicine., 45(9) 1008 - 1014

24. Siziya, S., 2005. "**Associations of Cement Dust with Occurrence of Respiratory Conditions and Lung Function**." East Africa Journal of Public Health., 2 (1):1-5.

25. Titan America. 2001. **Material Safety Data Sheet for Limestone** (Unpublished).

26. Green, D. A., G. McApine, S. Semple, H. Cowie and A. Seaton. 2007. "**Occupational and Environmental Medicine."** Mineral dust exposure in young Indians Adults: an effect on lung growth., 65:306-310

27. Mwaiselage, J., M. Bråtveit, B. Moen and Y. Mashalla. 2004. **"Cement Dust Exposure and Ventilatory Function Impairment."** Journal of Occupation and Environmental Medicine, 46, 658-67.

28. Oleru, U.G., 1984. "**Pulmonary function and symptoms of Nigerian workers exposed to cement dust."** Environmental Residues., 33 (2), 379-385.

29. AbuDhaise, B.A., A.Z. Rabi, M.A. alZwairy, A.F. elHader and S. elQaderi. 1997. **"Pulmonary manifestations in cement workers in Jordan."** International Journal Occupational Medicine and Environmental Health., 10(4), 417-428.

30. Abou-Taleb, A. N., A.O. Musaiger and R.B. Abdelmoneim. 1995. "**Health status of cement workers in the United Arab Emirates.**" Journal of the Royal Society for the Promotion of Health., 115 (6), 378-381.

31. Mhase, V. T., and P. S. N. Reddy. 2002. **Effect of Smoking on Lung Function of Workers Exposed to dust and fumes.** Indian Journal of Community., 27 (1).

32. Iyzcki, J., L. Gielec, W. Sulkowski, S. Kowalska. 1979. "**Respiratory track in workers chronically exposed to cement dust**." Medycyne Pracy., 30 (4), 241-246.

33. Lancaster, C. 1991. **Africa Economic Reforms: The external Dimension.** Washington D.C: Institute for International Economics.

34. Sheshamani, V., C. N. Mwikisa and K. Odegaard. 1995 – 2000. **Zambia's Health Reforms Selected Papers.** Department of Economics University of Zambia and Swedish Institute for Health Economics

35. Lancaster, C. 1992. **Aid to Africa**. Chicago: University of Chicago Press.

36. Central Statistical Office (CSO). 2003. **Zambia 2000 Census of Population and Housing, Analytical Report.** Lusaka: Central Statistical Office

37. Ministry of Education (MOH) [Zambia], Central Statistical Office [Zambia], and ORC Macro. 2006. **Zambia HIV/AIDS Service Provision Assessment Survey 2005**. Calverton, Maryland, USA: Ministry of Health, Central Statistical Office and ORC Macro.

38. UNEP/EEU. 7 March – 15 April, 1994. **Sub-regional workshop on environmental impact assessment for commonwealth countries of Eastern and southern Africa**. Workshop report. Livingstone, Zambia.

39. Trustees of Princeton University. 2006. **Environmental Health and Safety.**

40. Guy, W.R and A. Rothenburg 1986. **Color Atlas of Physiology.** West Germany: Appl Weinging.

41. Sidhu, K .S. 2003. **Methodology of Research in Education.** New Delhi: Sterling Publishers Private Limited.

42. Baron, R. A. 1998. **Psychology.** Boston: Allyn & Bacon.

Appendices

a. Information sheet: Respondent

Introduction

This consent form gives information about the study in which you are requested to participate in. To make sure that you have all the facts about this study, you must read this form or someone must read it to you. If you agree to participate in the study you should sign the consent form or put your thumbprint in the space provided if you cannot sign. You will be allowed to keep a copy of this form and discuss anything that is unclear to you concerning this study with the staff of the study. If you feel that you do not want to take part, you are free to refuse your consent and you will not be victimised in anyway.

Purpose of the Research and procedures

Mr M Samanyama of the Department of Community Medicine, School of Medicine, University of Zambia, is carrying out this study. The study is being done in partial fulfilment requirement of the Master of Public Health (MPH) degree, which will be submitted to the School of Medicine, Department of Community Medicine, University of Zambia. If you have questions about this study you can direct them to the following people on contact addresses: Principal Investigator, Mr M. Samanyama, P.O. Box 50110, Lusaka, Cell – 097477265; The Head of Community Medicine Department, P.O. 50110, Lusaka, Telephone number 252641; The Chairman, Research Ethics Committee of the University of Zambia, Ridgeway Campus, P.O. Box 50110, Lusaka, Telephone number 256067; Assistant Dean, University of Zambia, Graduate Proposal Presentation Forum (GPPF), P.O Box 50110, Lusaka

You are being asked to take part in a research study which aims to determine the association between limestone dust and occurrence of respiratory conditions among limestone crushers. The study is aimed at recruiting stone crushers (people) aged 16 to 59 years along Kafue Road, in Misisi compound. The study will also recruit people in the same age group living in Misisi (as a control group) but not involved in stone crushing.

After signing the informed consent, you will be asked to complete a questionnaire and respiratory test. The process will take about 20 minutes.

Risks, discomforts and benefits

There are no risks or discomforts that may arise from the study participants. Benefits of the study to participants are; those participants who will be found with lung impairment and respiratory conditions will be advised to go the nearest health centre for further medical check ups and treatment facemasks will be provided to all participants.

The results will be disseminated to Health Care Providers with the hope that if there is evidence to suggest that there is an association between limestone dust from crushed rocks and occurrence of respiratory conditions among stone crushers. The Health Care Providers would sensitize stone crushers on the need for protecting themselves from inhaling limestone dust.

Confidentiality

The information that the respondents will give will remain confidential and will not be made available to anyone who is not connected with the study. Your name will not used in the study.

The above section is to be detached and given to the participant.

b. Consent Form

By signing below, I confirm that I understand participation in this research and entirely voluntary. The material in this consent form has been explained to me, and my questions answered to my satisfaction. I freely and voluntarily choose to participate. I understand that participation or not, will not affect me in any way. I understand that my rights and privacy will be maintained.

I hereby give my consent to participate in the study of '**Associations of limestone dust and occurrence of respiratory conditions among stone crushers in Lusaka, Zambia'.**

______________________ ____________

Name of respondent **Date**

______________________ ____________

Signature of respondent/Thumbprint **Date**

______________________ ____________

Name of witness **Date**

______________________ ____________

Signature of witness **Date**

c. RESPIRATORY QUESTIONNAIRE

NAME ________________ **IDENTIFICATION No** _______

DATE OF INTERVIEW __________________

A. IDENTIFICATION DATA

Tick your response

1. Sex 1) Male

2) Female.

2. How long have you been crushing stones?

1) Less than six months

2) Six months or more

If ones answer to Q2 is 2, she/he is allowed to participant in the study and answer and questions in the questionnaire.

3. Age_______

4. Standing height _____

5. Weight ____

Use actual wording of each question. Put X in appropriate square after each question.

When in doubt record `No' or circle the appropriate answer.

B. COUGH

(On getting up)

6. Do you usually cough first thing in the morning?

1) Yes

2) No

7. Do you usually cough during the day or at night?

(Ignore an occasional cough.)

1) Yes

2) No

If `Yes' to either question (6 and 7), then answer the questions that follows.

8. Do you cough like this on most days for as much as three months a year?

1) Yes

2) No

9. Do you cough on any particular day of the week?

1) Yes

2) No

10. If `Yes'to Q 9, which day?

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Mon	Tues	Wed	Thur	Fri	Sat	Sun

C. PHLEGM or alternative word to suit local custom.

(On getting up)

11. Do you usually bring up any phlegm from your chest first thing in the morning? (Exclude phlegm from the nose).

1) Yes

2) No

12. Do you usually bring up any phlegm from your chest during the day or at night? (Accept twice or more.)

1) Yes

2) No

If `Yes' to question 11 or 12, then answer the questions that follow.

13. Do you bring up any phlegm like this on most days for as much as three months each year?

1) Yes

2) No

14. How long have you had this phlegm?

1) Less than three months.

2) Three months or more.

D. CHEST ILLNESSES

15. In the past three years, have you had a period of (increased) *cough and phlegm lasting for 3 weeks or more?

1) No

2) Yes, only one period.

3) Yes, two or more periods

*For subjects who usually have phlegm.

16. During the past 3 years have you had any chest illness which has kept you off your work, indoors at home or in bed? (For as long as one week)

1) Yes

2) No

17. Did you bring up (more) phlegm than usual in any of these illnesses?

1) Yes

2) No

If `Yes' to (17), then answer the question 18.

18. During the past three years did you have:

1) Only one such illness with increased phlegm?

a. Yes

b. No

2) More than one such illness?

a. Yes

b. No

E. TIGHTNESS

19. Does your chest ever feel tight or have breathing become difficulties?

1) Yes

2) No

20. Is your chest tight or have breathing difficult on any particular day of the week?

1) Yes

2) No

If `Yes' to Q19, answer question 21.

21. Which day?

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	Sun.	Sometimes.	Always.	no

If `Yes' to Q20, answer question 22.

22. If `Yes', at what time does your chest feel tight or have breathing difficult?

1) Before starting stone crushing.

2) After starting stone crushing.

(Ask only if NO to Question (20).

23. In the past, had your chest ever been tight or had breathing difficult on any particular day of the week?

1) Yes

2) No

24. If `Yes', on which day?

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	Sun.	Sometimes	Always

F. BREATHLESSNESS

25. Are you ever troubled by shortness of breath, when hurrying on the level ground or walking up a slight ill?

1) Yes

2) No

If `Yes', proceed to next question.

26. Do you get short of breath walking with other people at an ordinary pace on the level?

1) Yes

2) No

If `Yes', proceed to next question.

27. Do you have to stop for breath when walking at your own pace on the level ground?

1) Yes

2) No

If `Yes', proceed to next question.

28. Are you short of breath on washing or dressing?

1) Yes

2) No

G. OTHER ILLNESSES AND ALLERGY HISTORY

29. Do you have a heart condition for which you are under a doctor's care?

1) Yes

2) No

30. Have you ever had asthma?

1) Yes

2) No

32. If `Yes', did it begin:

1) before age 30

2) after age 30

33. If `Yes' before 30 did you have asthma before starting crushing stones?

1) Yes

2) No

34. Have you ever had fever or other allergies (Other than above)?

1) Yes

2) No

H. TOBACCO SMOKING*

34. Do you smoke?

    1) Yes

    2) No

If `No' to Q34, answer question 35

35. Have you ever smoked? (Cigarettes, cigars, pipe. Record 'No' if subject has never smoked as much as one cigarette a day, or 1 oz of tobacco a month, for as long as one year).

    1) Yes

    2) No

If `Yes' to Q33 or Q34, answer question 36.

36. What have you smoked and for how many years? (Write in specific number of years in the appropriate square)

Tobacco	**Years**								
	<5	5-9	10-14	15-19	20-24	25-29	30-34	35-39	>40
Cigarettes									
Pipe									
Cigars									

37. If cigarettes, how many packs per day?

    1) Less than 1/2 pack

    2) 1/2 pack, but less than 1 pack

    3) 1 pack, but less than 1 1/2 pack

    4) 1 1/2 pack or more

38. If an ex-smoker (cigarettes, cigar or pipe), how long since you stopped?

(Write in number of years)

1) 0-1 year

2) 1-4 years

3) 5-9 years

4) 10+ years

39. Have you changed your smoking habits since?

1) Yes

2) No

I. PREVIOUS EXPOSURE*

40. Have you ever worked in:

a) A foundry (as long as one year)?

1) Yes

2) No

b) Stone or mineral mining, quarry or processing company (as long as one year)?

1) Yes

2) No

c) Asbestos milling or processing?

1) Yes

2) No

d) Other dusts, fumes or smoke?

1) Yes

2) No

If yes, explain the changes

41. Type of exposure

____

42. Length of exposure

____

43. At what age did you first go to work in a textile mill'?

44. Spirometry readings:

i. FVC ....

ii. FEV ....

iii. FEV% ....

iv. PEFR ....

Thank you for your participation.

d. Research team

The Research team composed of the following people:

Principal Investigator

Technician

Medical Doctor

Principal Investigator

The Principal Investigator was responsible for data collection, analysis and compilation of the report.

Technician

The technician assisted the Principal Investigator to collect data of the participant's lung function using the spirometer.

Medical Doctor

The Medical Doctor checked the validity of the data which was collected using the spirometer (participants lung function) and supervised the Principal Investigator in the analysis of data.

THE UNIVERSITY OF ZAMBIA

RESEARCH ETHICS COMMITTEE

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Ridgeway Campus
P.O. Box 50110
Lusaka, Zambia

Assurance No. FWA00000338
IRB00001131 of IORG0000774

8 May, 2007
Ref.: 008-09-06

Mr Samanyama Mwanamakwa
University of Zambia
School of Medicine
Department of Community Medicine
P.O. Box 50110
LUSAKA

Dear Mr Mwanamakwa,

RE: RESEARCH PROPOSAL ENTITLED: **"ASSOCIATION OF LIMESTONE DUST AND OCCURRENCE OF RESPIRATORY CONDITIONS AMONG STONE CRUSHERS IN LUSAKA, ZAMBIA"**

The above-mentioned research proposal was presented to the Research Ethics Committee meeting held on 27 September, 2006 where changes were recommended. We would like to acknowledge receipt of the corrected version with clarifications. The proposal has now been approved. Congratulations!

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.

Yours sincerely,

fd/ Prof. J. T. Karashani, MB, ChB, PhD
CHAIRMAN

Date of approval: 8 May, 2007 **Date of expiry:** 7 May, 2008

THE UNIVERSITY OF ZAMBIA
SCHOOL OF MEDICINE

Telephone: 252641
Cell: 097 849302

Assistant Dean's Office (PG)
P.O Box 50110
LUSAKA

25th July, 2006

Mr. Mwanamakwa Samanyama
Dept. of Community Medicine
LUSAKA.

Dear Mr. Samanyama

Re: GRADUATE PROPOSAL PRESENTATION FORUM

Following the Graduate proposal presentation Forum (GPPF) which was held on Thursday, 20th July, 2006 in the Main Lecture Theatre (UTH) at 14:00 hours, we wish to inform you that your research proposal titled: **"Association of limestone dust and occurrence of respiratory conditions among stone crushers in Lusaka, Zambia"**, was approved by the Board of Graduate Studies of the School of Medicine. The assessors gave you a mark of 55%.

The overall comments were that;

1. There should be better selection of controls.
2. Make a clear statement about objective assessment of presence of respiratory disease.
3. You must do a better literature review to justify the study.

The proposal is judged as passed subject to the above adjustments.

Good luck in your research.

Mr. Kasonde Bowa, MSc (Glasgow) M.Med (UNZA), FRCS (Glasgow)
ASSISTANT DEAN, POSTGRADUATE

CC: Director, Graduate studies
Dean, School of Medicine
Head, Community Medicine