RISK FACTORS ASSOCIATED WITH TUBERCULOSIS AT MANGAUNG CORRECTIONAL CENTRE: RETROSPECTIVE ANALYSIS

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A research report submitted to the Faculty of Health Sciences, School of Public Health,

University of the Witwatersrand, Johannesburg,

In partial fulfilment of the requirements for the degree

of

Master of Public Health

October, 2013

DECLARATION

I, Serame Paulus Mogoere declare that this research report is my own work. It is being submitted for the degree of Master of Public Health at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other university.

Dr S. P Mogoere

……29th…….day of……October…….. 2013

DEDICATION

This is dedicated to my wife Bathabile Makhotso Mogoere, for her unrelenting encouragement, patience and support throughout this taxing time. Honey without you I may not have survived this period, Thank you.

It is also in memory of my father, Joseph Mogoere who instilled a sense of hard work and perseverance in me and encouraged me to pursue my studies against all odds. You have moulded the man I am, today.

ABSTRACT

Background

Prisons and jail systems worldwide are recognised as reservoirs for the transmission of communicable diseases. Tuberculosis (TB) is one of the fastest growing epidemics in prison populations in sub - Saharan Africa (SSA). Various factors have contributed to the breakdown of TB control in prisons in these low- and middle- income countries. Health care services in correctional centres are not adequately financed or supported, with little training offered to the health care professionals.

TB is both preventable and curable. A range of evidence- based interventions exist to prevent, treat and mitigate exposure to the disease in the general population. High prevalence of TB in prison populations has been observed to be 10 to 35 times higher than the general population. Studies conducted in prisons world- wide show that TB cause significant morbidity and mortality among prisoners and prison staff.

South Africa as a developing country has been one of the high burden countries in as far as Tuberculosis incidence is concerned. The TB epidemic has been worsened by the HIV/AIDS epidemic. An estimated 360 000 inmates move through the South African correctional centre system annually, this movement worsens the spread of communicable diseases especially TB. Correctional facilities house large numbers of inmates who are at high risk of developing

TB because of their difficult life circumstances and risky behaviours. If the spread of TB in prisons is not properly dealt with and controlled, it may have serious repercussions for the public health in general.

Mangaung Correctional centre is a privately administered prison situated in Bloemfontein. It is a maximum security facility with a population of 2928 male inmates. According to the TB registers, the prevalence of TB in this prison remains high. However factors associated with TB disease in this prison have not been studied.

The objective of this study is to determine and evaluate the odds associated with the risk factors contributing to contracting TB among inmates at Mangaung Correctional centre during a study period of a year.

Methods

This was a retrospective case - control analytical study reviewing existing data from the medical records of inmates diagnosed and treated for TB disease between July 2009 and June 2010. The cases were identified from the TB registers and the controls which were grouped as non TB cases, were selected randomly from the records of inmates who were treated at each of the six housing unit clinics during the study period.

A total of 1140 medical records were reviewed and relevant data was collected with a designed data capture sheet. The data was cleaned, checked for completeness and coded in Excel and then exported to STATA version 11.0, statistical software for appropriate analyses. The relationships between risk factors and TB were evaluated by univariate and bivariate analyses.

Categorical variables comparison was described using Pearson chi- square test or Fisher's exact test. A multiple logistic regression analysis was performed to find the association between TB disease and explanatory variables and odds ratios were calculated at 95% confidence interval and a p-value ($p \leq 0.05$) was regarded as significant.

Results

Hundred (n = 100) inmates who were diagnosed and treated for TB were identified as TB cases and 1040 inmates with no history of TB were regarded as the control group (Non TB cases). The majority (42.6 %) of the inmates in this study population were aged between 31 - 40 years. The mean age was 35.7 years, range 22 – 67 years. TB prevalence of 8.8% (n = 100/1140) was found.

The TB cases had more exposures than the non TB cases. 52% of inmates aged (31 - 40) years had TB disease. 47% of TB cases had low BMI $\leq$ 18.5 kg/m^2 and 31% had previous history of TB disease. 58% of the cases were HIV positive and 34% had further compromised immunity

with CD4 cell count $\leq$ 350 cells/mm^3. 43% of TB cases were substance abusers. The differences between the TB and non TB cases were significant with p-values less than 0.05.

The odds of contracting TB was not significant for the age group (31 – 40) years (OR: 1.02; 95% CI: 0.64 – 1.62). HIV co – infection increased the odds of developing TB disease four times more (OR: 4.2; 95% CI: 2.64 – 7.00). Previous history of TB disease tripled the odds (OR: 3.58; 95% CI: 2.25 – 5.70) of contracting TB. Smoking was not found to increase the odds to develop TB and the odds doubled (OR: 2.1; 95% CI: 1.16 – 3.81) for ex – smokers. The odds of contracting TB were 1.8 times more for those inmates who used drugs. Length of stay in prison was not significantly associated with the risk of developing TB disease in this prison, p = 0.218.

Conclusions

TB prevalence of 8.8 % (8772 per 100 000) among inmates in this prison is nine times higher than that of the general population, (948 per 100 000) population. The high prevalence found in this prison confirms that TB disease among inmates is a serious health problem that cannot be ignored any longer.

The study revealed that the odds of contracting TB are highly associated with the following risk factors: younger age group 21 – 30 years ,HIV co – infection, malnutrition (BMI $\leq$ 18.5), a history of previous diagnosed TB and substance abuse as compared to the control group.

It is well documented that TB is the number one cause of death among HIV patients, and HIV co – infection increases the likelihood of reactivation, re – infection and progression of latent TB to active disease. Given the high odds associated with these risk factors, accurate and systematic interventions need to be developed and implemented immediately to control the development and transmission of TB and HIV in this high risk environment.

ACKNOWLEDGEMENTS

Thank you to my supervisor Prof Peter Nyasulu for advice, encouragement, support and assistance.

Permission was granted by the G4S Correction Services (Bloemfontein) Pty Ltd, director Mr Johan Theron for the study to be conducted at Mangaung Correctional centre.

Thank you to the Faranani Life Health Solutions staff for their assistance and support in ensuring that the required data is gathered for this research report.

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CHAPTER ONE

1. INTRODUCTION

1.0 BACKGROUND

Prisons and jail systems worldwide have been known as focal points for the concentration and dissemination of Tuberculosis (TB) amongst inmates. They are increasingly becoming breeding grounds from which infection is transmitted to the general population. The spread of TB between prisoners, staff and visitors and the emergence of drug resistant TB in prisons now threatens the control efforts of National tuberculosis programmes in sub Saharan Africa (SSA). The control of TB in correctional settings has therefore been a longstanding concern to correctional service management and those responsible for the health care services delivery. (Koo, et al., 1997; O'Grady, et al., 2011)

Despite the fact that TB is largely a curable disease and there are standardised international guidelines on how to prevent and control the disease through the Directly observed treatment short course (DOTS) strategy outlined by WHO (TB, DOTS), 2009; TB remains a major public health problem in South Africa. Many factors have contributed to the situation: a general economic decline, intensive migration, increasing unemployment, homelessness, low tendencies to seek health care services, Human immune-deficiency virus (HIV) /

Acquired immune deficiency syndrome (AIDS) epidemic and a high rate of imprisonment due to a surge in crime in the country.

South Africa as a developing country has been one of the 22 high burden countries worldwide in as far as Tuberculosis incidence is concerned. It was ranked number 2 (two), second to Swaziland in the 2009 report by the World Health Organization (WHO). In 2009 the incidence rate of all forms of TB was 948/100 000 population per year, of this 691/100 000 had HIV co – infection. It is evident that the TB epidemic has been worsened by the HIV/AIDS epidemic, as it suppresses the patient's immune system thus predisposing them to opportunistic infections. (WHO Global TB control report, 2009)

According to WHO, the prevalence of TB in prisons is very high, it accounts for up to 25% of the TB burden in a given country. It is reported to be 10- to 100 – fold higher than in the general population, in both low- and high – TB incidence countries. Studies carried out in Botswana, Malawi, Tanzania and Ivory Coast state prisons found prevalence of 10 to 35 times higher in prisoners than in the general population. If our country is to meet its goals as set out in the National Strategic Plan on HIV, STI's and TB 2012 – 2016, the disproportional burden of TB in prisons needs to be controlled urgently before it leads to serious public health implications. (O'Grady, et al., 2011)

The high prevalence of TB in the prison population is associated with the following risk factors investigated in a number of studies undertaken in prisons in different countries. They include age, malnutrition, previous history of TB disease, substance abuse and HIV co – infection. Previous imprisonment, overcrowding, poor ventilation as well as poor living conditions in prisons have also been identified as additional risk factors associated with development of TB. Furthermore poorly resourced health care facilities in these settings, including inadequate TB treatment and control strategies which could possibly result in the development of drug resistant strains of TB have contributed to the problem. (Shah, et al., 2003; Lobacheva, et al., 2007)

Correctional facilities house large numbers of inmates who are at high risk of developing tuberculosis or are already infected with the disease at incarceration, which interrupts their TB treatment. Inmates are mainly from poor socio - economic backgrounds with low education, unemployment, poor living conditions and poor nutritional status. Others are co-infected with HIV or have full blown AIDS, this pattern supports research that linked poverty indicators with poor health status.

Many of the incarcerated inmates come from densely populated inner – city dwellings that predispose them to TB because of their difficult life circumstances and risky behaviours. The behavioural characteristics of substance abuse through intravenous (IV) drugs, narcotics,

dagga and alcohol abuse; and HIV infection are generally more prevalent among inmates than the public community. (Kim, et al., 2005)

Mangaung Correctional centre is a privately administered prison situated in Bloemfontein the capital of the Free State province. It is run by a British based company Global Solutions correctional services in partnership with the South African government Department of Correctional services. This is a maximum security facility exclusively for male offenders with moderate to severe criminal charges, serving long term sentences. The centre is one of 11 maximum facilities distributed throughout South Africa.

The prison consists of six housing units designed to each house 488 inmates. The units are subdivided into cells with two or four inmates sharing a cell. At any given time the number of inmates housed in a unit may vary as some inmates will be admitted at the health care facility or sent to solitary confinement (isolation units) due to bad behaviour. There is a total population of 2928 male inmates from all nine provinces and from neighbouring states like Lesotho, Zimbabwe and Mozambique.

Health care services are provided by Faranani Life Health Solutions which employs doctor driven primary health care approach. Health care provision is mainly on site with a 54 - bed inpatient health care facility and covers all acute, chronic and emergency aspects of care to

inmates. Out – patient primary health care clinic services led by professional nurses are provided to each housing unit on a daily basis, with doctor visits once a week.

The facility also offers initial TB screening to inmates at intake as a form of active case finding and during incarceration passive case finding is applied to diagnose TB to inmates who present at the prison clinics. Diagnosed TB patients are normally admitted to the health care facility for the first two weeks of their TB treatment and then discharged to continue treatments at unit clinics. Anti – retroviral drugs treatment is also provided to those inmates with HIV co-infection.

Health care provision is not limited to inmates, prison employees are also consulted on a need basis and during pre- employment medical examinations and emergencies. There are 400 employees who receive health care services on site.

The full time radiographer, psychologist and part time consultants in surgery, orthopaedics, specialist physician, psychiatrist and urologist are employed to support the primary health care doctors and professional nurses.

1.2 STATEMENT OF THE PROBLEM

According to the prison healthcare medical records of inmates, especially TB registers, it is reflected that on average a total of 35 inmates *(1195 per 100 000)* receive treatment for TB

at Mangaung Correctional centre on a monthly basis. (Prison TB register, 2008). This is compared to the case- load of 283.4 per 100 000 of smear positive TB cases in South Africa in 2007. TB prevalence in this prison still remains high as compared to the Free State Provincial case load of 300 per 100 000 of smear positive cases in 2007 (Free State TB register, 2008).

Since 2001, after the opening of the facility, five multi- drug resistant (MDR) tuberculosis cases have been diagnosed and two confirmed case of extensively drug resistant (XDR) tuberculosis was recorded. (Prison TB register, 2009). However factors associated with this high TB prevalence and development of TB disease in Mangaung Correctional centre, have not been studied.

Failure to control TB in prisons has the potential to disrupt the community TB programmes and compound the risk of MDR / XDR TB to the entire population. It is crucial to identify and mitigate; against those risk factors associated with the development and spread of TB in high-risk and overcrowded environments such as prisons. This may assist in controlling the spread of TB to epidemic proportions.

Possible risk factors associated with the development of TB in prisons as studied in Malawi, Ivory Coast and other developed countries include age, HIV co –infection, poor nutritional factors, longer length of stay in prisons and substance abuse. These factors will be investigated in this prison to determine their association with TB. (Koffi, et al., 1997 and Nyangulu, et al., 1997)

1.3 JUSTIFICATION OF THE STUDY

South Africa is a high burden country for TB infection as reported in 2009 by WHO. Demographic factors such as race, gender, low socio – economic status, poor living conditions and lately HIV infection are all well known risk factors associated with TB in general.

In addition to the high prevalence of TB in correctional facilities, inmates are vulnerable to develop TB because of their high - risk behaviour and overall poor living conditions in prison environment. If factors such as immune and nutritional status, previous history of TB, overcrowding and poor ventilation in prison, smoking and substance abuse are not investigated and properly dealt with, they may have serious repercussions for the public health in general. Both the inmates and correctional services employees may be affected because employees interact directly with their families and community when they leave their work place. (Steenland, et al., 1997; Koo, et al., 1997)

Prisons may be regulated but are not closed systems, so health problems within them are a critical part of public health. This facility houses inmates from different communities spread all over the country and neighbouring states. TB in correctional systems has a direct effect on public health because inmates will go back to communities when they are referred to public hospitals, clinics or are released from prison. Again inmates interact with their visitors, so we need to ensure that they are free from TB to limit the spread of the infection to their families and communities they are released into. Identifying and developing baseline data on the risk factors will help policy makers, prison managers and healthcare providers to achieve and implement better prison – specific TB control interventions and limit the spread thereof.

To my knowledge studies on prevalence of TB or analysis of risk factors for development of TB in prisons in South Africa has not been previously reported. The information might be unpublished or located in some red taped government reports.

The study aims to evaluate the degree of association between identified risk factors and the odds of contracting TB disease at this prison, Mangaung Correctional centre.

1.4 LITERATURE REVIEW

Tuberculosis (TB) is one of the fastest – growing epidemics in prison populations in sub – Saharan Africa (SSA). Despite its highly endemic nature, TB among prisoners in this region is

not well documented. Accurate data of TB in prisons in SSA countries are not readily available since surveillance and data reporting mechanisms are poor or non – existent. While there have been many comprehensive literature reports of TB in prisons from USA and Europe, very little research work has been done in developing countries including SSA on the risk factors associated with the incidence and spread of TB in the correctional facility settings.

Although precise information on prison conditions and the burden of the disease in prisons in Africa remains scarce, available data suggest that many of these facilities have outdated infrastructure and are overpopulated. The situation is even more disturbing given the difficult living conditions, extreme overcrowding, poor ventilation, poor sanitation and hygiene, poor nutrition and substandard health care. These conditions contribute to the high prevalence and transmission of TB in prison settings. (O'Grady, et al., 2011)

According to WHO, the prevalence of TB in prisons is very high, it accounts for up to 25% of the TB burden in a given country. It is reported to be 10- to 100 – fold higher than in the general population, in both low- and high –TB burden countries. Studies carried out in Ivory Coast, Malawi, Botswana, California and Bangladesh state prisons found TB prevalence of 10 to 35 times higher in prisoners than in the general population.

A prospective study of TB in Bouake prison camp, Ivory Coast from 1990 – 1992, showed the incidence of active TB to be 5803 per 100 000 inmates (n = 108/1861). In an active case finding study in Zomba Central prison, largest prison in Malawi, carried out in 1996 TB prevalence of 5142 per100 000 inmates (n = 47/914) was reported which was much higher than the general population. A point prevalence of TB among prisoners in Botswana was reported as 3797 cases per 100 000 population. A study carried out in California state prison in 1991 found a prevalence of 184 per 100 000 persons per year to be more than 10 times that reported among the general population (17.4 per 100 000 persons per year). A study in Dhaka central jail, Bangladesh reported a prevalence rate of 2 227 per 100 000 inmates which was 20 fold higher than the rate in the general population. (Banu, et al., 2010; CDC report, 2003; Koffi, et al.,1997; Koo, et al., 1997 and Nyangulu, et al., 1997)

Age has been identified as a risk factor in a number of studies. Pulmonary TB was the most common type of TB reported with a higher proportion being in young male inmates with the average age of 30 in the case finding survey carried out at Zomba Central prison in Malawi. This finding is in agreement with the studies carried out in East Ethiopian prisons where TB prevalence was higher among prisoners aged 15 – 44 years (13.4 %) compared to older

groups (4.8 %). In Bangladesh 56% (n = 137) of the inmates studied with active TB were aged between 21 – 30 years. (Abebe, et al., 2011; Banu, et al., 2010 and Nyangulu, et al., 1997)

In SSA, the region most affected by HIV, extraordinarily high rates of HIV have been documented in prison populations. HIV is a major predictor for tuberculosis, with HIV positive individuals at an estimated 20 times higher risk of developing TB during their lifetime. HIV epidemic and AIDS has been associated with the increase of TB cases in the general population. HIV co – infection increases the susceptibility to contagious diseases due to the compromised immune system. The high prevalence of TB disease in prisons has also been associated with the HIV/AIDS epidemic. (WHO Global TB control report, 2009)

Published literature in the developed world supports the findings the study of Rutta et al. (2001) done at Bugando Medical Centre, a referral hospital treating all inmates from Butimba prison in Tanzania where 25.9 % HIV co–infection was recorded in inmates with TB. Studies conducted in Chicago CCDOC county jail revealed that TB infection was three times higher (OR: 3.07; $p < 0.01$) among HIV positive inmates. In the penal camp of Bouake', Ivory Coast the authors found that 30 % of the prisoners were seropositive. A high HIV seroprevalence of 73 % (n = 45/62) was also reported in the study in Malawi. (Kim, et al., 2005; Koffi, et al., 1997 and Nyangulu, et al., 1997)

Inmates with suppressed immunity are more likely to develop TB than those with normal immunity. Low CD4 cell counts have been associated with the development of TB disease in literature. In California State prison HIV infected inmates with CD4 cell counts of <100 cells / mm^3, spending longer times in the communal day rooms were found to be at higher risk of developing TB. These inmates generally engage in fewer prison activities due to their ill health and low CD4 cell counts. The study also found that ambulatory inmates in this prison were at an increased risk of developing nosocomial infections. The association between TB transmission and overcrowding was also highlighted in this study. (Mohle – Boetani, et al., 2002)

Previously diagnosed TB disease and a family history of TB were identified as major risk factors for TB development in prisons. In a study done at Karachi juvenile jail, Pakistan 8.5 % (n = 386) prisoners reported a history of TB in the family and 4.4 % had been previously diagnosed with TB. Previous history of TB was also reported as a risk factor contributing to development of TB among prisoners in remand prisons in St. Petersburg, Russia. (Shah, et al., 2003; Lobacheva, et al., 2007)

It is well known that the association between malnutrition and TB is bi – directional, as TB may cause or predispose to malnutrition. Malnutrition as defined by a low BMI $\leq$ 18.5 kg/m^2 is positively associated as a risk factor for development of TB. In a prison in Bangladesh, the authors found that malnourished inmates were five times more likely to have TB. The likelihood of TB infection was 11 times more in inmates with severe malnutrition, BMI $<$ 17 kg/m^2. Malnutrition was also associated with TB disease in a penal camp of Bouake', Ivory Coast where 75 % (n = 108) of inmates with TB had malnutrition. In Tanzania 68.4 % (n = 343) of inmates with TB were classified as malnourished. (Banu, et al., 2010; Koffi, et al., 1997 and Rutta, et al., 2001)

Poor living conditions in prisons such as overcrowding not only contribute to the risk of airborne infections like TB but also heighten the tension among inmates, which fuel the risk of blood borne and sexually transmitted infections due to their high risk behaviours. These behaviours include coerced and unprotected sex, rape and unsafe injecting practices of intravenous (IV) drugs. Inmates who use intravenous drugs were found to be at high risk of developing TB. Drug use was also found to be associated with high HIV sero – positivity, which leads to high TB rates. The risk of having TB among inmates studied in remand prisons in St. Petersburg, Russia was more than two times for those who used narcotic drugs. In Chicago, CCDOC county jail study 27.7 % (n = 441) of TB group were IV drug users as compared to 14.1 % (n = 478) of non TB group. (Labocheva, et al., 2007 and Kim, et al., 2005)

Smoking is a well- known risk factor for a number of diseases. Smoking is associated with high risk of TB disease in most literature. The risk of TB is elevated for smokers than non-smokers in this study. A study in Dhaka central jail, Bangladesh also reported a strong association between smoking and TB infection with 85.7 % of TB cases smoking at least five cigarettes per day. In Ivory Coast, 52 % (n = 108) of prisoners with TB were smokers.

The architecture of prisons and the general living conditions in these facilities increase the risk of TB disease. Prison construction plans invariably focused on security as higher priority than adequate ventilation. Various studies showed that in situations where inmates with active TB live in poorly ventilated custodial settings the potential for rapid transmission of TB was high. The overcrowded conditions of most prisons and poor ventilated close quarters in which inmates are housed facilitate the transmission of TB. These factors may often lead to TB outbreaks in the prison systems. Although overcrowding in prisons increases the risk of TB, it will not be discussed in this study as the inmates in this centre are housed according to set norms. (Koo, et al.,1997; Lobacheva, et al., 2007).

TB outbreaks in the USA prisons, particularly in New York also showed that the length of stay in prison is associated with the TB development. The study also demonstrated that TB

outbreaks are often associated with strains of multi – drug resistant TB. These outbreaks did not only affect the inmates, but also spread to affect both the prison employees and medical personnel. The high prevalence of TB in Malawi prison was also associated with increased length of stay in prison. (Koo, et al., 1997; Nyangulu, et al., 1997)

1.5 OVERALL AIM

The aim of the study is to identify and evaluate risk factors associated with Tuberculosis among inmates at Mangaung Correctional Centre.

1.6 OBJECTIVES

- To determine risk factors contributing to contracting TB among inmates at Mangaung Correctional Centre during the study period of a year.
- To evaluate the degree of association between the identified risk factors and TB disease at this centre.

Definition of terms

TB cases: Inmates diagnosed with *Mycobacterium tuberculosis* by means of:

- Sputum positivity for acid-fast bacilli
- Positive culture for *Mycobacterium tuberculosis*
- Positive biopsy for acid-fast bacilli
- Clinical diagnoses with supportive chest radiograph

Non-TB cases (Controls): Those inmates with no history of TB.

HIV positive: Those inmates with HIV antibodies based on ELISA blood test and those with two positive bed - side finger prick rapid tests.

CD4 cells: White T helper cells which are progressively reduced in AIDS

BMI: Body mass index (kg/m^2) Source: WHO 2004, BMI Guidelines (18.5 – 22.9 normal BMI, <18.5 underweight)

CHAPTER TWO

2. METHODOLOGY

This chapter describes the design and the methods used in this study. The variables and data processing analyses are explained.

2.1 STUDY DESIGN

The study is a retrospective case – control analytical study reviewing existing data from the medical records of inmates diagnosed and treated for TB compared to those with no history of TB for the period of the study.

2.2 STUDY POPULATION

The study population are male inmates who presented at the clinics and were treated for any aliments including TB at Mangaung Correctional Centre between July 2009 and June 2010. Data will be sourced from available medical records and TB registers.

2.3 SAMPLING

Sampling was designed to create the TB cases and non TB cases (controls). A total of 1140 medical records were retrieved and reviewed. Hundred (n = 100) of the inmates were identified as TB cases from TB registers and 1040 non TB cases (controls) were randomly selected from patients who were treated at each of the housing unit clinics and the health care centre between July 2009 and June 2010. Systematic random sampling was used for selecting the controls in the study.

2.4 MEASUREMENT

A designed data capture sheet, with outlined risk factors to be investigated was used as a measurement tool to collect data from the medical records, see Appendix C. The following variables were chosen to be investigated in this study.

2.4.1 Outcome:

The study will demonstrate the degree of association between the identified risk factors and the odds of inmates developing TB during the study period, between July 2009 and June 2010.

2.4.2 Exposures:

The following independent variables were measured as risk factors for TB disease in this investigation. The variables were categorised into immune and nutritional factors, risky behaviour and incarceration factors:

Immune and nutritional factors:

- HIV co-infection
- CD4 cell count (cells/mm^3)
- BMI (kg/m^2) proxy for nutritional status

Risky behaviour:

- Substance abuse

Incarceration factors:

- Length of stay in prison (years)

2.4.3 Confounders:

- Age in years
- Smoking status
- Previous TB history

2.5 DATA PROCESSING AND ANALYSIS METHODS

Relevant data from the reviewed medical records was captured in Excel (Microsoft® Office 2010), cleaned, checked for completeness and coded. Data was then exported to STATA version 11.0 (Stata Corp, College Station, TX) statistical software for appropriate analysis. The numerical variables, Age and length of stay in prison were categorised and summarised as category variables.

The relationships between risk factors and TB were evaluated by bivariate and univariate analyses. Categorical variables comparison was described using Pearson chi- square test or Fisher's exact test where appropriate. A multiple logistic regression analysis was performed to find the association between TB disease and explanatory variables and odds ratios were calculated at 95% confidence interval and a p-value ($p \leq 0.05$) was regarded as significant, for improved precision of results.

The data set will also be used to determine the period prevalence rate of TB during the specified period in this facility. Statistical modelling was performed to account for confounding variables and improve the validity of the results. The final model fit to the data was assessed by the log likelihood ratio chi–square test.

2.6 ETHICAL CONSIDERATIONS

The study was cleared and approved by the University of the Witwatersrand Committee for Research on human subjects (Medical). Clearance certificate number: **M10832**. Approval and support letters to conduct the research in prison was obtained from the prison authorities and the clinic management.

Inmates are regarded as a vulnerable population in research and thus require special protection. To maintain confidentiality and anonymity to protect human rights of this population, there will be no actual human contact with the study subjects and no use of individual identifiers.

Data and information from obtained from the medical records was coded and only accessed by the researcher. The research findings will be made available to the prison authorities and the clinic management for consideration.

CHAPTER THREE

3. RESULTS

This chapter outlines the main findings of this investigation. The results are presented in table format. Table 1 – 5 reports the comparison between TB cases and non TB cases (controls) on the identified risk factors. These factors are categorised into Age grouping, immune and nutritional factors, confounders, risky behaviour and incarceration factors. Table 6 summarises the risk associated with contracting TB disease.

3.1 RISK FACTORS FOR CONTRACTING TB DISEASE

A total of 1140 medical records of male inmates were reviewed, n = 100 inmates had active TB disease, so were grouped as T.B cases and n = 1040 inmates were the control group non TB cases. The majority (42.6 %) of the inmates in this study population were aged between 31 – 40 years. The mean age was 35.7 years with the range of (22 – 67) years. The median length of stay in prison was 5 years (range: 1 – 22 years).

Table 3.1: Age Grouping

Age (years)	TB cases n = 100 n (%)	Non TB cases n =1040 n (%)	Fisher's exact
21 – 30	33 (33.0)	281 (27.0)	
31 – 40	52 (52.0)	434 (41.7)	
41 – 50	14 (14.0)	234 (22.5)	= 0.001
51 – 60	0 (0)	78 (7.5)	
61+	1 (1.0)	13 (1.25)	

Table 3.1 shows the age grouping between the TB cases and non TB cases. 33 % (n = 33) of the TB cases were aged 21 – 30 years compared to 27.0 % (n = 281) of non TB cases. 52% (n = 52) of TB cases compared to 41.7 % (n = 434) non TB cases were found in the age group 31 – 40 years. More inmates 22.5 % (n = 234) had no TB in the older age group 41 – 50 years, compared to the 14 % (n = 14) who had TB. The differences between the two groups were significant with Fisher's exact value = 0.001.

Table 3.2: Immune and Nutritional factors

	TB cases n =100 n (%)	Non TB cases n = 1040 n (%)	Pearson chi^2 P – value
BMI			
Below 18.5	47 (47.0)	159 (15.3)	$\chi^2 = 59.5302$
Above 18.5	53 (52.0)	881 (84.7)	p = 0.000
HIV			
Negative	27 (27.0)	384 (36.9)	$\chi^2 = 86.4148$
Positive	58 (58.0)	192 (18.5)	p = 0.000
Unknown	15 (15.0)	463 (44.6)	
CD4 count			
$>$ 350	21 (21.0)	95 (9.1)	$\chi^2 = 88.2416$
$\leq$ 350	34 (34.0)	84 (8.1)	p = 0.000
Unknown	45 (45.0)	861 (82.8)	

The TB cases had more exposures of the immune and nutritional factors compared to the non TB cases as shown in table 3.2. Forty seven (47 %) of the TB cases had low BMI of below 18.5 kg/m^2 which is associated with malnutrition. 58 % (n = 58) of TB cases were HIV positive

compared to 18.5 % (n = 192) non TB cases, for those inmates with compromised immunity and 44.6 % (n = 463) of non TB cases did not know their HIV status.

34 % (n = 34) of TB cases had low CD4 cell count of below 350 cells/mm^3compared to 8.1 % (n = 84) non TB cases. The difference in the two groups was statistically significant with p – values of less than 0.05.

Table 3.3: Confounders

	TB cases n =100 n (%)	Non TB cases n = 1040 n (%)	Pearson chi^2 P – value
Smoking			
Non smoker	36 (36.0)	422 (40.6)	$\chi^2 = 7.2642$
Smoker	45 (45.0)	512 (49.2)	p = 0.026
Ex -smoker	19 (19.0)	106 (10.2)	
Previous T.B			
No	69 (69.0)	924 (88.6)	$\chi^2 = 31.9907$
Yes	31 (31.0)	116 (11.2)	p = 0.000

Smoking in the two groups was high with 49.2 % (n = 512) of non TB cases and 45 % (n = 45) TB cases being smokers. But 19 % (n = 19) of TB cases were ex- smokers compared to 10.2 % (n = 106) non TB cases, see Table 3.3 above.

Table 3.4: Risky behavioural factor

	TB cases n =100 n (%)	Non TB cases n = 1040 n (%)	Pearson chi^2 P – value
Substance abuse			
No	45 (45.0)	621 (59.7)	$\chi^2 = 8.0842$
Yes	43 (43.0)	309 (29.7)	p = 0.018
unknown	12 (12.0)	110 (10.6)	

The risky behavioural factor of inmates through substance abuse was high in TB cases with 43 % (n = 43) reporting using drugs as compared to 29.7 % (n = 309) non TB cases, with p = 0.018, shown in Table 3.4.

Table 3.5: Length of stay in prison

Stay in prison (years)	T.B cases n = 100 n (%)	Non T.B cases n =1040 n (%)	Fisher's exact
1 – 5	11 (11.0)	72 (6.2)	
6 – 10	45 (45.0)	395 (37.9)	
11 – 15	26 (26.0)	312 (30.0)	= 0.218
16 – 20	13 (13.0)	169 (16.3)	
20+	5 (5.0)	92 (8.9)	

The increased length of stay in prison as a risk factor between the two groups was comparative as shown in Table 3.5. The difference between the groups was not statistically significant, Fisher's exact = 0.218.

Table 3.6: Risk factors and degree of association (Odds ratios)

Variables	Risk	
	Odds ratio	**95 % CI**
Age (years)		
21 – 30	1	
31 – 40	1.02	0.64 – 1.62
41 – 50	0.51	0.27 – 0.97
51 – 60	ND	
61+	0.65	0.08 – 5.17
BMI		
Below 18.5	1	
Above 18.5	0.21	0.14 – 0.32
HIV		
Negative	1	
Positive	4.2	2.64 – 7.00
Unknown	0.46	0.24 – 0.88
CD4 count		
$>$ 350	1	
$\leq$ 350	1.83	0.98 – 3.39
Unknown	0.24	0.14 – 0.41
Smoking		
Non smoker	1	
Smoker	1.03	0.65 – 1.63
Ex -smoker	2.10	1.16 – 3.81
Previous T.B		
No	1	
Yes	3.58	2.25 -5.70
Substance abuse		
No	1	
Yes	1.87	1.21 – 2.92
unknown	1.51	0.77 – 2.93

3.2 THE DEGREE OF ASSOCIATION BETWEEN IDENTIFIED RISK FACTORS AND TB

The younger age group 21 – 30 years had increased odds of contracting TB. The odds ratio was borderline and not significant (OR: 1.02; 95% CI: 0.64 – 1.62) for the age group (31 – 40) years. The older age group (41 – 50) years had lower odds of contracting TB (OR: 0.51; 95% CI: 0.27 – 0.97). The inmates with BMI above 18.5 kg/m^2 had less odds (OR: 0.21; 95% CI: 0.14 - 0.32) of developing TB than those with BMI below 18.5 kg/m^2. Being HIV positive increases the risk four times (OR: 4.2; 95% CI: 2.64 – 7.00) than the HIV negative status.

CD4 cell count $>$ 350 cells/mm^3 is associated with development of TB. Lower CD4 cell count $\leq$ 350 cells/mm^3 does not necessarily increase the odds of contracting TB (OR: 1.83; 95% CI: 0.98 – 3.39), as shown by the 95% CI that includes 1.0. The odds of TB are borderline (OR: 1.03; 95% CI: 0.65 – 1.63) for smokers and twice as high (OR: 2.1; 95% CI: 1.16 – 3.81) for ex-smokers as compared to non – smokers. The result for smokers is, borderline because of the confounding nature of smoking as a risk factor. Previous history of TB disease triples the odds of contracting TB (OR: 3.58; 95% CI: 2.25 – 5.70). Substance abuse also increases the odds of TB 1.87 times high (OR: 1.87; 95% CI: 1.21 – 2.92), as shown in table 3.6 above.

3.3 SUMMARY OF MAIN FINDINGS

A prevalence of 8.8 % (n = 100/1140) was found among the inmates studied. The TB cases had more risk factors as compared to the non TB cases (control group). The risk factors identified as contributing to the development of TB disease are:

- Age (21 – 30) years
- HIV co - infection
- BMI $\leq$ 18.5 kg/m^2
- CD4 cell count $\leq$ 350 cells/mm^3
- Smoking (ex- smoking)
- previous TB history
- substance abuse

The differences between the two groups were statistically significant with $p \leq 0.05$. Length of stay as a risk factor for TB in this study was not statistically significant, Fisher's exact value 0.218. The degree of association (odds ratios) for the identified risk factors was high for those inmates with exposures.

CHAPTER FOUR

4. DISCUSSION

This discusses the main findings of the study summarised in relation to the objectives. Then the discussion of implications, limitations and strengths to the study follows.

4.1 SUMMARY OF STUDY FINDINGS

This study showed a high prevalence of 8.8 % (8772 per 100 000) of TB disease among inmates in Mangaung Correctional centre. The prevalence is nine times higher than the total TB prevalence of the general population 948 per 100 000 as reported in 2009. High prevalence observed in this prison is in line with studies carried out in Cameroon, Malawi, Tanzania, Botswana and East Ethiopia, where TB prevalences in prisoners were 10 to 35 times higher than in the general population. (Noeske, et al., 2011; Nyangulu, et al., 1997; Rutta, et al., 2001; CDC report, 2003 and Abebe, et al., 2011)

There is a significant association between age and the risk of contracting TB. Inmates aged 21 – 30 years are at higher risk of developing TB than those of older age. Thirty three (33 %) inmates aged between 21 – 30 years and 52 % (n = 52) age group 31 – 40 years had TB in this study. This finding is in agreement with the studies in East Ethiopian prisons where TB

prevalence was higher among prisoners aged 15 – 44 years (13.4 %) compared to older age groups (4.8 %). TB was also found to be more prevalent among male inmates with the average age of 30 years, at Zomba Central prison in Malawi. (Abebe, et al., 2011; Nyangulu, et al., 1997)

HIV infection is a significant risk factor for TB disease. A four times increased risk (OR: 4.2; 95% CI: 2.64 – 7.00) of developing TB disease is associated with HIV co – infection in this study. Of the TB cases studied 58 % (n = 58) were HIV positive. It is well documented in previous studies conducted in other prisons worldwide that HIV co – infection increases the risk of TB among prisoners. It is also reported that HIV increases the likelihood of re – activation, re – infection and progression of latent TB to active disease.

In Tanzania, Bugando Medical centre HIV co – infection of 25.9 % (n = 433) was recorded among inmates with TB from Butima prison. A high HIV seroprevalence of 73 % (n = 45/62) was reported in the study in Malawi. A study in Chicago CCDOC county jail revealed that TB was three times higher (OR: 3.07; $p < 0.01$) among HIV positive inmates. (Rutta, et al., 2001; Nyangulu, et al., 1997 and Kim, et al., 2005)

Low CD4 cell count $\leq$ 350 cells/mm^3 is associated with the risk 1.83 times higher of developing TB in this study. This observation is similar to that in California state prison where HIV infected inmates with CD4 cell counts $<$ 100 cells/mm^3, were found to be at higher risk of developing TB disease. This confirms that inmates with suppressed immunity are more likely to develop active T.B infection than those with normal immunity. (Mohle – Boetani, et al., 2002)

Malnutrition as defined by a low BMI $\leq$ 18.5 kg/m^2 is positively associated as a risk factor for development of TB. Forty seven (47 %) of TB cases in this study had low BMI $\leq$ 18.5 kg/m^2 compared to only 15.3 % (n = 1040) of non TB cases. It is well known that the association between malnutrition and TB disease is bi – directional, as TB can cause or predispose to malnutrition. This study finding that inmates with low BMI are more likely to develop TB compared to those with normal BMI $>$ 18.5 kg/m^2 is in accordance with literature.

In a prison in Bangladesh, the authors found that malnourished inmates were five times more likely to have TB. The likelihood of acquiring TB was 11 times more in inmates with severe malnutrition, BMI $<$ 17 kg/m^2. Malnutrition was also associated with TB disease in a penal camp of Bouake', Ivory Coast where 75 % (n = 108) of TB infected inmates had malnutrition. (Banu, et al., 2010 ; Koffi, et al., 1997)

Thirty one (31 %) of TB cases studied had a history of previous TB disease compared to 11.2 % (n = 1040) non TB cases. This revealed that the risk of T.B infection is three times higher (OR: 3.58; 95% CI: 2.25 – 5.70) for those inmates with history of previous TB. This result was also observed in a number of previous studies. In Cameroon, previous TB disease was associated with a high risk (OR: 4.06; 95% CI: 1.70 – 9.71) of developing TB. Those inmates with a history of TB disease had three- fold higher risk (OR: 3.25; 95% CI: 2.28 – 4.64) than those without as reported in Bangladesh. (Noeske, et al., 2011 and Banu, et al., 2010)

Smoking is a well- known risk factor for a number of diseases. Smoking is associated with high risk of TB in most literature. The odds developing of TB for smokers were borderline (OR: 1.03; 95% CI: 0.65 – 1.63) compared to non- smokers in this study. This result was not significant due to smoking being a confounder. Increased odds, twice as high (OR: 2.10; 95% CI: 1.16 – 3.81) is associated with being an ex-smoker.

A study in Dhaka central jail, Bangladesh also reported a strong association between smoking and TB with 85.7 % of TB cases smoking at least five cigarettes per day. In Ivory Coast, 52 % (n = 108) of prisoners with TB infection were smokers. A number of previous studies have reported smoking associated with increased risk of developing TB disease but with statistically insignificant values ($p > 0.05$). This could probably be due to the confounding

characteristic of smoking as a risk factor for development of TB disease. (Banu, et al., 2010; Koffi, et al., 1997 and Shah, et al., 2003)

Substance abuse is observed in 43 % of TB cases in this study. The risk of TB is 1.87 times higher for substance abusers than non- abusers. This result is supported in a number of previous studies where drug use among inmates was associated with increased risk of TB development. The risk of having TB among inmates studied in remand prisons in St. Petersburg, Russia was more than two times higher (OR: 2.6; 95% CI: 1.1 – 6.2) for those who used narcotic drugs. In Chicago, CCDOC county jail study 27.7 % (n = 441) of TB group were IV drug users as compared to 14.1 % (n = 478) of non TB group. (Labocheva, et al., 2007; Kim, et al., 2005)

In this study the length of stay in prison is not significantly associated with contracting TB Fisher's exact value = 0.218, p – value greater than 0.05; despite previous studies reporting either short or long stays in prison as risk factors for TB. Most studies reported development of TB disease significantly associated with the first six months of incarceration of prisoners.

This could be because prisoners come from high risk communities with high prevalence of TB and may be already exposed to the disease prior to incarceration.

Previous imprisonment and pre – trial jail stays were also identified as risk factors for developing TB in literature. In general inmates stay longer in remand jails or police holding cells awaiting trial, due to the prolonged criminal justice process of court days and delayed sentencing. These factors were not considered in this study, mainly because of limitations of the data source. (Banu, et al., 2010; Kim, et al., 2005)

4.2 IMPLICATIONS AND STRENGTHS OF STUDY

The present study is the first to investigate the risk factors associated with TB among the inmate population in South Africa.

The study identified the risk factors and their degree of association for contracting TB disease in prison, Mangaung Correctional centre; but the factors are not limited to this prison they can be generalised to use for other prisons.

It is implied from the study that with the risk factors for contracting TB in prisons identified, this would lead to more accurate and improved diagnosis and treatment systems developed. The results observed here call for urgent attention by prison and national authorities to the seriousness of TB disease in prison environment and highlight the need for policy changes to develop prison – specific interventions which are integrated in the National TB control programme.

This study forms a baseline platform from which more elaborate investigations need to be conducted to further characterise the risk factors for development and spread of TB in prisons.

4.3 LIMITATIONS TO THE STUDY

In considering the findings of this study, the following limitations need to be highlighted.
A retrospective case - control analytical study design is limited by the data source in this case the medical records. Information that can be retrieved from these records is mostly clinical, in some cases the records were incomplete, inaccurate or details were simply missing. Details about socio – demographic characteristics like race, level of education, employment and marital status or incarceration factors like pre – trial jail stays and previous imprisonment are not contained in medical records. This kind of information is only available in prison records which were inaccessible for this study.

High population turnover in prison also posed limitation, inmates are continuously being transferred to other facilities or released on parole this meant their medical records were not available for investigation. Medical records of deceased and released inmates are not kept at this prison but are turned over to the Department of Correctional service to become

property of the state. In this study of the 112 identified TB cases, only 100 medical records were available for investigation.

The study population was limited to inmates only and did not include the prison staff.

Despite these limitations, the findings can be used for effective TB control interventions.

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

This study is the first to report the risk factors associated with contracting TB in this prison. The findings that inmates are at an increased risk of developing TB disease are in line with earlier studies conducted in prisons in other countries.

The high prevalence of 8.8 % observed in this prison confirms that TB disease among prisoners is a serious health problem that can never be ignored any longer. Prisoners are the most vulnerable, yet possibly the most marginalised population in our society. Prisoners have the right to receive better healthcare. Their health status cannot be separated from their behaviours and living conditions.

With the risk factors identified and the associated risk established, accurate and systematic interventions need to be developed and implemented immediately to control the development and transmission of TB disease in this high risk environment and prevent the spread to the general population.

5.2 RECOMMENDATIONS

Standard recommendations of infection control and prevention, isolation of patients and protection of medical staff apply to all institutions. However these are not implemented in most prisons in sub- Saharan African countries. (O'Grady, et al., 2011)

A closer look at the risk factors associated with TB in this prison gives some indication of where targeted interventions need to be focused. The identified risk factors: Age (21 – 50) years; HIV co – infection; low BMI $\leq$ 18.5 kg/m^2; low CD4 cell count $\leq$ 350 cells/mm^3; previous history of TB disease; smoking (especially ex- smokers) and substance abuse should help target the high risk groups among inmates that must be closely monitored for developing TB.

TB screening and treatment completion are critically important for inmates, to control the spread of TB disease. It is recommended that TB control programmes be introduced in the prison environment according to the following guidelines: - (DOH Guidelines for TB: Correctional service 2013 and O'Grady, et al., 2011)

5.2.1 TB Screening, treatment and prevention

- Though inmates are screen on admission to this prison, there is a need to increase the frequency of screening periodically during incarceration and on release or

transfer from this prison to others. Standardised symptom – based questionnaires should be developed for screening.

- Screening needs to extend to contacts or cell mates of newly identified smear – positive TB cases. Special attention should be given to those inmates reporting positive family history of TB or previously diagnosed TB and ex – smoking as they have more odds of developing TB. Due to the high prevalence of TB and HIV/AIDS among prisoners, parallel screening of TB and HIV is necessary and should be done regularly.
- Chest X – ray screening must be introduced for smear- negative inmates with persistent symptoms and HIV positive inmates. Smear- or culture- positive and drug resistant inmates should be treated according to the National TB management guidelines. MDR-TB inmates should be referred to specialized MDR –TB unit for further management.
- Since compromised immunity, low CD4 cell count and malnutrition are associated with an increased risk of TB development and reactivation of latent TB to active TB, All HIV positive inmates require repeat CD4 testing every six months and regular TB symptom and STI screening.
- All HIV positive inmates with active TB and CD4 cell count $<$ 350 cells/mm^3 should receive cotrimoxazole prophylaxis and ART. Inmates with CD4 cell count $<$ 100 cells/mm^3 should be screened for *cryptococcal* disease.

- Isoniazid preventive therapy (IPT) should be given to all HIV infected inmates, who are not on TB treatment or are asymptomatic for TB.

5.2.2 Infection control

Infection control consists of environmental, administrative and personal protection aspects.

- **Environmental control**

  There is a need to improve overcrowding, poor ventilation and sanitation in this prison especially at workshops, class rooms and communal areas. Natural ventilation is recommended where possible, and UV germicidal radiation where affordable.

- **Administrative control**

  These involve formation of infection prevention and control committee.
  Regular risk assessments and screening must be performed; and education and training of staff and inmates in a form of information and awareness campaigns.
  These are integral parts of TB and HIV control programmes in prisons, with the aim to increase knowledge and antagonise the stigma and discrimination related to these diseases.

- **Personal protection**

  Coughing is known to produce TB bacilli which is airborne and remain viable for a long time, thus exposing everyone in the surroundings to infection whether another inmate, member of staff or even visitors. It is important for staff and inmates to wear face masks where applicable and practise proper coughing etiquette.

  It has been reported in literature that sharing a cell with a TB patient or inmate with chronic cough is associated with high risk of TB infection. It is recommended that inmates with Pulmonary TB should be isolated for at least two weeks. (Abebe, et al., 2011)

5.2.3 Collaborative approach

For effective TB control in prisons and the prevention of TB transmission to the general community. A multifaceted collaborative approach is required between healthcare systems both in and outside prisons. Considering the high population turnover in prisons, it is important to ensure that inmates, who are released or transferred before completion of their treatment, are able to continue treatment.

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APPENDIX A: ETHICS CLEARANCE

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Dr SP Mogoere

CLEARANCE CERTIFICATE	**M10832**
PROJECT	Risk Factors Associated with Tuberculosis at Mangaung Correctional Centre: Retrospective Analysis
INVESTIGATORS	Dr SP Mogoere.
DEPARTMENT	School of Public Health
DATE CONSIDERED	27/08/2010
DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 27/08/2010 **CHAIRPERSON** .....
(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable
cc: Supervisor : Dr P Nyasulu

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES...

APPENDIX B: PERMISSION LETTER (MCC PRISON)

G4S Correction Services
(Bloemfontein) (Pty) Limited
Mangaung Correctional Cent
Private Bag x101, Fichardt Parl
9317, Bloemfontein, South Afric
Dewetsdorp Road, Grootvlei,
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www.careandjustice.co.za

Ethics and Post-Graduate Committees
School of Public Health
University of the Witwatersrand

Attention of: Dr. Mary Kawonga

29 March 2010

Dear Dr. Mary

TB RESEARH PROJECT: DR. S.P. MOGOERE (9202733N): MANGAUNG CORRECTIONAL CENTRE (MCC)

The management of this Correctional Facility grants the above mentioned student permission to conduct a TB research project in this centre for study purposes.

We concur that TB is a priority public health problem that requires careful management to combat its spread. We therefore request the student to discuss the outcomes and proposed improvement measures of this research with the centre's management.

Yours sincerely

Johan Theron
Director MCC
Tel No.: +27 (51) 406 5404
E-mail: johan.theron@za.g4s.com

APPENDIX C: DATA CAPTURE SHEET

Inmate CODE	AGE	HIV co-infection			BMI		Diagnosis date	Type of TB
	Years	Positive	Negative	Unknown	Below 18.5	Above 18.5	YYYY/ MM/ DD	

Previous TB history		Smoking			Substance abuse			Length of Stay (years)	CD4 count level
Yes	No	Smoker	Non smoker	Ex- smoker	Yes	No	Unknown		