UNIVERSITY OF VENDA

THE PREVALENCE OF WORK RELATED RESPIRATORY SIGNS AND SYMPTOMS AMONG MAINTENANCE AND TRANSPORT SECTION EMPLOYEES AT MAPULANENG HOSPITAL

BY

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DECLARATION

I, Radebe Philemon Lovers Ngowakhe, hereby declare that the work on which this dissertation is based, is original (except where acknowledgement indicates otherwise) and that neither the whole work nor any part of it has been, is being, or shall be submitted for another degree at this or any other university, institution for tertiary education or examining body.

Signature

Date: 2010-08-01

DEDICATION

I dedicate this work to my late father Sponono Alphus Radebe, my late sisters Busisiwe, Ntombikayise and Ntombifuthi, who left too early to see this happening. In addition, also to current and past employees as well as pensioners living or dead of Mapulaneng Hospital, who might have been affected in one way or another by past or current work related exposures.

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LIST OF ABBREVIATIONS

APPA	- Atmospheric Pollution Prevention Act
DWARF	- Department of Water Affairs and Forestry
DEAT	- Department of Environment and Tourism
COIDA	- Compensation for Occupational Diseases Act
CPSC	- Consumer Product Safety Commission
CWP	- Coal Workers Pneumoconiosis
HAP	- Hazardous Air Pollutants
MAQOHSC	- Mining and Quarrying Occupational Health and Safety Committee
MHSA	- Mines Health and Safety Act
MRC	- Medical Research Council
NEMA	- National Environmental Management Act
ODMWA	- Occupational Diseases in Mines and Work Act
PM	- Particulate Matter
PPE	- Personal Protective Equipment
VOC	- Volatile Organic Compounds
SASOHN	- South African Society for Occupational Health Nurses
SVOC	- Specific Volatile Organic Compounds
USA	- United State of America

LIST OF CHEMICAL SYMBOLS

SO_2 - Sulphur dioxide

SO - Sulphur Oxides

CO_2 - Carbon dioxide

CO - Carbon oxide

O_2 - Oxygen

UV - Ultra Violet

Oz (O_3) - Ozone

NO_x - Nitrate oxide

NO_2 - Nitrogen dioxide

N_2O - Nitrous oxide

H_2S - Hydrogen Sulphide

Pb - Lead

OPERATIONAL DEFINITIONS

Boiler - a coal-fired device for producing steam, which is used for cooking and production of hot water

Employees - all transport and maintenance workers employed at Mapulaneng Hospital in 2009

Work Related Respiratory signs and symptoms - all upper and lower respiratory related signs and symptoms, mostly experienced by employees when at work; excluding allergy related respiratory signs and symptoms, childhood respiratory problems and infections

Workshop area - the area between the boiler, incinerator and generator house, workshop, government garages as well as transport and maintenance offices

Workshop - part of the boiler house, which is utilized by the maintenance staff, such as, plumbing, carpentry, welding and electrical employees

Incinerator - a coal-fired device, used for burning of all hospital medical wastes, situated between the transport section offices and workshop; three (3) meters away from the workshop, five (5) meters away from the transport and technical support offices and ten (10) meters away from the boiler house

ABSTRACT

The Prevalence of Work Related Respiratory Signs and Symptoms among Maintenance and Transport Employees at Mapulaneng Hospital in the Department of Health, Mpumalanga Province

Background and Introduction

The prevalence of respiratory problems and its effects on the health of Mapulaneng transport and maintenance employees is not known. This is of special concern in the workshop area, where multiple hazardous dust particles and fumes are generated by different work activities in that area.

Objective

To determine the prevalence of work related respiratory signs and symptoms among transport and maintenance employees at Mapulaneng Hospital in 2009.

Methodology

An interviewer-administered questionnaire was administered to Mapulaneng transport and maintenance employees. Overall, 44 employees in maintenance and transport sections were included in the survey **(response rate 98%).** The prevalence and odds ratios were computed against 64 controls, who were derived from the general administrative employees of Mapulaneng Hospital. Controls with a history of respiratory related allergies, asthma (not work related) and past TB, were excluded in the final analyses.

Results

The prevalence of some work related respiratory signs and symptoms studied were significantly higher among Mapulaneng hospital maintenance and transport employees: excessive dryness of the nostrils (64%), itching of nasal mucosa (59%), excessive running (45%), sneezing (36%), coughing (55%), wheezing (20%), breathlessness (20%) and phlegm (27%). The effect of exposure in some of the signs and symptoms was more pronounced than, or of the same magnitude to that of smoking. Smoking as well as exposure indicated an advanced effect with regards to breathlessness, wheezing and phlegm.

Conclusion

The study mainly demonstrated an excess of work related respiratory symptoms among Mapulaneng Hospital maintenance and transport employees, which proved high and significant for transport section employees, an occupational group not traditionally associated with hazardous exposures. This increase might be associated with the hours spent by transport employees in the workshop area and are without protective clothing. The study also suggested that smoking was synergistic to breathlessness, wheezing and phlegm.

CHAPTER 1

INTRODUCTION

1.1. Background of the study

Outdoor air pollution has numerous man made and natural sources.[1] Exposure to non-toxic and toxic irritants, dust, smoke or fumes is commonplace in the rest of the industrial world.[2] In South Africa, especially in the Highveld region, a large number of the population is exposed to pollutants at levels exceeding the air quality standards. This is due to the Highveld region being densely industrialized; these industries, mines and power plants expel emissions into the atmosphere, thus polluting the air of the surrounding areas.

The burning of fuel, coal or any other material, result in different emissions released into the air; causing pollution of the immediate environment.[1, 2, 3] This has been proved and is supported by an enormous amount of studies conducted all over the world. *Asbestos, coal dust, and (burning) gases such as Sulphur dioxide (SO_2), Carbon dioxide (CO_2), Carbon oxide (CO), Nitrate Oxide (NO_X...).*[3] contribute to these toxic emissions.

The Department of Health, Mpumalanga Province, has approximately 23 public hospitals, which comprise 18 District Hospitals and 5 Regional Hospitals. Most, but not all public hospitals, are equipped with boilers and incinerators, used for burning medical waste, such as, sharps, gloves et cetera, and providing heat in the production of steam, which is used as energy for cooking, provision of hot water and sterilizing medical equipment, to name but a few.

The process of fire generation involves burning of coal, which results in air pollution from the smoke as well as other known and unknown by-products. Coal is fed from the storage bunkers into semi-pulverizing mills, which further grind the coal. The semi-pulverized

coal is fed to the boiler burners in the furnace, where it burns. Coal and silica dust gets liberated through the process into the environment and pollutes it.[3, 4]

Coal contains sulphur and during combustion SO_2 is produced.[4] Incomplete combustion of coal produces nitrogen oxide in the form of smoke, which gets liberated in the air and pollutes the environment. In this instance, sulphur in the coal is converted into hydrogen sulphide during the coal burning processes.[3]

Mapulaneng Hospital boiler has been designed to burn low-grade coal. While this supports South Africa's coal export capabilities, it provides challenges for air quality. To further add insult to injury, these boilers and incinerators are old models, which are not properly maintained.

At Mapulaneng Hospital this unhealthy situation is compounded, when coal delivery takes place, because coal dust particles cover the whole workshop area polluting the immediate environment. There are also no barriers to act as windbreakers for the pile of coal and ash (a by-product of coal) from the boiler and incinerator, which is just dumped in the open space in front of the boiler house. When windy; coal and ash dust is swept over the whole surrounding workshop area, including offices currently utilized by employees.

The transport section shares the same area with the boiler and incinerator. When government vehicles are left running, or moved out of the garages, exhaust fumes add to the pollution. Furthermore, a standby generator for the hospital is also situated within the same area. The standby generator is diesel-fuelled and is utilized in the event of electricity supply disruption. When it runs diesel (exhaust) fumes further pollute the environment.

1.2. Statement of the problem

Clean air is an important part of a healthy environment. With the passing of Environmental Laws, renewed efforts were contracted to properly account for emissions, characteristic of industrial, domestic and road motor vehicles. Most industries and mines have implemented well established atmospheric emissions, by installing monitoring devices at their sites to screen primary pollutants, such as, hydrogen sulphide, sulphur dioxide, nitrous oxide, carbon dioxide, fly ash et cetera and ensure that its emissions are within acceptable levels.[5] None exist in the Department of Health Hospitals, Mpumalanga Province.

The prevalence of respiratory problems and its effect on the health of the Mapulaneng transport and maintenance employees is unknown. This is of special concern in the workshop area where multiple hazardous dust particles and fumes from the coal and ash, including smoke from the coal burning process in the boiler, incinerator, plus the exhaust fumes from the vehicles and standby generator create in the workshop locale, one of the most heavily polluted areas within the hospital perimeter. Since the area in question is utilized by transport and maintenance employees, the health of these exposed individuals is at stake.

1.3. The purpose of the study

The purpose of the proposed study was:

To determine the prevalence of work related respiratory signs and symptoms among transport and maintenance employees at Mapulaneng Hospital in 2009.

1.4. Objectives of the study

The specific objectives of the study were:

1.4.1 To identify, describe and explore work related respiratory signs and symptoms experienced by Mapulaneng Hospital transport and maintenance employees in the Department of Health, Mpumalanga Province.

1.4.2 To measure the frequency of work related respiratory signs and symptoms.

1.4.3 To assess whether lifestyle habits, such as, smoking and living conditions (household) have an effect on the vulnerability to increased work related respiratory signs and symptoms.

1.4.4 To explore risk factors to work related respiratory signs and symptoms by occupational categories.

1.5 Significance of the study

Findings of the proposed study were expected to:

1.5.1 For employees under maintenance and transport department in Mapulaneng Hospital, if the prevalence of respiratory problems among employees is found to be high, the investigation, prevention will be motivated for and treatment will be implemented.

1.5.2 For hospital management and policy maker, if the prevalence of respiratory problems among employees is found to be high, subsequence to working environment change and improvement of the working condition will be suggested. Information will be submitted to policy maker for appropriate planning and inspections of the working environment in the hospital.

1.5.3 For Occupational Health Practitioners. The findings will increase understanding to Mapulaneng Hospital Occupational Health staff and others health practitioners on the effect of such exposures in relation to the care of the exposed individuals and to a potential community concern.

1.5.4 For other researches. It will also be useful for those who wanted to undertake similar researches or further investigations.

CHAPTER 2

LITERATURE REVIEW

Air pollution is one of the world's most serious, environmental health problems. This has been common knowledge for many years and numerous researchers are supporting this actuality. The related literature review for this study comprises six parts:

1. Overview of air pollution related legislative requirements;
2. Air pollution and heath situation in South Africa;
3. The structure, functions and patho-physiology of the respiratory system;
4. Respiratory problems related to indoor and outdoor pollution;
5. Respiratory diseases related to coal and silica dust; and
6. Respiratory problems related research.

2.1 Overview of air pollution related legislative requirements

During the last decade, the term "Environmental Management" has become a necessary realistic principle. It is no longer seen as an ideal vision to strive towards in strategic plans, but rather a *resource to be utilized within existing company resources, in ensuring the continuous identification, management and mitigation of significant environmental impacts* that may be caused by companies in the process of conducting their business.[6] The Environment Conservation Act, sets the scene for the management of environmental aspects with *the main aim of ensuring and maintaining a sustainable environment, balanced against economic growth and the legitimate, controlled use of environmental resources.*[6]

The Environmental Conservation Act, on the other hand "*provide for the effective protection and controlled utilization of the environment and for matters incidental thereto.*[6] Seen within the context of the legislation and its requirements, it is clear that certain standardized approaches to ensure a uniform approach towards environmental management that have measurable deliverables had to be developed. In terms of part IV:

Control of Environmental Pollution, section 19, on prohibition of littering *no person shall discard, dump or leave any litter on any land or water surface, street, and road etc.*[6] This can also include "littering"/(polluting) the atmosphere.

Air pollutants are mostly encountered occupationally. In the workplace, air, machinery, other resources, and hazards are regulated under the Occupational Health and Safety Act. With the enactment of the Occupational Health and Safety Act in 1993, South Africa joined the rest of the world in the prevention of occupational and environmental diseases. The act clearly places the responsibility in the hands of industries (companies, businesses or self employed) to prevent harm to employees, the environment and people living in the surrounding areas; *the provision and maintenance of systems of work, plant and machinery that are safe and without a risk to health*".[7] For the first time, a regulation was promulgated that will hold industries (companies, businesses or self employed) responsible and accountable for the control of hazardous substances.[7]

The Australian Mining and Quarrying Occupational Health and Safety Committee (MAQOHSC) published a practical guide for the control of hazardous substances in quarries in 1998, which was also adopted by South Africa. The MAQOHSC practical guide covers the common chemicals found in the industry and simplifies identification, assessment and control methods that may be used to minimize risks to health.[8]

Following to the above statement, section 8 of the Occupational Health and Safety Act (Act 85 of 1993), specifies that every employer shall provide and maintain, as far as is reasonably practicable, a working environment that is safe and without risk to the health of his employees.[7] The Regulations for Hazardous Chemical Substances are of importance for the employer to implement in order to identify, measure and control exposure to hazardous chemicals that are in the work environment.[7]

The requirements for this legislation are that:

(i) The employer must identify the risks in the work place, alert employees into awareness of such situations and train them how to deal with hazards, if or when encountered. This risk assessment should be repeated as processes change, when there is reason to suspect that a previous assessment is invalid, or every 2 years.[7]

(ii) In areas where employees are exposed, by inhalation, to hazardous substances, air monitoring must be conducted, in order to determine the extent of exposure.[7]

(iii) Control measures are to be implemented according to the provision of these Regulations, where the level of exposure exceeds the occupational exposure limits for the identified hazardous chemical substances. A hazardous chemical substance includes various dusts, organic and inorganic chemicals and gases.[7]

Toxic substances used in the workplace may escape into the air, soil, ground and surface water. Release can occur as a result of industrial processes, domestic waste generation, accidents and improper disposal of toxic substances and hazardous materials. The term "Environmental Management" has become a necessary realistic principle during the last 10 years. It is no longer seen as an ideal vision to strive towards in strategic company plans, but rather a resource to be utilized within existing company resources, ensuring the continuous identification, management and mitigation of significant environmental impact that may be caused by companies.[6]

In South Africa, *documented environmental management started with the birth of South African history during the settlement of Europeans in the Cape.*[9] Such awareness grew through the decades until the intensification of the environmental concern between 1940 and 1969, where some of the issues, such as, Soil Conservation, Air Pollution, Water Pollution and Nature Conservation et cetera, were legislated.[10]

The National Environmental Management Act, provides for a *co-operative environmental government by establishing principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance and procedures for co-ordinating environmental functions exercised by organs of state; to provide for the prohibition, restriction or control of activities which are likely to have a detrimental effect on the environment; and to provide for matters connected therewith.*[11] The Act further prescribes the rights of *everyone* to an environment that is not harmful to the *health or well-being* of people. It further states it is everyone's duty to protect the environment that will also be of benefit to present and future generations.[11] Such protection can be ensured *through reasonable legislative and other measures that prevent pollution*, which is described as *any change in the environment caused by...substances, odours, dust, emitted from any activity and ecological degradation.*[11]

The majority of fly ash produced during the process of coal burning in many companies, for example, in power generating plants is not freely released into the atmosphere, but collected either by scrubbers, bag filters or electrostatic precipitators to prevent its release into the atmosphere.[3, 12] This is regulated through provisional and registration certificates as well as provisional licenses and licenses that are issued to each of the power plants to control the emissions from these plants.[11] The conditions of emissions are described in the certificates and licenses that are issued. Government institutions in South Africa, including Mpumalanga Department of Health, are not obliged to comply with these.

In South Africa, the registration for non government departments is done through the Chief Air Pollution Officer, according to the requirements of the Atmospheric Pollution Prevention Act (APPA) Act 45 of 1965.[13] This Act is briefly explained as follows:

Part 1:

It provides for the establishment of a National Advisory Committee, subcommittees and appeal boards; appointment of a chief air pollution control officer and inspectors as well as their powers.[13]

Part 2:

It deals with the control of noxious or offensive gases and is enforced by the chief officer, who is employed by the Department of Health (but not for health departments). This part deals with the registration of scheduled processes. There are 69 scheduled processes registered in South Africa. These include power stations, chemical industries, cement manufacturing and metallurgical processes. This part of the legislation specifies that no one can operate a process that emits noxious or offensive gases unless he/she has a registration certificate.[13]

Part 3:

This part covers atmospheric pollution by smoke and is the responsibility of a local authority. The local authority must set standards to be adhered to for emission by smoke. This part prohibits a person to install an instrument that will produce dark smoke exceeding the standard set by the local authority. Provisions are given for start up periods and during the overhauling of the equipment or plant. This part declares residential areas as smoke control zones. These regions are considered as smoke free zones.[13]

Part 4:

It provides for dust control, which is vested in the chief officer. This part of the legislation is intended for all persons who operate plants that can release dust into the residential areas. Proper controls must be implemented in order to reduce dust emissions.[13]

Part 5: (Emission by vehicles)

This part of the Act prohibits the emission of smoke by diesel driven engine vehicles. The applicable local authorities have a set of standards to adhere to. This part makes it an offence for any person, who drives a vehicle that emits smoke greater than the limits set by a local authority.[13]

Part 6: (Special provisions)

This part contains general provisions including penalties for contravening the act and the fact that the State may make contributions towards expenditure incurred in research and equipment to combat air pollution. With the emphasis on continual improvement for the control of environmental impacts, the above Act was considered as being outdated for a number of reasons. This Act does not provide for the allocation of functions of the provincial and local governments as contemplated in the Constitution; it has inadequate compliance and enforcement mechanisms to apply the Act effectively, and it lacks transparency in decision making.[13]

The Department of Environment Affairs and Tourism (DEAT) presented an improved legislation, which was aimed at replacing the outdated Atmospheric Pollution Prevention Act (APPA). This new National Environmental Management Act is briefly set out below.

2.1.1 The National Environmental Management: Air Quality Bill

The National Environmental Management: Air Quality Bill was approved in Parliament during August 2004; and is discussed below. The objective of this Bill is:

(i) to reform the law regulating air quality in order to protect and enhance the quality of air in the Republic of South Africa, taking into account the need for sustainable development;[11]

(ii) to provide for a national norms and standards regulating air quality monitoring, management and control by all spheres of government; for specific air quality measures; and for matters incidental thereto.[11]

The Act also gives effect to everyone's right "to an environment which is not harmful to their health and well-being"; and protect the environment by providing reasonable legislative and other measures that:

(i) prevent pollution and ecological degradation,

(ii) promote conversation, and

(iii) secure ecological sustainable development and use of natural resources while promoting justifiable economic and social development.[11]

The Bill contains nine chapters of which a few are briefly discussed below:

Chapter 1: Interpretation and fundamental principles

This chapter gives various definitions that are applicable in enforcing the proposed act. A definition of interest in this chapter is air pollution. It is defined as any change in the composition of the air caused by smoke, soot, dust (including fly ash), cinders, solid particles of any kind, gases, fumes, aerosols and odorous substances. This chapter defines the scope of all spheres of government to which this Bill, with provincial legislation, a municipality by-law or Act of parliament, is applicable and the recourse to be followed in case a conflict arises.[11]

Chapter 2: National framework and national, provincial and local standards

This chapter gives the Minister the power to establish a national framework, which is binding to all organs of state in all spheres of government. The framework must establish national standards for municipalities and provinces to monitor ambient air quality and the collection and of management of data, necessary to assess compliance with the Act. The Minister may also prescribe the manner in which air quality measurements and reporting must be carried out.[11]

Chapter 3: Institutional and planning matters

It provides for the establishment of National Air Quality Advisory Committee as a subcommittee of the National Environmental Advisory Forum in terms of the NEMA,

appointment of national, provincial and municipal air quality officers as well as their powers and activities. [11]

Both the national department and provinces must include air quality management plans in the environmental management plan as per NEMA requirements. This chapter gives guidelines on the contents of such a plan to which all organs of the state must comply. In addition, it is required that all organs of the state submit reports annually for air quality management plans that were drawn. [11]

Chapter 4: Air quality management measures

This chapter describes the responsibilities of a Minister or MEC in declaring an area as a priority area, the conditions under which an area can be declared or withdrawn as a priority area. It also describes the management of priority areas and the consultative process from the Minister, national air quality officer, provincial and municipality air quality officers of the affected province and municipality. Under this chapter the Minister or MEC prescribes the regulations for implementing and enforcing priority areas and quality management plans for funding and measure to facilitate compliance. [11]

According to this chapter no person without an atmospheric emission license will conduct an activity listed either in the National or Provincial listing of activity; however, other government departments do conduct such related activities. According to this chapter, the Minister or MEC may, by notice in the Gazette, after following a consultative process prescribed in the Act, declare controlled emitters and set standards for controlled emitters as well as the manner in which measurements of emissions must be carried out. [11]

This chapter, furthermore, prohibits any person to manufacture, sell or use any appliance or conduct any activity declared as a controlled emitter, unless that appliance complies with the standards set by the Minister. The Minister or MEC may, by notice in the Gazette, declare any substance contributing to air pollution as a priority pollutant and require persons within a specified category to submit to either the Minister or MEC a

pollution prevention plan for approval; which must be in compliance with the requirements prescribed.[11] None of the government institutions comply with these.

The question one should ask is why the government is reluctant to enforce these legislations in their departments. Does it mean the life of its own employees is not worthwhile?

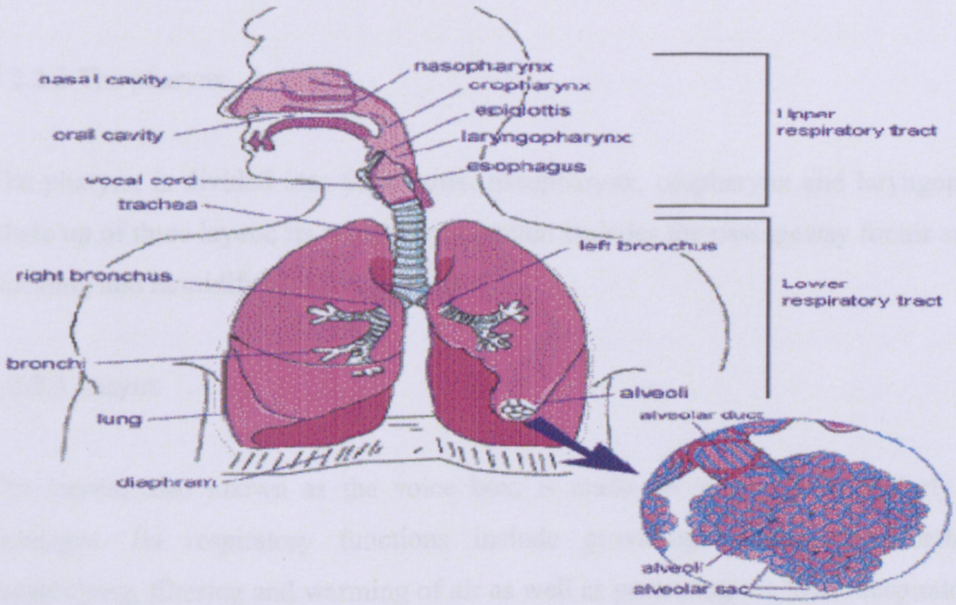
2.2 The structure, functions and patho-physiology of the respiratory system

2.2.1 The anatomy of the respiratory system

The organs of the respiratory system are:

- Nasal cavity and nose
- Mouth
- Pharynx
- Larynx
- Trachea
- Bronchi
- Bronchioles and
- Alveoli

Diagram 1: Diagram of Human Respiratory System [14]



2.2.2 The structure and function of the respiratory system

2.2.2.1 The nasal cavity and nose

The nasal cavity is described as the main route of air entry, which consists of an irregular cavity divided by a cartilage called the septum. The nose is lined with a vascular *ciliated columnar epithelium,* which contains mucus-secreting globet cell.[15] The function of the nose is to initiate the process by which air is warmed, moistened and filtered. Warming is due to the large vascularity.[15, 16]

Filtering and cleaning occurs as hairs at the anterior nares trap larger particles. Smaller particles, such as, dust and microbes settle and adhere to the mucus. Mucus protects the underlying epithelium from irritation and prevents drying. Synchronous beating of the cilia wafts the mucus towards the throat, where it is swallowed or coughed up (expectorated). Humidification occurs as the air travels over the moist mucosa; it becomes saturated with water vapour. The nasal mucosa is easily aggravated by irritants

like dust, fumes or smoke; this results in sneezing; a reflex action that tries to expel an irritant.[15]

2.2.2.2 The pharynx

The pharynx is divided into three parts: nasopharynx, oropharynx and laryngopharynx. Made up of three layers; its respiratory function includes the passageway for air and food, warming and humidifying of air et cetera.[16]

2.2.2.3 Larynx

The larynx, also known as the voice box, is made up of several irregularly shaped cartilages. Its respiratory functions include providing passage to breathed air, humidifying, filtering and warming of air as well as protecting the lower respiratory tract against food particles seeping through.[16]

2.2.2.4 Trachea

The trachea is also called the windpipe and is the continuation of the larynx. The trachea also comprises three layers of tissue. The respiratory function of the trachea includes; *mucociliary escalator,* which is the synchronous and regular beating of the cilia of the mucous membrane lining that wafts mucus with adherent particles upwards towards the larynx, where it is either swallowed or coughed up, *cough reflex and warming humidifying and filtering.* [15, 16]

2.2.2.5 Bronchi and bronchioles

The trachea divides into two bronchi. Bronchi are composed of the same tissue as the trachea, and are lined with ciliated columnar epithelium. The bronchi progressively subdivide into *bronchioles, terminal bronchioles, respiratory bronchioles, alveolar ducts* and finally, *alveoli.* The functions of the respiratory bronchi include; the control of air entry, the diameter of respiratory passages is altered by contraction or relaxation of the

involuntary muscle in their walls, thus regulating the volume of air entering the lungs. These changes are controlled by the automatic nerve supply: parasympathetic stimulation causes constriction and sympathetic stimulation causes dilatation. This also assists during exposure to toxic or irritant substances whereby the volume of air entry to the lungs is restricted or reduced.[15, 16]

Other functions include; the warming and humidifying, support and patency, removal of particular matter and cough reflex. The cells of the body need energy for all their metabolic activities. Most of this energy is derived from chemical reactions, which can only take place in the presence of oxygen (O_2). The respiratory system provides the route by which the supply of oxygen, present in the atmospheric air, enters the body; in addition it provides the route of excretion for carbon dioxide. The condition of the atmospheric air entering the body varies considerably according to the external environment, for example, dryness, coldness, dustiness, fumes (organic and inorganic), moistness or heat all have an effect on the respiratory system.[16]

2.3 Air pollution and the health situation in South Africa

Air pollution stems from many sources and is made up of many kinds of gases, droplets and particles that reduce the quality of the air. Air pollution occurs everywhere and the difference is only the amount of toxins liberated in the atmosphere.[17, 18, 19]

In urban areas air pollution may be caused by cars, buses, airplanes, as well as industry and construction. In rural areas, dust from tractors ploughing fields, trucks and cars driving on dirt or gravel roads, rock quarries and smoke from wood and crop fires contribute to air pollution.[17]

Ground-level ozone is the major part of air pollution in most places. Ground-level ozone is created when engine and fuel gases, already released into the air, interact when sunlight hits them. Ozone levels increase when the air is still, the sun is bright and the temperature is warm. Ground-level ozone should not be confused with the "good" ozone that is miles up in the atmosphere and that protects us from the sun's harmful radiation.[20]

2.3.1 Classification of air pollutants

TABLE 1: Classification of air pollutants [21]

A. Primary-secondary pollutants

(i) Primary: pollutants emitted directly into the atmosphere (e.g., SO_2, some NO_X species, CO, PM)

(ii) Secondary: pollutants that form in the air as a result of chemical reactions with other pollutants and gases (e.g., ozone, NO_X, and some particulates)

B. Indoor-outdoor pollutants

(i) Indoor pollutants

(a) Sources: cooking and combustion, particle resuspension, building materials, air conditioning, consumer products, smoking, heating, biologic agents

(b) Products: Combustion products (e.g., tobacco and wood smoke), CO, CO_2, SVOC (e.g., aldehydes, alcohols, alkanes, and ketoses), microbial agents and organic dusts, radon, manmade vitreous fibres

(ii) Outdoor pollutants

(a) Sources: industrial, commercial, mobile, urban, regional, agricultural, natural

(b) Products: SO_2, ozone, NO_X, CO, PM, SVOC.

C. Gaseous-particulate pollutants

(i) Gaseous: SO_2, NO_X, ozone, CO, SVOC (e.g., PAH, dioxins, benzene, aldehydes, 1,3-butadiene)

(ii) Particulate: coarse PM (2.5-10mm; regulatory standard = PM10), fine PM (0.1-2.5mm; regulatory standard = PM2.5); ultra fine PM (<0.1 mm; not regulated)

NO_X - Nitrogen oxides; SVOC - specific volatile organic compounds.

2.3.2 Air pollution health situation in South Africa

The air pollution situation in South Africa is similar to that of other developing countries. The main sources of ambient air pollution in South Africa are derived from burning of coal, oil and natural gas in industrial processes, power generation and vehicle emissions.[17, 18, 19] *Indoor air pollution results from burning of coal, wood, kerosene and other non electric energy fuels for domestic energy needs, cigarette smoking, the use of insecticides and general household materials containing aldehydes, benzene and other toxic substances.*[22, 23, 24, 25] *The most common air pollutants in South Africa include criteria pollutants, namely: sulphur dioxide (SO_2), oxides of nitrogen (NO_X), particulate matter (PM), lead (Pb),*[17] *ozone (O_3), carbon monoxide (CO),*[17, 26, 27] *and volatile organic compounds (VOCs) including acrylonitrile and benzene.*[23, 28]

Statistics on the levels and trends in air pollution in South Africa is inadequate and this makes control difficult. [29] *Generally South African air quality is regarded as good with levels of SO_2, O_3 and nitric oxide (NO) falling within the South African guidelines for human health protection.*[29] *There are, however, exceptions in areas of heavy industrial development, such as, the Vaal Triangle,* [26, 30, 31] *the South Durban Industrial Basin*[32] *and Cape Town,*[33] *where the recommended WHO guidelines and the South African National Guidelines are exceeded from time to time.* [19, 32] *The Vaal Triangle experiences the problem of SO_2, particularly for short term exposures (<24-hour) and particulates.*[19] *The South Durban Basin is affected by high SO_2 concentrations,*[34] *while Cape Town experiences brown haze,*[35] *mainly as a result of vehicular emissions.*[33]

Air pollution and health impact studies in South Africa reflect that people exposed to air pollution experience health problems including respiratory conditions, such as, wheezing, shortness of breath, blocked and runny nose, sinusitis, rhinitis, hay fever, productive cough, bronchitis, bronchiolitis and pneumonia.[25, 36, 37, 38] *and high lead levels in the blood of children.*[39] *Air pollution exposure and response is influenced by several factors including vulnerability factors.*[40]

2.4 Respiratory problems related to indoor and outdoor pollutants

Both indoor and outdoor pollution can have adverse health effects.[10]

2.4.1 Health effects of indoor pollution

Indoor air pollution is ever-present and takes many forms, ranging from smoke emitted by solid fuel combustion, especially in households of developing countries, to complex mixtures of volatile and semi-volatile organic compounds present in modern buildings.[21] The primary cause of indoor air quality problems in homes are gases or particles released into the air, which stem from pollution sources. Biomass, which ranges from animal dung, wood to crop residues is used in more than two fifth of the world's households as the principal fuel. [41, 42]

Inadequate ventilation can increase indoor pollutant levels, because it prevents outdoor air from expelling and diluting indoor emissions. This undesirable effect is further worsened by high temperature and humidity levels, which in turn increase concentrations of some pollutants.[43] Indoor cooking and heating with biomass fuels (agricultural residues, dung, straw and wood) or coal, produces high levels of indoor smoke that contains a variety of health-damaging pollutants.[42]

As evidenced, there are many sources of indoor air pollution in homes. These include combustion sources such as oil, gas, kerosene, coal, wood, and tobacco products. Building materials and furnishings as diverse as deteriorated asbestos-containing insulation, wet or damp carpets, and cabinetry or furniture made of certain pressed wood products can also contribute to this polluted state of affairs. Furthermore, products for household cleaning and maintenance, personal care, hobbies, central heating and cooling systems as well as humidification devices can also compound the problem. Outdoor sources such as radon, pesticides, and outdoor air pollution, can also have an effect on indoor pollution.[43]

The relative importance of any single source depends on how much of a given pollutant it emits and how hazardous those emissions are. In some cases, factors, such as, the age of the source and whether regular maintenance has been done, are significant. For example, an improperly adjusted gas stove can emit significantly more carbon monoxide than one that is properly adjusted. Some sources, such as, building materials, furnishings, and household products like air fresheners, are more or less continuously releasing pollutants. Other sources, related to activities carried out in the home, release pollutants intermittently. These include smoking, the use of unvented or malfunctioning stoves, furnaces, or space heaters, the use of solvents in cleaning and hobby activities, the use of paint strippers in redecorating activities, and the use of cleaning products and pesticides in house-keeping. High pollutant concentrations can remain in the air for long periods after some of these activities were conducted. [43]

The number of times an individual is exposed differs from one person to another. Effects may either manifest after a single exposure or repeated exposures. These include irritation of the eyes, nose, and throat, headaches, dizziness, and fatigue. Such immediate effects are usually short-term and treatable. Sometimes the treatment is simply eliminating the person's exposure to the source of the pollution, if it can be identified. Symptoms of some diseases, including asthma, hypersensitivity pneumonitis, and humidifier fever, may also show up soon after exposure to some indoor air pollutants. There is consistent evidence that exposure to indoor air pollution can lead to acute lower respiratory infections in children under five, and chronic obstructive pulmonary disease and lung cancer (where coal is used) in adults.

Table 2 summarizes the status of evidence on the health effects of indoor air pollution.

TABLE 2: Health effects of indoor air pollution [44]

Health Outcome	Evidence
- Acute lower respiratory infections (children <5yr) - Chronic obstructive pulmonary disease (adults) - Lung cancer (coal)	Between 10 – 20 studies (but few measured exposure or dealt with confounding factors)
- Tuberculosis - Cataract - Upper airway cancer - Asthma	Several consistent studies (more conflicting for asthma)
- Low birth weight - Perinatal mortality - Otitis media	Very few studies support; support from environmental tabacco smoke and/ or ambient air studies
- Cardiovascular disease	No study. But suggestive

There is emerging evidence, which suggests that indoor air pollution in developing countries may also increase the risk of other important child and adult health problems; however, this evidence is tentative and based on fewer studies. It includes conditions such as: low birth weight and perinatal mortality (still births and deaths in the first week of life), asthma, otitis media (middle ear infection) and other acute upper respiratory infections, tuberculosis, nasopharyngeal cancer, laryngeal cancer, cataract (blindness) and cardiovascular disease.[45]

2.4.2 Health effects of outdoor pollution

The earth's atmosphere consists mainly of gases. These gases are not harmful at certain exposures, but should those limits be exceeded or should gases get mixed with primary gases, secondary gases can be produced, which may be harmful to humans, vegetation and animals. [10]

The atmosphere extends to an altitude of between 800 and 1000 kilometres above the surface of the earth. The lower layer of the atmosphere, which is (10-15 kms), is the most important layer for life and geochemical processes; it is called "the troposphere". The troposphere is defined as a combination of gases regarded as most important for life. These gases, constituting the atmosphere from time to time, includes, SO_2, nitrogen oxides, hydrogen sulphides and carbon monoxides, along with a variety of more exotic hydrocarbons, which even in small quantities, can be harmful to the environment. [10]

Most of the so-called trace species, emitted into the atmosphere, is in reduced form (e.g. hydrogen sulphide) and when it returns from the atmosphere to the earth surface (troposphere) gets oxidized during the process of photochemical reaction, for example, sulphuric acid. The afore mentioned two processes, photochemical and oxidation are prominent in air pollution processes of the atmosphere and in smog formation.[10]

Three main sources of pollution are:

i. Combustion of fuel (obtaining energy and heating);
ii. Emissions from transport vehicles using fuel (waste gases); and
iii. Dust and heat from chemical manufacturers (cement and brick factories or power plants).[10]

Chemical substances released by industries in the process of fuel and coal combustion directly into the atmosphere are called *primary pollutants*. [10] Seen in the modern context, it is generally acceptable that pollutants undergo *chemical changes in the presence of molecular oxygen (O_2), water (H_2O), and Ultra Violet (UV) solar energy and form*

secondary products such as sulphur acid, which arises from sulphur dioxide in the presence of steam.[12, 46]

The burning of fuel is regarded as the major source of pollutants released into the atmosphere.[12, 41, 42] In the process of fire making for incinerators and boilers coal is used, which mainly contains carbon and when under going incomplete combustion it produces CO_2 (carbon dioxide), NO_X (nitrogen oxides) and SO_2 (sodium dioxide).[12] There seems to be a general agreement between Eskom Newsand Sasol report on the study of Vaal Triangle that "*The most prevalent industrial gases emission include, hydrogen sulphide and* NO_X.[3, 12]

Exposure to outdoor air pollution and other industrial emissions pose a threat to nature, human beings and vegetation. The effect of air pollutants has been largely investigated, and *low level exposures cause damage to small airways of experimental animals.*[1] Transient reduction of lung function was evident among volunteers exposed to air pollutants, at the concentration in the range of current legislated standards, often present during pollution episodes.[19, 27] Acute exposure to ozone is associated with respiratory problems, such as, coughing, and shortness of breath.[12]

Evidence suggests that urbanization, with its high levels of vehicle emissions and westernized lifestyle are linked to the rising incidence of respiratory problems, as seen in most industrialized countries.[10] Moreover, the increase in respiratory allergy parallels an increase in outdoor and indoor air pollution. Although the role played by outdoor pollutants in allergic sensitization of airways has yet to be elucidated, it is well established that outdoor pollution exacerbates respiratory symptoms in atopic subjects.[10, 12]

Studies related to automobile emissions have been conducted world wide.[32, 46] The great concern is the health effects of such exposure to human beings. Pollutants, which are derived from vehicle emissions, include particulates (PM10), sulphur dioxide, nitrogen dioxide, carbon monoxide, volatile organic compounds (VOCs), hazardous air pollutants

(HAPs) and Ozone, a secondary pollutant formed between the interaction of NO_X, VOCs and sunlight.[46, 47]

Ozone *(O_3)*

Exposure to Ozone *(O_3)* affect the structure and function of the respiratory tract in a variety of ways.[10] A large body of knowledge has been accumulated regarding the effects of ozone on respiratory functions in humans, especially on what is called *transient exposure that has been studied largely in animals*. This includes *mucocilliary and early alveolar ozone particles clearance, a functional response in microphages and epithelial cells and changes in lung cells secretion*.[10] Exposure to ozone also alters responsiveness of airways to other bronchi constructive changes as measured by changes in the respiratory system.[1] *O_3* affects the respiratory system to form lung oedema. It also compounds conditions like asthma.[46]

Sulphur oxides *(SO)* **and dioxide** *(SO_2)*

Sulphur dioxide *(SO_2)* is a colourless, reactive gas that is odourless at low concentrations, but pungent at very high concentrations.[1, 10] The major emitters of *SO_2* are fossil fuel-burning power plants and industrial boilers. *Sulfur [sic.] Oxides (SO) are produced by combustion of fuels (products) containing sulfur [sic.] such as coal.... and petroleum.*[1] Sulphur compounds such as *SO_2* in oxidized forms are also regarded contributors to air pollution in highly industrialized areas. Sulphur dioxide exposure constricts air passages, creating problems for people with asthma. *SO act as irritants and they increase respiratory symptoms at a concentration of $\geq$ 5ppm (part per million), but lower concentration may increase the respiratory symptoms which causes bronchospasm in asthmatic and chronic bronchitis*.[10]

The adverse effect of particles depend on their chemical composition, for example, *the presence of trace metals and hydrocarbons, and on the size, which determines the site of deposition within the respiratory tract*. At low levels of exposure *SO_2* can cause eye, nose and respiratory irritation, whilst at high exposure levels can cause lung airways to narrow further, resulting in wheezing, chest tightness and breathing problems.[1]

Exposure to SO_2 can cause impairment of the respiratory function, aggravation of existing respiratory diseases (especially bronchitis), and a decrease in the ability of the lungs to clear foreign particles. It can also lead to increased mortality, especially if elevated levels of particulate matter (PM) are also present. Groups that appear most sensitive to the effects of SO_2 include asthmatics and other individuals with hyperactive airways, and individuals with chronic obstructive lung or cardiovascular disease. Elderly people and children are also likely to be sensitive to SO_2.[46]

The presence of particulate matter appears to aggravate the impact of SO_2 pollution. Several studies of chronic effects have found that people living in areas with a high particulate matter and SO_2 levels, have a higher incidence of respiratory illnesses and symptoms than people living in areas without such a synergistic combination.[46]

Nitrogen dioxide *(NO_2)*

Nitrogen dioxide (NO_2) is one of a group of chemicals, collectively known as *NOx*. This categorization includes chemicals such as *nitrous oxide (N_2O) and nitric oxide (NO) et cetera*.[10] Breathing high levels of NO_2 causes *irritation of the respiratory tract and shortness of breath*.[48] The effect of NO_2 exposures include the irritation to the mucous membrane of the respiratory tract and in terms of effective concentration, acute respiratory tract irritation symptoms, such as, nausea, cough, itchy eyes, throat irritation and dyspnoea may occur at a certain exposure. Included in the list of respiratory symptoms, where complications are advanced, after exposure to chemical and air pollution are, *labored [sic.] breathing, wheezing, coughing, dryness of nose, itchy ears and nose, running [sic.] nose, and sore throat*[10, 12, 49] This group of nitrogen-based gases are toxic to the human body, affecting the respiratory system, and can result in physical damage to the lung tissue and possibly lung oedema (excessive build up of watery fluid in the lung tissue).[46]

Particulate matter

Particulate matter is the term for solid or liquid particles found in the air. Particles differ in size, colour and weight. Some are large or darker, to be seen as soot or smoke, whilst others are very light and tiny, in such a way that they can not be visible to the naked eye.

Mobile sources are blamed by many studies as the main contributor to the problem, whilst diesel powered vehicles and engines contribute more than half of the mobile source particulate emissions.[10]

Fine particles have become a health concern because very fine particles can travel long distances and reach the deepest areas in the lungs. Identified health effects in many studies, include asthma, difficulty in breathing, wheezing, painful breathing and chronic bronchitis, especially in children and elderly.[10, 12]

Particulate matter, which includes ash, automotive emissions, cigarette smoke, dust and pollen, *alters the immune defense [sic.] system, causes pulmonary problems and respiratory irritation.*[2] A report on MRC study on Vaal Triangle air pollution, particulate matter states it *can cause chronic coughing, bronchitis and chest illness.*[12, 48] and *particles suspended in the air can cause eye, nose, throat, and lung irritation.*[48]

Carbon monoxide

Carbon monoxide is defined as a colourless, odourless, but poisonous gas emitted from the vehicle exhaust as a result of incomplete combustion processes of fuel and oil. Its effect is to interfere with the blood ability to carry oxygen to vital organs and other tissues. The health effect of carbon monoxide exposure results in symptoms similar to flu, but without fever, and *includes headache, fatigue, shortness of breath, nausea and dizziness*[10, 50] as well as high dose exposure, resulting in death.[10]

This source also illustrates the amounts of chemical emissions per country and nationally of several European countries by use of bar graphs. The former USSR is the highest in SO_2 emissions, Germany, the highest on NO_X, whilst Switzerland is the lowest on both.[10]

Adverse health effects from other gaseous co-pollutants, such as SO_2, nitrogen dioxide (NO_2), and carbon monoxide *(CO)*, should not be underappreciated. Recent epidemiologic studies conducted throughout the world have provided valuable insight into the associations between SO_2, NO_2, and CO exposure and increases in cardiopulmonary mortality, respiratory and cardiovascular hospital admissions,

emergency admissions caused by stroke (SO_2), and myocardial infarction (NO_2 and CO). [51, 52, 53]

2.5 Respiratory diseases related to coal and silica dust

Occupational health is fundamental to public health, for it is clear that major diseases need to be addressed by workplace programmes as part of the disease control strategy. Occupational safety and health can contribute to improving the employability of workers, through workplace redesign, maintenance of healthy and a safe work environment, training and retraining, assessment of work demands, medical diagnosis, health screening and assessment of functional capacities. [7]

Occupational diseases are often not curable but they are always preventable. Improving ventilation, wearing protective equipment, changing work procedures and educating workers are the key factors for prevention. [54]

Occupational diseases are caused by exposure to harmful hazards (chemicals, physical, biological and ergonomical) at the workplace. There is evidence that these hazards affect a considerable number of people, particularly in rapidly industrialized countries. In many cases occupational diseases are severe and disabling. However, two factors make them easily preventable: first, the causal agents of these diseases can be identified, measured and controlled; secondly, the population at risk are usually easily accessible and can be regularly supervised and treated.[7] Dust as one of the occupational hazards is present in many workplaces and can incapacitate men and women alike to impaired health and shortened lives. Death often comes with little warning; unfortunately the dusty job is rarely identified as the culprit. [45]

Dust is defined differently be different authors. Defined as *Airborne particulate matter ranging in diameter from 10 to 50 microns, generated by activities such as cutting, crushing, detonation, grinding, and handling of organic and inorganic matter such as coal, grain, metal, ore, rock, wood,* [55] and also as, *small, dry, solid particles projected into the air by natural forces, such as wind, volcanic eruption, and any mechanical or*

man-made processes such as crushing, grinding, milling, drilling, demolition, shoveling, conveying, screening, bagging, and sweeping. Dust particles are usually in the size range from about 1 to 100μm in diameter, and they settle slowly under the influence of gravity. [56] This particles are small in such a way that they can remains suspended in the air for some time. *Dust particles with black upper and gray or white lower surface would cause warming, whereas those with opposite color arrangement would cause cooling. Industrial dust (generated by cutting, drilling, grinding, or sawing) can pose health risks if inhaled and (because such particles usually are less than 10 microns in diameter) would be more hazardous due to its ability to embed deep into lungs and other tissue.* [55]

Increased international concern about dust hazards during the last few decades has resulted in more widespread applications of dust control practices, greatly reducing the threat of many of the occupational dust diseases. This is mainly because it was a key priority for top management, and workers are continually made aware of this commitment. Incentive systems for supervisors and workers are designed to encourage safe procedures and not just productivity. [4]

Dust is everywhere; we inhale some of it with every breath we take. Most dusts are harmless, but certain dusts can produce pathological changes in lung tissues, changing healthy tissue into useless fibrous or scar tissue. [57]

Particles of industrial dusts are in most cases very small to the extent that they are only visible by microscope and are basically behaving like air. These can pass unimpeded through the protective hair and mucus in the upper airways. Dermatitis, bronchitis, eye injuries and lung diseases can result from exposure to hazardous dust. [58]

Particle size directly affects dust toxicity; the smaller the particles, the further it will travel and reach into the lungs. Some particles are so small that they are breathed in and out unchanged as molecules of air. The more dust is retained by the body, the more severe the resulting illness. In addition, it should be noted that the health risk of exposure to dust depends on the type of dust (physical, chemical and mineralogical characteristics), which will determine its toxicological properties. [10]

Soluble dusts are absorbed from the lungs into the bloodstream, causing damages to other organs. Insoluble dusts do not dissolve or only dissolve in small amounts and often remain in the lungs for long periods of time. It has been shown that the accumulation of large enough burdens of insoluble particles in the lungs leads to impaired clearance. This so-called "dust overload" condition may occur as a result of prolonged occupational exposure, even at relatively low levels. Such overload may be a precursor to the formation of tumours, even for substances, which have previously been regarded as relatively innocuous. [59] The lung tissue is by far the most efficient medium the body has for capturing and absorbing airborne contaminants. [15, 16, 49]

The lungs are the most susceptible part of the human body and can fight to repel pollutants; but many modern industrial dust particles are so fine and penetrating that they are able to sink deep into the lungs, eventually blocking and covering the main connections between life-giving oxygen and the bloodstream. Scar tissue is produced (process called fibrosis), because the lungs can neither remove nor destroy the dust. This occurs because certain particles, such as silica-containing dusts are cytotoxic; in other words these cells kill the macrophage cells that engulf any insoluble particles, which are deposited in the lung. [60]

Pulmonary diseases from industrial dusts are classified as pneumoconiosis, which literally means that dust is retained in the lungs. Pneumoconiosis is the non-neoplastic reaction of the lungs to inhaled mineral or organic dust and the resultant alteration in their structure. It excludes diseases mainly of the airways like asthma, bronchitis, and emphysema. Pneumoconiosis development depends on the kind and size of dust particles and the individual workers' susceptibility, as well as the duration of exposure and exposure to other chemicals or to simultaneous exposure to cigarette smoke. [4, 61, 62]

Coal workers' pneumoconiosis is caused by inhalation of coal dust and is more prevalent in underground workers exposed to higher concentrations of dust than in surface workers. [4, 62] Silicosis is a pneumoconiosis caused by inhalation of quartz, which is lethal to macrophages that ingest it and releases their enzymes. Pneumoconiosis was at one of its highest levels during the 1930s, mainly because of the general lack of controls. [4]

Dusts are generated during the handling, pulverization, grinding, crushing, rapid impact and decrepitating of organic and inorganic substances such as rock, ore, metal, coal and wood.[4] Occupational disease, as any condition is listed in either the Occupational Diseases in Mines and Works Act (ODMWA) or the Compensation for Occupational Injuries and Diseases Act (COIDA).[63] One of the principal features of MHSA is the enforcement of the primary responsibility for ensuring a healthy and safe working environment in mines on the mine owner (employer). [63] The mining related lung diseases listed for compensation purposes in South Africa are exhaustive and include amongst other disease silicosis on miners and surface workers exposed to silica dust, coal workers' pneumoconiosis in coal miners.[64]

Many authors describe coal dust exposure as occurring predominantly in association with mining operations, such as those below ground, but this does not mean that nothing happens above the ground. Risk factors, which are associated with coal dust *include the percentage of carbon (low-versus high rank coal), the presence of additional contaminants such as silica, dust levels…* [1]

In studies, conducted, it became apparent that coal dust is associated with *coal workers pneumoconiosis (CWP).*[61,62,65] In addition to symptoms of breathlessness, seen in complicated CWP, bronchitis symptoms were prominent including lung parenchyma changes.[62, 65]

A study, which examined 8555 bituminous coal miners, found the prevalence of bronchitis among non smokers to have increased from 12% of those less than 30 years old to 46% among those over 60 years old. Among the smokers, the prevalence increased from 22% to 65%, respectively.[66]

Dust control measures safeguards the health of employees and the community. It also helps to promote worker efficiency and morale.[61] In a coal-fired boiler or incinerator plant, coal is the main raw material of production and it is well expected that employees will be exposed to coal dust and fly ash (with a probability of developing silicosis, because of the prevalence of crystalline silica in coal) at various stages of production.[12]

Ash dust, if liberated to the environment in high concentrations, contributes to the haze or smog that is seen in the sky and can reduce visibility, which may cause traffic accidents. Aerosols in the atmosphere that scatter and adsorb light reduce visibility. Fine particles like those of fly ash with a diameter of less than 2.5 micrometers, have the largest effect on visibility.[3]

Ash dust can also cause damage to most of the infrastructure if combined with wind and will reduce aesthetics. Other environmental impacts occur when these particles deposit onto man-made materials, such as, monuments or statues. Damage occurs because of wet or dry depositions of contaminants on structures. This is possible when excessive fly ash is released during coal combustion processes.[3, 5] Fly ash and coal dust as by-products of coal burning consists mainly of fine particles. The particle sizes of such dusts are distributed on the basis of internationally accepted differentiation between inhalable and respirable fractions.[69] Employees in the near or immediate vicinity of the coal-fired boiler are generally exposed to a certain amount of dust because of the above mentioned by-products of coal burning.[70]

At the 3rd Conference of the Parties to the Basel Convention on Trans-boundary Movements of Hazardous Wastes and their Disposal held in 1995; a ban was adopted on the trade of hazardous wastes from industrialized countries to developing countries. This international agreement was justified by the desire to protect importing countries from the influx of wastes, presenting hazards to public health and the environment.[71]

At the 4th Conference of the Parties held in 1998; two lists of wastes were defined: List A, contained wastes considered as hazardous, and List B, specified non-hazardous wastes. Both lists are now part of the Basel Convention.[71] Fly ash dust was found in both lists, which provides inconclusive findings about the hazards of this compound. Due to the above information, an interest developed for the determination and establishment of risks associated with employees' exposure to fly ash dust and other occupational exposures.

Electric power plants are described as the major emitters of sulphur dioxide as a result of their coal burning activities. This does not mean that other companies and organizations do not also contribute to the problem. Sulphur dioxide can be converted to the sulphated particulates that contribute to haze, which consists mostly of diluted sulphuric acid.[67] When clouds are formed in the presence of this haze; there is a possibility that the rain falling from such clouds will be acidic.[68] Acid rain is formed when sulphur dioxide and NO_X emissions in the atmosphere react with oxygen, oxidants and water to form acidic components, referred to acid deposition or acid rain.[68]

In heavy industries these gases are released from the combustion of coal that is impure, because of large sulphur and nitrogen contents. Excessive release of sulphur and nitrogen dioxides into the atmosphere, contributes to the formation of acid rain. [68]

Acid rain deposits into water and results in the elevation of the pH for lakes and other water catchments resources. The nitrogen in acid rain adds to the total loading of nitrogen in water-bodies. As coastal ecosystems become overly rich in nitrogen, conditions favour more frequent and more severe emergence of algal blooms, which deplete oxygen, harming fish and reducing plant and animal diversity. [43]

2.6 Respiratory problems related research

According to the preliminary results of the MRC study; the Vaal Triangle study indicates that the levels of particulate matter in the Vaal Triangle exceeds the USA health standard. [25] The objectives of the MRC study conducted on the Vaal Triangle air pollution were:

1) *To monitor and quantify the concentration of pollutant content of the Highveld Vaal Triangle's stratosphere,* and
2) *To investigate the health effects of air pollution on population of the Vaal Triangle.* [25]

The first report of the MRC study released in mid-March 1995; revealed ozone and particulate concentration that were a course of concern. MRC researchers reported that the study *was complicated by varied and complex sources of air pollution in the Vaal*

Triangle, including industrial waste gases, domestic coal burning emission, and pollen the last being the substance which flourishes abundantly in the Vaal Triangle region.[12, 25] The more prevalent industrial gases included: SO_2, hydrogen sulphide (H_2S), and nitrogen oxides *(NO_X)* as well as *secondary by product*, ozone pollutants as a results of oxidation processes.[12]

Results of the South African Vaal Triangle study on air pollution yielded the following results; 65,9% of the sample reported having suffered from upper respiratory tract related problems, such as, *sinusitis, rhinitis, and hay fever* and 28,9% of the sample reported having suffered from lower respiratory tract related problems such as *bronchitis, chronic cough and chronic chest illnesses.* [25]

A South African study conducted in south-central Durban, one of the most heavily polluted areas in South Africa, was aimed at investigating the prevalence of asthma and respiratory symptoms using a cross-sectional survey of 213 households in the communities of Merewent (Indians dominant) and Austernville (coloureds dominant). Respiratory related signs and symptoms reported include: *asthma diagnosed by doctor, wheezing, and shortness of breath, chronic cough, chronic phlegm, frequently blocked-running nose, and sinusitis.* [37]

The conclusion drawn from three cross-sectional studies conducted by the National Institute for Environmental studies in Japan; which were aimed at investigating the effect of automobile exhaust on respiratory symptoms, was based on the estimated odds ratios for certain respiratory symptoms, such as, *chronic wheezing, chronic cough, chronic phlegm, and shortness of breath* ranged from 0.76 to 2.75, with 95% confidence limits of the odds ratios for chronic cough and chronic phlegm excluded; and approached 1.00 in each of the studies. Results of this study suggested that exposure to automobile exhaust emissions might be associated with an increased risk of certain respiratory symptoms. [47]

Another study was conducted in three Chinese cities and aimed at examining potential association between air pollution exposures and respiratory symptoms of about 4,108

adult Chinese. The results revealed a significant and strong effect of air pollution on the prevalence rates of *cough, phlegm, persistent cough and wheeze.*[72]

A study conducted in Italy, revealed the prevalence of respiratory symptoms in general population samples, exposed to different levels of air pollution. Two samples aged 8 to 64 living in unpolluted, rural area and in the urban area were examined. One sample was divided into three groups according to place of residence in the urban–suburban areas and to outdoor exposure. A significant prevalence rate in particular *rhinitis and wheezing* were higher in urban zones whilst *chronic cough and phlegm* were higher in the zone with increased automobile exhaust and additional industrial exposure.[73]

An additional study was conducted on school growing children in the vicinity of a coal-fired power station plant in Israel. According to their report an increased prevalence of part of the respiratory symptoms, such as, productive coughs (sputum), *wheezing with and without cold and wheezing accompanied by shortness of breath (amongst those living in the area classified as most polluted) was evident.*[70] In the hierarchical multicity analyses study on the respiratory effects of sulphur dioxide, this next source conclude that an association exist between sulphur dioxide exposure and asthma admission particularly in children.[74] This suggests that by reducing child exposure to sulphur dioxide, hospital admission will decrease too.

A further resource concentrated on the prevalence of respiratory problems among welders in an unorganized sector (where the use of PPE is not strictly compelled) in Baroda City and reported a 33.33% and 14.28% result for cough and breathlessness, respectively.[75] Another study revealed chronic bronchitis in 25%, cough in 23% and breathlessness in 28% welders in India.[76] Furthermore, a study in Scandinavia also reported work related cough in 22% of welders.[77]

Similar studies have shown that residing near busy roadways is associated with increased asthma hospitalizations, decreased lung function, and increased prevalence of respiratory signs and symptoms.[14]

CHAPTER 3

RESEARCH METHODOLOGY

Introduction

This chapter explains and justifies the research approach taken to obtain data, that is, the methodology of the research, study design; study population and collection instrument are discussed. The preparation of the questionnaire and the pilot study, the validity and reliability of measuring instruments and the limitations of the study are described. This section also indicates how the data was organized and analyzed and how the findings were examined, interpreted and disseminated. The date entering as well as the techniques to be used in data analysis is also discussed.

3.1 Study design

The research design used for this study is a descriptive cross-sectional study. This design presents providers and planners with information, which will assist in designing services and allocate resources efficiently.[78] The study was conducted in the present time to examine what currently exists, in order to give description of the current status of work related respiratory problems among Mapulaneng maintenance and transport employees.[79]

3.2 Study population

The population of this study consisted of Mapulaneng Hospital maintenance and transport employees, who were in employment at Mapulaneng Hospital in November and December 2009. The population comprised maintenance employees from the following occupational categories: boiler operators, electricians, plumbers, welders, carpenters, painters, builders; as well as transport employees from the following occupational categories: drivers and transport admin.

A total population of 44 employees were studied, which consisted of 32 permanent maintenance employees (25 males and 7 females) and 12 permanent transport employees (11 males and 1 female) working at Mapulaneng Hospital in the Department of Health, Mpumalanga Province.

3.3 Study setting

Mapulaneng Hospital (Workshop Area): Mapulaneng Hospital is a Regional Hospital situated in Bushbuckridge local municipality at Ehlanzeni District in Mpumalanga Province. The hospital was founded by Swiss Missionaries in 1936 and was then known as Masana Hospital. It was transferred from the Swiss Mission to the Lebowa Government in 1976 and renamed Mapulaneng Hospital. The hospital employed about 680 personnel.

3.4 Variable of the study

The variables of the study included:

3.4.1 Socio-economic and demographic characteristics of the sample.

3.4.2. History of illness (personal and family) of the sample.

3.4.3. Household environment and transportation methods of the sample.

3.4.4. The frequency of the signs and symptoms experienced by the sample.

3.4.5. Lifestyle of the sample.

3.5 Instrument development, reliability and validation

An interviewer-administered questionnaire was designed and developed by the researcher. The questionnaire was initially designed in English and translated to Pulane (a locally spoken language, however, not listed as one of the official languages) by Pulane speaking employees and back to English to ensure consistency. Although there were some differences noted; adjustments were effected accordingly. The questionnaire was also given to the language specialist Lexicography MER Mathivha Centre for African Languages and the Department of Linguistics of the University of Venda for

verification, but was rejected because Pulane only exists as a spoken tongue, and not as a written code. Interviewers were given an opportunity to decide their language preference for their interview. Only 79% preferred to be interviewed in English.

The questionnaire was aimed at collecting data pertinent to the study. The instrument was developed using information on the effects of air pollution on the respiratory system gathered through literature review. The questionnaire was divided into five sections as follows:

1st Socio-economic and demographic characteristics

2nd History of illness prior to present occupation

3rd Household environment and transportation

4th Frequency of signs and symptoms, which were divided into

- Upper respiratory signs and symptoms

(Excessive dryness of the nose, itching/irritation of the nasal mucosa, excessive dryness of the nose and sneezing)

- Lower respiratory signs and symptoms

(Coughing, breathlessness, wheezing ad phlegm)

5th Life style questions

3.5.1 Reliability and validity

The instrument was developed using information on the effects of air pollution on the respiratory system gathered through literature review and previous studies conducted, which the researcher regarded as valid and reliable. The questionnaire was also developed in consultation with Eskom Occupational Health Nurses Thelma Nzima (Current Pensioner), and Faslina Mashile the Occupational Health and Safety Nurse (Mapulaneng Hospital). The same questionnaire was validated by various specialists and experts, which include the Eskom Occupational Medicine Practitioner, Dr. Mike Simon, who verified the contents' relevancy and terminology used. Furthermore, the questionnaire was compared to validated questionnaires used in other respiratory related studies.

A uniform way of recording responses was ensured through training of the research assistant. The aim was to structure the interview situation as much as possible, in order to ensure that each respondent was exposed to the same questions, which were asked in the same order, with identical phrasing, and as far as possible with the same cues and tones from the interviewer.

3.5.2 Pre-testing of the instrument

A preliminary small-scale pilot of the actual study was conducted at Mapulaneng Hospital in Mpumalanga Province. The Public Works employees, who were excluded from the study, were utilized in the pre-testing of the research questionnaire. This involved the pre-testing of the instrument as well as the logistics of the whole research. Twenty cases were randomly selected from Public Work employees. The researcher ensured gender representation of the randomly selected pilot. After pre-testing and reliability analysis, improvement of the questionnaire was ensured, before it was used in the study.

3.6 Data collection

Data collection was conducted using research assistants by the name of Truely Nonyane and Nyiko Ndubane, who were conversant in local spoken languages. Data collection was done during the second week of December 2009 and second week of January 2010. This was done from 11h00 to 13h00 and 14h00 to 15h30 for the whole three weeks. The normal working hours were not disrupted in a major way, because interviewees were not called at the same time. The duration of interviews ranged between 30 to 45 minutes per person. A quiet, cool, clean and private venue was arranged. This was done in order to let the participants feel relaxed and free to answer all questions. Subjects were reassured of confidentiality.

3.7 Data management

Data, which was compiled on a daily basis was filed, labelled and stored securely for data entry. Data master sheets were formulated to cater for all variables of interest in a coded format. Microsoft Excel software was utilized to record data into a double entry two Microsoft Excel sheets method. Back up copies were made of all the data. Cleaning of the data was first carried out visually and then again electronically by running a frequency distribution for each variable, identifying and eliminating the input error identified.

3.8 Data analyses and presentation

The data was analyzed using Microsoft Excel data analyses tools. Data was carefully checked in order to identify strange values, also called outliners and errors, to prevent the introduction of biases at this stage. Furthermore, data was analyzed unadjusted. Data was summarized as follows: frequency tables to summarize the sample distribution per department and occupational or job category, sample specific socio-demographic information, including gender, years in current occupation, personal history of respiratory related illnesses, frequency of work related respiratory signs and symptoms, life style characteristics of the sample and prevalence and odds ratio of work related respiratory signs and symptoms.

Graphs were used to depict the ages, level of education, family history of Asthma and TB and alternative source of energy. Pie charts were used to display history of occupational exposure, travelling on dust roads and sleep disturbance problems. A descriptive statistical technique, such as, mode, mean, percentage and standard deviation was used to calculate the frequency of work related respiratory signs and symptoms for the upper and lower respiratory organs.

A mean test was used to analyze the interviewees ages and years in maintenance and transport department employment services. Frequency distributions were calculated presented in summaries using a histogram and pie charts. The Chi-square test was used to

analyze the different number of demographic and living conditions of those with respiratory health problems. The prevalence rates were calculated. Odds ratio and 95% confidence intervals were calculated, using a calculator for confidence intervals and odds ratio to measure risk factors for respiratory health problems. [80] P values were calculated using an online graphpad software quickcalcs. [81]

3.9 Ethical consideration

- The research proposal was presented to the Higher Degree's Committee University of Venda for Science and Technology for approval. Ethical clearance was also requested from University Health and Safety Research Ethics Committee (see Appendix I).
- Further approval to conduct the study was sought from the Head of Department: Department of Health, Mpumalanga Province (see Appendix II).
- A letter requesting permission to conduct the study was written to Mapulaneng Hospital Chief Executive Officer (see Appendix III).
- At the beginning of the study consents were requested from all the participants (see Appendix VIII).
- Participants were be briefed by the researcher on the purpose of the study and how confidentiality will be ensured of information given by coding of questionnaires to ensure anonymity.
- Participants who did not want to be part of the study were given freedom to withdraw at anytime of the study.

3.10 Research report

The result of the study will be presented to Mapulaneng Management and employees and will be sent to the Head of Department: Department of Health, Mpumalanga Province.

The paper will also be presented to Mpumalanga Province; Occupational Health and Safety Practitioner forum and be published in the Journal for South African Society for Occupational Health Nurses (SASOHN).

CHAPTER 4

DATA PRESENTATION

Data presentation is displayed in the form of frequency tables, histograms, and pie charts. Presented firstly, is the study population distributed per departments and job categories, followed by socio economic and demographic data of the participants. Data is being presented in relation to the stated objectives of the study findings presented in this chapter and are based on the data obtained from the questionnaire, which was administered to transport and maintenance employees of the Department of Health at Mapulaneng Hospital. This chapter presents a summary of relevant analysis carried out on data collected in this study.

Baseline demographic and socio-economic characteristics of the sample

4.1 Study population

Table 3 shows the sample distribution per departments. Participants for this study were from two departments. A total of 44 Mapulaneng Hospital employees from maintenance and transport departments were included as participants in this study. The response rate was 98%. Interviewer administered questionnaires were completed in their working areas and at their own convenient time. The total number of questionnaires completed differed from department to department and from occupational categories.

Table 3: Distribution of the sample per department

Department Name	Total number
Maintenance	34
Transport	10
Total	44

Table 4 shows the sample distribution per occupational categories. Participants for this study were drawn from ten (10) different occupational categories.

Table 4: Distribution of the sample by occupational category

Occupational Category	Total number	%
Driver	7	16%
Transport Admin	3	7%
Boiler Operators	7	16%
Painting	5	11%
Carpentry	6	14%
Electrical	4	9%
Building	3	7%
Plumbing	5	11%
Welding	3	7%
General Workers	1	2%
Total	44	100%

4.2 Demographic data

The mean age of the respondents was 45.8 (range 28 to 60). Figure 1 indicates ages of the respondents and shows that about 15 respondents were between 51 and 60 years old and were mostly men. About 16 respondents were between 41 and 50 years old. A further 11 respondents were between 31 and 40 years old. Only 2 respondents were between 25 and 30 years old.

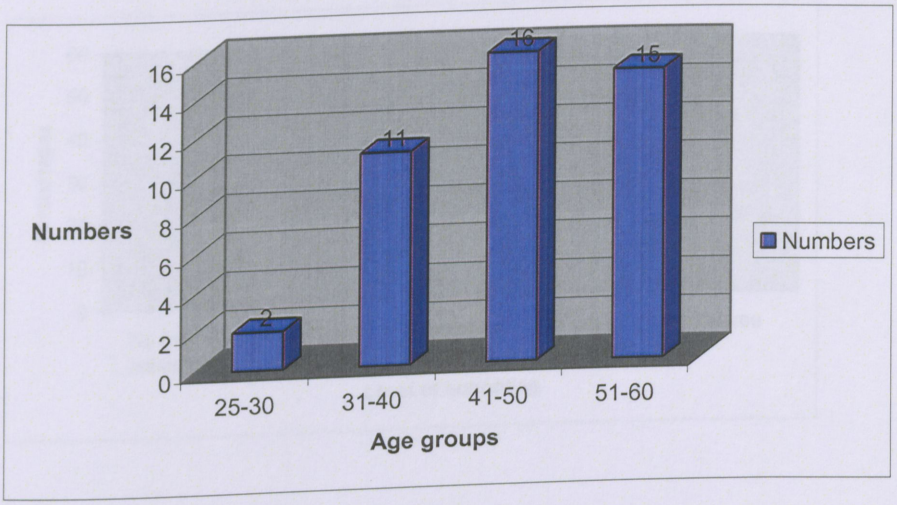


Figure 1: Ages of the respondents

Table 5 depicts the gender of the respondents. From table 5, it can be seen that there were more males (36) compared to (8) females in the maintenance and transport departments.

Table 5: Gender of the respondents

Gender	Respondents
Female	18.%
Male	82%

Figure 2 indicates respondent's level of education, which may have an impact on the understanding and prevention of exposure to work hazards. In this study 100% of participants indicated as having received some form of structured education. The study indicated that 22% of the participants had up to primary education and could read and write. It was also found that 52% of participants had up to secondary schooling, whilst 26% of the participants had certificates and diplomas. None had a degree or higher.

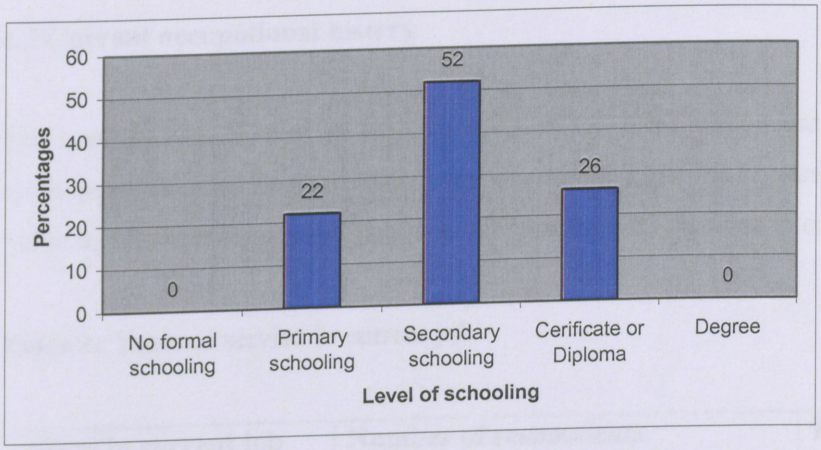


Figure 2: Respondents' level of education

The educational level of respondents in terms of age categories is indicated in Figure 3. The younger respondents received higher education than the older respondents. All respondents (100%) aged between 25 and 30 years have completed a diploma or a certificate, while a reduction of 45% was observed in the age group 31 and 40, and only a few of the older respondents have completed education at this level. On the other hand 47% of older respondents have completed their secondary education, whilst 47% had completed primary education. Only 6% had a diploma or certificate.

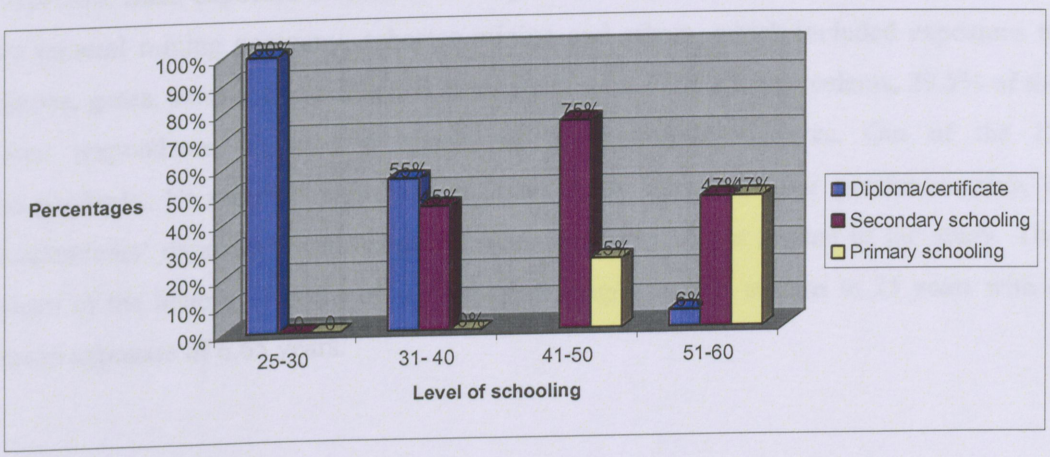


Figure 3: Educational level of the respondents according to age categories

4.3 Current occupational history

The occupational history of respondents differed from respondent to respondent. The mean years of duration in current jobs was found to be 12.1 years (range 1-39 years). Table 6, below, indicates the categories of respondents' duration in current jobs.

Table 6: Years of service in current job

Years in current job	Number of respondents	Percentages
0 – 5 years	15	34%
6 – 10 years	7	16%
11 – 20 years	12	27%
21 and above	10	23%
Total	**44**	**100%**

4.4 History of related occupational exposure

Figure 4 shows the percentage of respondents who had a history of related occupational exposure. Such exposure included a history of working in a foundry, working in a stone or mineral mining company, asbestos mining and others, which included exposures to fumes, gases, smoke, chemicals and other dusty jobs. Only 13 respondents, 29.5% of the total respondents, reported a history of occupational exposures. Out of the 12 respondents, 10 reported exposures to other dusty jobs and after careful scrutiny, 3 respondents' exposures were excluded when found to be not related to the study. The years of the history of occupational exposure ranged from 2 months to 15 years with a mean exposure of 6.65 years.

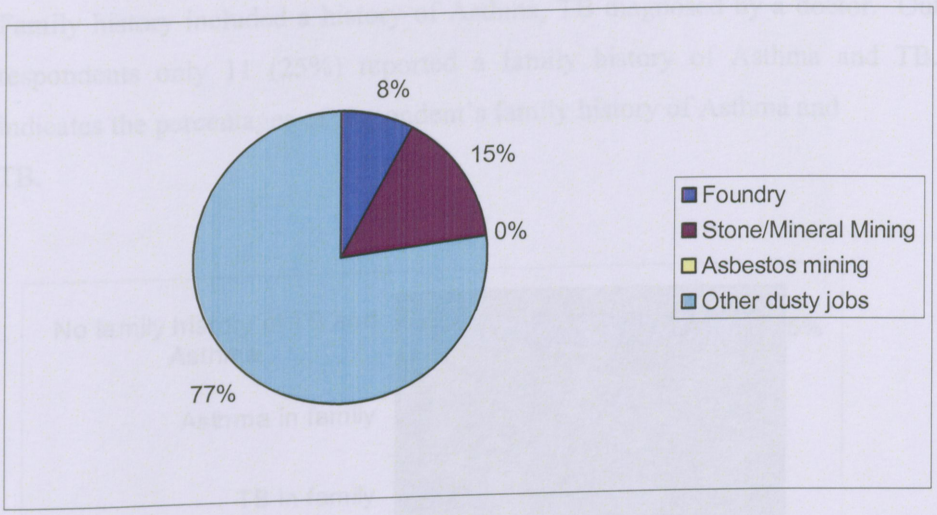


Figure 4: Respondents' history of occupational exposure and exposure type

4.5 History of illness (personal and family)

The personal history, of respiratory related illnesses reported by participants, is shown in Table 7. Personal history included a history of Asthma, TB diagnosed by a doctor and any history including own perception relating to allergies, such as, pollen, house or dust mites allergy and animal allergy. Only 27% of the respondents reported a personal history of respiratory related conditions.

Table 7: Respondents' personal history of respiratory related illnesses

Illness/ Condition	Number of respondents	% of respondents with history of illnesses
Asthma	3	25%
Tuberculosis	1	8.3%
Pollen Allergy	3	25%
House/dust Allergy	4	33.3%
Animal Allergy	1	8.3%
Total	12	100%

Family history included a history of Asthma, TB diagnosed by a doctor. Out of the 44 respondents only 11 (25%) reported a family history of Asthma and TB. Figure 5 indicates the percentages of respondent's family history of Asthma and TB.

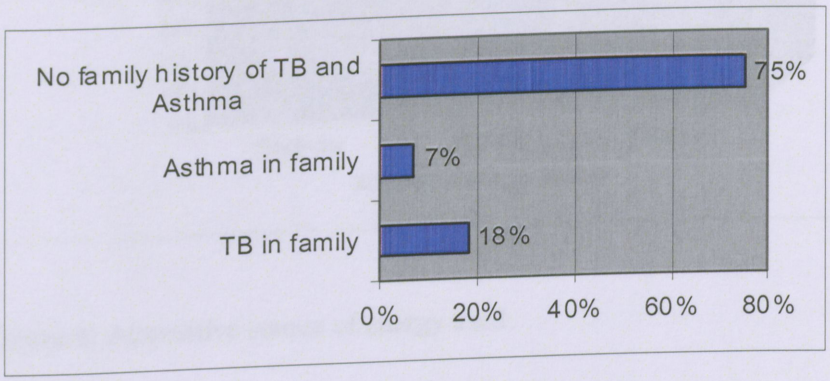


Figure 5: Respondents' family history of Asthma and TB

4.6 Household environment and transportation

The source of energy utilized mostly by respondents is electricity. 100% of respondents indicated the use of electricity as the main source of energy. Alternative sources of energy indicated by respondents included wood (84%), paraffin (11%) and electricity (5%). Only 2 respondents indicated the use of electricity only. Figure 6 represents percentages of respondents per alternative source of energy.

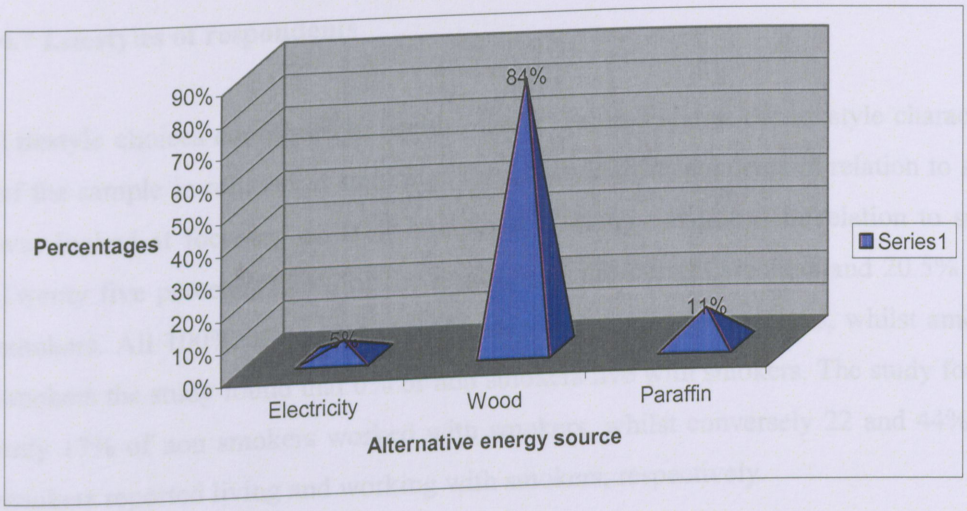


Figure 6: Alternative source of energy used

Different routes and modes of transportation were used by respondents. Some respondents used transportation, whilst others walked to work. Nineteen (19) of the respondents travelled on dust roads and 25 travelled on tarred or paved roads. Figure 7 indicates the percentages of respondents who walked or travelled on dust roads and the percentage of those who did not.

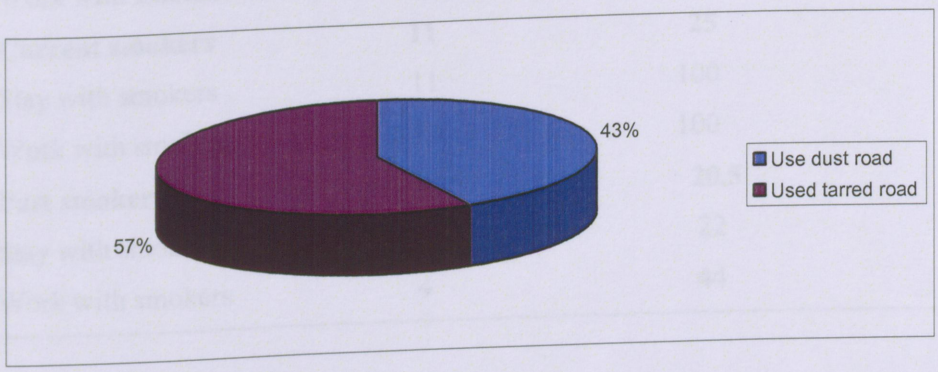


Figure 7: Percentages of respondents who travel on dust roads

4.7 Lifestyles of respondents

Lifestyle choices contribute to health effects. Table 8 shows the lifestyle characteristics of the sample in relation to smoking. The lifestyle of respondents in relation to smoking was looked at focusing on their home and working conditions in relation to smoking. Twenty five percent (25 %) of the respondents are current smokers and 20.5% are past smokers. All 100% of current smokers stay and work with smokers, whilst among non smokers the study found that 0% of non smokers live with smokers. The study found that only 17% of non smokers worked with smokers, whilst conversely 22 and 44% of past smokers reported living and working with smokers, respectively.

Table 8: Smoking history, working and living conditions of respondents in relation to smoking

Variable	n44	% (Weighted)
Smoking		
Non smokers	**24**	**54.5**
Stay with smokers	0	0
Work with smokers	4	17
Current smokers	**11**	**25**
Stay with smokers	11	100
Work with smokers	11	100
Past smokers	**9**	**20.5**
Stay with smokers	2	22
Work with smokers	4	44

4.8 Frequency of work related respiratory signs and symptoms

Table 9 indicates the percentage of work related respiratory sign and symptoms experienced by respondents and the controls. Experiences of respiratory sign and symptoms differed from department to department and from respondent to respondent.

Table 9: Prevalence and frequency of work related signs and symptoms of the study respondents and the study control subjects

		Maintenance and Transport employees	**Study Control subjects**
Variables		**n 44**	**n 64**
Upper respiratory related	Excessive dryness	28 (64%)	14 (22%)
	Itching of the nasal mucosa	16 (36%)	14 (22%)
	Excessive running of the nose	20 (45%)	11 (17%)
	Sneezing	26 (59%)	12 (18.7%)
Lower respiratory related	Coughing	24 (55%)	2 (3.1%)
	Wheezing	9 (20%)	2 (3.1%)
	Breathlessness	9 (20%)	4 (6.2%)
	Phlegm	11(25%)	2 (3.1%)

4.9 Risk of work related respiratory signs and symptoms of the sample by selected characteristics

Tables 10, 11, 12 and 13 below indicate the prevalence of work related excessive dryness and irritation of the nasal mucosa; work related excessive running of the nose and sneezing; work related coughing and wheezing; work related breathlessness and phlegm, respectively. Respondents were compared against each other as per selected characteristics. Table 10 shows that non smokers had a higher prevalence of work related excessive dryness of the nose than the smokers.

Table 11 shows no difference in the groups on the prevalence of work related excessive running of the nose and sneezing, whilst table 12 shows an increased risk of work related wheeze in the age group 25 to 40 years than those above 40 years. Table 13, on the other hand, indicates an increased risk of work related breathlessness on those travelling on dust roads to and from work.

Table 10: Odds ratio (95% CI) of work related excessive dryness, irritation of the nasal mucosa by selected characteristics

	Excessive nasal dryness (n = 28)			**Irritation of nasal mucosa (n =16)**		
	n	OR	95% CI	n	OR	95% CI
Sex						
Male	22	0.5	0.11 to 2.68	15	3.43	0.71 to 16.55
Female	6	0.8	0.37 to 8.68	1	0.29	0.06 to 1.41
Age groups						
25 - 40 yrs	11	3.52	0.93 to 13.31	6	0.78	0.47 to 6.8
> 40	17	0.28	0.07 to 1.08	10	0.56	0.15 to 2.1
Travel dust road						
Yes	10	0.44	0.13 to 1.5	5	0.47	0.14 to 1.6
No	18	2.27	0.66 to 7.7	11	2.1	0.62 to 7.19
Smoking						
Yes	4	0.08	0.02 to 0.34	6	1.62	0.43 to 6.14
No	24	11.9	2.9 to 48.0	10	0.62	0.16 to 2.3
Time spent /day						
< 4 hours	12	1.2	0.41 to 3.74	8	1.76	0.54 to 5.78
> 4 hours	16	0.8	0.27 to 2.42	8	0.57	0.17 to 1.86
Duration in current job						
< 10 years	17	3.16	0.94 to 10.66	9	1.5	0.44 to 4.9 7
> 10 years	11	0.32	0.09 to 1.06	0.68	0.2 to 2.29	
Alternative energy used						
Wood	24	0.5	0.07 to 3.64	14	0.91	0.14 to 6.11
Paraffin	4	1.94	0.27 to 13.77	2	1.09	0.16 to 7.3
Statistical significant p<0.0001						

Table 11: Odds ratio (95% CI) of work related excessive running of the nose and work related sneezing by selected characteristics

	Excessive running n=20)			Sneezing(n=26)		
	n	OR	95%CI	n	OR	95%CI
Sex						
Male	18	2.68	0.58 to 12.26	23	2.91	0.6 to 13.6
Female	2	0.37	0.08 to 1.71	3	0.34	0.07 to 1.6
Age groups						
25 - 40 yrs	7	1.6	0.4 to 5.8	5	0.31	0.08 to 1.13
> 40	13	0.62	0.17 to 2.26	21	3.27	0.89 to 12.01
Travel dust road						
Yes	6	0.38	0.12 to 1.25	13	1.9	0.59 to 6.4
No	14	2.62	0.8 to 8.56	13	0.5	0.15 to 1.71
Smoking						
Yes	18	2.6	0.7 to 9.48	18	1.02	0.27 to 3.87
No	2	0.38	0.1 to 1.4	8	0.98	0.26 to 3.7
Time spent /day						
< 4 hours	9	1.36	0.44 to 4.19	11	1.17	0.39 to 3.5
> 4 hours	11	0.74	0.24 to 2.27	15	0.8	0.28 to 2.56
Duration in current job						
< 10 years	11	1.43	0.44 to 4.63	12	0.69	0.2 to 2.27
> 10 years	9	0.7	0.22 to 2.26	14	1.4	0.44 to 4.74
Alternative energy used						
Wood	19	3.41	0.54 to 21.64	24	2.8	0.42 to 18.71
Paraffin	1	0.29	0.05 to 1.86	2	0.36	0.05 to 2.39
*** Statistical significant p<0.0001**						

Table 12: Odds ratio (95% CI) of work related cough and wheezing by selected characteristics

	Cough (n=24)			Wheeze (n=9)		
	n	OR	95% CI	n	OR	95% CI
Sex						
Male	18	0.37	0.08 to 1.71	9	4.49	0.69 to 29.3
Female	6	2.68	0.58 to 12.3	0	0.2	0.03 to 1.46
Age groups						
25 - 40 yrs	4	0.26	0.07 to 0.96	3	1.25	0.26 to 6.1
> 40	20	3.78	1.04 to 13.7	6	0.8	0.16 to 3.9
Travel dust road						
Yes	10	0.9	0.31 to 2.63	4	1.06	0.24 to 4.6
No	14	1.1	0.38 to 3.2	5	0.94	0.22 to 4.05
Smoking						
Yes	7	0.83	0.2 to 3.05	1	0.3	0.1 to 1.52*
No	17	1.21	0.33 to 4.47	8	3.17	0.66 to 15.3
Time spent /day						
< 4 hours	12	1.57	0.47 to 5.25	2	0.5	0.12 to 2.41
> 4 hours	12	0.64	0.19 to 2.13	7	1.89	0.4 to 8.6
Duration in current job						
< 10 years	9	0.34	0.11 to 1.1	4	0.76	0.18 to 3.24
> 10 years	15	2.93	0.91 to 9.47	5	1.31	0.31 to 5.59
Alternative energy used						
Wood	21	0.88	0.14 to 5.67	9	4.1	0.43 to 38.8
Paraffin	3	1.14	0.18 to 7.34	0	0.24	0.26 to 2.31
*** Statistical significant p<0.0001**						

Table 13: Odds ratio (95% CI) of work related breathlessness and phlegm by selected characteristics

	Breathlessness (n = 9)			Phlegm (n = 12)		
	n	OR	95% CI	n	OR	95% CI
Sex						
Male	9	4.49	0.7 to 29.3	11	2.4	0.4 to 13
Female	0	0.2	0.03 to 1.5	1	0.41	0.07 to 2.2
Age groups						
25 - 40 yrs	1	0.34	0.07 to 1.6	4	1.28	0.3 to 5.4
> 40	8	2.97	0.6 to 14.5	8	0.78	0.19 to 3.3
Travel dust road						
Yes	4	1.06	0.25 to 4.6	3	0.37	0.1 to 1.4
No	5	0.94	0.2 to 4.05	9	2.7	0.72 to 10
Smoking						
Yes	7	1.66	0.3 to 8.0*	9	1.46	0.3 to 6.1*
No	2	0.6	0.12 to 2.9	3	0.7	0.2 to 2.7
Time spent /day						
<4 hours	4	1.75	0.4 to 7.99	7	7.76	1.8 to 33.7
> 4 hours	5	0.57	0.12 to 2.6	5	0.13	0.03 to 0.6
Duration in current job						
< 10 years	3	0.44	0.1 to 1.88	6	1	0.27 to 3.7
> 10 years	6	2.27	0.5 to 9.6	6	1	0.27 to 3.7
Alternative energy used						
Wood	8	1.1	0.1 to 10.4	11	1.6	0.2 to 12.3
Paraffin	1	0.9	0.1 to 8.6	1	0.63	0.08 to 4.8
*** Statistical significant p<0.0001**						

4.10 Risk of work related respiratory signs and symptoms of the sample by current occupation

Respondents were compared with controls that were derived from the general admin staff at Mapulaneng Hospital. A total number of 64 controls were used in the study. The mean age of the controls was 42.46 (range 26 – 63 years). Table 14 represents a summary of risk of work related excessive dryness and irritation of the nasal mucosa. There were considerable variations in risk by occupation. The prevalence and odd ratio of association with work related excessive dryness of the nasal mucosa were only significantly increased among the transport admin staff (OR 58.23, 95% CI 4.008 -125.58, Prev % 100). However, a greater than 22 fold increased risk was found in driving and boiler operating, whilst a 16-fold increase in risk was found in the electrical section. The prevalence and odds ratio of association with work related itching of the nasal mucosa was found to be non significant in all occupations. However, a higher prevalence of work related irritation or itching of the nasal mucosa was found to be at 66.7%, 60%, 50% and 42.9% in the transport admin, plumbing, carpentry section and boiler operating, respectively.

Table 15 shows a summary of risk of work related excessive running of the nasal mucosa and sneezing. The prevalence and odds ratio of association with work related excessive running of the nasal mucosa and sneezing were only significantly increased for general workers (OR 225.13, 95% CI 1.4404 -35186), this represent only one case. However, a greater than 22, 21 and 10-fold increased risk was found in builders, drivers and boiler operators, respectively. The prevalence and odd ratio of association with work related sneezing was found to be increased in general workers, welders, electricians, drivers and plumbers as evidenced by the odds ratio for association of 148.4, 100, 25.1, 18.9, and 10.9, respectively. Admin transport and boiler operators shared an odd ration of 17.3.

Table 14: Prevalence and odds ratio (95% CI) of work related upper respiratory signs and symptoms (excessive dryness and itching of the nasal mucosa) by current occupation

Work related excessive dryness of the nose	**Cases**	**Prev (%)**	**OR**	**95% CI**
1. Driving	6	85.7	22.43	4.01 to 125.58
2. Admin Transport	3	100	58.23	4.15 to 816.63
3. Boiler Operating	6	85.7	22.43	4.01 to 125.58
4. Painting	3	60	7.56	0.93 to 61.58
5. Carpentry	2	33.3	1.897	0.26 to 13.72
6. Electrical	3	75	16.31	1.61 to 165.23
7. Building	2	66.7	11.33	0.76 to 167.77
8. Plumbing	2	40	2.73	0.32 to 23.19
9. Welding	1	33.3	1.91	0.12 to 30.16
10. General Work	0	0	0.28	0.02 to 32.89
Work related itching of the nasal mucosa	**Cases**	**Prev (%)**	**OR**	**95% CI**
1. Driving	2	28.6	1.46	0.23 to 9.32
2. Admin Transport	2	66.7	11.33	0.76 to 167.77
3. Boiler Operating	3	42.9	3.11	0.51 to 19.13
4. Painting	0	0	0.26	0.03 to 2.49
5. Carpentry	3	50	4.52	0.65 to 31.35
6. Electrical	1	25	1.2	0.11 to 13.43
7. Building	1	33.3	1.91	0.12 to 30.16
8. Plumbing	3	60	7.56	0.93 to 61.58
9. Welding	1	33.3	1.91	0.12 to 30.16
10. General Work	0	0	0.28	0.02 to 32.89

Table 15: Prevalence rates and odds ratio (95% CI) of work related upper respiratory signs and symptoms (excessive running of the nose and sneezing) by current occupation

Work related excessive running of the nose	**Cases**	**Prev (%)**	**OR**	**95% CI**
1. Driving	5	71.4	21.4	3.35 to 136.69
2. Admin Transport	1	3.3	2.95	0.15 to 59.07
3. Boiler Operating	4	57	10.63	1.59 to 70.95
4. Painting	0	0	0.28	0.02 to 3.33
5. Carpentry	2	33.3	2.86	0.34 to 24.26
6. Electrical	2	50	8.09	0.63 to 103.62
7. Building	2	66.7	22.57	1.23 to 412.68
8. Plumbing	2	40	4.35	0.43 to 43.85
9. Welding	1	33.3	2.95	0.15 to 59.07
10. General Work	1	100	225.13	1.44 to 35186
Work related sneezing	**Cases**	**Prev (%)**	**OR**	**95% CI**
1. Driving	5	71.4	18.91	3.03 to 117.97
2. Admin Transport	2	66.7	17.38	1.03 to 293.58
3. Boiler Operating	5	71.4	17.32	2.82 to 106.43
4. Painting	2	40	3.65	0.39 to 34.52
5. Carpentry	2	33.3	2.46	0.31 to 19.59
6. Electrical	3	75	25.12	2.24 to 281.98
7. Building	0	0	0.28	0.01 to 5.7
8. Plumbing	3	60	10.91	1.22 to 97.51
9. Welding	3	100	100.1	6.36 to 1576.6
10. General Work	1	100	148.41	1.1 to 19930.4

Table 16 represents a summary of the risk of work related coughing and wheezing. There were considerable variations in risk by occupation. The prevalence and odds ratio of association with work related coughing significantly increased for most of the occupations. A very high increase of (OR 2568702300, 95% CI 2925312. - 29284746336085.8) in risk of work related coughing than controls was noted in general workers, however this represent only one case. A greater than 69567-fold increased risk was found in welders. A 4 197-, 976- and 396-fold increased risk was found in electricians, carpenters, boiler operators and drivers, respectively, whilst a 4185-fold increase risk was found in plumbers and painters. A 1050-fold increased risk was seen in builders and transport admin. The prevalence and odd ratio of association with work related wheezing was found to be significantly increased in transport admin and welders as evidenced by odds ratio of association of 1050. However, a higher prevalence of work related wheezing was found to be 976, 165 and 112 in boiler operators, electricians and in drivers, respectively

Table 17 shows a summary of the risk of work related breathlessness and phlegm. The prevalence and odds ratio of association with work related breathlessness was found to be significantly increased in boiler operators and drivers (OR 58.04, 95% CI 4.3156 – 780.85). The prevalence and odds ratio of association with work related phlegm was found to be significantly increased in builders (OR 1003244.7, 95% CI 12655.3 – 79531877.4) and electricians (OR 4197.67, 95% CI 59.19 - 297683.0007). A further 1050-, 776-, 251- and 112-fold increased risk was noted in transport admin, plumbers, carpenters and drivers.

Table 16: Prevalence rates and odds ratio (95% CI) of work related lower respiratory signs and symptoms (cough and wheeze) by current occupation

Work related cough	Cases	Prev (%)	OR	95% CI
1. Driving	3	42.9	396.99	19.22 to 8200.76
2. Admin Transport	1	33.3	1050.85	4.06 to 272082.5
3. Boiler Operating	4	57.1	976.34	60.24 to 15823.4
4. Painting	3	60	4185.15	128.28 to 136537.1
5. Carpentry	3	60	4185.15	152.09 to 57540.1
6. Electrical	2	33.3	4197.67	59.19 to 297683
7. Building	1	33.3	1050.85	4.0587 to 272082.5
8. Plumbing	3	60	4185.15	128.28 to 136537.1
9. Welding	2	66.7	69567	544.5 to 8887565.5
Work related Wheeze	**Cases**	**Prev (%)**	**OR**	**95% CI**
1. Driving	2	71.4	112.05	3.89 to 3226.39
2. Admin Transport	1	33.3	1050.85	4.06 to 272082.48
3. Boiler Operating	4	57.1	976.34	60.24 to 15823.37
4. Painting	0	0	0.33	0 to 73.07
5. Carpentry	0	0	0.33	0 to 48.29
6. Electrical	1	25	165.82	1.26 to 21887.13
7. Building	0	0	0.34	0 to 295.82
8. Plumbing	0	0	0.33	0 to 73.066
9. Welding	1	33.3	1050.85	4.06 to 272082.48
10. General Work	0	0	0.35	0 to 30271.08

Table 17: Prevalence and odds ratio (95% CI) of work related lower respiratory signs and symptoms (breathlessness and phlegm) by current occupation

Work related breathlessness/ tight chest	**Cases**	**Prev (%)**	**OR**	**95% CI**
1. Driving	3	42.86	58.04	4.32 to 780.53
2. Admin Transport	0	0	0.33	0 to 42.66
3. Boiler Operating	3	42.86	58.04	4.32 to 780.53
4. Painting	0	0	0.32	0 to 15.46
5. Carpentry	0	0	0.32	0 to 11.43
6. Electrical	1	25	15.1	0.3 to 701.79
7. Building	0	0	0.33	0 to 42.66
8. Plumbing	1	20	7.51	0.23 to 244.97
9. Welding	1	33.3	47.62	0.6 to 3775.26
10. General Work	0	0	0.34	0 to 1200.36
Work related Phlegm	**Cases**	**Prev (%)**	**OR**	**95% CI**
1. Driving	2	28.6	112.05	3.89 to 3226.4
2. Admin Transport	1	33.3	1050.85	4.06 to 272082.5
3. Boiler Operating	0	0	0.32	0 to 35.06
4. Painting	0	0	0.33	0 to 73.07
5. Carpentry	2	33.3	251.33	7.01 to 9010.62
6. Electrical	2	50	4197.67	59.19 to 297683
7. Building	3	100	1003245	12655 to 79531877
8. Plumbing	2	40	776.28	16.2 to 37080.3
9. Welding	0	0	0.34	0 to 295.8
10. General Work	0	0	0.36	0 to 30271.08

CHAPTER 5

DISCUSSION, LIMITATIONS, CONCLUSION, RECOMMENDATIONS

5.1 Discussion

This chapter discusses the results provided, based on the data gathered through a researcher administered questionnaire. Data gathered was analysed to obtain relevant interpretation, and scientific deductions. Objectives of the study were kept in mind at this stage. The evidence provided, partly correlated with the existing body of knowledge to try and ensure scientific plausibility.

Baseline demographic and social characteristics of the sample

After an extensive literature review, the researcher designed and used a respiratory questionnaire to glean required information. The study analyzed the collected data to determine the prevalence of work related respiratory problems among maintenance and transport employees at Mapulaneng Hospital.

Gender

This study shows that Mapulaneng Hospital maintenance and transport departments are male dominant. This is in line with known statistics on male dominancy in technical jobs. Such jobs used to be labelled *jobs for men*, but even though the tide has recently changed, these positions are still predominantly filled by males. The study found that only 18% of the respondents in maintenance and transport departments were females, this mirrored findings of major studies conducted all over the world. The findings are also consistent with earlier findings. In studies conducted on the incidence of respiratory symptoms among female woodworkers exposed to dry wood, a total of 1,377 woodworkers were studied of which only 21% constituted females.[82]

Age

The mean age of the respondents was 45.9% (range 28 – 60 years). The mean age was too big and this was found to be a good indication and a warning sign of an aging workforce. This is supported by statistics, which reveal only 29.5% of the respondents ages fell between 25 and 40 years. The study also found that only 6% of the respondents were between 25 and 30 years. One possible meaning of the high mean age might be skill drainage; hence it is possible that old employees exit the institution without passing on their knowledge and experience to the younger generation.

Level of education

There was an indication of an increasing level of education in the maintenance and transport departments, which was evidenced by the findings of the study indicating that 100% of the respondents reported having some form of formal education. The level of education of employees was found to be 22%, 52%, and 26% for primary, secondary and certificates or diplomas, respectively.

The study also found that 100% of the younger employees held higher qualifications than the older ones. Findings of this study indicated that 100% of the employees aged between 25 and 30 held N3 qualifications or higher and 50% of those between 31 and 40 years of age had secondary education. This showed high educational levels in the young generation and the reverse in the older employees, indicating that younger respondents received a higher education than older respondents. All respondents aged between 25 and 30 years have completed a diploma or certificated degree, while the same is reduced to 50% in the age group of 31 and 40, and only a few of the older respondents have completed education at this level. On the other hand the majority of the older respondents have completed their secondary education.

Frequency of work related respiratory symptoms

Work related upper respiratory signs and symptoms

The prevalence of work related upper respiratory signs and symptoms for excessive dryness of the nose in maintenance and transport departments was 64% whereas 59%, 45% and 36% of the respondents reported work related sneezing, excessive running of the nose and itching of the nasal mucosa, respectively. The prevalence of work related upper respiratory signs and symptoms for excessive dryness of the nose in control subjects was 21.9% whereas 18.7%, 21.9% and 17.2% of the control subjects reported work related sneezing, excessive running of the nose and itching of the nasal mucosa, respectively. The current study found a prevalence rate of 45% for excessive running of the nose among the maintenance and transport employees. This is inconsistent with earlier studies on the prevalence of work related excessive running of the nose, by being within the wide range of 25.9 to 50% reported from studies in various countries conducted on the general population, whether children or adults.[37]

The prevalence of work related excessive dryness of the nose in maintenance and transport departments was 64%, sneezing 59% and itching 36%. These appear to be high, but the research failed to correlate this finding with previous studies, due to a lack of extensive research conducted on work related upper respiratory problems in employees. These findings are also supported by findings in controls, which found that all upper respiratory signs and symptoms in the control group were far lower than the prevalence reported in research respondents.

However, the study revealed that 64% of respondents in maintenance and transport departments reported work related excessive dryness of the nose and 41% of those who reported work related excessive dryness of the nose were from the maintenance department, but this represents only 31% of the total study population. On the other hand 90% of transport staff reported work related excessive dryness of the nose and this represents only 13,6% of the study population. This indicates an increase in work related excessive dryness of the nose in transport employees. A possible explanation or

speculation about the findings is that transport employees are exposed to the workshop environment and spend longer periods than the other groups in different job categories; they are not issued with protective clothing as their occupational category does not require them to use PPE.

The prevalence rate of sneezing in maintenance and transport department employees was found to be 59% as opposed to 18.7% found in control subjects. This represents 70% of transport department employees and 56% of maintenance employees. This finding further indicates that transport employees may be the most affected by upper respiratory problems. These results leave much to be desired concerning the cause of such problems; especially because the transportation sector is not regarded as a high risk sector in terms of respiratory problems; this is further supported by the fact that no protective clothing is prescribed for public drivers and admin staff. Even worse is the fact that transport admin staff reported a 100% and 70% for work related excessive dryness and sneezing, respectively. This significant finding can be explained by considering the risky environment they work in.

Work related lower respiratory signs and symptoms

The study revealed that 55% of respondents in maintenance and transport departments, compared to 3.1% of control subjects, reported work related coughing; 83.3% of the respondents were from the technical department. The prevalence rate for work related coughing in the technical department was found to be 58.8%. The rate is above the wide range of coughing prevalence reported by other studies, which is between 8.1 to 35% [25, 83] and 47% for cough.[84] This significant finding can be explained by the risky type of work performed by maintenance staff, the sick working environment they work in and possibly the question of the appropriateness and effectiveness of the protective clothing used. The significant prevalence rate reported for work related coughing was found to be excessively increased in most occupations.

A population-based study on welding exposures at work identified cough as a respiratory symptom in welders and also showed a strong relation between at least one welding related respiratory sign. Furthermore, the study showed that 6.6% of the respondents who reported work related cough also reported tuberculosis (TB) diagnosed by a doctor, this constituted only 3% of the study population.[85, 86, 87]

The study found that 20% of the respondents in maintenance and transport departments reported work related wheezing during the past 12 months as compared to 3.1% in the control subjects. These figures are within the range reported in earlier population based studies conducted in developed, under developed and industrialized countries, which range between 2,1 and 42%.[37, 83, 88, 89, 90]

The present study showed that 66.7% of the 20% who reported wheezing also reported asthma diagnosed by a doctor. These results can be explained by the relationship between wheezing and asthma, which has been reported by many studies. What was not found was any relationship between asthma and the working environment, since the subjects who reported asthma, indicted that they were diagnosed prior to current employment. However, subjects reported an increase in asthma related signs and symptoms, including increased attacks since being in their current job.

What the study found interesting was that during data collection, one of the subjects, whose spouse also took part in the survey, indicated under family history of asthma that his spouse was recently diagnosed with asthma by a doctor, but the researcher found that during data analyses, no female respondent reported asthma diagnosed by a doctor. This suggest a possibility that some of the respondents might not have responded faithfully to the questionnaires. To avoid such, attempts were made to brief all participants on the purpose of the study and how confidentiality would be ensured on information given. Participants were also informed of their rights of not responding to questions they felt uncomfortable with, rather than giving incorrect responses. Based on the findings of the study a conclusion could not be made on the relationship between asthma diagnosed by a doctor and self reported wheezing. This pattern, of research participants not responding faithfully to research questions, is also confirmed by a cohort study conducted in the

European Community on the increase of asthma, but not in symptoms, which found an increase in the proportion of those who reported asthma, excluding the proportion of those reporting symptoms suggestive of asthma.[91]

The prevalence of work related breathlessness in maintenance and transport departments was found to be 20% for the study population as compared to 6.2% found in the controls. This finding is within the range of 20 – 40% reported in other studies[90] and far below the prevalence of 77% in a study conducted in China.[84] While the findings produced by a study in China are acknowledged, it should be noted that China is a country with poor environmental pollution control systems, and most of its residents in cities are living under harmful air quality conditions.[72]

The prevalence of work related phlegm in maintenance and transport departments was found to be 27% as compared to 3.1% reported by the control subjects. These findings are within the range of 20 – 40% reported in other studies.[90] A study conducted in China reported 37% for chronic phlegm, which was also within the range reported by other studies.[33, 90]

Work related signs and symptoms by selected characteristics

The odds ratio (95% CI) of work related upper respiratory signs and symptoms were scrutinized by selected characteristics such as sex, age groups, travelling on dusty roads, smoking, hours per day spent in the workshop area, duration of service in current job and household environment. The study found an 11-fold increase of work related excessive nasal dryness in none smoking respondents (OR 11.9 with CI 2.9 - 48), which was found to be weak and statistically not significant. This finding may be explained by the sensitivity of non smokers' nasal mucosa as compared to that of smokers, who are less sensitive, because of smoking.

This study also found that for the variable gender, both males and females had almost an equal risk chance of suffering from work related excessive nasal dryness, it was found to be the same for research respondents, who spent less or more than 4 hours in the

workshop area. The study also found a 3-fold risk increase for employees with less than 10 years service and those of age groups between 25 and 40 years of age; however, this finding was not statistically significant.

The study found a more than 2-fold increased risk for employees above 40 years of age concerning work related coughing and a 7-fold increased risk for phlegm in employees that spent less than 4 hours in the workshop area, a result which was found to be weak and not statistically significant.

For work related lower respiratory signs and symptoms (such as work related coughing, wheezing, breathlessness and phlegm) by selected characteristics such as sex, age groups, travelling on dusty roads, smoking, hours per day spent in the workshop area, duration of service in current job and household environment, the following results emerged. The study found a more than 3-fold increase of work related coughing in the age group of above 40 years of age compared to respondents of less the 40 years of age (OR 3.78 with CI 1.04 - 13.68), which was found to be weak and statistically not very significant.

The study found that for the variable on smoking, non smokers had a more than 3-fold risk of work related wheezing than smokers. This was found to be a highly statistical significant, with a p value (<0.0001). This study found that smokers were 1.66 more at risk of work related breathlessness than non smokers and 1.46 more at risk for work related phlegm, which again was found to be statistically significant with a p value (<0.0001). Furthermore, results revealed that research respondents, who spent less than 4 hours in the workshop area per day, were more than 7-fold (OR 7.76) at risk of suffering from phlegm; however this was found to be weak and statistically not highly significant.

Risk of work related signs and symptoms per occupational categories

This study identified several occupations in maintenance and transport departments that were associated with work related upper respiratory signs and symptoms, such as, work related excessive dryness of the nasal mucosa, work related excessive running of the nasal mucosa and work related sneezing, when compared to controls. An increased risk

of work related excessive dryness, work related excessive running of the nasal mucosa or work related sneezing was reported by the research subjects.

A 22-, 21-, and a more than 18-fold increased risk of work related excessive dryness, itching of the nasal mucosa and sneezing was identified, respectively for Mapulaneng Hospital drivers. This was found to be above other job categories in the maintenance section. Driving work is not regarded as a high risk job for work related respiratory signs and symptoms. Although Mapulaneng Hospital drivers drive in heavy traffic congestion most of the time, this evidence alone is not enough to explain the significant risk increase in drivers. Another possible explanation is the result of their perceived sick workshop environment.

A study conducted on the respiratory symptoms and lung function in garage workers and taxi drivers on chronic respiratory symptoms, showed that garage workers had higher prevalence of symptoms than taxi drivers, being significantly greater for chronic phlegm, ($p<0.007$); dyspnoea ($p<0.001$]; and sinusitis ($p<0.03$). A higher prevalence of all acute symptoms was recorded in garage workers than in taxi drivers, although the differences were significant only for throat ($p<0.02$), hearing problems ($p<0.002$); nose (dryness, bleeding and secretion) ($p<0.008$); and lower back pain ($p<0.05$).[92]

Another study was conducted to determine the prevalence of some respiratory symptoms and possible diseases among taxi drivers and manual workers. This prospective study was performed on 165 Pakistani male drivers and 165 Pakistani male manual workers not exposed to dust or fumes, without occupational exposure from driving. The data on chronic respiratory symptoms showed that taxi drivers had a higher prevalence of symptoms than manual workers, being significantly greater for asthma (RR=1.72; 95% CI=1.00–2.88,*P*=0.037); allergic rhinitis (RR=2.41; 95% CI=1.46–3.94,*P*=0.0006); dyspnoea (RR=2.13; 95% CI=1.22–3.71,*P*=0.009); and nasal catarrh (RR=2.19; 95% CI=1.22–3.91,*P*=0.0106).[93]

Comparing this finding and to the current study, bearing in mind that these findings on drivers are more than what have been reported by boiler operators, moreover boiler

operators are provided with protective clothing, these simply mean Mapulaneng drivers are at a very high risk compared to both the controls and the rest of the maintenance staff.

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For boiler operators the study found a 22-fold risk for work related excessive dryness, a 17-fold increased risk of work related sneezing and a 10-fold increased risk of work related excessive running of the nose. Working in the boiler is associated with numerous occupational hazards. This occupational group is potentially exposed to various respiratory irritants, such as, organic dust and organic boiler chemicals.[94] Exposure to coal dust, coal ash, heat and smoke is part of boiler operators' daily encounter. The use of protective clothing has been prescribed by law for such operations; however, the study indicated an increase in work related upper respiratory signs and symptoms in boiler operators. This finding is not well supported by previous studies due to lack of literature. These results may be explained by considering the time spend by boiler operators in the workshop area in relation to the multiple hazards emanating from all workshop activities. Other possible explanations might be suggesting an improper utilization, non utilization or ineffective personal protective equipment for boiler operators.

A more than 58-fold and 17-fold increased risk of work related excessive dryness and sneezing was identified in Mapulaneng transport admin. However, fewer studies have been conducted on work related respiratory signs and symptoms in administration staff, maybe because admin staff is regarded as the not exposed group. On grounds of this, it was impossible to compare the findings of this study with existing knowledge. Nonetheless, the study findings indicated an increased risk of work related excessive dryness and sneezing in transport admin staff. Another study found a prevalence of work related asthma and wheezing among administration and finance staff to be at 2.97 and 8.8% for both, respectively.[95]

A 25-fold increased risk of work related sneezing was found in electrical employees. Whilst very few respiratory prevalence studies have been conducted on electricians, the results of this study seems to be very high. What can be deduced from the findings is that Mapulaneng Hospital electrical employees are 25 times more at risk of work related sneezing than the control group.

This study also identified a more than 225- and 148-fold increased risk for work related excessive running of the nose and sneezing in Mapulaleng Hospital maintenance general workers than the control group. General workers' duties include sweeping of the floors, cleaning of the offices and sweeping of the workshop yard. Multi hazard exposures are associated with this job, which includes dust from the coal, boiler ash, smoke and fumes; motor vehicle exhaust fumes; welding fumes; carpentry dust and chemicals, diesel fumes from the standby generator and asbestos. These findings can be attributed to the sick workshop environment general workers are working in. The study also identified several occupations in maintenance and transport departments that were associated with work related lower respiratory signs and symptoms, such as, work related cough, wheezing, breathlessness and phlegm.

An increased risk of work related coughing, wheezing, breathlessness or phlegm was found in Mapulaneng Hospital drivers, transport admin, boiler operators, painters, carpenters, electricians, builders, plumbers, welders and general workers. A more than 396-, 112-, 58- and a 112-fold increased odds of association was identified form drivers. Working as a full time driver, especially in heavy traffic areas, is associated with numerous occupational hazards. This group is exposed to traffic exhaust fumes on a daily basis. In most circumstances the vehicles driven by this occupational class do not have air cooling systems as a result manual cooling systems are used by opening the vehicles' windows, which further increase the risk of exposure. Several studies have reported an increased risk of breathlessness and tight chest as a result of exposure to automobile fumes.[47] Other studies found respiratory symptoms such as *chronic wheeze, chronic cough, chronic phlegm, and shortness of breath* ranging from 0.76 to 2.75, with 95% confidence limits of the odds ratio for chronic cough and chronic phlegm excluded and approached 1.00 in each study.[47]

A furthermore than 4197-fold work related cough and phlegm, and 165-fold for work related wheezing was identified in Mapulaneng electricians. The study also found a 1050-fold increased risk of work related cough, wheezing and phlegm, but not for work related breathlessness in Mapulaneng Hospital transport admin employees when compared to the control group.

An increased risk for work related coughing, wheezing and breathlessness, but not for phlegm was found in both boiler operators and welders. The prevalence reported by this study among welders was 66.7% for coughing, 33.3% for wheezing and 33.3% for breathlessness. A 69567-fold risk for work related coughing, 1050-fold risk for work related wheezing and a 47-fold risk for work related breathlessness was found in welders. This finding is consistent with earlier findings on welders, which identified coughing, wheezing and breathlessness as common respiratory related signs and symptoms in welders, [85] but not for the prevalence rates and the odds ratio, which were significantly higher in this study. A study among welders in an unorganized sector of Baroda City (in an unorganized sector the use of PPE is not stressed) reported the prevalence for coughing and breathlessness of 33% and 14.28% in welders, respectively.[75]

Findings of this study indicate a double risk for Mapulaneng welders.[84] These findings can partly be explained by the multiple exposures in the workshop area. This could suggest that Mapulaneng welders might either be exposed to other hazards at work, other than the job related ones or they might not be using correct personal protective equipment or personal protective equipment might not be appropriate or effective.

A 976-fold increased risk for both work related coughing and wheezing and a 58-fold increased risk for work related breathlessness, but not for work related phlegm was found in boiler operators. The prevalence of work related cough, wheezing and breathlessness were found to be 57% for both coughing and wheezing and 42.86% for breathlessness.

For Mapulaneng plumbers, the study found a 4185-fold increased risk of work related cough, 776-fold work related phlegm and a 7,5 work related risk for breathlessness, but not for wheezing. The prevalence rates among plumbers were found to be 60%, 20% and 40% for work related coughing, breathlessness and phlegm, respectively.

The study also found a more than 4197-fold and 251-fold risk of work related cough and phlegm, but not for work related wheezing and breathlessness in carpenters. The study found that Mapulaneng builders were affected by work related coughing and mostly by phlegm. These is shown by a 1050-fold and 1003244-fold increased risk of work related

cough and phlegm, respectively. The prevalence of work related coughing and phlegm among builders was found to be 33.3% and 100%, respectively. The exhaustive odds ratio and the wide confidence interval can be explained by the fewer number of cases observed.

Results of this study suggested that exposure to the workshop environment might be associated with an increased risk of certain respiratory symptoms. This prevalence of work related wheezing among drivers was found to be 71.4% whilst for work related coughing, breathlessness and phlegm prevalence rates of 42.86%, 42.86 and 28.6 were found, respectively. Findings of this study indicate that drivers had a high prevalence of work related wheezing. Furthermore a more than 112-fold increased risk of work related wheezing and phlegm was found in drivers, whilst a more than 398-fold and 58-fold increased risk was reported for work related coughing and breathlessness, respectively. No prevalence work related cough, work related wheezing and work related phlegm was found in drivers.

5.2 Limitations

There were certain limitations in this study.

5.2.1 Very little literature, which was specific to the subject being studied, was found during literature review, as a result related and closely linked literature was reviewed. This made it very difficult to correlate findings of the study with the existing body of knowledge.

5.2.2 The working definition of work related respiratory signs and symptoms used in this study have not previously been validated.

5.2.3 For several job categories this study was not able to assess the acceptable risk liability, as indicated by a wide 95% CIs, due to too few cases observed. In some occupational categories it was noted that there were fewer people employed, which made it difficult to interpret data as obverted by exaggerated prevalence rates and odds ratio of association.

5.2.4 Many comparisons were made in this analysis; therefore it is possible that some of the results may have been due to chance alone. There is a paucity of empirical research in which analysis has been by occupational categories that limited the comparisons with the literature.

5.3 Conclusion

The findings of this study have highlighted the health status of Mapulaneng Hospital maintenance and transport employees as shown by a high prevalence of some work related respiratory signs and symptoms. Based on these findings it becomes apparent that the research objectives have been successfully accomplished.

A successful achievement of the objectives of this study is stated below:

5.3.1 To identify, describe and explore work related respiratory signs and symptoms experienced by Mapulaneng Hospital employees at transport and maintenance sections in the Department of Health, Mpumalanga Province.

Work related signs and symptoms experienced by Mapulaneng Hospital transport and maintenance employees were found to be the upper respiratory related signs and symptoms, such as, work related excessive dryness of the nose, itching of the nasal mucosa, excessive running and work related sneezing. Lower respiratory signs and symptoms experienced by Mapulaneng Hospital maintenance were found to be work related coughing, wheezing, breathlessness and phlegm.

5.3.2 To measure the frequency of work related respiratory signs and symptoms.

The frequency of the identified upper respiratory work related signs and symptoms experienced by Mapulaneng Hospital transport and maintenance employees were measured and found to be 64%, 59%, 45% and 36% for excessive dryness, Itching of the nasal mucosa, excessive running of the nose and sneezing, respectively. The

frequency for work related lower respiratory signs and symptoms were found to be 55% for coughing, 20% for wheezing, 20% for breathlessness and 27% for phlegm.

5.3.3 To assess if lifestyle (smoking) and living conditions (household) have an effect on the vulnerability to increase work related problems, like respiratory signs and symptoms.

Smoking was found to be synergistic on breathlessness, wheezing and phlegm. These meant that symptoms of breathlessness, wheezing and phlegm were increased in smokers. Household environment, in relation to the usage of an alternative energy source, was found to be weak and non-significant for the studied respiratory signs and symptoms.

5.3.4 To explore the risk of work related respiratory signs and symptoms by occupational categories

Several occupations in maintenance and transport departments, even those not regarded as dangerous occupations, were found to be the most affected. The prevalence among transport employees was high in other symptoms, whilst their jobs were not regarded as hazardous. The health of this group of employees is at stake, especially because in terms of their occupation the use of PPE is not prescribed. This finding suggested that the environment in which they work is affecting their health. The study found that none of the transport employees was smoking

Based on all the above findings, it can be concluded that Mapulaneng maintenance and transport employees, especially transport section employees, have increased prevalence rates for some of the upper and lower work related respiratory signs and symptoms. Most of the prevalence rates were found to be far above the prevalence rates reported in previous similar studies conducted. For other occupational categories, such as, transport admin employees the study found that their prevalence was extremely increased when compared with their counter parts. The study

explained such findings by a possibility of the sick workshop area they work at.

5.4 Recommendations

Based on the findings of this study the following recommendations are made.

5.4.1 It is recommended that employees should be informed about the findings of this study and the importance of using personal protective equipment when working.

5.4.2 The Occupational Health and Safety section should evaluate the appropriateness and the effectiveness of the PPE supplied for all job categories.

5.4.3 In relation to the high prevalence observed in transport admin and drivers, decision and policy makers at Mapulaneng should relocate the transport office, to an area where the employees will not be exposed until the work environment is made safer.

5.4.4 These findings provide impetus for further research and actions at Mapulaneng Hospital, by Public Health Professionals which will prioritise occupational exposure on the public agenda.

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APPENDICES

Appendix I: University of Venda Research and Ethics Committee Clearance Certificate

SCHOOL OF HEALTH SCIENCES

02 APRIL 2009.

MR. P.LN. RADEBE
P.O. BOX 519
WATERVAL BOVEN
1195

RESEARCH PROPOSAL: RADEBE P.L.N.: STUDENT NO. 11523457

Senex at its meeting, which was held on 18 JULY 2005, has approved the research proposal of the above-named student.

The title of the research proposal is:

"THE PREVALENCE OF RESPIRATORY PROBLEMS AMONG MAINTENANCE AND TRANSPORT DEPARTMENT EMPLOYEES AT MAPULANENG HOSPITAL".

Ethical issues were given attention to.

The purpose of the research is to meet the requirements for the degree of **MASTER OF PUBLIC HEALTH.**

Thank you.

M. MABIDI
SCHOOL ADMINISTRATOR.

UNIVERSITY OF VENDA FOR SCIENCE & TECHNOLOGY
2009 -04- 02
EXECUTIVE DEAN
Faculty of Health, Agriculture, Rural Transformation & Forestry

UNIVERSITY OF VENDA

Appendix II: Department of Health, Mpumalanga Province's approval and permission to conduct the study

health
Department:
Health
MPUMALANGA PROVINCE

No. 7 Government Boulevard
Riverside Park
Extention 2
NELSPRUIT
1200

Private Bag X 11285
NELSPRUIT
1200
Tel.: +27 13 766 3429
Fax: +27 13 766 3458

Litiko LeteMphilo | UmNyango WezaMaphilo | Departement van Gesondheid

Enquiries: Molefe Machaba /Kate Mathe (013) 766 3009/3102

01 JUNE 2009

Mr Philemon Lovers Radebe
Mapulaneng Hospital
P/Bag X9305
BUSHBUCKRIDGE
1280
Mpumalanga

Dear Mr Philemon Lovers Radebe

APPLICATION FOR RESEARCH & ETHICS APPROVAL: THE PREVALENCE OF RESPIRATORY PROBLEMS AMONG MAINTENANCE AND TRANSPORT SECTIONS EMPLOYEES AT MAPULANENG HOSPITAL

The Provincial Research and Ethics Committee has approved your research proposal in the latest format that you sent. No issues of ethical consideration were identified.

Kindly ensure that you provide us with the report once your research has been completed.

Kind regards,

Molefe Machaba
Research and Epidemiology

04-06-2009
Date

Mpumalanga PHREC
Acting Chairperson: M. Machaba.

MPUMALANGA PROVINCE
DEPARTMENT OF HEALTH
PLANNING & INFORMATION
Date
2009 -06- 04
PRIVATE BAG X 11285
NELSPRUIT 1200

04/06/2009

We care Do you?
Sipumelelele

Appendix III: Mapulaneng Hospital permission letter

health
Department:
Health
MPUMALANGA PROVINCE

No. 1 Masana Trust
Graskop Road
BUSHBUCKRIDGE
1280

Private Bag X 9305
BUSHBUCKRIDGE
1280
Tel: +27 13 799 0214
Fax: +27 13 799 0339

Litiko LeteMphilo | Umnyango WezaMaphilo | Departement van Gesondheid

MAPULANENG HOSPITAL

Mr P.L.N. RADEBE
P.O. BOX 519
WATERVAL BOVEN
1195

RE: REQUEST FOR PERMISSSION TO CONDUCT RESEARCH AT MAPULANENG HOSPITAL

1. Your request to conduct research at Mapulaneng Hospital is hereby granted as the research proposal has been approved by the Provincial Research and Ethics Committee.

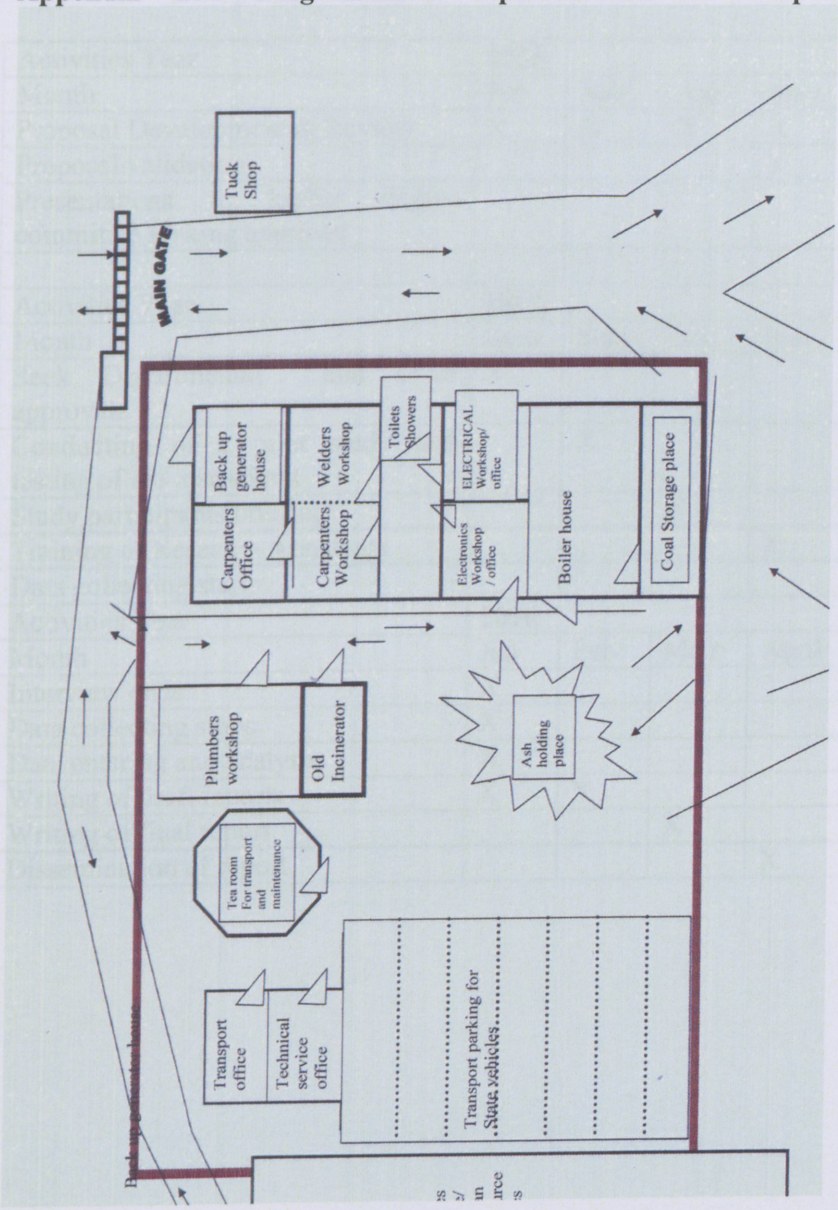
MR M.G. MASHILE
CHIEF EXECUTIVE OFFICER

We care Do you?
Siyanakekela

MPUMALANGA
A Pioneering Spirit

RESTRICTED

Appendix IV: Diagrammatic representation of Mapulaneng Workshop

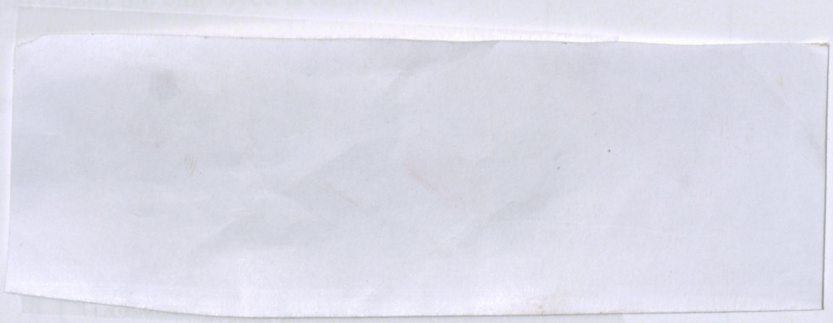


Appendix V: Proposed Work Plan for the Research Study

Activities Year	**2005**					
Month	Feb	Mar	Apr	May	June	July
Proposal Development & Review	X	X	X	X		
Proposal validation				X		
Presentations to higher degree committee seeking approval					X	
Activities Year	**2009**					
Month	June	Sept	Oct	Nov	Dec	
Seek Departmental and other approvals	X					
Conducting of a pilot study and testing of the instrument		X				
Study participants briefing			X			
Training of Research Assistants				X		
Data collecting starts					X	
Activities Year	**2010**					
Month	Jan	Feb	Ma r	April		
Interview ends	X					
Data collecting stops	X					
Data entering and analyses	X					
Writing of draft reports	X	X				
Writing of final report			X			
Dissemination of report				X		

Appendix VI: Estimated Budget For The Study

S/No	ITEM/ACTIVITY	Quantity	Unit Cost/rate R	No. of days	Total SA Rands
1	Payment of Research Assistants	2	80	10	1600
2	Translation of the questionnaires	4	120	1	480
3	Typing Printing Photocopying	3	350	1	1050
4	Editing	1	3000	1	3000
5	Printing and Binding of Study Report	9	420	1	3780
6	Refreshments	3	25	10	750
	TOTAL				14 440



APPENDIX VII: DATA COLLECTION TOOL

QUESTIONS FOR INTERVIEWER ADMINISTERED QUESTIONNAIRE FOR RESPIRATORY SYMPTOMS

This predetermined list of questions will be used in the structured interviews by the interviewer and a uniform way of recording responses will be ensured through training of interviewers. The aim is to structure the interview situation as much as possible in order to ensure that each respondent is exposed to the same questions, which are asked in the same order, with identical phrasing, and as far as possible with the same clues and tones from the interviewer.

Good morning/day/afternoon

Congratulations for being part of the study. My name is: ..... I will be asking you questions according to the list and will help to record your responses.

Questions	For Researcher use only
Part 1: Socio-economic and demographic characteristics of the sample. **Tick appropriate answer or write in where necessary.**	
1.1 **Name of the department** the employee is employed: **1** [ ] Maintenance **2** [ ] Transport	1 [ ]
1.2 **Position occupied** 1 [ ] Driver 2 [ ] Transport Admin 3 [ ] Boiler 4 [ ] Painting 5 [ ] Carpentry 6 [ ] Electrical 7 [ ] Building 8 [ ] Plumbing	2 [ ]

9 [ ] Welding 10 [ ] General worker	
1.3 How old are you : .....Years	3 [ ]
1.4 **Sex:** 1 [ ] Male 2 [ ] Female	4 [ ]
1.5 **Marital Status:** 1 [ ] Single 2 [ ] Married	5 [ ]
3 [ ] Widow 4 [ ] Separated/Divorced	
1.6 **Education**	6 [ ]
1 [ ] No education	
2 [ ] Primary School	
3 [ ] Secondary school or N3	
4 [ ] N4 certificate/diploma	
5 [ ] Bachelor or higher	
1.7 Years of service in your present department: .....years	7 [ ]
1.7.1. Years of Service in groups	
1 [ ] 0 - 10 years 2 [ ] Above 10 years	7.1 [ ]
1.8 How many hours do you spend around the workshop area per day? _____ hours.	8 [ ]
1.8.1 1 [ ] = Less than 4 hrs	
2 [ ] = Above 4 hrs	8.1 [ ]
1.9 Occupational History: Except current occupation	
1.9.1 Have you ever worked in:	
(a) A foundry?(Firm for casting metal) 1 [YES] 0 [NO]	
(1a) If yes, for how long?	9 [ ]
(b) Stone or mineral mining, quarry? 1 [YES] 0 [NO]	10 [ ]
(1b) If yes, for how long?	11 [ ]
(c) Asbestos milling or processing? 1 [YES] 0 [NO]	12 [ ]
(1c) If yes, for how long?	13 [ ]
(d) Other dusts, fumes or smoke? 1[YES] 0[NO]	14 [ ]
(If yes, Specify the type of work	15 [ ]
(2d) For how long?	16 [ ]

	17[ ]
Part 2: History of illness (personal and family)	
Tick √at the choices where applicable	
Personal	
2.1 Have you ever been diagnosed with asthma by a doctor?	
1 [ ] Yes 2 [ ] No (Q 2.2)	18[ ]
If yes, please answer the following questions	
When was it?	
2.1.1 When was it? 1 [ ] Whilst in current job	
2 [ ] Before current job	19[ ]
2.1.2 How was it managed?	
2 [ ] Cure by received treatment 1[ ] Still receiving treatment	20[ ]
0 [ ] Never treated, still remain the same	
2.2 Have you ever been diagnosed with tuberculosis by a doctor?	
1 [ ] Yes 0 [ ] No (Q 2.3)	21[ ]
If yes, please answer the following questions	
2.2.1 When was it? 1 [ ] Whilst in current job	
2 [ ] Previous job	22[ ]
2.2.2 How was it managed?	
2 [ ] Cure by received treatment 1[ ] Still receiving treatment	23[ ]
0 [ ] Never treated, still remain the same	
2.3 Did you ever suffer from any of the following respiratory related allergies?	
(a) Pollen allergy? 1 [YES] 0 [NO] (Q b)	
If yes, were you told by a doctor or own perception?	24 [ ]
Tick one.	
1 [Doctor] 0 [Own perception]	
	25 [ ]

(b) House dust mites allergy? 1 [YES] 0 [NO] (Q c)	
If yes, were you told by a doctor or own perception?	26[ ]
Tick correct one	
1 [Doctor] 0 [Own perception]	
	27[ ]
(c) Allergy to animals? [YES] 0 [NO] (Q d)	
If yes, were you told by a doctor or own perception?	28[ ]
Tick correct one	
1 [Doctor] 0 [Own perception]	
	29[ ]
2.5 Were you ever chest X-rayed by any medical person?	
1 [ ] Yes [ ] No (Q 2.6)	30[ ]
If yes,	
When was it? 1 [ ] Whilst in current job (Q 2.5.1)	
2 [ ] Before current job (Q 2.5.2)	31[ ]
0 [ ] Both (Q 2.5.1) an d (Q 2.5.2)	
If you were x-rayed in both current and previous jobs,	
what were the results?	
2.5.1. Whilst in current job	
2 [ ] Normal 1 [ ] Don't know 0[ ]	
Abnormal	32[ ]
2.5.2. Previous job	
2 [ ] Normal 1 [ ] Don't know 0[ ]	33[ ]
Abnormal	
Family History	
2.6 Have any of your family members ever been diagnosed with	
asthma by a doctor?	34[ ]
1 [ ] Yes 0 [ ] No (Q 2.7)	
If yes, please answer the following questions	35[ ]
2.6.1 How was it managed?	

2 [ ] Cure by received treatment 1[ ] Still receiving treatment 0 [ ] Never treated, still remain the same	
2.7 Have any of your family members ever had tuberculosis diagnosed by a doctor? 1 [ ] Yes 0 [ ] No (Q 2.8)	36[ ]
If yes, please answer the following questions	
2.7.1 How was it managed?	37[ ]
2 [ ] Cure by received treatment 1[ ] Still receiving treatment 0 [ ] Never treated, still remain the same	
Part 3: Household environment and transportation	
3.1 What source of energy do you mostly use at home?	38.1[ ]
4 [ ] Electricity	
3 [ ] Gas	
2 [ ] Coal and/or wood	
1 [ ] Paraffin	
0 [ ] Others? _____	
3.1.1 If your first choice is not available what source do you use?	38.2[ ]
4 [ ] Electricity	
3 [ ] Gas	
2 [ ] Coal and/or wood	
1 [ ] Paraffin	
0 [ ] Others? _____	
3.2 Is your house situated near a factory or workshop?	
0 [ ] Yes 1 [ ] No	39[ ]
If yes, what kind of a factory or workshop?	
3 [ ] Spray Painting workshop or Welding	40[ ]
2 [ ] Filling station	
1 [ ] Sewerage treatment plant	

0 [ ] Others? Specify _____	41[ ]
3.3 If you travel from home to work do you use a dusty road/area?	42[ ]
0 [ ] Yes 1 [ ] No	
If yes, how far is the distance on dusty road in kilometres?	43[ ]
3 [ ] More than 10 km	
2 [ ] Between 5 and 10 km	
1 [ ] Between 1 and 5 km	
0 [ ] Less than 1 km	

Part 4: The frequency of the signs and symptoms in the last 12 months.

Have you had one or more of the following complaints during work in the past 12 months?

Signs and symptoms	**Frequency** **Tick one**	For researcher use only
Lower Respiratory symptoms		
1. Coughing **0 [YES] 1 [NO]**	**[0] A: ALWAYS** (Mostly daily or more than once a day) **[1] O: OFTEN** (Every second day or once weekly) **[2] S: SOMETIMES** (Once a month) **[3] N: NEVER** (Nil to less than 2 times per year)	44[ ] 45[ ]
1.1 How is the problem when on vacation or on leave? 2 [Better] 1 [Same} 0 [Worse]		46[ ]
2 Wheezing	**[0] A: ALWAYS** (Mostly daily or	47[ ]

0 [YES] 1 [NO]	more than once a day) **[1] O: OFTEN** (Every second day or once weekly) **[2] S: SOMETIMES** (Once a month) **[3] N: NEVER** (Nil to less than 2 times per year)	48[ ]
2.1 How is the problem when on vacation or on leave? 2 [Better] 1 [Same} 0 [Worse]		49[ ]
3 Breathlessness **0 [YES] 1 [NO]**	**[0] A: ALWAYS** (Mostly daily or more than once a day) **[1] O: OFTEN** (Every second day or once weekly) **[2] S: SOMETIMES** (Once a month) **[3] N: NEVER** (Nil to less than 2 times per year)	50[ ] 51[ ]
3.1 How is the problem when on vacation or on leave? 2 [Better] 1 [Same} 0 [Worse]		52[ ]
4 Phlegm **0 [YES] 1 [NO]**	**[0] A: ALWAYS** (Mostly daily or more than once a day) **[1] O: OFTEN** (Every second day or once weekly) **[2] S: SOMETIMES** (Once a month) **[3] N: NEVER** (Nil to less than 2 times per year)	53[ ] 54[ ]
4.1 How is the problem when on vacation or on leave? 2 [Better] 1 [Same} 0 [Worse]		55[ ]

Upper Respiratory		
1. Excessive dryness **0 [YES] 1 [NO]**	**[0] A: ALWAYS** (Mostly daily or more than once a day) **[1] O: OFTEN** (Every second day or once weekly) **[2] S: SOMETIMES** (Once a month) **[3] N: NEVER** (Nil to less than 2 times per year)	56[ ] 57[ ]
1.1 How is the problem when on vacation or on leave? 2 [Better] 1 [Same} 0 [Worse]		58[ ]
2. Itching **0 [YES] 1 [NO]**	**[0] A: ALWAYS** (Mostly daily or more than once a day) **[1] O: OFTEN** (Every second day or once weekly) **[2] S: SOMETIMES** (Once a month) **[3] N: NEVER** (Nil to less than 2 times per year)	59[ ] 60 [ ]
2.1. How is the problem when on vacation or on leave? 2 [Better] 1 [Same} 0 [Worse]		61[ ]
3. Excessive running of the nose **0 [YES] 1 [NO]**	**[0] A: ALWAYS** (Mostly daily or more than once a day) **[1] O: OFTEN** (Every second day or once weekly) **[2] S: SOMETIMES** (Once a month) **[3] N: NEVER** (Nil to less than 2 times per year)	62[ ] 63[ ]
3.1. How is the problem when on vacation or on leave? 2 [Better] 1 [Same} 0 [Worse]		64[ ]

3. Sneezing **0 [YES]** **1 [NO]**	**[0] A: ALWAYS** (Mostly daily or more than once a day) **[1] O: OFTEN** (Every second day or once weekly) **[2] S: SOMETIMES** (Once a month) **[3] N: NEVER** (Nil to less than 2 times per year)	65[ ] 66[ ]
3.1. How is the problem when on vacation or on leave? 2 [Better] 1 [Same} 0 [Worse]		68[ ]

Part 5. Lifestyle Questions

	For Researcher use only
For the questions below, tick the most appropriate option	
5.1 Do or have you live/d or stay/ed with a smoking person? **0 [YES]** **1 [NO]**	69[ ]
5.2 Do you work closely with smoking person? **0 [YES]** **1 [NO]**	70[ ]
5.3 Do you smoke? 2 [ ] No I never smoked	71[ ]
1 [ ] I used to smoke but quit	
0 [ ] Yes, I am a smoker	72[ ]
If you currently smoke, how long have you been smoking?.....years	73[ ] 74[ ]
5.4 Do you exercise? ……..	75[ ]
What type of regular exercise? ……	76[ ]
How long do you exercise each session ?.....minutes	
5.5 Is your sleep ever broken **0 [YES]** **1 [NO]**	

Thank you for your time and accurate response. Enjoy your day.

APPENDIX VIII: LETTER OF INTRODUCTION

Hello, I am Radebe Philemon Lovers Ngowakhe from the School Health Sciences: Public Health Department, University of Venda for Science and Technology. I am conducting a study on the prevalence of respiratory problems among maintenance and transport employees at Mapulaneng Hospital. I hereby request you to take part in the study, which is hoped to benefit you, your colleagues, the hospital, the community and the Department of Health.

Please note the following:

- You are not being forced to take part in this study and it is your choice to participate or not. However I would appreciate it if you do share your experiences with me.
- Should you choose not to take part in the study, you will not be affected in any way whatsoever.
- If you agree to participate, you still have a right to discontinue at any stage with no penalties and you will not be prejudiced in any way.

I will not record your name anywhere on the questionnaire and no one will be able to link you to the answers you'll give. The information will remain confidential and there will be no "come-backs" from the answers you give.

The interview will last for plus or minus 45 minutes. I will be asking you a few questions and ask that you be as open and honest as possible in answering these questions. Some questions may be personal and of sensitive nature, do not respond to them. We know that you cannot be absolutely certain about the answers too but I ask you to think about the questions. If you need to speak to me at anytime I can be reached at the following cellular phone number 082 546 1802.

The results of the study will be discussed with maintenance and transport employees and the hospital.

Thank you

Radebe Philemon Lovers Ngowakhe

INFORMED CONSENT

CONSENT

I.....agree to participate as a research subject in this research, titled the Prevalence of Work Related Respiratory Problems among Maintenance and Transport Employees at Mapulaneng Hospital in Mpumalanga Province.

I have been given full explanations on how the study will be conducted and the role I am expected to play. I have also been informed that there are no risks involved and that my anonymity and confidentiality will be ensured.

Furthermore I was assured that I am not forced to participate and that I can still withdraw from the study at any stage.

Participant's Signature: .....

Date: .....