# PULMONARY FUNCTION AND THE PREVALENCE OF RESPIRATORY SYMPTOMS AMONG PEOPLE LIVING AROUND WAZO HILL CEMENT FACTORY IN DAR ES SALAAM

**By**

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A Dissertation Submitted in Partial Fulfillment of the Requirements For The Degree of Master of Medicine (Internal Medicine) of the Muhimbili University of Health and Allied Sciences.

Muhimbili University of Health and Allied Sciences

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## CERTIFICATION

The undersigned certify that he has read and hereby recommend for examination by the Muhimbili University of Health and Allied Sciences a dissertation entitled, ***Pulmonary Function and the Prevalence of Respiratory Symptoms among People Living around Wazo Hill Cement factory in Dar es Salaam*** , in partial fulfillment of the requirements for the degree of masters of medicine (internal medicine)

.....

Dr. Yassin Mgonda

(Supervisor)

Date.....29/10/07.....

**DECLARATION**

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I, Egina Francis Makwabe, hereby declare that this dissertation is my own original work and that it has not been presented to any other University for a similar or any other degree award.

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## DEDICATION

Dedication to my family for its sacrifice, My Wife Anita A Bitegeko for her kindness, tolerance and everlasting support, despite my little participation in the family. Her naturally positive and courageous way of thinking has helped me to see the good side of my tiresome days. My children Gloria and Samuel for missing me most of the time during this period.

## ABSTRACT

**Background:**The contribution of cement dust to air pollution is widely recognized, but relatively few studies have looked at the respiratory health status of subjects living near cement dust factories. Many studies have concentrated on the cement factory workers. This study aimed at determining the pulmonary function and the prevalence of respiratory symptoms among people living around Wazo Hill cement factory as compared to those living far away from the factory.

**Methods:**A descriptive cross-sectional comparative study was done in which 775 subjects were studied. Three hundred and ninety two subjects living around Wazo Hill cement factory formed the exposed group and 383 subjects living at Temeke SabaSaba, 37km from Wazo Hill Cement factory formed the unexposed group. Interviewer administered questionnaires were used to obtain sociodemographic characteristics and history of respiratory symptoms. The pulmonary function indices of FVC, FEV1 and FEV1/FVC were obtained using a bedside microspirometer. The measurements of height and weight were obtained from each subject.

**Results:** Of the total 775 individuals who met the inclusion criteria, there were 114 out of 392 (29%) exposed subjects who had chronic cough as compared to 70 out of 383 (18.28%) unexposed and the difference was statistically significant ($p < 0.01$). The exposed individuals had a significantly higher prevalence than controls for chronic sputum production, wheeze, and chronic bronchitis with the prevalence of 41.8%, 21.9%, and 16% versus 11%, 11.1% and 7.6% respectively

The exposed subjects had significantly lower FVC, $FEV_1$ and the ratio of $FEV_1$ to FVC, than the unexposed adjusted for age, height and smoking.

**Conclusions:** This study has showed that people living around Wazo Hill cement factory have a high risk of developing chronic respiratory symptoms as well as reduction of their pulmonary function as compared to those living far away from the factory

**ABREVIATIONS**

| | |
|---|---|
| COPD | Chronic Obstructive Pulmonary disease |
| $FEV_1$ | Forced Expiratory Volume in One second |
| $FEV_1$/FVC | Ratio of $FEV_1$ to FVC |
| FVC | Forced Vital Capacity |
| PEF | Peak Expiratory Flow Rate |
| TLC | Total Lung Capacity |
| VC | Vital Capacity |
| MEP | Maximal Expiratory Pressure |
| MIP | Maximal Inspiratory Pressure |
| RV | Residual capacity |
| RV/TLC | Ratio of RV to TLC |
| GOLD | Global initiative On Lung Diseases |
| ATS | The American Thoracic Society. |
| ERS | The European Respiratory Society |
| FEF | Forced Expiratory Flow |

## DEFINTION OF TERMS

**Chronic cough:**

Subjects were classified as having chronic cough if they answered yes to all of four questions:

- Do you usually cough first thing in the morning?
- Do you usually cough during the day or night?
- Do you cough as much as 4 – 6 times a day or more in a week?
- Do you cough like this on most days for as much as 3 consecutive months or more during the year?

**Chronic sputum production:**

The participant had to answer yes to all of the four questions:

- Do you usually cough with sputum first thing in the morning?
- Do you usually cough with sputum during the day or night?
- Do you cough with sputum as much as 4 – 6 times a day or more in a week?
- Do you cough like this on most days for as much as 3 consecutive months or more during the year?

**Dyspnoea:**

Subjects were classified as having dyspnoea if they answered yes to:

- Do you get shortness of breath when walking at your own pace on level ground?

**Wheeze:**

Subjects were classified as having a wheeze if they had ever experienced a whistling sound from the chest.

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**Chronic bronchitis:**

Subjects were classified as having chronic bronchitis if they had chronic cough and/or sputum production almost daily for at least 3 months a year for at least 2 consecutive years.

**Never smokers:**

Were defined as lifelong nonsmokers

**Ex- smokers:**

Those who had quit smoking for at least 1 year before the survey and

**Current smokers:**

Those who smoked at the time of the survey, including those who had quit less than 1 year before.

**Ever smokers:**

Comprised current smokers and ex smokers.

**The pack years:**

Those who were smoking 20 cigarettes a day for 1 year.

## LIST OF TABLES


| Table number | Title | Page |
|---|---|---|
| Table 1 | Characteristics of the exposed and unexposed group | 26 |
| Table 2 | Prevalence of Chronic Respiratory symptoms in the exposed And unexposed group | 28 |
| Table 3 | Ventilatory function indices between the exposed and unexposed group | 29 |
| Table 4 | Ventilatory function indices between the exposed and unexposed group according to smoking habits | 30 |
| Table 5 | Proportion of airflow limitation in the exposed and unexposed group | 31 |

**CONTENTS:**


1. Title i
2. Certification ii
3. Declaration and Copyright iii
4. Acknowledgement iv
5. Abstract vi
6. Table of Contents xi
7. List of Table x
8. List of Abbreviations vii
9. Definition of terms viii
10. Introduction and literature review 1
11. Problem Statement 14
12. Rationale and hypothesis of the study 15
13. Objectives 16
14. Methodology 17
15. Results 25
16. Discussion 32
17. Conclusion and Recommendation 36
18. Appendixes
    a. Appendix 1 Consent form 38
    b. Appendix 2 Questionnaire 40
    c. Appendix 3 References 41

## INTRODUCTION AND LITERATURE REVIEW

### Cement Production and composition

Cement is used for various purposes such as binding sand and gravel to form concrete, mortar for uniting the surfaces of various materials or for coating surfaces to protect them from chemical attack [1].Cement is delivered in bulk from road tankers and railcars or may be distributed in paper sacks for small-scale building operations [1].

The principal compounds used in the manufacture of cement are a combination of calcium, silicon, iron, and aluminium compounds in the form of limestone and clay[3]. After crushing and grinding, the ingredients are mixed and burnt in a rotary kiln, where pulverized coal, gas or oil is used as fuel. The clinker obtained from the kiln is cooled and then ground in ball mills, with gypsum being added, until the required fineness is obtained.

The most important constituents of the final Portland cement are tricalcium silicate, dicalcium silicate, tricalcium aluminate and tetracalcium aluminoferrite[3].It also contains varying amounts of calcium oxide, silcon oxide, aluminium trioxide, ferric oxide, magnesium oxide and alkali oxide[4,5];selenium[6];thalium[7] and low concentration of hexavalent chromium[3,8].The pH of the cement in wet solution is alkaline within the range of 12.5-13.5 [3,6,9]

### Exposure to cement dust

Exposure to cement dust occurs at most stages of the production activities in the cement factory, but is likely to vary due to the different stages of the process[3,9,10].

Workers who are in close contact with the production processes have been reported to have high exposure to total dust (11-230mg/m3) and respirable dust (2-46mg/m3)[3].

Despite the above explanation, most studies done in the developed countries in recent years show indications of improved dust control compared to studies in developing countries[3].

The extent to which exposure varies in the work place depends on many factors, some of which are related to the agent itself, but most are related to work content, task performed, production and environmental characteristics[11,12]. In order to understand the variation in dust exposure and risk of respiratory disorder in work places, knowledge about the magnitude of variability in dust exposure from day to day is important.

The magnitudes of various components are derived from repeated dust measurements collected from selected workers in the exposure groups. These components are used to determine the contrast in exposure levels between several exposure groups[13], the hypothetical attenuation of exposure-response relationship[14], the homogeneity in exposure levels[12,14,16], the precision in exposure levels[14],the probability of overexposure and exceedance relative to occupational exposure limits[12,16].

**Respiratory disorders caused by exposure to cement dust**

The cement dust irritates the mucus membranes of the respiratory airways[2, 5,9,19] that may lead to acute post shift reduction in PEF[20] and $FEV_1$ among exposed workers in a Portland cement factory.

The exact mechanism of the acute changes in the ventilatory function observed among exposed workers is unclear, but likely it depends on the mechanical composition of the concentration of the dust. Several studies in the cement industry have indicated the possibility of allergic reactions in the acute respiratory effect, possibly due to hexavalent chromium[22, 23,24].

Few previous studies in the United States and Norway investigated the concentrations of the constituents of airborne cement dust and showed that the concentration of alpha-quartz in the airborne cement dust is low[25,26]. Some studies have indicated the presence of irritant compounds such as calcium, magnesium, aluminium and chromium in the airborne cement dust[3, 4].Some studies have suggested that the mechanism for acute effects of chemical irritants on the respiratory airways is through irritation of the airways leading to neurogenic inflammatory responses including bronchoconstriction and acute respiratory symptoms[27,28].

It has been reported that repeated and prolonged inhalation of cement dust is associated with chronic respiratory symptoms[5,10,29-35]:slight abnormalities of the chest radiography[36,37] and impairment of lung function[5,19,29-31,33,38,39].However, some studies have not found such relationship[25,26,40,41].

This shows that previous studies in cement industries have come up with conflicting conclusions about the effect of cement dust exposure on the respiratory airways.

The reasons could be due to low dust exposure levels in some studies, the lack of contrast in exposure levels between selected groups, misclassification of workers with regard to exposure or use of surrogate of exposure such as duration of employment.

**Chronic Obstructive Pulmonary Disease (COPD)**

Epidemiological studies have several definitions of COPD, and comparing studies is therefore difficult[56]. The American Thoracic society definition in diagnosing COPD combines both chronic bronchitis and spirometric airway obstruction, a highly recommended criterion for COPD diagnosis[65,57].

The European Respiratory Society (ERS) and the Global Initiative for Chronic Obstructive Lung Disease (GOLD) definition of COPD are based only on the presence of airway limitation[57,73].

Thus a higher prevalence of COPD may be obtained by these criteria[57]. The precise and variable definition of COPD has made it difficult to quantify the morbidity and mortality of the disease and for comparison purposes between studies and countries[57]. Since 2001, the GOLD initiative for COPD has developed guidelines that could help in the diagnosis of clinical COPD. Thus, comparison between studies and countries could be easier[42]. In 2003, it was suggested that, for diagnosis of COPD, inclusion of other components in the diagnosis criteria is important both clinically and epidemiologically because it may help in the evaluation of COPD cases[58]

Occupational airborne exposures have been suggested to be an important risk factor for COPD independent of smoking, particularly when sufficiently intense and/or prolonged [42,46,47]. Few community based studies have shown an increase in the prevalence of COPD among dust exposed workers compared to un exposed controls[48, 49].

Airway hyper responsiveness is a risk factor for COPD, as it has been reported that subjects who are hyper responsive have lower lung function[50] and increased prevalence of chronic cough and phlegm[51]. The other possible risk factors for COPD include environmental pollution and severe childhood infection[52]. In addition, poor socio economic status might be a risk, as this reflects poor nutrition, low education and environmental air polution[52].

The role of cement dust in relation to development of COPD is not clear. Some studies have shown a possible relationship between cement dust exposure and the risk of COPD[53-55], but other studies have not found any increase in the prevalence of COPD among cement workers compared to controls[4, 25.56].

**COPD and Cigarette Smoking**

The association between smoking and COPD is well documented[42]. However not all smokers develop clinically significant COPD, which suggest that genetic as well as endogenous and exogenous factors may modify the individual risk[42,43]. It is believed that individuals with hereditary deficiency of alpha1-antitrypsin have an increased risk of developing COPD[44,45].

Other pulmonary diseases that have been reported to occur in cement exposed individuals include pulmonary alveolar proteineosis, presumably due to high silica exposure[59].,intercostals muscle impairment, due to deposition of cement components in the intercostals muscles via the blood stream[60] and lung cancer, presumably due to cement dust containing chromium 6[60,61].

Exposure to cement dust has long been associated with the prevalence of respiratory symptoms and varying degrees of airway obstruction in man. Apart from respiratory diseases, it has also been found to be the cause of lung and laryngeal cancer, gastrointestinal tumors and dermatitis [29].Studies indicates that cement dust has the potential to cause chronic productive cough and an obstructive impairment of pulmonary function. Is not possible to draw reliable conclusions on dose-response relationships, but the available data do raise concerns that respiratory deficits could develop with long-term average exposures to respirable cement dust above 1 but below 4 $mg.m^{-3}$ [29]

The contribution of cement dust to air pollution is widely recognized, but relatively few studies have looked at the respiratory health status of subjects living near cement dust factories. Many studies have concentrated on the cement industry workers. One study in Netherlands[71] reported the effects of air pollution in the children's schools living near major motorways.

The results indicate that exposure to traffic-related air pollution, in particular diesel exhaust particles, lead to reduced lung function in children living near major motorways[71].

Another study in United States of America studied whether exposure to air pollution affects the growth of lung function during the period of rapid lung development that occurs between the ages of 10 and 18 years[72].

The results of this study indicate that current levels of air pollution have chronic, adverse effects on lung development leading to clinically significant deficits in attained $FEV_1$ as children reach adulthood[72].

**Ventilatory function**

Ventilation is the process whereby the lungs replenish the gas in the alveoli. Measurements of ventilatory function in common diagnostic use consist of quantification of the gas volume contained in the lungs under certain circumstances and the rate at which gas can be expelled from the lungs[69].

Two measurements of lung volume commonly used for respiratory diagnosis are total lung capacity (TLC) and residual volume (RV). The former is the volume of gas contained in the lungs after a maximum inspiration, where as the latter is the volume of the gas remaining in the lungs at the end of a maximal expiration. The volume of gas that is exhaled from the lungs in going from TLC to RV is called the vital capacity (VC). Common clinical measurements of airflow are obtained from maneuvers in which the subject inspires to TLC and then forcibly exhales to RV[70].

Three measurements are commonly made from a recording of exhaled volume versus time i.e., a spirograme obtained during such a forced expiratory maneuver:

(1) the volume of gas exhaled during the fist second of expiration ( forced expiratory volume $FEV_1$ ),

(2) the total volume exhaled ( forced vital capacity FVC ),

(3) the average expiratory flow rate during the middle of the VC ( forced expiratory flow (FEF) between 25 and 75% of the VC, or $FEF_{25-75\%}$, also called the maximal midexpiratory flow rate (MMFR)[61,69]

Specifically, values of individual measurements falling below the fifth percentile are considered to be normal [61]

The normal value for the ratio $FEV_1/FVC$ is approximately 0.75 to 0.80, although this value does fall somewhat with advancing age[2]. The $FEF_{25-75\%}$ is often considered a more sensitive measurement of early airflow obstruction, particularly in small airways. However, these measurements must be interpreted cautiously in patients with abnormally small lungs (low TLC and VC). These patients exhale less air during forced expiration, and the $FEF_{25-75\%}$ may appear abnormal relative to the usual predicted value, even if it is normal relative to the size of the patient's lungs.[1,2]

It is also common practice to plot expiratory flow rates against lung volume (rather than against time). At TLC, before expiratory flow starts, the flow rate is zero; once forced expiration has begun, a high peak flow rate is rapidly achieved. As expiration continues and lung volumes approaches RV, the flow rate falls progressively, in a nearly linear fashion as a function of lung volume for a person with normal lung function.

During maximal inspiration fro RV to TLC, inspiration flow is most rapid at the midpoint of inspiration, so the inspiratory portion of the loop is U- shaped or saddle shaped.

The flow rates achieved during maximal expiration can be analyzed quantitatively by comparing the flow rates at specified lung volumes with the predicted values or quantitatively by analyzing the shape of the descending limb of the expiratory curve[62,64].

Assessing the strength of respiratory muscles is an additional part of the overall evaluation of some patients with respiratory dysfunction. When a patient exhales completely to RV and then tries to inspire maximally against an occluded airway, the pressure that can be generated is called the *maximal inspiratory pressure* (MIP). On the other hand, when the patient inhales to TLC and then tries to expire maximally against an occluded airway is called the *maximal expiratory pressure* (MEP). In proper clinical setting, these studies may provide useful information regarding the cause of abnormal lung volumes and the possibility that respiratory muscle weakness may be causally related to the lung volume abnormalities.[62]

**Patterns of abnormal ventilatory functions**

The two major patterns of abnormal ventilatory function, as measured by static lung volumes and spirometry, are restrictive and obstructive patterns. In the *obstructive pattern*, the hallmark is a decrease in expiratory flow rates.

With fully established disease, the ratio $FEV_1/FVC$ is decreased, as is the $FEF_{25-75\%}$. With early obstructive disease, which originates in small airways, $FEV_1/FVC$ may be normal.

The only abnormalities noted on routine testing of pulmonary function may be a depression in $FEF_{25-75\%}$ and an abnormal, i.e., curved, configuration in the terminal portion of the forced expiratory flow volume curve.[39]

In *obstructive* disease, the TLC is normal or increased.

When helium equilibration tests are used to measure lung volumes, the measured volume may be less than the actual volume if helium was not well distributed to all regions of the lung. Residual volume is elevated as a result of airway closure during expiration, and the ratio RV/TLC is increased. VC is frequently decreased in obstructive disease because of the striking elevations in RV with only minor changes in TLC. [20]

A restrictive pattern can be broadly divided into two subgroups, depending in the location of the pathology; pulmonary parenchymal and extraparenchymal. For extraparenchymal disease, dysfunction can be predominantly in inspiration or in both inspiration and expiration. The hallmark of restrictive pattern, found in all these categories, is a decrease in lung volumes, primarily TLC and VC. In pulmonary parenchymal disease, RV is also generally decreased, and forced expiratory flow rates are preserved.

In fact when $FEV_1$ is considered as a percentage of the FVC, the flow rates are often supranormal, i.e., disproportionately high relative to the size of the lungs[61].

In the extraparenchymal pattern characterized by inspiratory dysfunction, caused by either inspiratory muscle weakness or a stiff chest wall, inadequate distending forces are exerted on an otherwise normal lung[1]

As a result, TLC values are less than predicted, RV is often not significantly affected and expiratory flow rates are preserved.

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If inspiratory muscle weakness is the cause of this pattern, then MIP is decreased. In the extraparenchymal pattern characterized by inspiratory and expiratory dysfunction, the ability to expire to a normal RV is also limited, because of either expiratory muscle weakness or a deformed chest wall that is abnormally rigid at volumes below FRC. Consequently, RV is often elevated, unlike the pattern observed in the other restrictive subcategories. The ratio $FEV_1/FVC$ is variable and depends on expiratory muscle strength. If expiratory muscle strength is significantly decreased, then MEP is decreased, the ability to expire rapidly is impaired, and $FEV_1/FVC$ may be decreased even though there is no airflow[2,5]obstruction. If expiratory muscle strength is normal but the chest wall is abnormally stiff below FRC, then $FEV_1/FVC$ is normal or increased [21]

**Effects of Cement dust on pulmonary function.**

Cement dust irritates the skin, the mucus membrane of the eyes, and the respiratory system. Several studies have reported significant across shift reduction in the peak expiratory flow rate (PEF) [1,20] and in forced expiratory volume in one second ($FEV_1$)[20,21,5].

Exposed cement workers have significantly lower ventilatory function indices than control workers[5, 29, 39, 41]. However, the evidence for an exposure-response relationship between cement dust exposure and respiratory health effects is controversial [5, 39, 41,33,25,63]

A study done by Oleru [5] found lower forced vital capacity (FVC) and $FEV_1$ among highly exposed packers than medium exposed loaders; The study done by Alakija et al [39] found lower $FEV_1$ in workers who were in close contact with cement dust;

Yang et al [41] found lower FVC and $FEV_I$ among exposed than controls; and AbuDhaise et al [33] found no difference in ventilatory function indices between higher, medium and lower exposure groups. In an 11-year longitudinal study [63], no significant decrease in FVC and $FEV_1$ was found among cement workers. However, in this study, there was a substantial loss to follow up among the workers (47.1%), and the authors concluded that this might have caused an underestimation of lung function decline. A cross sectional study in the United States of America [25] found a significant relationship between current respirable dust exposure and a decline in PEF.

## STATEMENT OF THE PROBLEM

The Tanzania Portland cement Company Limited was established in 1959 and started production in 1965. It is located in Tegeta at Wazo Hill, 25 kilometers on the outskirts of Dar es salaam, off Bagamoyo road. It is the oldest and the largest cement company in the country, and supplies bulk and bagged cement products[1]. During its establishment in 1959, there were no people who were living around this factory but due to the fast growing population of Dar es Salaam city, it has now been surrounded by number of people who have made permanent residence surrounding the factory. As the factory has been constantly emitting cement dust to the surrounding area, these people who are living around the factory are at greater risk of developing health effects associated to cement dust exposure.

Exposure to cement dust has long been associated with the increased prevalence of respiratory symptoms and varying degrees of airway obstruction in man. Exposure to cement dust has also been associated with reduction of the ventilatory function. Apart from respiratory diseases, it has also been found to be the cause of lung and laryngeal cancer, gastrointestinal tumors and dermatitis

No local data are available to ascertain the magnitude of the respiratory health effects among the people living around Wazo Hill cement factory in our setup. A big study that will compare people living around this factory and those living far away from the Factory is needed to ascertain this problem.

## RATIONALE

Chronic exposure to cement dust has been reported to lead to a greater prevalence of chronic respiratory symptoms and a reduction of ventilatory capacity. The majority of the cement industries in developing countries have poor technology for dust control and lack of regular maintenances of machinery[1].

Regular 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, people who live around Wazo Hill cement factory which is situated within the human settlements can not protect themselves through personal protective equipment. These people are at an increased risk of developing health effects due to high cement dust exposure emitted from the industry.

This study will therefore explore the prevalence of chronic respiratory symptoms and ventilatory function among people living around Wazo Hill cement factory in Dar es salaam, Tanzania.

The information that will be generated by this study will be valuable for the cement industry in seeking to promote the respiratory health of people who live around this Portland cement factory; likewise the information obtained will be valuable to the people who do not live around the factory.

## OBJECTIVES;

### Broad Objectives;

To determine the ventilatory capacity and the prevalence of respiratory symptoms among people living around WAZO Hill cement factory in Dar es Salaam as compared with those living far away from the factory.

### Specific objectives

1. To asses the socio demographic characteristics of the people living around WAZO cement factory in Dar es Salaam and to compared them with those living far away from the factory.

2. To determine the prevalence of chronic respiratory symptoms among people living around WAZO cement factory in Dar es Salaam and to compared them with those living far away from the factory.

3. To Asses the pulmonary function among people living around WAZO cement factory in Dar es Salaam and to compared with those living far away from the factory.

## STUDY HYPOTHESIS

People who live around Wazo Hill cement factory have lower risk of developing respiratory symptoms as well as reduction of pulmonary function due to constant inhalation of cement dust from the factory as compared to those who do not live around the factory.

## METHODOLOGY:

### Study Design;

A descriptive cross sectional comparative study

### Study Area

The Tanzania Portland cement Company Limited was established in 1959 and started production in 1965.It is located in Tegeta 25 kilometers on the outskirts of Dar es salaam, off Bagamoyo road. It is the oldest and the largest cement company in the country, and supplies bulk and bagged cement products[1].

The factory was a parastatal company under the umbrella of Tanzania Saruji Corporation, the previous holding company for the building material producing companies in Tanzania. By the end of 1998, as a result of the Tanzania government policy on privatization, 60% stake of the company was acquired by SCANCEM International ANS of Scandinavia, a part of Heidelberg Cement.

This is one of the Western worlds largest cement companies, responsible for handling annually about 700,000 tons of cement per year and has a workforce of about 300 workers divided into into different departments [1].

The factory is located in Kunduchi ward, Kinondoni District. Seven streets, namely Madale, Wazo, Tegeta, Ununio, Mtongani, Kilongawima, and Sala Sala make up the Kunduchi ward. Of these only four streets surrounds the factory, these are Tegeta in the East, Madale in the west, Ununio in the North, and Wazo in the south.

**Target population:**

All people exposed to cement dust produced from Wazo Hill cement factory and those who live far away from the reach of the cement dust as a comparable group.

**Accessible Population:**

Residents residing within 5km from the epicenter (WAZO Hill cement factory) were eligible for participation in the study. Likewise Residents residing far away from reach of cement dust i.e Temeke Sabasaba approximately 37km from the factory were eligible for participation in the study as control.

**Sample size estimation;**

The required sample was obtained using the following formula:

$$N = \frac{Z^2 P (100-P)}{\varepsilon 2}$$

Where,

N=required sample size

Z=Critical value, equals to 1.96

ε=The maximum likely error is 5%

P=Prevalence of respiratory symptoms equals to 50%(maximum sample size).

$$N = \frac{(1.96)^2 \times p (100 - p)}{5^2}$$

$$N = \frac{(1.96)^2 \times 50 \times 50}{25}$$

N= 385.

Total numbers of subjects studied were 770, of these, 385 came from people living around Wazo cement factory and 385 people from Mtoni Saba Saba.

**Study duration**

The study was conducted between February and November 2006

**Sampling procedure and recruitment**

**Control group**

Multistage sampling procedure was used to obtain the subjects to be studied as control group. The study was conducted in Dar es Salaam which comprises of three Districts namely Kinondoni, Ilala, and Temeke. Temeke District was randomly selected using rotary method of random sampling. Temeke District comprises twenty four Wards, these are Kigamboni, Vijibweni, Kisarawe 2, Somangira, Kimbiji, Mbagala, Chamazi, Yombo Vituka, Charambe, Toa Ngoma, Miburani, Temeke, Mtoni, Keko, Kurasini, Azimio,

Tandika, Sandali, Chang'ombe, Mbagala Kuu, Mangarawe, Pemba Mnazi, Mji Mwema, and Sisi kwa Sisi. Of these Wards, Mtoni was randomly selected .

The Mtoni Ward comprises four streets namely, SabaSaba, Bustani, Mtoni, and Relini. Mtoni Relini was randomly selected.

Number of house holds studied was selected using systematic sampling technique of which one after every two household was selected. Every member of household who met the inclusion criteria was interviewed using interviewer administered questionnaire and measurements of Height, Weight and spirometric measurements i.e $FEV_1$ and FVC, were taken. Those who were not present during the day of assessment were interviewed on Saturday and Sunday.

**Inclusion criteria were**

1. Living around Wazo Hill Cement Factory continuously for period not less than two years
2. Those who gave the informed verbal consent

**Exclusion criteria were:**

1. Unwillingness to give consent to participate in this study.
2. Incomplete spirometric performances
3. History of working in a dusty Industry e.g. Cement Factory, Foundry, Asbestosis, Cotton, Sisal or Flux
4. Individuals who have lived in the study sites for less than two years

5. Individuals with respiratory symptoms due to a well established cause unrelated to dust exposure.

**Data collection and Instruments used**

A structured questionnaire modified version of the British Medical Research Council respiratory questionnaire[63] was used. It consisted of questions on demographics, Work history, smoking habits and respiratory symptoms.

An interviewer administered questionnaires were used in which participants were asked questions and there answers were filled in the questionnaires. The investigator checked the questionnaire to ensure that they were well completed.

Subjects were also asked if they ever had asthma, chest injury/operation or any other severe debilitating diseases such as heart conditions, asthma, diabetes mellitus, and pulmonary tuberculosis.

**Ventilatory function**

Ventilatory function was assessed to all subjects included in the study. It was recorded using Micro spirometer according to the American Thoracic Society recommendations for acceptability and reproducibility.[65,66] The spirometer was calibrated daily.

The measurement procedures were explained and demonstrated to each subject. The subject was instructed to practice deep inspiration and forceful expiration in sitting position before three to five acceptable attempts of forced expiratory registrations were recorded. The registrations with highest FVC and $FEV_1$ were taken for analysis

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A small group of 10 to 15 subjects were gathered and spirometry was conducted in a room with an ambient room temperature $26^0$C, barometric pressure at sea level of 760 mm Hg and saturation. Predicted values for FVC and $FEV_1$ for male subjects were derived using the regression equation for adult male Tanzania by Mustafa.[64]

$$FVC\ (l) = 0.0604H - 0.016A - 6.14$$

$$FEV_1\ (l/s) = 0.046H - 0.022A - 3.864$$

H is height in centimeter and A is age in years. To compare observed and reference ventilatory function levels, I used percentage of predicted values (ie, a ratio of observed to predicted times 100) for FVC (FVC%) and for $FEV_1$($FEV_1$%). Subjects with Spirometric air flow limitation were defined as those with a ratio of $FEV_1$ to FVC of less than 0.7.[41, 63]

- **Weight**

  Weight was measured using a solar cell SECA weighing scale with a patient putting on light cloths and removing shoes. Weight was taken to the nearest 10grams.

- **Height**

  Height was measured using a height board fixed on the wall with a flat stepping floor.

Patients removed their shoes and stood upright on the flat stepping floor of the board, with a headpiece placed on the head at 90°. The reading was recorded to the nearest 10mm.

**Piloting the study**

This was done for two weeks prior to actual data collection so as to test the practicability of the questionnaire. Some questions which were initially misunderstood were adjusted. Thereafter, the questionnaire was easily administered and brought up the intended information.

## Data Analysis

The investigator and a computer programmer, who was familiar with research, carried out data entry and analysis using EPI INFO version 3.3.2 and SPSS (Statistical Package for Social Science) version 11.5 computer programmes. Chi-square was used to detect differences in the frequencies of categorical characteristics between the groups. Analysis of Variance was used to detect differences in mean values between the groups.

The differences in chronic respiratory symptoms between the exposed group and the control group were analysed using logistic regression while adjusted for age , pack-years, and education. A P value of less than 0.05 was considered statistically significant.

**Ethical clearance**

Ethical clearance to carry out this study was obtained from the Research and Publication Committee of Muhimbili University College of Health Sciences.

The aim and the methods of the study were explained to the subjects who gave informed verbal consent for participating in the study. Those who were found to have severe symptom were managed according to the management protocol of each complication diagnosed.

## RESULTS

### *Study population*

The total number of subjects who fulfilled the inclusion criteria were 775. In the exposed group there were 392 and the remaining 373 were in the control group. The exposed group and the control group differed in age, sex, height and current smoker ($P < 0.001$) (Table 1). The age for both the exposed and control groups, ranged from 13 to76yrs with mean ages of 28.5 and 35 respectively. The two groups significantly differed in terms of number of subjects who were current smokers. There were more people who were current smokers in the exposed group 74 (18%) as compared to the control group 33 (8.6%) ( $P < 0.001$). The exposed and control differed in age, controls were on average much older than the exposed (mean 35.2 versus 28.5 respectively).The groups did not differ significantly in education, weight, pack years and smoking status (never and ever smokers) (Table 1).

**Table 1**. Baseline characteristics of the exposed and unexposed groups at Wazo Hill cement factory and Temeke SabaSaba (N = 775)

| | Age (yrs) (mean) (sd) | Sex | | Height (cm) (mean) (sd) | Weight (kg) (mean) (sd) | Education | | Smoking status | | | Pack years Mean (sd) current |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | M N (%) | | | | Prima N (%) | Post N (%) | Never N (%) | Ever N (%) | Current N (%) | |
| Exposed (n=392) | 28.56 (11.3) | 245 (62.5) | 147 (37.5) | 160.9 (8.91) | 58.3 (14.5) | 330 (84) | 62 (15.8) | 309 (79) | 83 (21) | 74 (18) | 4.4 ( 6.7) |
| Controls (n=383) | 35,.22 (16.0) | 164 (42.8) | 219 (57.2) | 157.7 (8.0) | 57.5 (14.6) | 310 (80) | 73 (19) | 326 (85) | 57 (15) | 33 (8.6) | 8.5 (15.1) |
| P - value | <0.01 | <0.01 | <0.01 | < 0.01 | 0.483 | 2.34 | | 0.23 | | < 0.01 | 0.55 |

**Chronic respiratory symptoms**

There were significant different between the exposed and the control group with regards to the chronic respiratory symptoms. Of the 775 exposed individuals, There were 114 (29%) exposed subjects who had chronic cough as compared to 70 (18.28%) controls and the difference was statistically significant ($p < 0.01$). The exposed group had a significantly higher prevalence than controls for chronic sputum production ,wheeze, and chronic bronchitis with the prevalence (41.8%,21.9%,and 16% versus 11%, 11.1% and 7.6% respectively) ($p = < 0.01$) (Table 2). When adjusted for age, height, sex, and smoking status, still there was significant difference between exposed and control group with regards to the chronic respiratory symptoms (Table 2) .

**Table 2:** Prevalence of Chronic Respiratory symptoms in the exposed and control groups at Wazo Hill cement factory and Temeke SabaSaba (N=775)

| | Exposed group[a] n=392 (%) | Controls group [a] n=383(%) | OR (95%CI ) [b] | P-value |
|---|---|---|---|---|
| Chronic cough | 144 (29) | 70 (18.28) | 6.2 (4.2 - 9.4) | < 0.01 |
| Chronic sputum production. | 164 (41.8) | 42 (10.97) | 1.9 (1.3 – 2.7) | <0.01 |
| Wheeze | 86 (21.9) | 45 (11.7) | 2.5 (1.6 - 3.8) | <0.01 |
| Chronic Bronchitis | 63 (16.1) | 29 (7.6) | 2.6 (1.5 – 4.2) | <0.01 |

[a] Prevalence expressed in number (%). [b] odds ratio(95% confidence interval) analysed by logistics regression model adjusted for age, sex, height , pack-years and smoking status.

***Pulmonary function***

In general the exposed group had significantly lower FVC, $FEV_1$, and $FEV_1$/FVC than the control group after adjusting for age, height, and pack years (Table 3).How ever it has been found that both the exposed and the control groups had mean reduction of FVC, $FEV_1$, and $FEV_1$/FVC as compared to expected values (Table 3).

FVC was higher in the unexposed group with the mean of 2.16 as compared to the exposed group with the mean of 1.97 and the difference was significant. $FEV_I$ and $FEV_1$/FVC were also higher in the unexposed than the exposed group (mean 2.09 versus 1.84 respectively) and the differences ware significant ($p<0.001$) (table 3)

**Table 3.** Ventilatory function indices between the exposed group and control group at Wazo Hill cement factory and Temeke Sabasaba (N = 775).

| | Observed FVC (L) (mean) SD | Observed $FEV_1$ (L/s) Mean SD | N | $FEV_1$/FVC N Mean SD | Expected FVC(L) Mean SD | Expected $FEV_1$ (L/s) |
|---|---|---|---|---|---|---|
| Exposed (n=392) | 1.867 (0.48) | 1.836 (0.49) | | 1.003 (0.06) | 2.823 (0.52) | 2.62 (0.48) |
| Controls (n=383) | 2.158 (0.65) | 2.09 (0.62) | | 1.022 (0.11) | 3.119 (0.53) | 2.9071 (0.43) |
| P - value | <0.01 | <0.01 | | <0.01 | <0.01 | <0.01 |

P values when comparing groups obtained using independent t test.

Out of 775 subjects studied, there were 140 who had ever smoked of whom 83 were from the exposed group and 57 from the unexposed (Table 4).

The exposed ever-smokers had lower FVC (mean 1.84), and $FEV_1$ (mean1.8), than the unexposed ever-smokers. Similarly, exposed never-smokers had significantly lower FVC (mean 2.03), and $FEV_1$ (mean 2.00), than unexposed never-smokers. Table 4.

**Table 4.**

Ventilatory Function indices between the exposed group and unexposed group according to smoking habits at Wazo Hill cement factory and Temeke Sabasaba (N = 775).

| | Exposed Group Mean(SD) (N=392) | | Unexposed group Mean (SD) (N=383) | |
|---|---|---|---|---|
| | Ever-smokers (n=83) | Never-smokers(n=309) | Ever-smokers(n=57) | Never smokers(n=326) |
| Observed FVC (L) | 1.84(0.47) | 2.03(0.49) | 2.08(0.65) | 2.38(0.62) |
| Observed $FEV_1$(L/s) | 1.8(0.47) | 2.00(0.5) | 2.01(0.6) | 2.34(0.6) |
| $FEV_1$/FVC | 0.97(0.5) | 0.98(0.1) | 0.97(0.5) | 0.98(0.5) |
| Expected FVC (L) | 2.8(0.51) | 02.9(0.56) | 3.06(0.52) | 3.32(0.51) |
| Expected $FEV_1$ (L/s) | 2.6(0.51) | 2.6(0.47) | 2.88(0.41) | 2.99(0.49) |

The p- value in above table was calculated using the independent student t test when comparing groups and was $<0.05$.

**Airflow Limitation**

The ratio of $FEV_1$ to FVC indicates airflow obstruction and thereby, airflow limitation. Of the 45 out of 775 subjects with $FEV_1$/FVC ratio less than 0.7, 36 out of 45 (80%) were from the exposed group and the remaining 9 out of 45 (20%) were from the unexposed.(Table 5)

Of the 19 out of 775 subjects who had $FEV_1$/FVC ratio less than 0.6, 16 out of 19 (84%) were exposed and the remaining 3 out of 19 (16%) were not exposed.(Table 5)

**Table 5:**

Prevalence of Airflow limitation in the exposed and unexposed groups ($X^2 = 22$) at Wazo Hill cement factory and Temeke Sabasaba (N = 775).

| $FEV_1$/FVC | Exposed N(%) | Unexposed N(%) | Total N(%) |
|---|---|---|---|
| < 0.6 | 16 (84) | 3 (16) | 19 (100) |
| <0.7 | 36 (80) | 9 (20) | 45 (100) |

## DISCUSSION

The objective of this study was to determine whether those people who live around Wazo cement factory have increased frequency of respiratory symptoms as well as reduction of their respiratory symptoms as compared to those who do not live around this factory. This study, a cross sectional comparative study involving 775 proved that living around this factory is associated with increased risk of respiratory symptoms and reduction of pulmonary function. The estimated prevalence of chronic respiratory symptoms among health East African individuals unexposed to cement dust is 15%.[68] In this study it has been shown that the prevalence is higher in exposed subjects as compared to unexposed subjects. These results underline the respiratory health effects of cement dust which is constantly emitted from the industry. These findings confirms the previously reported higher prevalence of respiratory symptoms among exposed individuals as compared with controls [5,25,33,40]. A recent study did not find any increased prevalence of respiratory symptoms among exposed individuals versus non exposed controls.[26]

However, that study examined former exposed workers rather than current workers. Comparing symptom rates between studies is difficult because many factors vary such as study populations, tenure years, age, smoking habits, and how the respiratory symptoms were defined. The validity of this study is strengthened by the high response rate in both the exposed and non exposed subjects. Furthermore, several previous studies [5,40] did not adjust for possible confounders of respiratory symptoms such as age, sex and smoking, as done in this study.

Chronic cough, chronic sputum production, dyspnoea, shortness of breath and chronic bronchitis were significantly higher among people living around Wazo Cement factory as compared to those who live in Temeke. The higher prevalence could be attributed to cement dust inhalation from the industry.

However due to methodological shortcomings of cross- sectional studies, I can not prove a causal relationship. In order to ascertain causal relationship, cumulative total cement dust exposure measurement and a prospective design has to be instituted. Mwaiselage[1] and previous studies in Mexico[10] and Morocco [34] showed that there is significant correlation between chronic respiratory symptoms and cumulative total dust exposure but again these studies could not prove a causal relationship.

No association was found in the studies done in Jordan[33] Taiwan, [40] and the United States between dust exposure [33,35,40] and most of the inquired respiratory symptoms, but this is because dust exposure were relatively low as compared with the former studies.

The ever-smokers were more likely to report chronic bronchitis and dyspnoea than never smokers. Therefore, the relative contribution of smoking in development of respiratory symptoms should be of concern in this community.

**Ventilatory function impairment**

The exposed subjects had significantly lower values for ventilatory function indices than unexposed subjects.

These results are similar with those of Oleru[5] in Nigeria, Alakija et al[38] in Nigeria, Al Neaimi et al[29] in United Arab Emirates and Mengesha and Bekele[12] in Ethiopia. However, a clear comparison is difficult because the study population differs. This study included only those people who were living around the Cement factory while the above studies included only cement workers who were directly exposed to cement dust.

Exposed ever-smokers had significantly lower ventilatory function than unexposed ever-smokers. Ever-smokers and never-smokers did not differ within the exposed and un-exposed groups. The number of pack-years was not significantly associated with FVC and $FEV_1$ in the multiple linear regressions.

This might be due to simply because the prevalence of smoking was low. The prevalence of smoking in this study was similar to that among the general population in an urban area of Dar es Salaam[67]. Other studies with a higher prevalence of smoking still had no associations. For example, for Al Neaimi et al[29] the current smokers were 34.3%, and for Yang et al[40] the current smokers were 44.6%. In the United States of America[26], the prevalence of current smokers was 43.6% (ever-smokers:70.7%), In Norway,[19] the prevalence was 29.4% (ever-smokers:68.9%).

**Airflow Limitation**

The ratio of FEV1 to FVC indicates airflow obstruction and thereby, airflow limitation. Approximately 36 (80%) of the exposed and 9 (20%) of the unexposed met the criteria of airflow limitation.[27,28]

Although very few studies have reported the prevalence of airflow limitation, the prevalence of air flow limitation in this study was higher in the exposed group than in the unexposed group. These findings are also similar to those of Al Neaimi et al, [29] who found a higher prevalence of airflow limitation among exposed cement workers (36%) than control workers (10%). A study by Oleru[5] defining airflow limitation as $FEV_1/FVC$ <60% found no cement worker had airflow limitation. However I view this definition as categorizing only those with severe airflow limitation. For example, I found only 19 out of 775 subjects studied with $FEV_1/FVC < 0.60$. A recent study in Norway[29] used a definition of $FEV_1/FVC < 0.70$ and $FEV_1 < 80\%$ of predicted values and reported that 17.6% of the former cement workers had airflow limitation 20% of controls.

## STUDY CONCLUSIONS

1. This study has confirmed that exposure to cement dust is associated with chronic respiratory symptoms such as Chronic cough, Chronic sputum production, Dyspnoea, Wheeze and Chronic Bronchitis as it has been more prevalent in exposed as compared to unexposed subjects.

2. This study has demonstrated that living near to Wazo Hill Cement Factory is associated with reduction of the pulmonary indices i.e FVC, $FEV_1$, and the ratio of $FEV_1$ to FVC than the unexposed controls. These results strongly indicate that cement dust exposure is deleterious to the respiratory airways, leading to ventilatory function impairment.

3. Prolonged exposure to cement dust seems to be an important risk factor for ventilatory function impairment, and Chronic respiratory symptoms irrespective of smoking habits. It was also observed that not all exposed subjects developed the disease, implying that individual susceptibility presumably play part.

## RECOMMENDATIONS FOR PREVENTIVE MEASURES

1. There is a need for health surveillance programmes around the factory to identify individuals with respiratory health problems as early as possible. This can be done by the health officials and the management of the factory.

2. Regular maintenances and repair of the factory as well as the use of powerful and adequate air filtration devices will reduce dust exposure

3. Policy makers and planners especially the government should not allow factories such as Portland cement factory to be constructed in the residential area. There should be an area of at least 5km from the epicenter (Portland cement factory) where it should be strictly prohibited from putting human settlements.

## LIMITATION OF THE STUDY

1. The control of this study was obtained at Temeke Sabasaba which is located in the urban area. The results might have been confounded by the effects of urbanization. The rural setting as control area would be more appropriate

## APPENDIX 1

## CONSENT FORM

**INTRODUCTION:**

Good morning/ Good afternoon,

My name is Dr. Egina Makwabe. I am a student at the Muhimbili University College of Health Sciences of the University of Dar es salaam. I am undertaking a course leading to the award of a Masters of Medicine degree in Internal Medicine.

I am conducting a research on the prevalence of respiratory symptoms and pulmonary function among people the neighborhoods of Wazo cement factory in Dar es Salaam.

If you agree to participate in this Research, you will be asked some questions and then have your weight, height taken.

Finally the spirometric measurements will be taken after being asked to breath into a special instrument.

If you have any doubts, you can contact my supervisor,

Dr. Y. Mgonda

Senior Lecture,

Muhimbili University college of Health Sciences

P.O. BOX 65001

Tel. 0744 277554

Dar es Salaam.

Thank you very much.

I..... whose signature appears below, with my own consciousness, agree to participate in the research process after being fully explained and understood the procedures pertaining to my participation in the research.

.....

.....

Signature of participant Witness

**Appendix II: Consent: Swahili version**

Habari za saa hizi,

Jina langu ni Dr Egina Makwabe nafanya kazi katika hospitali ya taifa ya Muhimbili. Ninafanya utafiti unaohusu watu wenye matatizo ya kifua kuangalia iwapo yaliyosababishwa na kuishi karibu na kiwanda cha kutengeneza simenti cha Wazo. Utafiti huu unafanyika kwa watu wanaoishi karibu na kiwanda cha sementi cha Wazo na wale wanaoishi Temeke Sabasaba.

Watakaokubali kushiriki itawabidi wasaini fomu kuonyesha wazi kukubali kwao. Pia, tutawahoji maswali kadhaa na baadae kupimwa kwa kifaa maalumu cha kupima mapafu na kupima uzito na urefu kwa ajili ya utafiti huu.

Faida utakayopata katika utafiti huu ni kujua kama una matatizo ya kifua au la na hivyo kusaidia kupatiwa matibabu. Mbali na faida utapata usumbufu kidogo wakati wa kutumia mashine ya kupima kifua.

Taarifa zote utakazotupa ni siri na zitatumika tu kwa ajili ya kuboresha huduma ya afya na utabibu kwa wagongwa. Ushiriki wako ni kwa hiari kabisa na pia unayo haki ya kujitoa katika utafiti huu wakati wowote ule utakapojisikia kufanya hivyo. Uamuzi wako wa kushiriki ama la katika utafiti huu, hautaadhiri hata kidogo haki yako kama mgojwa ya kupata huduma na tiba.

Nitafurahi ukikubali kushiriki katika utafiti huu.

**Dr Egina F Makwabe**

**Mtafiti.**

Mimi _____

Nimeelewa maelezo yaliyoandikwa hapo juu na kuridhika na maswaji niliyopewa kwa maswali yangu yote. Mimi kwa hiari yangu mwenyewe, bila kushurutishwa na mtu, ninakubali kushiriki kwenye utafiti huu.

Mgonjwa:_____

Shahidi:_____

Tarehe:_____

## APPENDIX 3

## QUESTIONNAIRE

**THE PREVALENCE OF RESPIRATORY SYMPTOMS AND PULMONARY FUNCTION AMONG PEOPLE LIVING AROUND WAZO CEMENT FACTORY**

**1. Questionnaire for Assessing Chronic Respiratory Symptoms.**

**A. Demographic data**

1. Identification no.

2. Date of birth

3. Sex

(a) Male

(b) Female

4. Place of residence (a) East (b) West (c) North (d) South

5. Marital status:

Single (b) Married (c) Separated/Divorced (d) Cohabit (e) Widowed

6. Educational level:

None (b) Primary (c) Secondary (d) College (e) University

**B. Occupational history**

7. Have you ever worked in a dusty industries/factories in the past? 1.Yes 2. No

If Yes which dusty factories/industries and for how many years?

Foundry;----years

Asbestos;---years

Stone, mineral or quarry;---years

Cotton, sisal or flux;-----years

Others;--------

8. Which department were/are you in this cement factory------

Which section are/were you working---------

What is/was your job title-------

For how long did you/have you been working in this section-----

10. Have you ever worked in these sections in the past in this factory? 1. Yes 2.No

If no proceed to section C(question 11).If yes, which other section(s)

Crusher:-----years

Crane;-----Years

Raw mill; ------years

Kiln------years

Cement mill;-----years

Packing----------years

Maintenance-----years

Quality assurance----years

Personnel--------years

Business--------years

Accounts----years

Any other sections not mentioned above--------years

**C. Chronic Respiratory Symptoms**

**Cough**

11. Do you usually cough first thing in the morning [yes ] [ no ]

(Clearing the voice doesn't apply)

12. Do you usually cough at all during the day or night [yes] [no]

13. Do you usually cough as much as 4 – 6 times a day,4 or more days in a week [yes]

[No]

If yes to any of the above question 11, 12 or 13

14. Do you cough like this on most days for as much as 3 months or more a year?

[Yes] [no]

**Cough with sputum Production**

15. Do you usually cough with sputum first thing in the morning?[yes] [no]

(Clearing the voice doesn't apply)

16. Do you usually cough with sputum at all during the day or night? [yes] [no]

17. Do you usually cough with sputum as much as 4-6 times a day, on 4 or more days in a week? [yes] [no]

If yes to any of the above question 15,16 or 17

18. Do you cough with sputum like this on most days for as much as 3 months a year? [yes] [no]

For cough and cough with sputum production (If yes on any of the questions11-19)

19. Have you had cough and/or cough with sputum production in more than 3 years? [yes] [no]

20. During the last 3 years have you had any periods with increased cough and/or cough with sputum production lasting in 3 months or more [yes] [no]

21. How many times have you had such period--------

**Breathlessness**

If disabled from walking by any condition other than heart or lung disease please describe and proceed to question 22

Nature of disability----------

22. Are you troubled by shortness of breath when hurrying on level ground or walking up a slight hill? [Yes] [no]

23. Do you have to walk slower than people of your age on the level ground because of breathlessness? [Yes] [no]

If yes to any of the above questions 22 or 23

24.Do you have to stop for breath when walking at your own pace on level ground? [Yes] [no]

25.Are you breathless when dressing or when at rest? [Yes] [no]

26.For how many years have you had breathlessness? -------Years

**Wheezing**

26.Does your chest ever sound wheezy(whistling) sound? [yes] [no]

27.If yes to the above question 26

For how many years has this been present-----years?

Have you ever required medicine or treatment for these attacks? [yes] [no]

**Past respiratory illnesses**

28.Have you ever been treated by a physician or admitted to hospital for any of the illnesses stated below?

Injury or operation affecting your chest [yes] [no] [don't know]

Heart trouble [yes] [no] [don't know]

Bronchitis [yes] [no] [don't know]

Pneumonia [yes] [no] [don't know]

Pulmonary tuberculosis [yes] [no] [don't know]

Asthma [yes] [no] [don't know]

Any other respiratory illness ----------

**Smoking habits**

29.Have you ever smoked cigarettes?[Yes][no]

If yes to the above question 29

Do you now smoke? [Yes] [no]

How old were you when you first started regular smoking---age

If you have stopped smoking cigarettes completely, how old were you when you stopped? -----age in years

How many cigarettes do you smoke per day now? -----

On the average of the entire time you smoked, how many cigarettes did you smoke? -----

---Per day

**D. Ventilatory function test**

FEVI

FVC

$FEV_1/FVC$

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