Occupational Exposure to Tuberculosis among Health Care Workers: Retrospective Cohort Study at Health facilities in Lusaka, Zambia

By

Nachombe Nang'amba

MSc Epidemiology

A dissertation submitted to the University of Zambia in partial fulfillment of the requirements of the degree of Master of Science in Epidemiology.

The University of Zambia, Lusaka

Supervisor: Dr G. Chongwe

Co Supervisor: Mrs. N.S. Munyinda

Dr D. M Chanda

2016

TABLE OF CONTENTS

CHAPTER 5

CHAPTER 6

CHAPTER 7

7.0 APPENDICES

List of tables

DECLARATION

This dissertation is the original work of **Nachombe Nangámba**. It has been done accordance with the guidelines for dissertations for the University of Zambia. It has not been submitted elsewhere for a degree at this or another University.

Signature……

Date……

CERTIFICATE OF COMPLETION OF DISSERTATION

I..... hereby certify that this dissertation is the product of my own work and, in submitting it for the Degree of Master of Science in Epidemiology programme, further attest that it has not been submitted to another University in part or in whole for the award of any programme.

Signature……

Date…….

Supervisor

I, …… having supervised and read this dissertation is satisfied that this is the original work of the author under whose name it is being presented.

I confirm that the work has been completed satisfactorily and is ready for presentation to the examiners.

Supervisor's signature……

Date……..

Head of Department……..…….

Signature…….

Department…….

CERTIFICATE OF APPROVAL

The University of Zambia approves this dissertation of Nachombe Nangámba in partial fulfillment of the requirements for the award of the degree in Master of Science in Epidemiology.

Examiner's signature	**Date**
……..	……
……..	……...
……..	……...

DEDICATIONS

I dedicate this work to the glory of God without which I would not have seen this project to completion.

ACKNOWLEDGEMENTS

Firstly I would acknowledge and appreciate my supervisors for the continued support, patience, mentorship and encouragement rendered during the course of this project.

Secondly I would like to acknowledge all my other mentors who have encouraged and provided guidance to me despite the various challenges encountered at different levels.

A special acknowledgement goes to my friends (especially the BC) and my classmates who have been a never ending support group till the completion of this work.

I would like to thank my friends and family for their continued supported and understanding during the time of my studies.

Most importantly a special thank you to my husband Joel Kandila, for the sacrifices made and being a never ending source of support and encouragement during the time of my studies.

ABBREVIATIONS

AIDS	Acquired Immune Deficiency Syndrome
DOTS	Directly Observed Therapy Short-course
DR-TB	Drug Resistant Tuberculosis
HBCs	High Burden Countries
HCWs	Health Care Workers
HIV	Human Immunodeficiency Virus
IP	Infection Prevention
KAP	Knowledge Attitude and Practice
LDMO	Lusaka District Medical Office
LMIC	Low and Middle Income Countries
LTBI	Latent Tuberculosis Infection
MDG	Millennium Development Goals
MDR-TB	Multi-Drug Resistant Tuberculosis
NTP	National Tuberculosis Program
OHSA	Occupational Health and Safety Act No. 36 of 2010 of the Laws of Zambia
PHA	Public Health Act Cap 295 of the Laws of Zambia
PLWH	People Living with HIV
PIS	Participant Information Sheet
PPE	Personal Protective Equipment
ROC	Receiver Operating Characteristic
STI	Sexual Transmitted Infection
SSA	Sub – Saharan Africa
TB	Tuberculosis
UNZABREC	University of Zambia Biomedical Research Ethics Committee
UTH	University Teaching Hospital
WHO	World Health Organization
XDR-TB	Extensively Drug Resistant Tuberculosis

OPERATIONAL DEFINITIONS

Health Care Workers (HCWs): Individuals who are employed under Zambian Ministry of Health deployed under Lusaka district and work from TB high risk areas.

Personal protective equipment (PPE): Instruments or equipment that can be used by an individual as a barrier to protect themselves from infection or injury.

Prevalence: Is the total number of cases of a disease in the population, at that particular time.

Incidence: Is the number of new cases of a disease in the population over a period of time.

Nosocomial infection: Infections that are acquired in the hospital setting. These infections are commonly occurring among HCWs as a result of occupational exposure.

Latent TB: Refers to an individual that has acquired TB infection but does not have active disease and is non infectious.

Active TB: Refers to an individual who as developed TB disease and is infectious.

Occupational exposure: These are exposures that occur due to an individuals working environment.

TB high risk area: This refers to areas within the health facility where TB patients or samples from TB patients are found or handled.

Exposed: HCWs identified to be working from TB high risk areas.

Unexposed: HCWs who do not work from the TB high risk areas.

CHAPTER 1

1.0 ABSTRACT

Tuberculosis (TB) is classified as one of the occupational diseases and Health Care Workers (HCWs) are considered one of the vulnerable groups to acquiring TB due to its mode of transmission. The health facility being a source of infection for the HCWs creates a vicious cycle of TB infection back to the communities. This study aimed to establish the burden of TB among HCWs, assess the working environment of HCWs working from high risk areas as well as understand their perceptions with regards infection prevention and the use of Personal Protective Equipment.

A concurrent mixed methods study design was used with the larger part being quantitative. The study combined retrospective cohort and qualitative case study designs. Information on TB cases amongst HCWs at facilities that offer TB services was gathered. A checklist was used to assess environmental working conditions. Interviews with HCWs from high risk areas using a semi-structured questionnaire was used in the qualitative study. The quantitative data collected was analysed using Stata version 12. Descriptive characteristics, univariate and multivariate analysis using logistic regression was done providing crude and adjusted odds ratios. Thematic analysis was used to analyse the qualitative data by establishing themes. Triangulation was done at discussion phase of the study.

The prevalence of TB among HCWs was 1801 per 100,000 persons. This is three times higher than that of the general population in Zambia. The TB low risk area accounted for 70% of the TB cases recorded. Majority of cases recorded were female (61.5%). Professionals had the highest recorded cases of 47%. Adjusting for professionals Community volunteers and Support staff had increased odds of 8.6 (AOR 8.2 CI, 1.61-41.6) and 1.11 (AOR 1.4 CI, 0.23-8.52) of acquiring TB respectively. All health facilities largely depended on natural ventilation although mechanical ventilation was applied where natural ventilation was insufficient.

Interviews revealed that all HCWs were aware of TB, its modes of transmission and that they were at risk. The respondents felt that they were better placed as they were more likely to exercise caution compared to HCWs from low risk areas. This is largely due to the fact that they handled confirmed cases of TB. Similar studies should be done for HCWs from TB low risk areas. Periodic screening for TB among HCWs should be encouraged to provide better monitoring and evaluation of surveillance data and infection prevention measures.

CHAPTER 2

2.0 BACKGROUND

Tuberculosis (TB) is a chronic infectious disease caused by *Mycobacterium tuberculosis.* It is still one of the world's leading infectious diseases associated with high morbidity among communities in low and middle income countries (LMIC) (Klimuk *et al*., 2014). TB is an airborne acquired infection which results from the inhalation of bacilli that are spread through coughing or sneezing from someone with active TB. According to the 2014 World Health Organization (WHO) World TB report, there were 9 million new cases in 2013 and 1.5 million deaths (1.1 million among the HIV-negative people and 0.4 million among the HIV-positive people) (Zumla *et al*., 2015).

The prevalence of TB is high in low and middle income countries and as a result, TB is sometimes referred to as a disease of poverty (Lienhardt *et al*., 2002, Lonnroth *et al*., 2009). High prevalence of TB is characterized by barriers in treatment, poor diagnosis and poor reporting (Chanda and Gosnell, 2006, Lienhardt *et al*., 2002). The WHO has classified the worst affected countries as the TB High Burden Countries. There are 22 countries in this category of high prevalence rates and majority of them are in sub-Saharan Africa (SSA) and Asia (Zumla *et al.*, 2015). According to surveillance in Zambia, the incidence of TB per hundred thousand people has been reported to be about 350 to 500 which is considered as high but Zambia still does not fall under the 22 countries categorized as TB high burden countries (Kapata, 2014). The first National TB Prevalence Survey in Zambia conducted in 2013 - 2014 indicated that the prevalence of TB is at 455 per 100,000 persons (Kapata *et al*., 2016). Zambia has been established as one of the 41 high TB/HIV-burden countries, the high incidence of TB among people living with HIV (PLWH) (WHO, 2015).

TB is transmitted by inhalation of droplet nuclei that is released from an infected individual with active TB (Klimuk *et al*., 2014). However one does not always develop active TB disease after being infected with the infectious bacilli. This is because the body is able to contain the bacilli and prevent it from spreading further and causing harm when the person's immunity is strong. This means that a person can be infected with TB and not have TB disease unless their immunity is compromised (Lienhardt *et al.*, 2002). This is referred to as latent TB. One can have latent TB for all their life and it may never develop into active disease. When one has latent TB they cannot transmit the infection to other people. However,

once the immunity is compromised, active disease can develop and the individual becomes infectious (Lienhardt *et al*., 2002).

Given that the mode of transmission of TB is airborne, it poses an even greater potential risk of infection for the Health Care Workers (HCW) in health facilities (Sehulster and Chinn, 2003). HCWs are classified as one of the vulnerable populations to acquire latent TB (Casas *et al*., 2013). Various health professionals are vulnerable in different ways. The most vulnerable are those who work from TB high risk areas in health facilities (Anderson *et al*., 2007). This is because these HCWs come into close contact with TB suspects and confirmed patients almost on a daily basis in their quest to provide health care.

It has been previously documented that more than 50% of HCWs worldwide are estimated to have latent TB infection with an overwhelming majority of cases among HCW in Health facilities in the low and middle-income countries (Tudor *et al.*, 2014). The lack of proper personal protective equipment (PPE), improper engineering of hospital facilities (buildings) to accommodate both HCWs and TB patient, and inadequate ventilation are some of the attributed reasons to this increased risk (Casas *et al*., 2013). Lusaka, the capital city of Zambia has a population of approximately 2 million people. Lusaka district alone has the highest number of cases reported among districts in Zambia (Kapata, 2014). The District has 29 clinics and three (3) hospitals operating under the Lusaka District Medical Office (LDMO) and Ministry of health (MoH) respectively. Studies have shown that HCWs operating from high TB high risk areas are at higher potential of acquiring latent TB and subsequently developing disease. Thus some studies have classified TB as an occupational disease (Menzies *et al.*, 2007).

2.1 STATEMENT OF THE PROBLEM

Zambia has one of the highest ranked incidence rates of TB. It is ranked the 13th highest incidence rate of TB in the world with an incident rate of 350 to 500 per 100, 000 population (Kapata, 2014). This therefore shows that TB is still a major cause of mortality and morbidity in the country. Lusaka, the capital city of Zambia accounts for up to 37% of the nation's TB prevalence. This is the country's highest incidence rate of TB (Kapata, 2014).

The HCWs in Lusaka District are highly likely exposed to TB during the course of their work due to its mode of transmission (airborne). HCWs operating from TB high risk areas attend to TB patients at different times and frequency of contact is unknown. This poses a risk of acquiring latent TB which can eventually develop into disease (Casas *et al*., 2013, Kapata, 2014, Tudor *et al.*, 2014). The danger in this, is that HCWs are at a higher risk of acquiring TB from patients with active TB and can then become potential sources of infection within the hospital, to their immediate families and the community (Chen *et al*., 2010, Joshi *et al*., 2006).

Literature has shown that the incidence of TB among HCWs is not well documented in most countries. Although studies done so far even in high income countries have indicated that the prevalence of TB in this vulnerable group is two (2) and in some instances three (3) times that of the general population (Cuhadaroglu *et al*., 2002, Jo *et al*., 2008, Joshi *et al*., 2006, Kanjee *et al*., 2011, Menzies *et al*., 2007, Tudor *et al*., 2014).

Currently there is no published information as to the extent or risk of hospital acquired TB by HCWs in the health facilities of Lusaka District. This study will endeavor to find out the prevalence of TB among HCWs and the possible potential hazards in their working environment.

2.2 LITERATURE REVIEW

2.2.1 GLOBAL BURDEN OF TB

According to the WHO, the global burden of Tuberculosis in 2014 was approximately 9 million new cases and 1.5 million deaths. The 22 High Burden Countries (HBCs) account for approximately 80% of the global TB burden. TB is still the second highest cause of morbidity from infectious disease after HIV. The Stop TB Partnership has seen a reduction globally in the TB incidence by about 1.5% per year between 2000 and 2013. However The Stop TB Partnership is still yet to meet its target of 50% of reduction in prevalence of TB by 2015 compared to 1990. In a bid to meet this target by the time period of the Millennium Development Goals (MDG), The Stop TB Partnership developed the The Stop TB Strategy (2006-2015). This was developed to accommodate the gaps in the DOTS programme and it encompasses activities such as the Intensified Case Finding, Isoniazid Preventive Therapy for people living with HIV and Infection Control Practices (Ayles *et al*., 2009, Zumla *et al.*, 2015).

The prevalence of TB worldwide has been exacerbated by co-infection with Human Immunodeficiency Virus (HIV). Most TB HBCs have a high incidence of HIV infection. TB HIV co-infection has been documented to be the leading cause of death, amongst people living with TB (Zumla *et al*., 2015).

The sixth Millennium Development Goal (MDG) includes the mandate to reduce the incidence of TB through the strategies implemented in the Stop TB Strategy through to the end of 2015. This was developed to address gaps that were seen after DOTS was implemented. WHO however has developed yet another vigorous campaign to be implemented after 2015 called the "End of TB Strategy" with a target set to end TB by 2035 (Lonnroth *et al*., 2009, Zumla *et al*., 2015).

Majority of the TB HBCs are in Africa and Asia (Ayles *et al*., 2009, Viney *et al*., 2014). WHO, 2014 World TB report indicated that Sub – Saharan African countries had a high prevalence of TB (Zumla *et al*., 2015). A study done in South African, Kwa-Zulu Natal showed a prevalence of TB of more than 1000 per 100,000 persons per year with 70% of them having HIV co-infection and more than 1200 MDR-TB cases reported per year. This high prevalence has been attributed to TB-HIV co-morbidity (Kanjee *et al*., 2011). TB has

been classified as a disease of poverty and thus the worst affected people are those with low economic status (Tanimura *et al*., 2014, Viney *et al*., 2014).

2.2.2 BURDEN OF TB IN ZAMBIA AND LUSAKA

TB in Zambia is a major cause of morbidity and mortality especially among people living with HIV (Ayles *et al*., 2009). Zambia, although not among the 22 TB HBCs is ranked 13th with the high incidence rate of 350 to 500 cases reported per 100,000 persons (Kapata, 2014). The high burden of TB in Zambia has been attributed to the high burden of HIV in the country with a prevalence of about 70% among TB patients (Ayles *et al*., 2009, Kapata *et al*., 2011).

The burden of TB in Zambia had escalated from 1990 the years before the introduction of the Daily Observed Treatment (DOTS) Short-course. This was due to the introduction of the Health Reforms which saw a near collapse of the National TB Control Programme (NTP) when vertical health programmes were abolished and integrated on the general health system. At the time of the collapse of the NTP, WHO did not receive any information from Zambia regarding the prevalence of TB from 1997 to 1999 (Kapata *et al*., 2011).

Trends in the high number of cases of TB in Zambia occur in areas along the line of rail and in most urbanized areas. Lusaka, the capital city of Zambia has the highest incidence of TB and accounts for about 37% of the country's burden of the disease (Kapata, 2014).

2.2.3 PREVALENCE OF TB AMONG HEALTH CARE WORKERS

HCWs found in the TB high risk areas are among the most vulnerable groups of people in society to develop TB. Thus TB has been established as an occupational disease for HCWs. Some studies have shown that the risk of TB among HCWs is approximately two or three fold that of a given population in an area (Anderson *et al*., 2007, Cuhadaroglu *et al*., 2002).

Due to the mode of transmission of TB, HCWs found in TB high risk area are more likely to acquire latent TB through nosocomial infection. A study done to assess the prevalence of TB among HCWs in England and Wales had shown that even though the general population had a low prevalence of TB, it was still relatively higher among HCWs (Anderson *et al*., 2007).

Similar studies carried out in Turkey and the Netherlands indicated similar results and further recommended that the health status of HCWs be appropriately monitored through pre-employment screening and periodic monitoring. This would greatly assist in reducing the incidence of TB among HCWs (Cuhadaroglu *et al*., 2002, de Vries *et al*., 2006).

2.2.4 OCCUPATIONAL RISKS ASSOCIATED WITH HOSPITAL ACQUIRED TB

TB has been established as an occupational diseases and it affects HCWs of different professions. According to WHO findings from systematic reviews the relative risks of acquiring the Latent TB infection (LTBI) in high income countries was 10.06 and in low income countries was 5.77. The relative risk of acquiring TB disease in low income countries was 5.77 and in high income countries was 1.99. According to Menzies *et al,* relative risk of TB in HCWs in low income countries is high due to the high burden of disease, whilst in high income countries it is still relatively high due to the concentration of care of TB patients (Menzies *et al*., 2007, Tudor *et al*., 2014, WHO, 2009).

The risk of acquiring *Mycobacterium tuberculosis* from patients to health care workers in the hospital settings is not well monitored. According to Joshi *et al*., the risk of hospital acquired TB in low and middle income countries is attributed to the lack of resources that are provided to prevent nosocomial transmission of TB. In the USA, the Centre for Disease Control (CDC) has provided guidelines that are being used to minimize the potential exposure to *M. tuberculosis* through air space shared with infectious TB (Jensen *et al*., 2005, Joshi *et al*., 2006).

The WHO Stop TB Strategy has the 3 I's implemented in a bid to meet its aims with regards to the MDGs. The three I's include, Isoniazid Preventive Therapy for people living with HIV, Intense Case Finding and Infection Control Practices. In order to effectively run a TB infection control programme it must comprise of administrative, environmental and respiratory protection components (Zumla *et al*., 2015).

2.2.5 ADMINISTRATIVE TB INFECTION CONTROL IN HEALTH FACILITIES

The hospital administration plays a key role in protecting HCWs from acquiring TB due to occupational exposure. This however is largely dependent on the available resources (Tudor *et al*., 2014). In low income countries resources allocated to the health sector must be shared. The opportunity cost of not providing for instance routine screening of TB for HCWs and lack of training on occupational TB leads to the spread of Latent TB. This subsequently leads to development of disease among HCWs and the spread of infection to the communities (Kanjee *et al*., 2011). At facility level, hospital administration should provide services of their HCWs through an infection control committee (Jensen *et al*., 2005, WHO, 2009).

A study done in Taiwan based on the perceptions of HCWs who had suffered from TB indicated a need to have the hospital management look into surveillance of occupational infections and frequent training of HCWs on occupational exposure to TB as well as the use of PPE. It was further noted that administrators should not take for granted that HCWs from their academic training are exposed to various type of infection prevent equipment and its relevance. This study also brought to light that structural short falls of the working environment i.e. the poor ventilation in some isolation rooms was also a contributing factor (Chen *et al*., 2010).

A similar study done in South Africa in 2011 showed that even though N95 respirators had been provided for the HCWs attending to MDR-TB patients, this did not prevent the further spread of infection. This was because some of the HCWs did not know how to properly use the N95 respirators and did not know the difference with the other respirators provide (Kanjee *et al*., 2011).

2.2.6 ENVIRONMENTAL TB INFECTION CONTROL IN HEALTH FACILITIES

The environment a HCW is subjected to when attending to TB suspects or patients is of utmost importance. Due the mode of transmission of TB the working environment of the HCW can either enhance or have a preventive effect to acquiring the infection. Some studies indicate that having inadequate ventilation, leading to inadequate exchange of air flow in a room (either natural or mechanical) can further increase the risk of getting infected with TB (da Costa *et al*., 2011). Therefore a building structure must be tailored to help prevent the

further spread of infection as well protect the HCWs (Jensen *et al*., 2005, Sehulster and Chinn, 2003, WHO, 2009).

2.2.7 PERSONAL PROTECTIVE EQUIPMENT

PPE is an essential barrier for biological contaminants. The provision and proper use of PPE is dependent on the Health Facility (administration) and the knowledge of the HCW (Chen et al., 2010, Tudor et al., 2014). There are different levels of vulnerability to acquiring TB for HCWs, largely due to profession and frequency in contact with TB patients or TB suspect (Jo *et al*., 2008). A study by Chanda, showed that in Zambia, nurses had a higher chance of acquiring TB due to their close and frequent contact with TB patients or suspects (Chanda and Gosnell, 2006). However, recommendations from the CDC and WHO have shown that actually all HCWs have a potential chance of acquiring infection (Jensen *et al*., 2005, WHO, 2009). As such the use of PPE accompanied with other preventive measures is important in order to protect people working from a TB high risk area from getting TB (Chen *et al*., 2010).

2.2.8 LEGAL CONSIDERATIONS

TB is a notifiable disease in accordance with the Public Health Act, CAP 295 of the Laws of Zambia (PHA) under PART III, Sections 9 and 10. All care providers attending to TB clients are expected to ensure that such cases are notified in line with the Government polices such the National HIV/AIDS/STI/TB Policy and the Tuberculosis and TB/HIV manual which have been designed to ensure prompt and efficient response to the disease (Government of the Republic of Zambia, 1930).

The Occupational Health and Safety Act, No. 36 of 2010 of the Laws of Zambia (OHSA) under PART IV Sections 15, 16 and 17 provides information on the duties of employees and employers with regards to the health and safety of an employee in work place (Government of the Republic of Zambia, 2010).

However, these pieces of legislation do not clearly bring out the issues of employee health and safety in relation to hospital acquired infections such as TB for HCWs. Further the OHSA No. 36 of 2010 of the Laws of Zambia also needs to provide more specific information to employers and employees with regards to health and safety for different sectors of work (Government of the Republic of Zambia, 2010, Government of the Republic of Zambia, 1930).

CHAPTER 3

3.0 JUSTIFICATION/RATIONALE

In the bid to achieve the global "End of TB Strategy" beyond 2015, the WHO and its member states (Zambia inclusive) have an undoubtable task of eliminating all potential sources of TB infection (Zumla et al., 2015). Among the major challenges of ending TB is the issue of addressing the social determinants of TB that cause barriers to successful treatment and control of TB (Chanda and Gosnell, 2006, Kapata, 2014, Zumla *et al*., 2015).

Failure to monitor and prevent hospital acquired TB can result in a potential source of infection of TB for patients in the hospital with other illness and their care givers "the HCWs". In as much as HCWs offer their services in the plight to cure TB, they too are vulnerable to acquiring the infection. HCWs can serve as a potential reservoir for infection to the public (Chen *et al*., 2010).

As earlier alluded to, the prevalence of active TB amongst HCWs is not well documented especially in middle and low income countries (Menzies *et al.*, 2007). Issues of poor reporting in case of illness among HCWs, lack of frequent staff training on the importance and use of PPE and adequate screening measures for hospital acquired TB can lead to the further spread of infection within the hospital and in the community (Chen *et al*., 2010, Kanjee *et al*., 2011). Due to the nature of their work, HCWs are at risk of acquiring many infectious diseases including TB.

This study established prevalence of TB among HCWs in Lusaka and provided a means of appreciation for need of the surveillance of hospital acquired TB for the safety of HCWs. A study conducted by Chanda in 2006, only focused on nurses acquiring TB from patients at UTH (Chanda and Gosnell, 2006).

This study encompassed all health workers including supporting staff and community volunteers as they too are exposed by working in the health facilities. Through this study information on the burden of TB in HCWs will be known and can be used to infer to the situation in Zambia as well as add to the body of knowledge.

Further the information from this study can be used by program implementers to develop policies and occupational health safety measures in order to protect HCWs from acquiring TB infection founded on evidence.

The aim of this study is to establish prevalence of TB among HCWs and risks that are associated with their working environment in Lusaka's health facilities.

3.1 RESEARCH QUESTIONS

- Is the occupational environment HCWs are exposed to a contributing factor to acquiring TB?
- Do the HCWs have sufficient knowledge on TB prevention and infection prevention barriers and an adequate supply of personal protective equipment?

3.2 OBJECTIVES

3.2.1 GENERAL OBJECTIVE

1. To determine occupational exposures to TB in Health Care Workers working from TB high risk areas and assessing the factors related to infection control in health facilities in Lusaka District.

3.2.2 SPECIFIC OBJECTIVES

1. To establish the prevalence of TB amongst HWCs in the health facilities of Lusaka District.
2. To assess the environmental conditionals at TB High risk areas in health facilities.
3. To establish the knowledge on TB prevention and infection prevention barriers among HCWs.

CHAPTER 4

4.0 METHODOLOGY

4.1 STUDY DESIGN

This study used a concurrent mixed methods study design. This means the study encompassed both quantitative and qualitative study designs. The greater part of this study was quantitative. The qualitative component was triangulated at the interpretation stage. Data collection for both components of the study was collected and analyzed separately. Detailed account on the actual types of study design and subsequent methodology for each component of the study (quantitative and qualitative) have been further explained in the text.

4.2 STUDY SETTING

This study was conducted in health facilities in Lusaka under the jurisdiction of the Lusaka District Medical Office (LDMO). Lusaka district has 29 clinics spread around the district. Other health facilities include the hospitals in the district namely Levy Mwanawasa General Hospital, Chainama Hospital and University Teaching Hospital. Lusaka has 32 health facilities under MoH, of which only 25 facilities offer TB health services.

TB health services offered at health facilities in Lusaka vary according to the catchment population, the demand for the service at a particular health facility as well the availability of personnel to provide various services. TB health services offered included outpatient treatment and diagnostics services. Outpatient treatment facilities facilitate for TB patients receiving DOTS. TB diagnostic services offered at health facilities included laboratory and radiology services.

All health facilities that offer TB health services offered outpatient treatment services. However TB diagnostic services were not available at all health facilities. This was attributed to the demand for the service in a particular catchment area and the availability of skilled personnel. Lusaka has 8 health facilities that offer only TB outpatient services facilities. These facilities record less than 50 new cases of TB annually. The remaining 17 health facilities offer diagnostic services of which only 8 provide for both radiology and laboratory services. These facilities may record from 50 to over 500 new cases of TB annually.

Information for the study was collected from 22 clinics and one hospital. This was due to two clinics being located in the outskirts of Lusaka district and one hospital did not have available documented information needed for the purposes of this study. The health facilities included in this study had a total of 5773 HCWs i.e. MoH staff and community volunteers.

In the aim of bringing TB health services closer to the communities in Lusaka, the LDMO had in some health facilities improvised the use of structures. This means some structures used by HCWs to provide TB health services are not purposefully designed for such an activity to be carried out. The improvised structures used for TB health services were either made of permanent building material (in this case a room of a building) or temporal in nature (in some cases made of prefabricated material or a pitched tent).

4.3 QUANTITATIVE STUDY

This component of the study was an analytical study design which took a retrospective cohort study approach. In order to establish the number of HCWs in Lusaka district that had developed TB, the study looked at records from 2010 to 2014. A check list developed was used to determine the risks associated with the line of work in the high risk areas. This was done for each health facility visited.

4.3.1 STUDY POPULATION

The study population included all HCWs who had worked in the Lusaka District health facilities from January, 2010 to December, 2014.

ELIGIBILITY CRITERIA

The study included all employees of Ministry of Health under LDMO who had worked between the January 2010 and December 2014 at the health facilities visited. Students on practical training and community volunteers who developed TB during the period of interest were also considered in the study.

4.3.2 SAMPLE SIZE CALCULATIONS

The prevalence of TB in Zambia had been established at 13.5% with an incidence rate of 350 to 500 per 100000 persons (Kapata *et al*., 2011, Kapata, 2014). Literature showed that the prevalence of TB among HCWs was two to three fold that of the general population (Jo *et al*., 2008, Joshi *et al*., 2006). This study took the conservation approach and used two-fold as an

estimate for prevalence of TB among HCWs in Lusaka. Therefore an estimated prevalence of 27% (13.5 x 2) was considered for sample size calculation for this study. The sample size calculation using the proportions formula as shown below:

Formula: $$n = \frac{(Z_1 + Z_2)^2 \times 2p\,(1 - p)}{(p_2 - p_1)^2}$$

$$n = \frac{(Z_1 + Z_2)^2 \times 2p\,(1 - p)}{(p_2 - p_1)^2}$$

$$n = \frac{(1.96 + 0.84)^2 \times [2 \times 0.2025\,(1 - 0.2025)]}{(0.135 - 0.27)^2} = 138.9$$

n = sample size
Z_1 = 1.96 for 95% confidence interval
Z_2 = 0.84 for 80% power
P_1 = proportion in exposed group, 0.27
P_2 = proportion in unexposed group, 0.135
$P = (p_1 + p_2)/2$ average of p_1 and p_2

A sample size (n) 140 participants was considered the upper limit of the sample size calculated. Adjusted for non-response of 50% the sample size was considered at,

$$n = \frac{140}{0.5} = 280$$

The sample size was 280 participants in each group adjusted for 50% non-response. Therefore total sample size for both the exposed and unexposed was 560 samples.

4.3.3 SAMPLING PROCEDURES

Lusaka has 32 health care facilities which are classified as primary, secondary and tertiary health facilities. Only 25 facilities in Lusaka offer TB health services. This study purposefully included all health facilities offering TB health services. However, the study collected information from 21 primary health care facilities and one tertiary health care facility. All available records of TB cases among HCWs were collected from the 22 health facilities included in the study.

4.3.4 OUTCOME AND PREDICTOR VARIABLES

This part of this study had dependent and independent variables as follows;

- *Dependent Variable:* confirmed cases of TB in HCWs from health facility records during the period of study. This variable was categorical and had a binary outcome.

- *Independent Variables:* these included age, sex, profession, type of TB acquired, department HCW was deployed to and area of residence. This information was collected using the available records.

- Data collected using the checklist was as follows, type of ventilation, provision of Personal Protective Equipment (PPE), type of PPE available/provided, use of PPE when attending to TB patients.

4.3.5 DATA COLLECTION

Data was sought from the records at health facilities containing information on the TB notification for HCWs. A table containing the variables of interest has been designed for collecting data from the hospital records (refer to appendix I). Each health facility will be allocated a separate information table.

Observations were made with the aid of a checklist developed (refer to appendix II) in order to establish the prevailing situations in the TB high risk areas with regards ventilation and personal protective equipment.

4.3.6 DATA ANALYSIS

All the information gathered during data collection was checked for accuracy and completeness before it was used in the analysis stage of this study. All continuous data were made categorical. Frequency distributions and percentages for each category were analyzed using Stata Version 12. Associations were tested using Pearson's Chi-square and Fisher's exact test Chi-square (where observations are less than five) with P-value considered significant at less than 0.05 and confidence level of 95%. Logistic regression using a logit link function was used for univariate and multivariate analysis as the outcome variable (exposure to working from TB high risk area) had a binary outcome. A stepwise logistic regression was done to establish the best predictors of developing TB disease associated with exposure to working from a TB high risk area. These included only variables that where

significant at multivariate analysis. The best model was then tested using the Likelihood Ratio test. Thereafter performance of the model was determined using the Receiver Operating Characteristic (ROC) curve.

4.4 QUALITATIVE STUDY

This component was a qualitative case study design that established the perceptions of key informants, the HCWs who work in the high risk areas from selected health facilities visited. This was done by the means of a Knowledge, Attitude and Practice (KAP) survey aided by a semi structured questionnaire.

4.4.1 STUDY POPULATION

The study population included selected HCWs that were found to be working in the TB high risk areas in the health facility at the time of the study.

ELIGIBILITY CRITERIA

Participants of the interviews were health facility employees and community volunteers who were working from the TB high risk areas at the time of the study.

4.4.2 SAMPLING PROCEDURE AND SAMPLE SIZE

The health facilities were categorized according to the TB health services offered in order to understand perceptions and experiences of HCWs at different levels of service delivery. The categories developed for the health facilities were as follows;

Category one: Health facility offering outpatient services, laboratory services and radiology services.

Category two: Health facility offering outpatient services and laboratory services.

Category three: Health facility offering outpatient services only.

Participants were purposefully selected bearing in mind the type of work a HCW is engaged in at the health facility. Only those that gave informed consent were interviewed. Interviews were conducted until the researcher had reached a point of saturation; the total sample of the qualitative study thereby stood at 13 participants.

4.4.3 DATA COLLECTION AND ANALYSIS

The qualitative part of this study used a thematic approach to achieve its objective. Below are the themes that were developed and used to analyze the data:-

1. Duration of work in the high risk area.
2. Knowledge on transmission of TB.
3. Knowledge on exposures associated with their work.
4. Knowledge on importance of safety measures.

Data was acquired from interviews that were conducted using a semi-structured questionnaire with open ended questions to ensure that the respondents were not restricted when responding to a question (refer to appendix V). This allowed for respondents to give in-depth accounts of their understanding of infection prevention and occupation exposure issues. The interviews were recorded using a voice recorder to ensure all the respondents response was captured and for easier transcribing before analysis. The recordings were then transcribed and manually searched for common terms and meanings from the responses given for each question by each respondent. This was done by reading and re-reading the transcribed notes thereafter highlighting and recording of common terms and meanings. These were then gathered and themes were then defined, named and recorded. The data used in this study was collected only by the principal investigator.

This information obtained was then triangulated into the results analyzed from the quantitative part of the study. The recorded interviews obtained during this study will be disposed off at the end of the study period.

4.5 ETHICAL CONSIDERATIONS

Ethical approval was obtained from UNZABREC to be able to conduct the study. Permission was then sought for from Lusaka District Medical Office and University Teaching Hospital management to carry out the study within their facilities.

The ethical issues that were encountered during this study include;

- The risk that health status of the employees working in the health facilities would be exposed.
- The risk of the breach of confidentiality for the employees picked for the KAP survey.
- Loss of time due to participating in the interview for HCWs who consented to take part in the study.

Permission from the custodians of the Health Files of HCWs was sought before undertaking the study. Information from the TB registers and information collected from respondents after the interviews was kept confidential. De-identification by use of codes developed by the principal investigator was used to ensure that all information collected was not easily linked to the source thus protecting their identity.

Informed consent from the interview participants was obtained before commencement of the interviews using the Participant Information Sheet (PIS) (refer to appendix III). Then the participant agreed to participate in the study by signing on a consent form (refer to appendix IV). High levels of confidentiality were maintained to protect the identity of the respondents.

CHAPTER 5

5.0 RESULTS, DATA ANALYSIS AND INTEPRETATION

The results and analysis of the quantitative and qualitative components of the study had been presented separately. The various methods used for the analysis have been indicated and the interpretation of each of the results have been given thereof. Below are the findings in relation to the study objectives.

5.1 QUANTITATIVE RESULTS AND ANALYSIS

5.1.1 PREVALENCE OF TB AMONGST HCWs IN LUSAKA

1. Descriptive characteristics of HCWs who developed TB disease from January 2010 to December 2014.

The study was able to establish a total of 104 cases of TB among health care workers from 22 health facilities visited between the period of January 2010 to December 2014. Most number of cases recorded was in the year 2014 with 40 cases recorded from the total of 104. Female HCWs had the most recorded cases of TB during the period of study compared to the male HCWs accounting for 62% and 38% respectively. The study results showed that the population of HCWs with the most recorded cases was professionals with nurses accounting for almost half of the cases of professionals. The study established that department with the most number of cases recorded HCWs with TB was the Outpatient department. The findings have been further illustrated in table 1 below:

Table 1: Frequency distribution of descriptive characteristics of HCWs with TB recorded in the TB registers between January 2010 and December 2014.

Characteristic (N=104)	Frequency	Percentage (%)
1. Year of diagnosis		
2010	10	9.62
2011	13	12.5
2012	18	17.31
2013	23	22.12
2014	40	38.46
2. Age at the time of diagnosis in years		
≤ 40	76	73.1
41 to 50	17	16.35
Above 50	11	10.58
3. Sex		
Female	64	61.54
Male	40	38.46

4.	**Type of TB diagnosed**		
	EPTB	26	25.00
	EPTB-R	4	3.85
	MDR-TB	2	1.92
	PTB	72	69.23
	PTB	5	4.81
5.	**Type of work engaged in**		
	Clinical Officer	7	6.73
	Classified Daily Employee	20	19.22
	Clerk	9	8.65
	Community Volunteer	21	20.2
	Counsellor	2	1.92
	Doctor	10	9.6
	Student	3	2.88
	In-charge	2	1.92
	Laboratory Technician	2	1.92
	Nurse	25	24.04
	P.O.P Technician	1	0.96
	Pharmacy Technician	2	1.92
	X-Ray Technician	2	1.92
6.	**Work Category**		
	Professional	49	47.12
	Student	3	2.88
	Support	30	28.85
	Volunteer	22	21.15
7.	**Department deployed to**		
	All departments	9	8.65
	Anti-Retroviral Treatment	15	14.42
	Chest Clinic	1	0.96
	Inpatient Department	11	10.58
	Laboratory	2	1.92
	Labour ward	5	4.81
	Mother and Child Health	3	2.88
	Outpatient Department	34	32.69
	Pharmacy	1	0.96
	Radiology	3	2.88
	Registry	2	1.92
	Security	1	0.96
	Specialised clinic	1	0.96
	TB Corner	16	15.38
8.	**Department deployed to by category**		
	High risk	31	29.81
	Low	73	70.19
9.	**Area of residence by category**		
	High	29	27.88
	Medium	17	16.35
	Low	58	55.77

EPTB – Extra Pulmonary Tuberculosis
EPTB-R– Extra Pulmonary Tuberculosis Relapse
MDR-TB – Multi-Drug Resistant Tuberculosis
PTB - Pulmonary Tuberculosis
PTB-R - Pulmonary Tuberculosis Relapse

2. Association between working from the TB high risk area and TB disease among HCWs

This study explored the association between the exposure to working from a TB high risk area and the development of TB disease amongst the cases of TB established from HCWs during the period of study. There was an association between working from the TB high risk area and the HCWs sex, work category and department deployed under by category as these were statistically significant with a P-value of less than 0.05. The variables year of diagnosis, age, type of TB and area of residence by category were not statistically significant. This has been further illustrated in table 2 below:

Table 2: Association of exposure to working from TB high risk area and characteristics of HCWs who developed TB.

Variable	Exposure to high risk area (N=104)		P-value
	Yes n (%)	No n (%)	
1. Year of diagnosis			**0.09[b]**
2010	5 (50)	5 (50)	
2011	3 (23.08)	10 (76.92)	
2012	5 (27.78)	13 (72.22)	
2013	2 (8.7)	21 (91.3)	
2014	7 (17.5)	33(82.5)	
2. Age at the time of diagnosis in years			**0.216[b]**
≤ 40	13 (17.11)	63 (82.89)	
41 to 50	6 (35.29)	11 (64.71)	
Above 50	3 (27.27)	8 (72.73)	
3. Sex			**0.05[a]**
Male	8 (20)	32 (80)	
Female	14 (21.88)	50 (78.13)	
4. Type of TB diagnosed			**0.3[b]**
EPTB	6 (23.08)	20 (76.92)	
EPTB-R	2 (50)	2 (50)	
MDR-TB	-	2 (100)	
PTB	12 (17.91)	55 (82.09)	
PTB-R	2 (40)	3 (60)	
5. Work Category			**0.001[b]**
Professional	6 (12.24)	43 (87.76)	
Student	-	3 (100)	
Support staff	4 (13.33)	26 (86.67)	
Volunteer	12 (54.55)	10 (45.45)	
6. Department deployed to by category			**<0.001[b]**
High	22 (70.97)	9 (29.03)	
Low	-	73 (100)	
7. Area of residence by category			**0.182[b]**
High	3 (10.34)	26 (89.66)	
Medium	14 (24.14)	44 (75.86)	
Low	5 (29.41)	12 (70.59)	

[a] -Pearson's Chi-square
[b] - Fisher's exact Chi-square
EPTB – Extra Pulmonary Tuberculosis
EPTB-R– Extra Pulmonary Tuberculosis Relapse
MDR-TB – Multi-Drug Resistant Tuberculosis
PTB - Pulmonary Tuberculosis
PTB-R - Pulmonary Tuberculosis Relapse

3. Determinants of suffering from TB among HCWs (univariate and multivariate analysis)

The table below shows crude and adjusted odds ratios of predictors of TB disease among HCWs. There were more cases of TB reported in the later years of the study (2013 and 2014) thus having significant P-values. This gave an indication that data was better captured in the latter years of the study period. The adjusting for being a professional, a volunteer had increased odds of developing TB disease for both crude and adjusted odds ratios of 8.6 and 8.2 respectively with significant P-values. The result indicated that community health workers were 8.2 times likely to develop TB control for professionals. Controlling for high residential area, HCWs who lived in low residential areas had an increased odds of 6 of developing TB disease though this was not statistically significant. This has been further shown in the table 3 below:

Table 3: Determinants of suffering from TB among HCWs (univariate and multivariate analysis)

Variable		Univariate			Multivariate		
		OR	CI	P-value	AOR	CI	P-value
1.	**Year of diagnosis**						
	2010	1	1	1	1	1	1
	2011	0.3	(0.05-1.79)	0.19	0.39	(0.04-3.73)	0.41
	2012	0.38	(0.77-1.92)	0.24	0.38	(0.05-2.58)	0.32
	2013	0.09	(0.01-0.64)	0.02	0.02	(0.001-0.51)	0.02
	2014	0.21	(0.04-0.94)	0.04	0.16	(0.02-0.96)	0.05
2.	**Age at the time of diagnosis in years**						
	≤ 40	1	1	1	1	1	1
	41 to 50	2.64	(0.83-8.43)	0.1	5.81	(1.08-31.28)	0.04
	Above 50	1.82	(0.42-7.89)	0.42	4.53	(0.46-44.87)	0.19
3.	**Sex**						
	Male	1	1	1	1	1	1
	Female	1.12	(0.42-2.97)	0.82	1.58	(0.39-6.43)	0.52

4.	**Type of TB diagnosed**					
	EPTB	1	1	1	1	1
	EPTB-R	3.33	(0.38-28.9)	0.27	12.1	(0.59-246)	0.1
	MDR-TB	Undefined	1	1	1	1	1
	PTB	0.72	(0.24-2.19)	0.57	0.74	(0.15-3.73)	0.71
	PTB-R	2.22	(0.29-16.55)	0.44	1.51	(0.11-21.5)	0.76
5.	**Work Category**					
	Professional	1	1	1	1	1	1
	Student	Undefined	1	1	1	1	1
	Support staff	1.1	(0.28-4.28)	0.88	1.4	(0.23-8.52)	0.71
	Volunteer	8.6	(2.56-28.47)	<0.001	8.2	(1.61-41.6)	0.01
6.	**Area of residence by category**					
	High	1	1	1	1	1	1
	Medium	2.76	(0.72-10.51)	0.31	2.2	(0.3-15.8)	0.44
	Low	3.61	(0.74-17.64)	0.11	6.02	(0.61-59.2)	0.12

OR - Odds Ratio,
CI - Confidence Interval
AOR - Adjusted Odds Ratio
EPTB – Extra Pulmonary Tuberculosis
EPTB-R– Extra Pulmonary Tuberculosis Relapse
MDR-TB – Multi-Drug Resistant Tuberculosis
PTB - Pulmonary Tuberculosis
PTB-R - Pulmonary Tuberculosis Relapse

4. Predictor variables of TB disease among HCWs in Lusaka

The table 4 shows best predictors of developing TB disease using the stepwise regression model using adjusted odds ratios. This further shows that the year of diagnosis and the HCWs work category were the best predictors. The work category of a HCW was the most significant predictor in the model.

Table 4: Table of best predictors of TB among HCWs

Variable	Predictor variables		
	AOR	**CI**	**P-value**
1.	**Year of diagnosis**		
	2010	1	1	1
	2011	0.21	(0.03-1.61)	0.14
	2012	0.39	(0.06-2.4)	0.31
	2013	0.12	(0.01-0.89)	0.04
	2014	0.19	(0.03-0.99)	0.05
2.	**Work Category**			
	Professional	1	1	1
	Student	Undefined	1	1
	Support staff	1.11	(0.27-4.57)	0.88
	Volunteer	8.6	(2.39-31.1)	0.001

OR - Odds Ratio
CI - Confidence Interval
AOR - Adjusted Odds Ratio

The P-value of the likelihood ratio test was determined at 0.06 which is greater than 0.05. This means that the nested model is more preferred to best predict the causes of TB among HCWs compared to the full model. The specificity of HCWs who were truly exposed to TB high risk areas was established at 23%. Sensitivity of HCWs who were truly not exposed to TB high risk areas in health facilities was established at 98%. The positive predictive value was established at 71% and the negative predictive value was 82%. The data was correctly classified at 82%. The area under the ROC curve was established at 0.737 suggesting that the classifications made were not due to chance as ROC statistic is closer to 1 than 0.5.

5. Prevalence of TB amongst HCWs

The study established a population 5,773 HCWs identified at the 22 health facilities visited during the period of study. This included all categories of workers i.e. professional staff, support staff (classified daily employees) and community volunteers. Of these 443 HCWs operated from TB high risk areas and 5330 HCWs operated from other departments of health facilities. The prevalence of TB among HCWs has been further illustrated in table 5 below:

Table 5: Table showing exposure status to working from TB high risk area and developing TB disease

Exposure status	**Disease status**		**Total**
	Disease	No disease	
Exposed	22	421	443
Not exposed	82	5248	5330
Total	**104**	**5669**	**5773**

Thus the prevalence of TB is considered as follows:

$$\text{Prevalence} = \frac{\text{Total number of TB cases among HCWs}}{\text{Total number of HCWs at facilities}}$$

$$= \frac{104}{5773} \times 100{,}000$$

$$= 1{,}801 \text{ per } 100{,}000 \text{ persons}$$

The prevalence of TB in the general public in Zambia was established at 455 per 100,000 persons: (Kapata *et al.*, 2016), this is three (3) times less than the prevalence of TB established amongst HCWs at 1,801 per 100,000 persons, with an odds ratio of 3.3 and a risk ratio of 3.2.

5.1.2 ENVIRONMENTAL CONDITIONS IN HEALTH FACILITIES OFFERING TB HEALTH SERVICES

Description of structural and ventilation conditions at health facilities offering TB health services.

A total number of 22 study sites were visited in this study. TB health services of interest in this study that were offered at the health facilities visited included outpatient treatment services and diagnosis services (laboratory services and radiology services). All 22 study sites visited offered outpatient treatment services, whilst only 15 laboratory facilities and 7 radiology facilities were visited. It was noted through observations made that the outpatient treatment facilities heavily relied on natural ventilation as a means of ventilation compared with the laboratories and x-ray imaging rooms (radiology). In the case of the laboratories visited, 10 of 15 had employed mixed ventilation, 2 laboratory facilities had only natural ventilation and 3 relied on mechanical ventilation only. The three laboratory facilities that used mechanical ventilation were provided with biosafety cabinets for processing of samples. It was noted that the radiology services offered for TB diagnosis at facilities visited was x-ray imagining. In order to contain the radiation emitted during imaging, the imagining rooms are enclosed, they do not have windows. Majority of the x-ray imaging rooms at sites visited (4 out of 7) had mechanical ventilation. This has been further illustrated in table 6 below:

Table 6: Description of ventilation methods used at health facilities offering TB health services

Types of ventilation	**Type of TB services offered**		
	Outpatient treatment (N= 22)	**Laboratory (N= 15)**	**Radiology (N=07)**
Natural Ventilation	20	02	02
Mechanical Ventilation	-	03	04
Hybrid (mixed ventilation)	02	10	01

The study was able to provide a description of the structures where TB health services are offered from the study sites visited. It was noted that though some facilities had structures purposefully designed to be able to accommodate the TB health service. Some facilities had

improvised and in some instances temporal structures. This was mostly observed in the case of outpatient treatment facilities. Laboratory and radiology had more purposefully designed structured with few improvised structures. This has been further illustrated in table 7 below:

Table 7: Description of structures at health facilities where TB health services are offered

Type of structure	**Type of TB service offered**		
	Outpatient treatment (N= 22)	**Laboratory (N= 15)**	**Radiology (N= 07)**
Permanent structure purposefully designed	10	11	06
Permanent structure improvised	09	04	01
Temporal structure (shelter or pitched tent)	03	-	-

5.2 QUALITATIVE RESULTS AND ANALYSIS

Data was collected using interviews with a semi-structured interview guide. This was done in order to understand the perceptions with regards to infection prevention for HCWs working from TB high risk areas. A total number of 13 participants were interviewed across various professions. The number of professions interviewed have been summarised in table 8 below:

Table 8: Table showing the number of HCWs interviewed and their respective professions

Profession	**Number interviewed**
Doctor	01
Nurse	04
Laboratory Technician	02
Radiologist	03
Volunteer	03
Total	13

The results from the interviews have been further discussed below:

1. **Duration of work in the high risk area.**

Most respondents said they reported for work at 07:30hrs and left work at 16:00hrs from Monday to Friday and spend an average of 5 hours in the morning continuously during the course of their duties.

It was noted that handling of TB specimen and attending to TB patients was subject to the type of work one was engaged in at the health facility. Doctors, nurses, clinical officers dealt directly with patients as they administered drugs and assessed the patients at the outpatient facilities. Radiologists experienced direct contact with patients as they prepared the patients before x-ray imagining. Laboratory staff have little or no contact with TB patients but instead they handled specimen during specimen processing for diagnosis. Volunteers on the other hand had contact with specimen and patients. Community volunteers would aid the movement of specimen provided by the patients from the TB treatment facility areas (TB corner) to the laboratory as well as assisting in offering health education at the clinic as the conducted contact tracing.

Verbatim for volunteers:

> *"We deal with different types of TB, for example those (patients) referred to as smear positive, when those are identified we follow them to where they live, contact tracing. We go and screen everyone in the home because TB is very dangerous it's infectious".*

> *"We don't handle them as such because what happens is when we give them those bottles to put in the sputum, the patient themselves have to produce the sputum and spit in the bottle then we have some special plastic that we use to put the samples in, the patient puts the sample in that plastic own their own we then prepare the lab forms which we hand to the patient to put in the special plastic together with the sputum. We direct them how to put them they then do it themselves and then we tell them to put them in the cooler box. But we handle them ourselves after they (the samples) have been placed in the cooler box when taking the samples to the lab …… when we take the samples to the lab, we are the ones who remove them from the cooler box, meanwhile we are still wearing gloves".*

2. **Information on pre-screening and periodic screening**

The interviews revealed that all professional staff underwent pre-screening tests before commencement of their work as per requirement. This was not the case for voluntary staff. However follow-up screening for any disease during the period of employment is left solemnly at the discretion of an individual. In some health facilities, staff are encouraged by their superiors to have regular health checks done for their own benefit. It was also noted that cases of communicable diseases such as TB amongst HCWs was not well documented and monitored. For example one respondent actually felt that their health status was confidential and thus their employer did not have to keep a record.

Verbatim professional staff:

> ***Question:*** *"So for the other tests (screening) that you have done for yourself, they are not part of your employee file?"*
>
> ***Respondent:*** *"Uh-uh (no), that's personal".*

3. **Knowledge on transmission of TB**

All HCWs interviewed provided adequate information on the TB disease and the various modes of transmission. The importance of having adequately ventilated homes and isolation of TB patients in the home and at the health facility was well recommended by all staff interviewed.

Verbatim:

> "*At home most of the times I just keep the house ventilated then just open the windows make sure you clean the house, air is moving freely yeah".*
>
> *"At work, I just tell the patients to mind the way they are coughing to cover their mouth and nose, yes, …… and how they spit the sputum".*

Some staff from the outpatient felt that due to their work (long term service in the high risk area) they are somewhat immune to the disease because they live with the bacteria every day. Others felt very vulnerable to infection but felt they had no choice but to work. Some staff on the other hand felt that working from the TB high risk area was a protective measure as they were more likely to exercise caution when handling TB patients.

Verbatim:

> *"I think that here with us here at TB corner we are much safer than the others from the other departments, we are far much better because here we usually deal with eh, known TB cases. Unlike our friends those from the registry, a patient come, they are the ones who welcome that patient and not knowing what the patient is suffering from, even the clinicians who screen them. So I think that's where it is important for everyone to be screened".*

Not all staff interviewed understood the phrase 'personal protective equipment or PPE'. After further clarification they were able to provide information of the types of PPE that they knew and those that are made available to them.

PPE found to be widely associated with the HCWs from the high risk areas varied according to the service one offered at the facility. The HCWs at the TB outpatient facilities were more inclined to use aprons and gloves. The aprons were always made available for staffs whereas the gloves were only used when needed. The HCWs from the TB outpatient facilities expressed concern with the use of the ordinary face masks. They felt the face masks were a likely source of discrimination for to the patients. Thus HCWs preferred to work without them even in the event that they are made available by the health facility. The HCWs interviewed from the TB outpatient areas expressed little knowledge about the N95 face mask. Only one TB outpatient health facility stated they had an adequate supply of N95 masks and only used them when necessary as they are very expensive.

The HCWs from the radiology departments visited only used coats and expressed a challenge in maintaining a safe distance from the patients as they positioned the patients before imagining.

Verbatim:

> *"We attend to TB patient first and as quickly as possible. Sometimes the patients don't know how to stand when getting an x-ray so you have to come and show them what to do. Even if you demonstrate there are times you have to physically position the patient. That is putting me at risk since I have to come so close to the patient and sometimes they are coughing".*

The HCWs from the laboratories visited expressed more detailed knowledge on PPE and is uses. They further provided a broader range of PPE they use during processing of specimen. The PPE identified included the use of lab coats, gloves, the use of N95 masks and the use of bio-safety cabinets to process samples (only found at 3 facilities out of 15 visited).

4. Knowledge on exposures associated their work

All respondents interviewed felt that they were exposed to TB because of their work. Examples of exposure cited by HCWs included when a patient is coughing uncontrollably in the premises without following proper coughing etiquette and when handling samples before processing especially in the absence of a biosafety cabinet. Most respondents felt that other HCWs actually other HCWs avoided being deployed to work from the TB high risk areas due to the exposure to TB associated with work. Most respondents from outpatient facilities felt they would seldom find replacements when they wanted to work from other departments.

Verbatim:

> *"Of course when the patient comes, there are those of them like the way I say when one coughs they cough about thousands of bacilli's so you could imagine they are there in the room, now talking a thousand can you be an exception, the answer is no. So one being exposed is high, is very high that you can't run away from it".*

> *"We are not most of the times rotated,……not everyone is willing to work from here,…… when my friend went on leave, I remained. And if there was someone who was willing to come that person was going to come and help me. Same with me, when I went on leave my friend remained alone here. So to that it can just explain that people are not willing, because us nurses we can work anywhere,…… maybe it's because it's an infectious area they are scared of getting infected".*

All respondents felt that pre-screening and subsequent regular screening for TB was important in order to safe guard their health. All respondents felt that screening should be mandatory for all staff regardless of the area of operation. It was mostly suggested that regular screening for TB should be done biannually. The most suggested method of screening suggested was using the smear microscopy or Polymerised Chain Reaction (PCR) using the gene x-pert as they seemed less invasive.

Verbatim:

> *"I think screening (of TB) should be done at least once a year".*
>
> *"it is very much necessary, in fact if there was such a deliberate policy were by we are told to go for screening,…… yeah regular screening that would really help yeah, but we were told on our own personal effect we should be doing that. We were told as TB health workers to regularly go for TB screening every time which is done under culture and sensitivity".*

5. Knowledge on the importance of safety measures

Respondents felt they would be better protected from TB if ideal working conditions and environment were provided. An example stated of an ideal environment included providing specially designed structures that are well ventilated with necessary equipment to minimise transmission of TB to the HCWs.

Most respondents expressed that the availability of essential PPE such as gloves were not to be compromised especially in the laboratories and when giving injections. However Standard Operating Practices (SOPs) in the laboratories should be strictly observed when handling TB. Respondents felt in the case TB outpatient facilities, the use of improvised rooms in structures did not provide adequate ventilation and distance from the patients and the HCW.

Verbatim of HCW working from improvised facility:

> *"…. starting with facility itself you know, we can be protected if the rooms for TB were big to allow ventilation so that ah, at least there is proper protection for us. You see what I mean, if the rooms are spacious and big eh, it becomes less congested even if somebody would be coughing and at least there would be good ventilation around air circulation around in which you can easily contract TB, yeah".*

All respondents expressed the concern of having to adequately protect themselves from TB at work as a direct means of also protecting their immediate families from contracting the infection.

It was noted that some HCWs who suffered from TB preferred to get treatment of other facilities other than where they worked from. Most respondents attributed this to the stigma attached to TB being co-infected with TB thus there was a fear of one exposing their health status to fellow work mates.

"It's stigma which is in us people that makes us uhmm to fear to say maybe if I get TB drugs where am working from people will start talking about me, saying, mwabaona siapa bana dwala (meaning, have you seen they have eventually gotten sick). So people won't want to be stigmatised that's why they would prefer to go and collect their medication somewhere where they are not known leaving their clinic".

CHAPTER 6

6.0 DISCUSSION

This study established that there is a high burden of TB among HCWs in Lusaka with a prevalence of 1801 per 100,000 persons. The most number of recorded cases of TB were from nurses and community volunteers. The factors found largely to be responsible for TB in HCWs were the work category and the year of diagnosis. From the 22 study sites, the study established that proper ventilation was an important aspect in infection control measures in health facility structures. Purposefully built structures for TB health services provided better ventilation means compared to improvised use of structures. Natural ventilation was the most widely employed method of ventilating structures although some facilities had either mechanical ventilation or hybrid ventilation. The study also established that HCWs were aware of their risk to TB during their course of work. Further HCWs were limited to the use of ventilation and handwashing as major infection prevention measures because the appropriate PPE (N95 mask) was generally not readily available except at one facility.

This study established that there was an increase in notification of TB among HCWs from the period 2010 to 2014. This increase coincides with the findings of the first National TB Prevalence Survey in Zambia which indicated an increase in the prevalence of TB in Zambia at 455/100,000. The result was much higher than that reported in surveillance data of 388/100,000. This could have been due to more recent data being more easily accessible compared to older records. This could also be attributed to improved data capture of cases of TB among HCWs. Some studies showed that an increase in HCWs workforce may contribute to a decrease in notification rates (Buregyeya *et al*., 2013, Chen *et al*., 2010, Joshi *et al*., 2006).

The findings have shown that the prevalence of TB among HCWs in Lusaka is three times that of the general population at 1801 per 100,000 persons. This study also found that the HCWs had an increased odds of 3.3 and an increased risk of 3.2 of developing TB disease compared to the general population. The high relative risk has been attributed to frequency in contact with TB patients as also established in other similar studies (de Vries *et al*., 2006, Tudor *et al*., 2014).

Despite the increase in surveillance data for the prevalence of TB among HCWs, it was established in this study that the HCWs, still felt the available records, were an under

estimation as there was a sense of fear of stigma likely to be faced by a HCW diagnosed with TB. A study done in Taiwan on the perceptions and needs of HCWs who had suffered from TB revealed that HCWs felt intimidated by the difference in association with their fellow HCWs during screening and receiving of drugs as they were now the patients (Chen *et al.*, 2010).

An introduction of mandatory periodic TB screening for HCWs using low invasive methods and development of support groups for HCWs receiving TB treatment could provide for better monitoring of TB disease. This would eventually assist in addressing barriers associated with access to reporting illness and TB treatment for HCWs. Other studies indicated that developing a surveillance system especially for HCWs would provide a good indicator for monitoring infection prevention controls of TB (Buregyeya *et al*., 2013).

The majority of cases of TB among HCWs were amongst those 40 years and below with the average being 40 years (41.4%) and a range of 20 to 76 years. The study showed that there was no association between working from a TB high risk area and ones age at both univariate and multivariate stages. Similar studies conducted established median ages of 35 years (Alonso-Echanove *et al.*, 2001).

Literature has shown through various studies that HCWs with close contact with patients such as nurses and physicians are at a greater risk of acquiring TB (Chanda and Gosnell, 2006, Joshi *et al*., 2006, Tudor *et al*., 2014). This study found that cases of TB were most experienced among nurses, support staff (classified daily employees) and community volunteers. This could be as a result of their higher staffing levels compared to other carders especially at primary health facilities. However their attitude towards infection prevention measures could be a major contributing factor. As seen in other studies, some HCWs in this study actually felt they were immune to infection because they live with the bacteria every day (Sherman *et al*., 2011). A study done in Taiwan indicated that HCWs who had suffered from TB established over familiarity with work which could have contributed to their development of infection and eventually disease (Chen *et al*., 2010).

The most number of cases of TB among HCWs were reported from those who worked from TB low risk areas in health facilities as also recorded in other studies (Cuhadaroglu et al., 2002). This was reflected as 70% of TB cases recorded were from HCWs working from TB low risk areas. The low number of cases from TB high risk areas could be as a result of the structural designs taken into account and infection prevention procedures by HCWs from TB

high risk areas. Other factors such as delayed diagnosis or miss diagnosis of patients at general outpatient departments have been attributed to increased risk of exposure for HCWs from low risk areas (Cuhadaroglu *et al*., 2002, Tudor *et al*., 2014, von Delft *et al*., 2015). Thus the urgent need of establishing periodic screening programme for TB and frequent knowledge gap sharing for all HCWs including volunteers cannot be over emphasized (Chen *et al*., 2010).

Knowledge on infection prevention was well articulated by participants of the interviews. It was also noted that the knowledge packages for the HCWs were tailored to their roles in the health service. As a result some HCWs had insufficient information on PPE and the different types of PPE that can be made available to them thus compromising their ability to protect themselves especially for community volunteers who has an increased odds of 8.4 to developing TB. A study conducted in Germany, attributed the high rates of Tuberculin skin test conversion among housekeeping staff to low knowledge levels on infection prevention and preventive measures (Sherman *et al*., 2011).

The study further established that despite having adequate knowledge, some HCWs working from TB high risk areas felt immune to the disease due to frequent exposure whereas others felt exposed to the disease. It was also noted that the use of surgical mask was widely discouraged when attending to TB patients in the health facilities. This however increased risk of exposure to TB as the N95 mask was not readily available at primary health care facilities. Some HCWs felt that the surgical masks did not offer adequate protection and they showed more care than discrimination when they did not use the masks. Similar studies have shown that HCWs felt a sense of immunity to TB since they were the care givers as well as a more relaxed cautiousness to infection prevention because TB is curable. However, literature further coined the effects of TB once the HCW suffered from TB which included denial, anxiety, fear of the unknown future, adverse effects from treatment, financial burden, transmitting TB to family and friends as well as stigma (Chen *et al.*, 2010, von Delft *et al.*, 2015).

This study established that fear of stigma from co-workers, friends and family would be a reason as to why HCWs did not report their disease at their place of work. This however meant that they would collect drugs from another health facility without disclosing that they are HCWs resulting in possible underestimation of surveillance data. This affects perceived magnitude of the problem of TB in HCWs. Studies have shown that the provision of

counselling facilities and support groups for HCWs who suffer from TB can provide psychological support (Chen *et al*., 2010).

The majority of HCWs who had TB during the period of study reside in low-cost residential areas. Low-cost areas are characterized with overcrowding and poor housing and therefore have high prevalence of TB. However at univariate and multivariate analysis, this was found not to be statistically significant in this study. Other studies with similar findings indicated that despite having a high TB disease burden in low-cost residential areas, HCWs have a high risk of acquiring TB because of their work (Kompala *et al*., 2013, Tudor *et al*., 2016).

Natural ventilation was the most widely used means of ventilation in infection prevention especially in the outpatient treatment facilities structures. The use of natural ventilation has been recommended as a cost effective means of providing the much needed air-exchanges that are required in a TB treatment facility (Atkinson *et al*., 2009, Kompala *et al*., 2013). However it was noted that despite having 20 of the treatment facilities visited heavily relying on natural ventilation as a means of ventilation, only 50% of the structures used were purposefully designed rooms for attending to TB patients. The use of improvised rooms as outpatient treatment facilities however compromises the quality at which the air exchanges take place in room used as a TB health facility and promote overcrowding of HCWs and patients (Jensen *et al*., 2005, Jo *et al*., 2008, Kompala *et al*., 2013, Menzies *et al*., 2007).

The purposefully designed structures had higher floor to window ratio and thus provided more natural lighting which promoted the germicidal effect by UV light for TB. This was also noted for the temporal structures (shelters and outside pitched tents). This was found to be in line the WHO guidelines on the natural ventilation in health facilities (Atkinson *et al*., 2009). Improvised structures relied on constantly keeping the door and available windows open in order to maximise on the air flow. The use of improvised structures or rooms has been seen to be associated with budgetary constraints in low and middle income countries (Atkinson *et al*., 2009, Franchi *et al*., 2007, Kompala *et al*., 2013).

Hybrid ventilation was mostly used in laboratories and radiology facilities. Studies have shown that where the quality of ventilation is compromised or where the concentration of droplet nuclei is likely to be high in the air, the use of hybrid ventilation is an added protective means for the HCWs (Atkinson *et al*., 2009, Kompala *et al*., 2013). Though there was evidence of non-functional mechanical ventilation in one of the x-ray imaging rooms

were as one x-ray imaging room had no mechanical ventilation. This showed that there was a breach in the maintenance of equipment thus compromising the quality of air.

6.1 LIMITATIONS

- The use of secondary data was likely to underestimation the number of cases of TB reported among HCWs. This was largely due to the fear of stigma from co-workers as TB disease is associated with compromised health and HIV. Thus HCWs were more likely to seek treatment from elsewhere without disclosing that they are HCWs.
- Some health care facilities had no system in place to monitor the number of TB notification among HCWs and though were not included in the study. Privately run health institutions were not included in this study this affected the generalizability of the findings.
- Time and financial constraints could not allow for distant health facilities such as Lilayi and State lodge health centers to be included in this study. This as well affected the generalizability of the findings.

6.2 CONCLUSION

The prevalence of TB in HCWs in Lusaka is three times that of the general population. To effectively address the occupational exposure to TB for HCWs a combination of good administrative measures, appropriate working environment, functional equipment, adequate PPE and good knowledge, attitudes and practices on the part of HCWs needs to be employed in health facilities.

Mandatory periodic screening of TB for all HCWs should be introduced to improve on surveillance data as well as to be used as an indicator for monitoring and evaluating of strategies for infection prevention.

Although Zambia has available guidelines for infection prevention strategies to protect HCWs from TB in health facilities, the implementation of these guidelines are not being fully realised due to the opportunity cost attached to foregoing health interventions for other ailments.

Therefore if Zambia is to meet the targets set for the "End of TB Strategy" more needs to be done in view of protecting the HCWs from acquiring TB from work in order to prevent the possible vicious cycle of TB infection back to the communities.

6.3 RECOMMENDATIONS

It has been shown that structural design plays an important role in the IP in health facilities. Thus TB being and airborne infectious disease there is need to assess other working areas that are considered low risk. The outpatient department showed the highest number of TB cases among HCWs thus there is need to evaluate efficiency of ventilation in these areas health facilities.

This study recommends that the infection prevention policies in relation to TB should be further assessed considering protection of the health of the HCWs in Zambia.

The study also recommends that the infection prevention practices and perceptions of HCWs from other department should be further understood to reduce the number of cases in the low risk areas.

It is further recommended that studies be done to provide more evidence based information on the amount of airflow in the high and low risk areas to ensure that it meets the required standards of more than 12 air changes per hour (Kompala *et al*., 2013) for a health care setting.

Periodic screening of HCWs for infectious disease should be made mandatory and a good record keeping system should be developed in order to establish a data base that can serve for intervention researches as well as to safe guard the good health of HCWs.

6.4 REFERENCES

ALONSO-ECHANOVE, J., GRANICH, R. M., LASZLO, A., CHU, G., BORJA, N., BLAS, R., OLORTEGUI, A., BINKIN, N. J. & JARVIS, W. R. 2001. Occupational transmission of Mycobacterium tuberculosis to health care workers in a university hospital in Lima, Peru. *Clin Infect Dis,* 33**,** 589-96.

ANDERSON, C., ABUBAKAR, I., MAGUIRE, H. & SONNENBERG, P. 2007. Survey of tuberculosis incidents in hospital healthcare workers, England and Wales, 2005. *J Public Health (Oxf),* 29**,** 292-7.

ATKINSON, J., CHARTIER, Y., PESSOA-SILVA, C. L., JENSON, P., LI, Y. & SETO, W.-H. 2009. Natural Ventilation for Infection Control in Health-Care Settings-WHO Publications/Guidelines. *WHO Press.*

AYLES, H., SCHAAP, A., NOTA, A., SISMANIDIS, C., TEMBWE, R., DE HAAS, P., MUYOYETA, M. & BEYERS, N. 2009. Prevalence of tuberculosis, HIV and respiratory symptoms in two Zambian communities: implications for tuberculosis control in the era of HIV. *PLoS One,* 4**,** e5602.

BUREGYEYA, E., NUWAHA, F., VERVER, S., CRIEL, B., COLEBUNDERS, R., WANYENZE, R., KALYANGO, J. N., KATAMBA, A. & MITCHELL, E. M. H. 2013. Implementation of tuberculosis infection control in health facilities in Mukono and Wakiso districts, Uganda. *BMC Infect Dis,* 13**,** 360.

CASAS, I., ESTEVE, M., GUEROLA, R., GARCIA-OLIVE, I., ROLDAN-MERINO, J., MARTINEZ-RIVERA, C. & RUIZ-MANZANO, J. 2013. Incidence of tuberculosis infection among healthcare workers: risk factors and 20-year evolution. *Respir Med,* 107**,** 601-7.

CHANDA, D. & GOSNELL, D. J. 2006. The impact of tuberculosis on Zambia and the Zambian nursing workforce. *Online J Issues Nurs,* 11**,** 4.

CHEN, M. F., WANG, R. H., YANG, Y. O., LIN, L. J., STOCKER, J., CHEN, S. W. & CHIN, C. C. 2010. Voices from the frontline: Perceptions and needs of nurses involved in a nosocomial cluster of tuberculosis infection. *Appl Nurs Res,* 23**,** 207-13.

CUHADAROGLU, C., ERELEL, M., TABAK, L. & KILICASLAN, Z. 2002. Increased risk of tuberculosis in health care workers: a retrospective survey at a teaching hospital in Istanbul, Turkey. *BMC Infect Dis,* 2**,** 14.

DA COSTA, J. C. T., SILVA, R., FERREIRA, J. & NIENHAUS, A. 2011. Active tuberculosis among health care workers in Portugal. *Jornal Brasileiro de Pneumologia***,** 636-645.

DE VRIES, G., SEBEK, M. M. & LAMBREGTS-VAN WEEZENBEEK, C. S. 2006. Healthcare workers with tuberculosis infected during work. *Eur Respir J,* 28**,** 1216-21.

FRANCHI, A., RICHELDI, L., PARRINELLO, G. & FRANCO, G. 2007. Room size is the major determinant for tuberculin conversion in health care workers exposed to a multidrug-resistant tuberculosis patient. *Int Arch Occup Environ Health,* 80**,** 533-8.

GOVERNMENT OF THE REPUBLIC OF ZAMBIA, 1930. Public Health Act Cap 295. Zambia: Laws of Zambia.

GOVERNMENT OF THE REPUBLIC OF ZAMBIA, 2010. Occupational Health and Safety Act No. 36 of 2010. Zambia: Laws of Zambia.

JENSEN, P. A., LAMBERT, L. A., IADEMARCO, M. F. & RIDZON, R. 2005. Guidelines for preventing the transmission of Mycobacterium tuberculosis in health-care settings, 2005. *MMWR Recomm Rep,* 54**,** 1-141.

JO, K. W., WOO, J. H., HONG, Y., CHOI, C. M., OH, Y. M., LEE, S. D., KIM, W. S., KIM, D. S., KIM, W. D. & SHIM, T. S. 2008. Incidence of tuberculosis among health care workers at a private university hospital in South Korea. *Int J Tuberc Lung Dis,* 12**,** 436-40.

JOSHI, R., REINGOLD, A. L., MENZIES, D. & PAI, M. 2006. Tuberculosis among health-care workers in low- and middle-income countries: a systematic review. *PLoS Med,* 3**,** e494.

KANJEE, Z., CATTERICK, K., MOLL, A. P., AMICO, K. R. & FRIEDLAND, G. H. 2011. Tuberculosis infection control in rural South Africa: survey of knowledge, attitude and practice in hospital staff. *J Hosp Infect,* 79**,** 333-8.

KAPATA, N. 2014. *The Social Determinants and Characteristics fo Tuberculosis Patients in four Peri- Urban Health Facilities in Lusaka District, Zambia.* Masters in Public Health, University of Zambia.

KAPATA, N., CHANDA-KAPATA, P., NGOSA, W., METITIRI, M., KLINKENBERG, E., KALISVAART, N., SUNKUTU, V., SHIBEMBA, A., CHABALA, C., CHONGWE, G., TEMBO, M., MULENGA, L., MBULO, G., KATEMANGWE, P., SAKALA, S., CHIZEMA-KAWESHA, E., MASIYE, F., SINYANGWE, G., ONOZAKI, I., MWABA, P., CHIKAMATA, D., ZUMLA, A. & GROBUSCH, M. P. 2016. The Prevalence of Tuberculosis in Zambia: Results from the First National TB Prevalence Survey, 2013-2014. *PLoS One,* 11**,** e0146392.

KAPATA, N., CHANDA-KAPATA, P., O'GRADY, J., SCHWANK, S., BATES, M., MUKONKA, V., ZUMLA, A. & MWABA, P. 2011. Trends of Zambia's tuberculosis burden over the past two decades. *Trop Med Int Health,* 16**,** 1404-9.

KLIMUK, D., HUREVICH, H., HARRIES, A. D., BABRUKEVICH, A., KREMER, K., VAN DEN BERGH, R., ACOSTA, C. D., ASTRAUKO, A. & SKRAHINA, A. 2014. Tuberculosis in health care workers in Belarus. *Public Health Action,* 4**,** S29-33.

KOMPALA, T., SHENOI, S. V. & FRIEDLAND, G. 2013. Transmission of tuberculosis in resource-limited settings. *Curr HIV/AIDS Rep,* 10**,** 264-72.

LIENHARDT, C., BENNETT, S., DEL PRETE, G., BAH-SOW, O., NEWPORT, M., GUSTAFSON, P., MANNEH, K., GOMES, V., HILL, A. & MCADAM, K. 2002. Investigation of Environmental and Host-related Risk Factors for Tuberculosis in Africa. I. Methodological Aspects of a Combined Design. *American Journal of Epidemiology,* 155**,** 1066-1073.

LONNROTH, K., JARAMILLO, E., WILLIAMS, B. G., DYE, C. & RAVIGLIONE, M. 2009. Drivers of tuberculosis epidemics: the role of risk factors and social determinants. *Soc Sci Med,* 68**,** 2240-6.

MENZIES, D., JOSHI, R. & PAI, M. 2007. Risk of tuberculosis infection and disease associated with work in health care settings [State of the Art Series. Occupational lung disease in high- and low-income countries, Edited by M. Chan-Yeung. Number 5 in the series]. *The International Journal of Tuberculosis and Lung Disease,* 11**,** 593-605.

SEHULSTER, L. & CHINN, R. Y. 2003. Guidelines for environmental infection control in health-care facilities. Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC). *MMWR Recomm Rep,* 52**,** 1-42.

SHERMAN, H. A., KARAKIS, I., HEIMER, D., ARZT, M., GOLDSTEIN, W., BOUHNIK, L. & MAIMON, M. N. 2011. Housekeeping health care workers have the highest risk for tuberculin skin test conversion. *The International Journal of Tuberculosis and Lung Disease,* 15**,** 1050-1055.

TANIMURA, T., JARAMILLO, E., WEIL, D., RAVIGLIONE, M. & LONNROTH, K. 2014. Financial burden for tuberculosis patients in low- and middle-income countries: a systematic review. *Eur Respir J,* 43**,** 1763-75.

TUDOR, C., VAN DER WALT, M., MARGOT, B., DORMAN, S. E., PAN, W. K., YENOKYAN, G. & FARLEY, J. E. 2014. Tuberculosis among health care workers in KwaZulu-Natal, South Africa: a retrospective cohort analysis. *BMC Public Health,* 14**,** 891.

TUDOR, C., VAN DER WALT, M. L., MARGOT, B., DORMAN, S. E., PAN, W. K., YENOKYAN, G. & FARLEY, J. E. 2016. Occupational Risk Factors for Tuberculosis Among Healthcare Workers in KwaZulu-Natal, South Africa. *Clin Infect Dis,* 62 Suppl 3**,** S255-61.

VINEY, K. A., JOHNSON, P., TAGARO, M., FANAI, S., LINH, N. N., KELLY, P., HARLEY, D. & SLEIGH, A. 2014. Tuberculosis patients' knowledge and beliefs about tuberculosis: a mixed methods study from the Pacific Island nation of Vanuatu. *BMC Public Health,* 14**,** 467.

VON DELFT, A., DRAMOWSKI, A., KHOSA, C., KOTZE, K., LEDERER, P., MOSIDI, T., PETERS, J. A., SMITH, J., VAN DER WESTHUIZEN, H. M., VON DELFT, D., WILLEMS, B., BATES, M., CRAIG, G., MAEURER, M., MARAIS, B. J., MWABA, P., NUNES, E. A., NYIRENDA, T., OLIVER, M. & ZUMLA, A. 2015. Why healthcare workers are sick of TB. *Int J Infect Dis,* 32**,** 147-51.

WHO 2009. WHO policy on TB infection control in health-care facilities, congregate settings and households Annexes (CD-ROM). *WHO policy on TB infection control*.

WHO 2015. World Tuberculosis Report 2015. *WHO publications,* WHO/HTM/TB/2015.22**,** 204.

ZUMLA, A., GEORGE, A., SHARMA, V., HERBERT, R. H., OXLEY, A. & OLIVER, M. 2015. The WHO 2014 global tuberculosis report--further to go. *Lancet Glob Health,* 3**,** e10-2.

CHAPTER 7

7.0 APPENDICES

Appendix I: Dummy table to be used for data collection on HCWs with TB.

DATA COLLECTION SHEET

Date of data collection: _____

Name of investigator: _____

Name of Health Facility: _____

Serial Number	Year of data entry	Age	Sex	Type of TB diagnosed with	Type of Profession	Department deployed under at time of diagnosis	Area of Residence

SUMMARY

Total Number of TB cases recorded:
- Male:
-Female:

Total number of staff at facility: Professionals ☐
Support staff ☐
Community volunteers ☐

Total number of according to types of TB acquired:

Appendix II: Check list

CHECK LIST

Remember to:

- Introduce Yourself.
- Explain purpose of study.
- Get Informed Consent.

Answer or tick (√) where appropriate.

==========

Section A: Background information

1. Name of health facility:_____
2. Type of TB ward: In-patient ward ☐ Out-patient ward ☐

==========

Ventilation (condition of working areas)

3. Describe the type of ventilation: Through ventilation ☐ Cross ventilation ☐
   Other ☐ Describe further below;

   _____

4. Number of windows per room:_____
5. Can windows easily open? Yes ☐ No ☐

==========

Section B: Personal Protective Equipment (PPE) for HCWs

6. Is PPE provided? Yes ☐ No ☐
7. Is it complete? Yes ☐ No ☐

8. What kind of PPE is provided *indicate each type in a list form? _____

S/N	Profession	Type of PPE available	Is PPE adequate?		Is PPE correctly used?
			Yes	No	

9. Use of PPE in high risk situations, e.g. when attending to patients: Yes ☐ No ☐

END

Appendix III: Informed Consent information sheet

UNIVERSITY OF ZAMBIA, SCHOOL OF MEDICINE
PUBLIC HEALTH DEPARTMENT

PARTICIPANT INFORMATION SHEET (PIS)

Study Title: Prevalence of Tuberculosis among Health Care Workers: Retrospective Cohort Study at Health facilities in Lusaka, Zambia

My name is NachombeNangámba. I am a student of the University of Zambia. This interview is part of my research in training for Master of Science in Epidemiology. I am carrying out this research to know how much health care workers are exposed to TB through their work. To be able to know this I will have to ask you a few questions on this topic. The purpose of this interview is to know your understanding of how Tuberculosis (TB) can be transmitted to you. This information together with other information I will collect will help me understand how health care workers like you end up suffering from TB.

I am carrying out this study to find out if health workers working in TB high risk areas like you end up getting TB because of the situation at work.

For me to understand how health care workers working from TB high risk areas have TB, I will need participants who work from there. You have been randomly picked to take part because you work in a TB high risk area.

If you agree to take part in the interview, I will ask you a few questions about your work. The interview may take about 20minutes. Our discussion will be kept private and your name will not be disclosed or written anywhere. I will be taking notes of what you are saying during our discussion. If you allow me, I will record our conversation for me to fully understand what you are saying.

I understand that during the interview you might say some sensitive information. I would like you to know that all the information given to me will be kept confidential and your name will not appear on any document or tape recording.

If you participate in the study you will have a better understanding on the benefits of using personal protective clothing. It is my hope that you and other health care workers working in TB corners will be able to benefit eventually from policy changes depending on the findings that will be discovered through this study.

There is no payment for participating in this study.
The information you will give me during this interview will be only accessed by me. This information will be kept highly confidential. I will keep a soft copy of information you will give me in a flash drive in case I have problems with the computer. I would like to remind you that no information will be kept with your name or identity.

The results that I will get after carrying out this study will be forwarded to the University for academic purposes and shared with the authorities that gave me permission to carry out my study here at your clinic.

You are free to take part or not to take part in the study and this will not affect you in any way.

If ever you have any questions, comments or complaints about this study, you can contact me NachombeNang'amba, on +260-968-311-638 during working hours (i.e. Monday to Friday 08:00 to 17:00 hours). For any ethical enquires you can contact the University of Zambia Biomedical Research Ethics Committee on:

Address:	UNZA Biomedical Research Ethics Committee Ridgeway Campus P.O. Box 50110 Lusaka, Zambia
Telephone:	260-1-256067
Fax:	260-1-250753
E-mail:	unzarec@zamtel.zm

Appendix IV: Informed Consent Form

UNIVERSITY OF ZAMBIA, SCHOOL OF MEDICINE PUBLIC HEALTH DEPARTMENT

CONSENT FORM

Study Title: Prevalence of Tuberculosis among Health Care Workers: Retrospective Cohort Study at Health facilities in Lusaka, Zambia

The purpose and process of the study has been explained to me clearly. I fully understand possible benefits and risks of this study. I therefore willingly agree and consent myself to take part in this research by appending my signature/thumb print below.

Name of participant: ……

Signature/thumb print:……

Date:……

Name of interviewer: ……..

Signature:……..

Date:……..

Appendix V: Interview Schedule

INTERVIEW SCHEDULE

Remember to:

- Introduce Yourself.
- Explain purpose of study.
- Get Informed Consent.
- Ensure Confidentiality.
- Thank the respondent after interview.

==========

Section A: Interviewer information

1. Name of interviewer: _____
2. Name of Health Center:_____
3. Date of interview: _____
4. Time started: _____
5. Time ended: _____
6. Respondent number: _____

==========

Section B: Duration of work in the high risk area

7. What time do you report for work?
8. What time you leave work?
9. How much time do you spend in the TB corner?
10. Do you have any contact with the TB patients?
11. Do you have any contact with any TB specimen?
12. How?

==========

Section C: Information on pre-screening and periodic screening

13. Were you screened for any diseases at the beginning of your employment?
14. What screening test where performed?
15. Were any results given to you?
16. In what format? (Let the respondent respond according but when necessary give them examples of by word of mouth or a hard copy of the results was given.
17. Were you given a certificate of wellness?
18. Have you experienced any other screening during your employment?
19. What tests were done and for what condition?
20. Were you given the results?

==========

Section D: Knowledge on transmission of TB

21. What do you understand about TB?
22. What are the modes of transmission?
23. How do you protect yourself from at home?
24. How do you protect yourself from TB at school?
25. What do you understand about personal protective clothing?

26. What kind of personal protective clothing do you use here at work?
27. * If inadequate or no PPE is given, ask respondent why?

==========

Section E: Knowledge on exposures associated with their work

28. How do you think you are exposed to TB during your work?
29. Do you this screening is necessary?
30. What kind of screening would you recommend?

==========

Section F: Knowledge on importance of safety measures.

31. How do you think you can be protected from TB here at work?
32. What measures of safety do you use?
33. What measures of safety do you use to protect yourself from transmission in the case of inadequate or no PPE?
34. What do you think is the importance of protecting yourself from transmission of TB?

END

*Remember to thank the respondent after the interview.