EPIDEMIOLOGY OF TUBERCULOSIS IN INMATES OF SELECTED CENTRAL PRISONS IN TANZANIA

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF PUBLIC HEALTH AND FOOD SAFETY OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

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ABSTRACT

A cross sectional study was carried out to determine prevalence of tuberculosis (TB) among prison inmates and assessed risk factors contributing to the disease in five selected Central prisons namely; Butimba, Isanga, Ruanda, Ukonga and Segerea in Tanzania. The prevalence was established based on sputum smear microscopic examination for Acid Fast Bacilli (AFB). Questionnaires were used to gather information from prison inmates and prison staff about possible risk factors for TB spread in prisons. Due to the current association between HIV infection and TB epidemic, HIV screening was carried out by testing capillary blood adhering to the National algorithm whereby two serial rapid antibody tests namely Alere Determine and Uni-Gold were used. A total of 370 prisoners out of 8330 inmates were involved and the overall prevalence of TB was 3.8%. On commencement of the survey, 71 prisoners (0.85%, n=71; N=8330) from studied prisons were under anti TB treatment. The overall prevalence of HIV in studied Prisons was 5.4%. It was also noted that overcrowding, poor ventilation, poor prison architecture, history of TB contact, HIV infection, smoking cigarettes, and limited knowledge on TB to prisoners were the risk factors for TB in prisons. The present study confirms the high prevalence of pulmonary tuberculosis in prison populations, thus suggest not only active transmission of the disease in the prison settings but also the need for executing urgent preventive measures.

DECLARATION

I, Wilson Emmanuel Rugamba, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.

Wilson Emmanuel Rugamba — 15-5-2014
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The declaration above is confirmed by

Prof. Kazwala, R. R. — 15/05/2014
(Supervisor) — Date

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LIST OF ACRONYMS

ACP	Assistant Commissioner of Prisons
AFB	Acid Fast Bacilli
AIDS	Acquired Immuno Deficiency Syndrome
BCG	Bacilli Calmette Guerin
BMI	Body mass Index
CDC	Centre for Disease Control and prevention
CGP	Commissioner General of Prisons
DOT	Directly observed Treatment
EPTB	Extra –pulmonary tuberculosis
ESR	Erythrocyte Sedimentation Rate
HIV	Human Immunodeficiency Virus
MDR	Multi Drug Resistance
MDR-TB	Multi drug resistance- tuberculosis
MPH & FS	Master of Public Health and Food Safety
NIMR	National Institute for Medical Research
NTLP	National Tuberculosis and Leprosy Program
PTB	Pulmonary Tuberculosis
RPO	Regional Prisons Officer
TB	Tuberculosis
USAID	United States Agency for International Development
WHO	World Health Organization
ZN	Ziehl Nielsen stain

CHAPTER ONE

1.0. INTRODUCTION

1.1. Background Information

Tuberculosis (TB) is a chronic infectious disease mainly caused by *Mycobacterium tuberculosis* and rarely by *Mycobacterium bovis* (reservoir cattle) and *Mycobacterium africanum* (NTLP, 2006; Nicki *et al.*, 2010). Transmission of infection occurs by airborne spread of infectious droplets nuclei emitted by a person with active tuberculosis of the lungs (PTB). The disease is always initiated by inhalation of aerosolized droplet nuclei from infected person. Moreover, human can acquire infection through inhalation of animal aerosols or consumption of raw infected milk, blood and meat.

The introduction of TB eradication scheme in cattle coupled with safeguarding the public such as milk pasteurization and meat inspection led to a decrease of incidence of extra-pulmonary tuberculosis (EPTB) in human in developed countries (Grange and Collins, 1987). Nevertheless, EPTB is still common in countries where the prevalence of tuberculous in livestock especially dairy cows is high (Kumar *et al.*, 2005). Tuberculosis is characterized clinically by a lifelong balance between the host and infection in which pulmonary and extra pulmonary foci may reactivate at any time after a long period of latency and that is why clinical signs and symptoms of the disease in human and animal are not apparent until late in the disease process.

The impact of tuberculosis in world health is significant; in 2006 there were estimated 9.2 million new cases, 14.4 million prevalent cases and 1.5 million deaths attributable to TB (Nicki *et al.*, 2010; IRIN, 2010).

Furthermore, the increase in prevalence of TB has been largely driven in Africa by HIV infection, decline in living standards in certain sectors of the population ineffectiveness of Bacille Calmette- Guerin Vaccination and lack of adequate population surveillance (Mera, 2003). Infection with HIV makes people susceptible to rapidly progressive tuberculosis. For instance, in 1985 to 1992 the number of tuberculosis cases in the United States increased by 20% because of increase of disease among people with HIV, immigrants and among those in jail or homeless shelter (Kumar *et al.*, 2005).

Apart from accompanying HIV infection, other contributory factors for the increase in prevalence of TB are; ineffective Bacillus Calmette Guerine (BCG) vaccination, lack of appropriate health care, development of drug resistance, illiteracy and ignorance about TB, poverty and poor living standards especially in rural areas, prisons and refugee camps and slums (Kumar *et al.*, 2005; Nicki *et al.*, 2010). Other risk factors for PTB infection to the susceptible individual includes close prolonged, indoor exposure to a person with sputum smear positive. Nevertheless, the risk of transmission of infection from a person with sputum smear negative is low and even lower with EPTB (WHO, 1996; Mera, 2003; Kumar *et al.*, 2005). These factors are almost usually present in most prisons thus poses a potential risk of TB spread among prison population and rest of the society.

The available data around the globe suggest that, jail inmates are at increased risk of contracting tuberculosis infection. Prisons are not closed institutions due to the fact that, prisoners are often mobile circulating within the prison systems and outside community thus may enhance TB transmission to the rest of the community.

The study conducted in Cameroon and Botswana reported that prisons are settings in which tuberculosis occur ten times the stated national rates (Wang *et al.*, 2003; Noeske *et al.*, 2006; Uwofeso *et al.*, 2010).

Tanzania is among countries with the highest TB burden which places it among twenty two high burden countries in the world. Since 1983, number of tuberculosis cases in Tanzania has been increasing, the recent data shows that a total of 63 453 TB cases of all forms were notified in Tanzania in the year 2010 (Hambergh and Weezenbeek, 2008; Mfinanga *et al.*, 2008; NTLP, 2010). Despite the fact that Tanzania met the World Health Organization global target of 85% treatment success, case detection rate for new sputum smear and TB cases remain low at 51% below WHO target of 70% (USAID, 2009). Perhaps this could be due to lack of surveillance and appropriate TB integrated activities.

On other hand, Tanzania's Prisons are seemingly overpopulated that poses a great risk of TB spread among Prison inmates, prison staff and the rest of community taking into account to the existing interactions among Prison population and the outside society (Maher *et al.*, 1998; CDC, 2003; ICR, 2007). Despite the risk of TB spread among Prison inmates, little is known about the magnitude and dynamics of the disease in Tanzania's Prisons.

1.2 Justification

The current study is important since the prevalence of tuberculosis was not yet been determined in the Central Prisons in Tanzania. Moreover, Tanzania Prisons Service is comprised of 127 prisons. These Prisons are overcrowded making a conducive environment for transmission of tuberculosis among the inmates as it was showed in previous study conducted at Butimba Prison in Mwanza Region (Rutta *et al.*, 2001).

Through this study, the expected findings are anticipated to be used in advising the Custodial Authorities and Policy makers to execute urgent measures in prevention of tuberculosis hence render prisoners safe while saving the imprisonment. Moreover, the Custodial Authorities and Policy makers in Tanzania are in need of evidence based policies and strategies, hence the obtained results from present study will act as catalyst to achieve this desire. The results indicates the risk of TB spread among prison population is high hence calls for further study in other prisons (WHO, 1998; Rutta *et al.*, 2001; Baussano *et al.*, 2010).

1.3. Objectives of the Study

1.3.1. Overall objective

To study dynamics of spread of tuberculosis in Prisons in Tanzania.

1.3.2. Specific objectives

i. To determine the prevalence of Tuberculosis in selected central prisons of Tanzania
ii. To identify risk factors associated with prevalence of tuberculosis in selected central prisons of Tanzania.

1.4. Research Questions

i. What is the prevalence of tuberculosis in five central prisons?
ii. What factors influence occurrence of pulmonary tuberculosis in five central prisons?

CHAPTER TWO

2.0. LITERATURE REVIEW

2.1. Definition

Tuberculosis is a highly contagious, acute or chronic debilitating infectious disease affecting all species of vertebrates. The disease is characterized clinically by a lifelong balance between the host and the infection in which pulmonary and extra pulmonary foci may reactivate resulting to progressive loss of body condition and tubercle formation in various body organs (Eshuish *et al.*, 1978; Brett and Humble, 1991). Tuberculosis is mainly caused by infection with *M. tuberculosis* and occasionally by *M. bovis* and *M. africanum* (NTLP, 2006). *M. tuberculosis* rarely cause progressive disease in lower animals other than non human primates while *M. bovis* is known to cause tuberculosis in most warm blooded vertebrates apart from human and cattle (Luziga, 2002; Nicki *et al.*, 2010).

The common tuberculosis in humans is the pulmonary form (PTB) which affects lungs and the associated lymph nodes. Extra- pulmonary tuberculosis (EPTB) is the form of tuberculosis that affect body organs other than lungs, such as pleura, lymph nodes, skin, pericardium, spine, bones, meninges, abdomen or genital urinary tract. It may affect any part of the body (NTLP, 2006).

2.2. Bacteriological Characterization of Mycobacterium

Bacteria in genus of *Mycobacterium* are non spore forming, slender, aerobic rods that grow in straight or branching chains.

They have a waxy cell wall composed of mycolic acid, which makes them acid fast meaning they retain primary stains for example carbofulschin or other arylmethane even on treatment with a mixture of acid and alcohol. *Mycobacterium* stain weakly positive with Gram stain (Daniel *et al.*, 1994; Wayne, 1994; Kumar *et al.*, 2005).

2.3. Epidemiology of Tuberculosis

2.3.1. Distribution

Tuberculosis is estimated to affect 1.7 billion individuals worldwide, with 8 to 10 million new cases and 1.7 million deaths each year (Kumar *et al.*, 2005). After HIV, tuberculosis is the leading infectious cause of death each year whereby most people affected are in developing countries. Historically, tuberculosis was a significant problem in the now developed countries; as it was responsible for up to quarter of deaths in Europe. However, due to improvement of social condition in the developed countries, the number of infections and deaths from the disease began to decline (Mera, 2003). Nevertheless, in Africa the resurge of TB has been largely driven by HIV infection and poverty while in the former Soviet Union and Baltic, the disease is driven by lack of appropriate health care exacerbated by social upheaval (Nicki *et al.*, 2010).

Between 1987 and 1993, notification rates for tuberculosis in London increased from 21 per 100 000 people to 31.5 per 100 000. The increase was most marked in inner city areas with high proportions of immigrants and unemployed people (Mera, 2003). Globally, the increase of TB prevalence is also associated with HIV/AIDS pandemic (Mera, 2003; Kumar *et al.*, 2005). In 2008, the World Health Organization Epidemiological TB report in prisons indicated that prisons have high prevalence of the disease (WHO, 2008).

The report showed that, prisons in the former Soviet Union had some of the highest primary TB. The incidence of 4 560 per 100 000 populations was reported where by multi-drug resistance TB (MDR- TB) for previous treated inmates ranged from 12% to 55% worldwide. It was also reported that prison staff of up to 1.5% in England had TB while 41% of prison inmates in Tanzania were reported to have active tuberculosis (WHO, 2008). Although most cases of tuberculosis are caused by *M. tuberculosis*, *M. bovis* has been the commonest cause of EPTB and is still occurring in countries that have TB infected dairy cows and drink unpasteurized milk and dairy products (Sjogren, 1978; Kumar *et al.*, 2005). EPTB used to be prevalent before the introduction of control measures. For example in Ireland, 8% of the isolates from lymph nodes were due to *M. bovis* infections, while in German, between years 1953 and 1957 *M. bovis* isolates in children was 45%. Also during the Second World War, *B. tuberculosis* was responsible for 10-30% of cases depending on the population at risk (Thoen and Steele, 1995).

Moreover, eradication programs of *B. tuberculosis* in cattle together with milk pasteurization, effective meat inspection and improving standard of living, the incidence of EPTB was greatly reduced in developed countries. In Africa, reported prevalence between years 1980 and 1989 was; 3.6% in Malawi, South Africa 7.2% while the prevalence in Ethiopia ranged from 1 to 1.5% (Thoen and steel, 1995). In Tanzania, a total of 63 453 tuberculosis cases of all forms were notified in the year 2010.Nevertheless, there was diminished 814 reported cases (All forms) in Year 2010 compared to Year 2009.

Among the reported cases, PTB smear positive cases were 24 769 (39.0%) while EPTB was 13 715 (21.6%) as reported by the NTLP Annual report (2010). Tuberculosis cases notified in Tanzania from the year 2009 to 2010 and distribution of TB cases notified by regions is shown in Table1 and Fig. 1.

Table 1: Tuberculosis cases Notified in Tanzania 2009- 2010

Type notified	2009		2010		Change	
	Cases	%	Cases	%	Num.	%
All forms	64 267	100	63 453	100	-814	-1.3
New forms						
-Pulmonary smear positive	24 895	38.7	24 769	39.0	-126	-0.5
-Pulmonary smear negative	21 750	33.8	21 184	33.4	-566	-2.6
-Extra -pulmonary	13 405	20.9	13 715	21.6	310	2.3
Total	60 050	93.4	59 668	94.0	-382	-0.6
Re-treatment						
-Relapse	1 487	2.3	1 430	2.3	-57	-3.8
-Failure	92	0.1	96	0.2	4	4.3
-Return to control	222	0.3	255	0.4	33	4.9
-Others	2 217	3.8	2 004	3.2	-412	-17.1
Total	4 217	6.6	3 785	6.0	-432	-10.2
Notification rates (new and Retreatment/100 000popn/yr)	153		147		-6	-4.2
Notification rates (new sm +/100 000popn/yr)	59		57		-2	-3.4

(Source: Tanzania NTLP Annual Report, 2010)

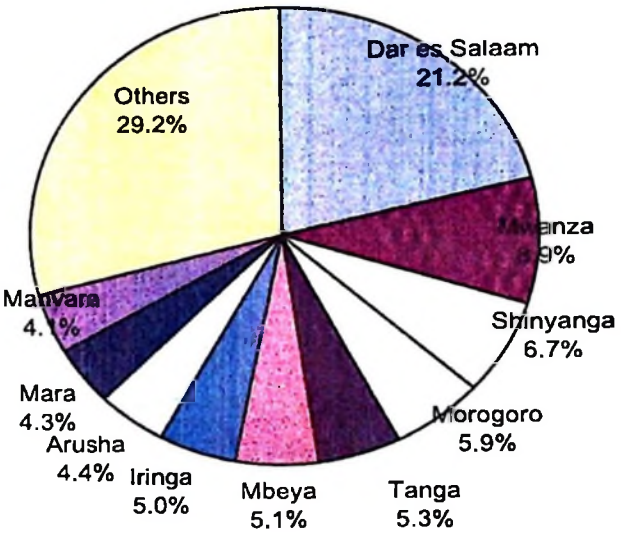

Figure 1: Distribution of TB cases notified in Tanzania by regions in 2010

(Source: Tanzania NTLP Annual Report, 2010)

2.3.2. Mode of transmission

Infection with *M. tuberculosis* is spread by inhalation of aerosolized droplet nuclei from a person with TB of the lung (PTB) who is coughing. Normally coughing produces tiny infectious droplets so called droplet nuclei. One cough can produce up to 3 000 droplet nuclei which remain in the air for a long time especially in poorly ventilated environment (WHO, 1996; Abebe *et al.*, 2011). On the other hand, *M. bovis* infection in humans occurs through consuming raw or undercooked meat and blood as well as raw milk and milk product such as cream, cheese, butter and yoghurt prepared from raw milk from cattle infected with TB. Aerosol transmission has also been reported (Sjogren and Hillerdal, 1978; Kumar *et al.*, 2005).

2.3.3. Predisposing factors of tuberculosis

2.3.3.1. Risk factors of TB infection

An individual risk of TB infection depends on the extent of exposure to droplet nuclei and his susceptibility to infection. The risk of infection of a susceptible individual is therefore high with close, prolonged, indoor exposure to a person with sputum smear positive. Once infected with *M. tuberculosis*, a person stay infected for many years, probably for life. The vast majority (90%) of people without HIV or any other debilitating illness but infected with *M. tuberculosis* do not develop tuberculosis (WHO, 1996; Abebe *et al.*, 2011).

2.3.3.2. Patient related risk factors

Tuberculosis is essentially a disease related to poverty that is why the disease remains a major health problem in developing countries. Decline in living standards, HIV infection, overcrowding, poor ventilation, and close contact to a patient with smear positive PTB remain major risk factors for the spread of TB (Kumar *et al.*, 2005; Mfinanga *et al.*, 2008; IRIN, 2010). Moreover, risk behaviors such as smoking cigarettes or tobacco, consumption of raw contaminated meat, raw blood and unpasteurized milk predisposes humans to the disease. Furthermore, tuberculosis has always been a serious problem among immune compromised individuals hence all conditions that suppress immunity such as AIDS, malignancy, cortical steroid therapy and malnutrition are attributing factors for TB (Nicki *et al.*, 2010).

2.3.4. Risk factors of PTB in prison population

Tuberculosis has always been a serious health problem among prison inmates hence prison termed as social determinant of tuberculosis (Uwofeso, 2010).

This is probably due to the fact that prisons act as reservoirs for TB, pumping the disease into the civilian community through inadequately treated former inmates, prisoner's visitors and prison staff (Kumar *et al.*, 2005). Most studies (worldwide) have revealed that, there are extremely higher numbers of TB cases in places of detention than in the rest of society (ICR, 2007; Adebe *et al.*, 2011; Moges *et al.*, 2012). Tuberculosis in prison settings has been correlated with poor living standards of prisoners, overcrowded and poorly ventilated prison cells, malnutrition and accompanying HIV infection (Haederle, 2000; IRIN, 2010).

Furthermore, risk behaviors such as sharing smoking of cigarettes or tobacco, sharing meals or utensils and close contact to inmates with active pulmonary tuberculosis predisposes them to contract the disease. Since tuberculosis flourishes in poorly ventilated places and crowding conditions, these factors are always present in most of prisons thus poses risk of TB spread among prisoners. Prisoners with long sentence of imprisonment are at high risk of contracting the disease due to the fact that they are longly exposed to TB environment. In additional to the mentioned factors, low level of education and inadequate or in accessible medical care are also contributory factors for tuberculosis spread among prison inmates. Moreover, prisoners are often highly mobile, circulating within the prison systems, different institutions of judiciary systems and health facilities and therefore pose the risk of transmitting and acquiring tuberculosis infection. Lack of routine screening of tuberculosis in most prisons is another factor that fastens transmission of TB (Haederle, 2000).

2.3.5. Pathogenesis

Infection with *M. tuberculosis* is spread by inhalation of the aerosolized droplet nuclei from infected patient whereas *Mycobacterium bovis* infection arises from consuming non

pasteurized infected milk, eating raw meat or blood from infected cattle. Once inhaled, the organism lodge in the alveoli and initiate the recruitment of macrophages and lymphocytes. Macrophages undergo transformation into epithelioid and langhhans cells which aggregate with the lymphocytes to form the classical tuberculous granuloma which aggregate to form a primary lesion or Ghon focus. Spread of organisms to the hilar lymph nodes is followed by a similar pathological reaction, the combination of primary lesion and regional lymph nodes is referred as the primary complex. Reparative process encase the primary complex in a fibrous capsule limiting the spread of bacilli hence the so called latent TB. However, lymphatic or haematogenous spread may occur before immunity is established or if those reparative processes fail. The estimated life time risk of developing disease after primary infection is 10% (Nicki *et al.*, 2010). In humans *M. bovis* causes EPTB forms of the disease. The primary complex consists of the lesions at the port of entry and in the local lymph nodes. If the infection is through inhalation, the primary complex is found in the lung but in case of oral route of infection pharyngeal and mesenteric lymph nodes are involved (Gracey, 1986). The complex may remain unchanged for a long time or post primary dissemination ensues which may take the form of acute milliary tuberculosis affecting other parts of the body.

2.3.6. Association of TB with HIV

HIV is the most important cause of the rapid increase of the current TB epidemic. The life time of developing TB in an individual who is HIV negative is 15-20%, while in HIV positive the risk is 50%.Moreover, individual infected with *Mycobacterium tuberculosis who* get infected with HIV have a 20-30 times higher risk of developing TB than those who are HIV negative (NTLP, 2006).

HIV increases the susceptibility to infection with *M. tuberculosis* as it progresses CD4 and T- Lymphocytes decline in number and function. The cells play an important role in the body's defense against tubercle bacilli, thus immune system become less able to prevent the growth even local spread of *M. tuberculosis*. On other hand, TB may accelerate the progress from asymptomatic HIV to symptomatic or AIDS hence increase mortality and morbidity among HIV positive patients (NTLP, 2006; Nicki *et al.*, 2010).

2.3.6.1. General trend of Tuberculosis

It is estimated that around one third of the world's population has latent TB. Majority of cases occur in the world's poorest nations. Globally the TB incidence rate per capita appears to be growing slowly in Western and Central Europe. Nevertheless, striking increase has occurred in countries of Eastern Europe and Sub-Saharan Africa. The African region has the highest estimated incidence rate of 345 per 100 000 populations annually. The resurgence of TB in Africa Sub–Saharan Africa has been largely driven by HIV disease and in appropriate health care (Nicki *et al.*, 2010).

2.3.6.2. General status of TB/HIV in Tanzania

The HIV epidemic has spread rapidly in Tanzania since the mid eighties. The current surveillance data estimates that 7-8 % of the population is infected with HIV with the highest prevalence found in urban areas and among young adults. Also it is the most important cause of the current TB epidemic. For instance, in 2010 a total of 56 849 (90%) of 63 453 notified TB cases were counseled and tested for HIV status. Of those tested, 21 662 (37.2%) were found to be co- infected with HIV (NTLP, 2006; NTLP, 2010).

3.3.7. Clinical features

Clinical manifestation of tuberculosis in humans varies depending on forms of tuberculosis, duration of infection and the age of infected individual.

2.3.7.1. Clinical features of pulmonary tuberculosis

Few patients develop a self limiting febrile illness but clinical disease only occurs if there is a hypersensitivity reaction or progressive infection. Three to eight weeks from time of infection, primary complex can be detected through chest x-ray also tuberculin skin test. Following post primary PTB, systematic symptoms including fever, profuse night sweat, malaise and progressive weight loss occur (NTLP, 2006; Kumar *et al.*, 2005). Other symptoms are due to the local inflammatory reaction in the lung. Cough is due to irritative secretions draining into the bronchi from sloughing areas of lung tissue. Initially the cough is dry but eventually it can be accompanied by scanty purulent or mucoid sputum due to cavitations formation in the lung. As the disease process become more chronic coughing of blood (haemoptysis) can occur although this symptom is occasionally the first symptom and may be due to endobronchial involvement or erosion of a pulmonary arterial branch by an enlarging cavity.

Clinical features of TB in young children, is characterized by hilar lymphadenopathy, pleural involvement, infrequent progression at the initial pulmonary focus and hypersensitivity reactions. Hilar lymphadenopathy is the hallmark of child hood pulmonary tuberculosis. Also mediastinal nodes draining the initial area of pneumonitis become massively enlarged, usually unilaterally causing bronchial compression resulting in a brass, non productive cough or lung collapse. Moreover, stunted growth, weight loss and haemoptysis may develop due to the disease complications (Nicki *et al.*, 2010).

2.3.7.2. Extra- pulmonary tuberculosis

Extra-pulmonary tuberculosis accounts for about 20% of cases in those who are HIV negative but is more prevalent in HIV positive individuals also *M. bovis* infection (Nicki *et al.*, 2010). Lymph nodes are the most common extra –pulmonary site of the disease. Cervical and mediastinal lymph glands are affected most frequently, followed by axillar and inguinal. Other clinical features of EPTB depend on body organ affected; chronic back pain may be caused by TB of the spine (Pott's disease). Headache, confusion and neck stiffness for TB meningitis are the other common signs. Moreover, chest pain, difficulty in breathing from TB pleurisy whereby; fever, night sweat, breathlessness, ascites other features for TB pericarditis while renal TB can present with haematuria and dysuria.

2.3.8. Diagnosis of tuberculosis

Since clinical signs and symptoms of tuberculosis in humans may be similar to other diseases, additional tests have to be used to confirm the disease.

2.3.8.1. Bacteriological diagnosis

Direct sputum for microscopy is the most important first step. The probability of detecting acid- fast bacilli (AFB) is proportional to the bacillary burden in the sputum. The most effective techniques used to stain sputum for direct microscopy are the Ziehl-Neelsen and rhodamine- aura mine stains. A positive smear is sufficient for the presumptive diagnosis of TB but definitive diagnosis requires culture. Smear negative sputum should also be cultured as only 10 to 100 viable organisms are required for sputum to be culture positive. Sputum smear positive for direct microscopy is typically positive when 5 000 to 10 000 organisms are present (Nicki *et al.*, 2010; Moges *et al.*, 2012).

Sputum culture is the gold standard and more sensitive method to detect *Mycobacterium* than AFB microscopy. However, the method is slow and expensive depending on the techniques; it takes two to eight weeks before a result is obtained. Moreover, bacteriological examination comprises the isolation of *Mycobacterium* on conventional media such as Lowenstein- Jensen with glycerol or pyruvate followed by biochemical characterization.

2.3.8.2. Tuberculin skin test

Tuberculin is a purified protein derived from attenuated *Mycobacterium*. Upon injection under the skin, a person infected with tuberculosis develops hypersensitivity to tuberculin which is measured in millimeter of indurations after 48-72 hours following intradermal tuberculin injection (NTLP, 2006). The induration of 10 mm or more is interpreted as positive, although a positive tuberculin test should only be one clue to be interpreted with other findings to support the diagnosis of TB.

Furthermore, the tuberculin skin test is valuable as a diagnostic tool in young children. The test cannot be used to diagnose TB in adults because, high proportion of adults are already infected with *Mycobacterium* and therefore will test positive without suffering from tuberculosis. Also tuberculin test should not be used in people with impaired body immunity because may well have a negative tuberculin skin test despite of having active tuberculosis (Advisory Council for the Elimination of tuberculosis and Advisory Committee on Immunization Practices, 2006).

2.3.8.3. Chest x- ray

Diagnosis of TB using chest x-ray is commonly done in many clinics and hospitals in Tanzania but its reliability is questionable because there are other chest diseases that may

produce similar changes (NTLP, 2006) Chest X-ray findings suggestive of pulmonary tuberculosis in patients with smear negative microscopy should always be supported by clinical findings.

2.3.8.4. Other diagnostic methods

A number of other new diagnostic techniques for tuberculosis have been developed. These includes polymerase chain reaction (PCR) which have been evaluated with promising success. Various PCR based methods are already in clinical use. For diagnostic purposes; the challenges of PCR is to differentiate infection against disease; Dead against alive bacteria. This technique is very sensitive and suitable in epidemiological investigation involving strains identification (Catley, 1992; Nicki *et al.*, 2010). Nevertheless, the method is highly expensive and scarce in most of Tanzania's health facilities.

2.3.9. Treatment of tuberculosis

The aim of treatment is to cure TB patients, prevent death from the disease or late complications and prevent further transmission of tuberculosis whereas the goals of therapy are to eliminate all tubercle bacilli from an infected individual and avoid the emergency of clinically significant drug resistance. Highly effective Short Course regimens are usually used. Treatment regimens are based on the principle of an initial Intensive phase which rapidly reduces the bacterial population, followed by a continuation phase to destroy any remaining bacteria. Treatment should be commenced immediately in any patient who smeared positive, or who is smear negative but with typical chest x- ray changes and no response to standard antibiotics (NTLP, 2006; Nick *et al.*, 2010).

In Tanzania, treatment of TB is based either on Short course chemotherapy (DOTS) or Long Course regimens in accordance to the national TB and Leprosy guidelines. Short

course chemotherapy is the most effective way to ensure rapid sputum conversion of infectious patients, thereby stopping for further transmission of *M. tuberculosis* to the community. The tendency of case recurrence after treatment is common in Tanzanian TB patients. For instance, in Year 2010 out of 63 453 all forms of reported TB cases; A total of 1 430 (2.3%) were relapse, while 96 (0.2%) were treatment failure and 255 (0.4%) were returned to control cases. Patients presenting with a second episode of active tuberculosis may be due to treatment failure, relapse or re- infection. Tuberculosis relapse and re-infected cases are particularly observed in people living with HIV/AIDS (NTLP, 2006).

2.4. Prevention and Control of Tuberculosis

Early case finding and adequate treatment of tuberculosis patients is the corner stone of tuberculosis control. The direct observed treatment short course (DOTS) stratage is the gold standard to achieve the aim and goals of treatment also to prevent the development of anti TB drug resistance. Improvement of health care services will improve detection and treatment of active and latent TB. Also contact tracing has the potential to identify the probable index case, and other cases infected by the same index patient.

Measures to control other source of infection including cattle derived *M. bovis* must be implemented. Measures such as milk pasteurization, appropriate meat inspection, inspection of slaughter houses would apparently be effective in protecting public from the disease. Also, there should be routine screening of TB to all HIV infected individuals, improvement of living conditions and reduce overcrowding (Advisory Council for the elimination of tuberculosis, 2006). The World Health Organization (WHO) recommends neonatal BCG vaccination in Countries with high prevalence of tuberculosis even those with high prevalence of HIV/AIDS. In Tanzania, BCG vaccination is recommended to all neonates.

CHAPTER THREE

3.0. MATERIALS AND METHODS

3.1. Study Areas and Population

This study was conducted between July and September 2012. It was carried out in the five central Prisons with respective regions in brackets as follows: Ruanda (Mbeya), Isanga (Dodoma), Butimba (Mwanza), Segerea and Ukonga (Dar es Salaam). Tanzania has a total of 127 Prisons; of those 13 are Central Prisons. Current estimated prison population in Tanzania is about 36 000 inmates. Studied Prisons were purposely selected because they are maximum security Prisons which comprise multitude of Prisoners with different length of imprisonment sentences. They were also defined according to geographical zones and regions thus provide good representation to general prison population.

3.1.1. Ruanda Prison

Is located about 4 km south of Mbeya City, where as Mbeya Region is in Southern highlands Zone of Tanzania, between latitudes 08° to 45°S and longitudes 35° to 45°E.The prison was designed to accommodate 400 inmates, although currently daily lockup ranges between 900 and 1 000 inmates. The prison comprises 33 cells of different sizes, among them 5 cells are for female prisoners while 5 cells are special cells for sick prisoners (sick bay wards). Generally, most of the cells in males section have small windows located high to the rear walls. The cells had surface area less than 2 m^2 per prisoner (Proposed sleeping space per Prisoner is 2 m^2).

Despite the fact that during the day, most prisoners are outside the prison for various reasons, the cells are kept locked for security purpose. The prison has the Health Centre with TB unit that caries routine TB screening to all new comer prisoners.

3.1.2. Isanga Prison

The Prison is in Dodoma region. It is located about 5 km south of Dodoma town. The region is in Central Zone of Tanzania between latitudes 06° to 08°S and longitudes 35° to 45°E. The Prison was designed to accommodate 784 inmates but currently daily housing is between 1 200 to 1 700 inmates. The prison comprises 69 cells which vary in sizes. Among the cells, five cells are for female prisoners while two are for sick bay wards. The dormitories or cell windows are small and located high to the rear walls. During the day cells are kept closed. The prison has the health centre but no TB unit, also no routine TB screening to all new comer prisoners. Anti TB drugs are regularly collected from the Dodoma regional tuberculosis and leprosy coordinator (RTLC) and dispensed to eligible patients under supervision of Prison TB/HIV coordinator.

3.1.3. Butimba Prison

Butimba prison is in Mwanza region. The prison is situated in Lake Zone, located about 9 km south of Mwanza City. Mwanza region is located north of Tanzania bounded by Lake Victoria to the north. The region lies between latitudes 02° to 30°S and longitudes 02° to 30°E. The accommodation capacity of the prison is 934 inmates but recorded daily lock up ranges between 2 400 to 2 980 inmates. The prison comprises 68 cells, of those 8 cells are for female prisoners while 2 cells are for sick prisoners. The cells and dormitories have small windows located high to the rear walls.

With respect to the sign board that indicates the dormitory or cell housing capacity, most of dormitories and cells were housing about twice of their capacity. Unlike males section, dormitories in female wing have wide windows placed in front. Nevertheless there are small windows located high to the rear walls in each cell. Moreover, the prison has the

Health centre, sick bays and TB unit that caries TB screening to prisoners with TB symptoms.

3.1.4. Ukonga prison

Ukonga Prison is in Dar es Salaam region (Eastern Zone). The prison is located about 18 km West of Dar es Salaam City. Dar es Salaam region is located in Eastern part of Tanzania. The region lies between latitudes 06° to 50°S and longitudes 33° to 12°E and is bounded by the Indian Ocean to the East while in the West is bounded by the Coast region. The Prison was built in 1945 and was designed to accommodate 900 prisoners but to date, the recorded daily lock up ranges between 1 800 to 2 000 prisoners. Also the prison has Health centre with TB unit. The prison comprises 76 cells. Of those, two cells are special cells for sick prisoners whereas the other two cells are isolated cells for TB patients. Most of the cells have small windows which are located high to the rear walls. This prison houses convicted male prisoners and deportees prior returned to their respective countries.

3.1.5. Segerea prison

The Prison is found in Dar es Salaam region (Eastern Zone). It is located about 24 km North West of the Dar es Salaam city. The Prison was designed for remands although it houses few convicted prisoners. It comprises 27 dormitories whereby six of them are for female prisoners while two of them are wards for sick prisoners.

The dormitories have wide windows placed to the front while small windows are paced high to the rear wall to let air out of the cells. The prison has small Dispensary within the prison which provides health services to Prisoners, Staff and their families. Fig. 2 is the map of Tanzania showing the regions where study prisons are located.

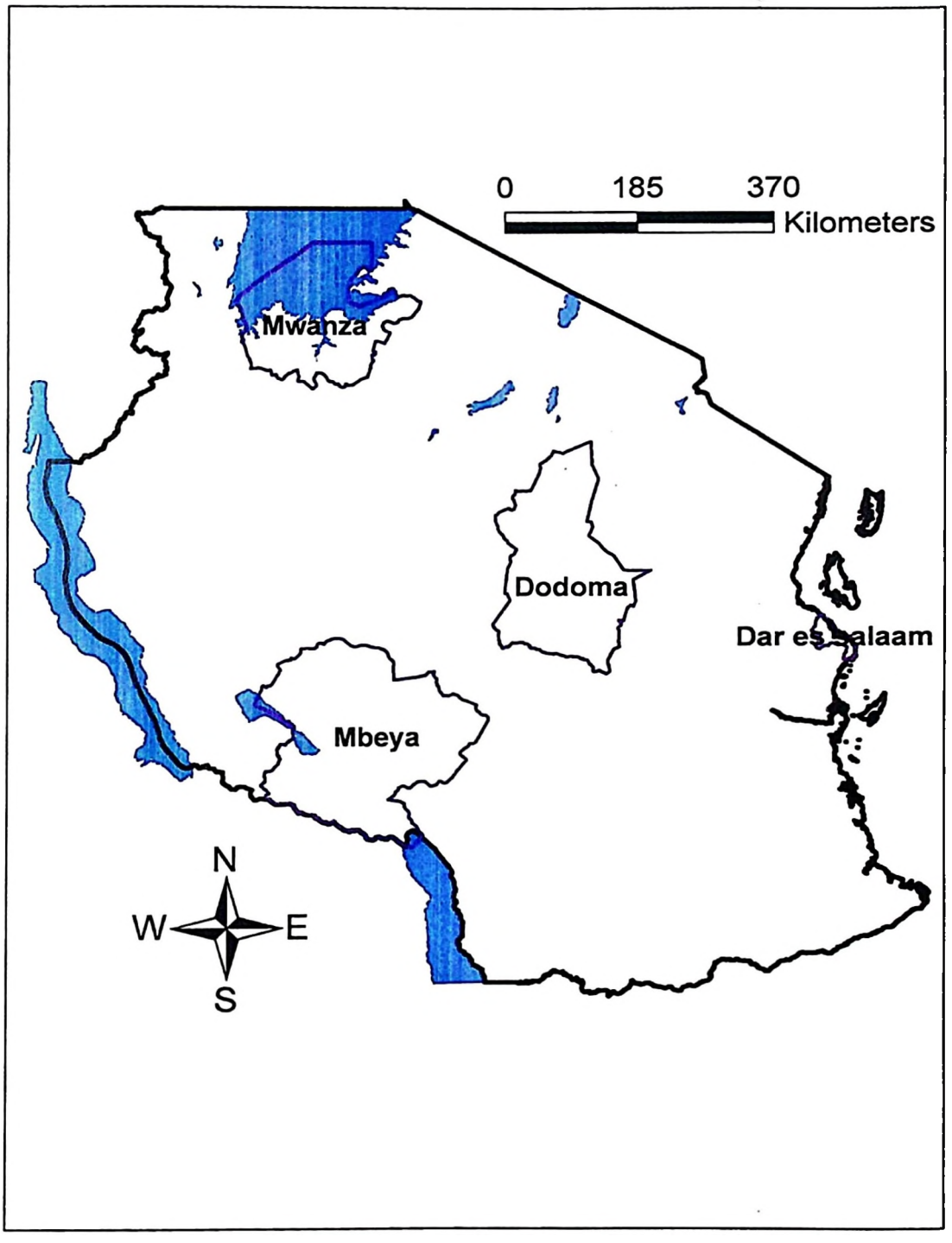

Figure 2: Tanzania map showing regions where study prisons are located

3.2. Study Design and Population

A cross sectional study design was employed (Kothari, 2004). Study units were prisoners and Prison staff from five selected central prisons in Tanzania.

3.3. Data Collection and Participants Eligibility Criteria

The survey utilized both quantitative and qualitative methods to collect data.

(a) Cross sectional survey was conducted in response to objective 1. Freely given informed consent were obtained before conducting TB screening to Prisoners. All study participants (Prisoners) were screened for tuberculosis by Ziehl Neelsen (ZN) staining of the sputum. (Request form for AFB microscopy was used to collect the data).

(b) In response to objective 2, both quantitative and qualitative methods were utilized. Structured questionnaires were self administered to prisoners and prison staff. Pre test counseling was done in group sessions whereas post test was offered to individual study participant before offering test results. Serological determinants for HIV infection was performed in accordance to the National algorithm for HIV testing. (HIV testing tool was used to collect the data). Each prisoner selected for the study was weighed and their height measured by using adult balance and standing height hence their Body Mass Index was determined.

3.3.1. Participants eligibility criteria

1. Prison inmates who were willing to participate.
2. Prison inmates who had constitutional symptoms of tuberculosis for more than three weeks such as; cough (not responding to broad spectrum antibiotics), fever, profuse night sweat and progressive loss of body weight.

3.4. Sample Size Estimation

The study sample was obtained by using the formula for sample size estimation as stated by Fisher *et al.* (1991); $n = Z^2 \times PQ / d^2$. Where n = estimated or required sample size, Z = standard normal deviation that corresponds to a level of statistical significance of 1.96., P = proportion of the study population estimated to have a particular characteristics, the prevalence of tuberculosis in prisons was estimated to be 40.7% (Rutta *et al.*, 2001). Q = Estimated non TB cases (59.3), d = Level of precision required of results (5). Therefore, $n = 1.96^2 \times 40.7 \times 59.3 / 5^2$, n=370 (prisoners involved in the study).

3.5. Sampling Procedure for Respondents

Before sampling, the study purpose was clearly explained to the participants in order to build trust and relieve fear for the study. The exercise was carried out early in the morning just after prisons unlock in order to avoid interferences with prison routine activities. Stratified sampling was employed to obtain a sample of 370 prisoners for the study. Each stratum was formed by prisoners with constitutional symptoms of TB from each prison cell hence systematic sampling was applied within each strum in order to obtain a required sample of 74 prisoners in each respective prison. This method enabled evenly sampling of all classes of prisoners with constitutional symptoms of TB taking into account that prisoners are housed in different cells according to classes.

3.6. Assessment of the Disease Risk Factors

3.6.1. Administration of questionnaires to prisoners and prison staff

Structured questionnaires (Appendices 1 and 2) were self administered to prisoners and prison staff to gather information on risk factors associated with the spread of pulmonary tuberculosis in prison population. This included, among other thing; history of TB contact,

risk behavior like sharing smoking cigarette or tobacco, history of TB contact, duration of stay in prison and assessment of knowledge on TB. Also general information about the prison was enquired such as; accommodation state of the prison, state of prison infrastructure, availability of fund to support prison health services and presence of TB Unit.

3.6.2. Anthropometric measurements

Each individual selected for the study were weighed and their height measured. Body weight was determined to the nearest 0.1 kg using adult balance and standing height was to the nearest 2 mm. Body Mass Index (BMI) defined as weight in kilogram divided by height in meter square was estimated by using a chart for evaluation of nutrition status in adults as designed by Tanzania Centre for Counseling, Nutrition and Health care (2005). Body Mass Index (BMI) was defined as weight in kilogram divided by height in meter square. Interpretation of BMI results was based on four categories; BMI representing poor nutrition category was BMI< 18.5, BMI 18.5-24.9 = Good nutrition status, BMI 25.0 - 29.9 = Overweight weight while BMI $\geq$ 30 = Obesity.

3.6.3. HIV screening to prisoners

All the study participants were counseled for HIV screening.

The consent form was filled in before carrying out the test. The result obtained was confidentially treated.

Nevertheless, all prisoners consented that, their test results should be disclosed to the Prisons Medical officers.

3.6.3.1. HIV tests

The rapid test for HIV antibodies screening was performed using two serial tests namely, Alere Determine ™ and Uni- Gold ™ tests in accordance to the Ministry of Health and Social Welfare algorithm for HIV testing. The Determine test was an initial test for HIV antibodies while positive result was confirmed by using Uni- Gold test.

3.6.3.2. Testing HIV by using Determine test

Protective foil cover was removed from Determine test strip and participant identity number was written on the test strip. Participant index finger was cleaned with a swab soaked in methylated spirit and allowed to dry. Thereafter, a new lancet was used to puncture the skin of the finger tip. While applying a gentle pressure to the base of the finger, 50 µl of whole blood was drawn by using the micro safe capillary tube and applied to the sample pad of the test then one drop of chase buffer was applied to the sample pad. A minimum wait of 15 minutes was allowed before reading the results. The result was interpreted to be positive when two Red bars appeared in both the control window and the patient window of the test while negative result was when only one bar appeared in the control window. All positive results obtained by using Determine test were confirmed by Uni- Gold test before provision of the results to the participant.

3.6.3.3. Testing of HIV using Uni-Gold test

Uni- Gold ™ HIV is a single reagent assay for the detection of antibodies to human immune deficiency virus types 1 and 2 in a serum, plasma or whole blood. This test is a rapid immune assay based on the immune chromatographic sandwich principle. Using aseptic techniques, index finger was cleaned with a cotton swab soaked in methylated spirit and allowed to dry. The test device was removed from protective wrappers and

labeled the participant identity number. Index finger tip was punctured by using a sterile lancet, using the disposable pipettes 60µl of whole blood was drawn to the sample port thereafter 60 µl of the wash reagent was added to the sample port. Ten minutes wait was allowed from the time wash reagent addition before reading the result. The result was interpreted to be positive if two red lines appeared in the test region and in the control region of the test device, while negative result is when only one red line appeared in the control region of the test device. According to the recent Algorithm for HIV tests, Uni-Gold test is used as confirmatory test when used in line with Determine as serial tests.

3.7. Tuberculosis Screening to Prisoners

3.7.1. Sputum sample collection

All the study participants were screened for tuberculosis by Ziehl Neelsen (ZN) staining of the sputum. Participants were instructed on how to produce good sputum specimen and how to avoid contamination of the containers with sputum. Sterile universal containers were used for collection of sputum samples. Every tuberculosis suspect candidate was required to submit two sputum samples for smear microscopy within 24 hours. One sputum sample was collected on the spot, while the second sample was collected in the early morning on the following day.

The exercise was carried out in the early morning just after prisoners unlock and before having breakfast. The specimens were collected in the open space and the exercise was supervised by the prison health staff and prison cell leaders. Before collecting specimens, each specimen was labeled the participant identity number on the lid of a sputum container and request form for AFB microscopy was properly filled in. After the samples were collected, the samples containers were kept in cool box until analysis. All the processes of

ZN staining and AFB microscopy was done at different laboratories in the five selected prisons.

3.7.2. Ziehl Neelsen staining

Since *Mycobacterium* is Acid Fast Bacilli, Ziehl Neelsen (ZN) staining was employed to distinguish *Mycobacterium* species from other microorganisms. Sample processing involved the following procedures: By using a wire sampler loop, a sputum sample was drawn from a sputum container and smeared on a glass slide. The smear was fixed by applying gentle heating then the smear was covered with one percent carbofulschin and heated until formation of steam. After three minutes, the slides were flashed with tap water and decolorized with acid alcohol (3% concentrated hydrochloric acid and 97% methyleted spirit) for five seconds. Thereafter, the slides were flashed with water then counter stained with methylene blue for 30 seconds then rinsed again with tap water. The slides were left to dry in air. All slides were examined microscopically added with oil emulsion at x100 magnification and x 6 eye piece lens for presence of AFB microorganisms. For the positive slides, the tubercle bacilli appeared red rods. During and after carrying out the laboratory tests, safety measures were adhered. Protective gears were used, all used swabs, sharps and sputum containers were kept in special containers thereafter were burnt in the incinerators.

3.8. Statistical Analysis

Data were collected, summarized and stored in Microsoft Excel spread sheet (Version 12, 2007) and analyzed by using Epi- Info statistical software (Version 7, Center for Disease Control, Atlanta, G. A., USA). Descriptive statistics for explanatory variables examined in the study were computed using Microsoft Excel. Proportions for TB and HIV prevalence

and risk factors for TB spread such as; poor ventilation, overcrowding, history of TB contact, poor hygiene and sharing utensils were calculated. The statistical significance for the proportions was compared using Chi- square test in Epi-Info software. A confidence limit of less than 5% was used.

3.9. Ethical Considerations

Ethical clearance for the study was obtained from the National Institute for Medical Research (Appendix3). Permission to conduct the study was obtained from the Tanzania Prisons Services. Participation into this study was voluntary. Participants were assured of anonymity of their test results and opinions. They were informed that they could decline their participation or to answer any asked question without negative consequences. A written informed consent was obtained from each participant and obtained Laboratory test results and information were confidentially treated.

CHAPTER FOUR

4.0. RESULTS

4.1. Demographic Characteristic of the Study Population

A total of 370 prisoners; 74 from each of the five selected prisons in Tanzania Mainland, were interviewed and screened for pulmonary tuberculosis and HIV. The five prisons involved in the study were Butimba, Isanga, Ruanda, Segerea and Ukonga. The social demographic information of respondents showed that majority (81.6%, n=302) were male prisoners. The age of respondents ranged from 16 to 78 years while most of the respondents (66.5%, n=246) involved had the age of 20 to 40 years. Many of the respondents (60%, n=222) had primary school education although Isanga prison had high number of prisoners (39.2%, n=29) who had never attended to school. The study had also showed that majority of prisoners had stayed in prison for more than five years (37.6%, n=139). Moreover 51.6% (n=190) of prisoners involved in this study were convicted prisoners where as 48.4% (n=180) were remands. It was also noticed that up to 64.3% (n=238) respondents had BMI which ranged from 18.5 to 24.9 suggesting that they were in a normal weight status. Nevertheless, Segerea prison had higher number of low body weight prisoners (14.9%, n=11) than the rest of prisons. Detailed demographic characteristics of respondent prisoners are shown in Table 2.

Table 2: Prisoners' demographic characteristics

Variable	Category	Number (%) of respondents in the five prisons					Total
		Isanga	Segerea	Ukonga	Ruanda	Butimba	
Sex	Male	54 (73)	62 (83.8)	74 (100)	53 (71.6)	59 (79.7)	302 (81.6)
	Female	20 (27)	12 (16.2)	0 (0)	21 (28.4)	15 (20.3)	68 (18.4)
Age (yrs)	<20	2 (2.7)	2 (2.7)	1 (1.4)	9 (12.2)	3 (4.1)	17 (4.6)
	20-40	39 (52.7)	61 (82.4)	52 (70.3)	47 (63.5)	47 (63.5)	246 (66.5)
	>40	20 (27.0)	14 (18.9)	25 (33.8)	21 (28.4)	27 (36.5)	107 (28.9)
Level of	None	29 (39.2)	6 (8.1)	11 (14.9)	18 (24.3)	14 (18.9)	78 (21.1)
education	Primary school	40 (54.1%)	46 (62.2	43 (58.1)	36 (48.6)	56 (75.7)	222 (60.0)
	Secondary school	2 (2.7)	16 (21.6)	18 (24.3)	15 (20.3)	3 (4.1)	54 (14.6)
	College	2 (2.7)	6 (8.1)	3 (4.1)	5 (6.8)	0 (0)	16 (4.3)
State of	Convicted	52 (70.3)	10 (13.5)	71 (95.9)	29 (39.2)	29 (39.2)	191 (51.6)
inmate	Remands	22 (29.7)	64 (86.5)	3 (4.1)	45 (60.8)	45 (60.8)	179 (48.4)
Duration of	0-30 Days	2 (2.7)	21 (28.4)	0 (0)	26 (35.1	9 (12.2)	58 (15.7)
stay in	1-12 Months	13 (17.7)	20 (27.0)	8 (10.8)	13 (17.6)	16 (21.6)	70 (18.9)
prison	1-5 years	26 (35.1)	23 (31.1)	15 (20.3)	12 (16.2)	27 (36.5)	103 (27.8)
	Above 5 years	33 (44.6)	10 (13.5)	51 (68.9)	23 (31.1)	22 (29.7)	139 (37.6)
BMI	<18.5	7 (9.5)	11 (14.9)	0	5 (6.8)	1 (1.4)	24 (6.5)
(Kg/m^2)	18.5-24.9	45 (60.8)	63 (85.1)	40 (54.05)	45 (60.8)	45 (60.8)	238 (64.32)
	25-29.9	16 (21.6)	0	32 (48.2)	21 (28.4)	23 (31.1)	92 (24.8)
	>30	6 (8.1)	0	2 (2.7)	3 (4.1)	5 (6.8)	16 (4.3)

4.2. Prevalence of Tuberculosis and HIV infection in prisoners

The overall prevalence of TB was 3.8% (95% CI=2.2 - 6.4%) obtained through direct sputum microscopic examination for AFB. The prevalence of TB with respect to studied Prisons was: Butimba 4.1%, Isanga 4.1%, Ruanda 6.7%, Segerea 1.4%, and Ukonga 2.7% (Table 3). During start of a TB survey in the five Prisons, it was recorded that 71 (0.8%) prisoners out of 8 330 had been diagnosed to be TB positive and were under anti TB treatment. In addition, the overall prevalence of HIV in studied prisons was 5.4% (95% CI=3.4-8.4%). A significantly (P = 0.0336) higher TB cases were recorded in HIV positive Prisoners (15%, n = 20) compared to TB cases in Prisoners who were HIV negative (3.1%, n = 350, RR = 4.8, 95% CI = 1.45–15.76). Moreover, higher prevalence (6.7%, n=5) was found in Ruanda prison than the rest of studied prisons. The prevalence of HIV was significantly higher in Segerea prison (P < 0.029) than the rest of studied Prisons.

Prevalence of PTB and HIV infection is presented in Table3.

Table 3: Prevalence of PTB and HIV infection in studied Prisons (n=74)

Prison Name	Number screened	Number (%) infected with TB	Number (%) infected with HIV
Isanga	74	3 (4.1)	2 (2.7)
Segerea	74	1 (1.4)	7 (9.5)
Ukonga	74	2 (2.7)	3 (4.1)
Ruanda	74	5 (6.7)	3 (4.1)
Butimba	74	3 (4.1)	5 (6.8)
Total	**370**	**14 (3.8)**	**20 (5.4)**

4.3. Assessment of Risk Factors Associated with the Spread of TB in Prisons

4.3.1. Prisoners response on PTB risk factors in prisons

A total of 370 prisoners from five selected prisons were interviewed and information was gathered regarding risk factors for the spread of PTB among Prisoners. It was found that majority (38.4 %, n= 142) of the respondent prisoners, considered overcrowding to be the most important risk factor for PTB spread in prisons as it was significantly noticed in Isanga, Segerea, Ruanda and Butimba Prisons($P<0.05$).

However, other risk factors also considered by majority of respondents as PTB risk factors included; poor infrastructure (19.2%, n=71), Prisoners low knowledge on TB (17.03%, n=63), cigarette smoking (13.8%, n=51) and poor ventilation (11.35%, n=42). The study has revealed that poor -infrastructure was significantly marked in Isanga, Segerea and Ruanda prisons ($P<0.01$). It was also observed that 4.3% (n=16) of respondents considered sharing of utensils/meals to be associated with the spread of PTB in prisons as was noticed in Segerea, Isanga and Ruanda prisons whereas poor ventilation was significantly associated with spread of PTB in Isanga, Segerea and Ruanda prisons ($P<0.001$). Sharing smoking was highly significant to Isanga, Segerea and Ruanda prisons while HIV/TB co-infection was remarkable in Isanga and Segerea prisons ($P< 0.001$).The present study revealed that history of TB contact was positively associated with the spread of PTB among inmates , this association was highly observed in Isanga, Ruanda and Butimba Prisons ($P<0.001$). Risk factors for the spread of PTB by Prisons as per prisoners' response with regard to positive sputum smear microscopy results are presented in Table 4.

Table 4: Risk factors for the spread of PTB in studied Prisons as per prisoners' response with regard to positive sputum smear microscopy results (n=370)

Risk factor	Number (%) of respondents					
	Isanga	**Segerea**	**Ukonga**	**Ruanda**	**Butimba**	**Total (%)**
Overcrowding	20 (27.03)	29 (39.2)	34 (46.0)	25 (33.8)	34 (46.0)	142 (38.4)
P value	0.0193*	0.0006*	0.1054	0.0139*	0.0339*	0.0953
Poor infrastructure	13 (17.6)	11 (14.9)	14 (18.9)	12 (16.2)	21 (28.4)	71 (19.2)
P value	0.0020*	0.0000*	0.3962	0.0001*	0.1476	0.0000*
Lack of knowledge	14 (18.9)	12 (16.2)	11 (14.9)	13 (17.6)	13 (17.6)	63 (17.03)
P value	0.0032*	0.0000*	0.4630	0.0001*	0.2883	0.0000*
Sharing utensil/meals	2 (2.7)	4 (5.4)	3 (4.1)	3 (4.1)	4 (5.4)	16 (4.3)
P value	0.0000*	0.0000*	0.7181	0.0000*	0.5825	0.0000*
Poor ventilation	5 (6.8)	3 (4.1)	10 (13.5)	12 (16.2)	12 (16.2)	42 (11.4)
P value	0.0000*	0.0000*	0.4875	0.0001*	0.3116	0.0000*
Poor hygiene	0	2 (2.7)	5 (6.8)	1 (1.4)	2 (2.7)	10 (2.7)
P value	-	0.0000*	0.6354	0.0000*	0.7015	0.0071*
Cigarette Smoking	6 (8.11)	11 (14.9)	10 (13.5)	11 (14.9)	13 (17.6)	51 (13.8)
P value	0.0000*	0.0000*	0.4875	0.0000*	0.2883	0.0000*
History of TB contact (>14 days)	2 (2.7)	0	0	1 (1.3)	2 (2.7)	5 (1.4)
P value	0.0000*	-	-	0.0000*	0.0000*	0.0000*
HIV/TB co- infection	2 (2.7)	4 (5.4)	1 (1.4)	0	0	7 (1.9)
P value	0.0000*	0.0000*	0.8371	-	-	0.0000*

* Statistically significant

4.3.2. Prison Staff opinions regarding PTB risk factors in Prisons

A total of 51 prison staff from the five selected prisons was interviewed in order to obtain information regarding risk factors for the spread of PTB in prisons. The results showed that poor ventilation (25.5%, n=13), overcrowding (23.5%, n=12) and lack of PTB routine screening (11.8%, n=6) were mentioned as key risk factors for the spread of PTB in prisons (Table 5).The Official approved housing capacity of 127 Prisons in Tanzania mainland is 29 400 prisoners but the current prisons population is about 36 000 prisoners. This implies that the current housing level is 122.4% above the accommodation capacity. It was further found that each studied Prison housed more than twice of its accommodation capacity as the situation was highly marked in Butimba Prison (Fig. 5).

Table 5: Risk factors for the spread of PTB in prisons as per prison staffs' response (n=51)

Risk factors	Number of respondents (%)
Poor ventilation	13 (25.5)
Overcrowding	12 (23.5)
No routine screening	6 (11.8)
Sharing meals	3 (5.9)
Lack of diagnostic facilities	3 (5.9)
Lack of funds	3 (5.9)
Lack of knowledge about PTB	3 (5.9)
Poor infrastructure	2 (3.9)
Transmission from other prisons	1 (2.0)
Compromised immune system	1 (2.0)
Lack of health education to prisoners	I (2.0)
Prolonged stay in prisons	1 (2.0)
Poor detection rate	1 (2.0)
Poor sanitation	I (2.0)

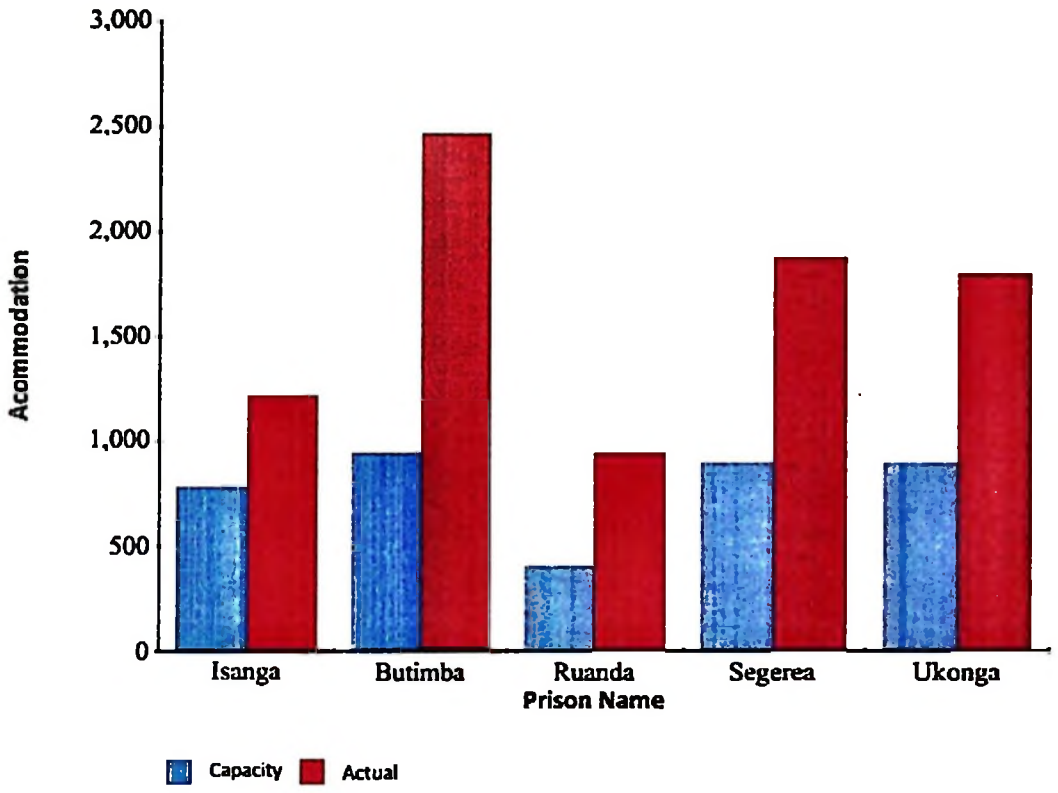

Figure 3: Accomodation situation in five studied prison

The study revealed that 98% (n= 51) of interviewed prison staff were aware of PTB in prisons; it further indicated that TB Units were available in Butimba, Ukonga and Ruanda prisons. Despite of having TB Units, routine TB screening to all new comer prisoners is only carried out in Butimba and Ruanda Prisons. Moreover, TB prisoners from Prisons that have no TB Units get regular supply of anti TB drugs from other public health facilities. The study has further showed that Ruanda was the only prison which was receiving financial support from the Non Governmental Organization to support TB screening. Prison staff opinions regarding health services and risk factors for spread of PTB are shown in Table 6.

Table 6: Prison staff opinions (%) regarding prison health services and risk factors for spread of PTB (n=51)

Parameter	Number of respondents (%)
Awareness of PTB	50 (98.0)
Presence of TB unit in prison	27 (53.0)
Routine screening of TB for prisoners	19 (37.3)
Regular financial support for TB patients	10 (19.6)
Place where TB patients get their anti TB drugs	
Prison health Facility	29 (57.0)
Other public health Facility	22 (43.1)

4.3.3. Relationship between Prisoners' BMI and PTB infection

The study has showed that; the rate of PTB was highly significantly associated with underweight prisoners ($P<0.001$) as revealed in Isanga, Segerea and Ruanda prisons. Moreover, the study has indicated that prisoners with normal weight or obese are not immune to PTB. Relationship between prisoners BMI and PTB is presented in Table 7.

Table 7: Prisoners' Body Mass Index (BMI) in relation to tuberclosis by prison (n=74; N=370)

BMI (Kg/m^2)	Number (%) of respondents					
	Isanga	**Segerea**	**Ukonga**	**Ruanda**	**Butimba**	**Total (%)**
Under weight (≤18.5)	7 (9.5)	11 (14.9)	0	5 (6.76)	1 (1.4)	2 4 (6.5)
P value	0.0000*	0.0000*	-	0.0000*	0.7878	0.0000*
Normal weight (18.5-24.9)	45 (60.8)	63 (85.1)	40 (54.1)	45 (60.8)	45 (60.81)	238 (64.3)
P value	0.0761	0.0000*	0.0568	0.0287*	0.0042*	0.0000*
Overweight (25.0-29.9)	16 (21.6)	0	32 (43.2)	21 (28.4)	23 (31.1)	92 (24.9)
P value	0.0949	-	0.1734	0.1477	0.1225	0.1959
Obesity (≥30)	6 (8.1)	0	2 (2.7)	3 (4.1)	5 (6.8)	16 (4.3)
P value	0.6723	-	0.0000*	0.7181	0.0000*	0.0000*

*Statistically significant

CHAPTER FIVE

5.0. DISCUSSION

This study confirmed high prevalence of tuberculosis among prison inmates in five studied Central Prisons in Tanzania Mainland. It also identified risk factors associated with occurrence of tuberculosis. Tuberculosis has been tremendously increasing in the society to the extent that Tanzania is among twenty two high TB burden countries in the world. Studies show that; in Tanzania, tuberculosis cases increased from 11 753 in 1983 to 63 453 in 2010 (NTLP, 2010). While incidences of tuberculosis has been increasing in the general society which currently seems to be strongly hit by HIV/AIDS, the status of tuberculosis in Prisons in Tanzania was not clearly known despite the fact that it is a place whereby human being live a stressed life under confinement.

Through the current survey, it has been established that the overall prevalence of tuberculosis in studied Prisons based on direct sputum microscopic examination for AFB was 3.8% (95% CI=2.2 - 6.4%). This is lower level compared to 40.7% which was previously reported by Rutta *et al.* (2001) at Butimba prison in Mwanza Tanzania and in Ethiopian prisons (9 - 10.4%) (Abebe *et al.*, 2011; Moges *et al.*, 2012). However, the prevalence of the current study (3.8%) was comparable to that reported in Cameroon (3.5), Zambia (4%), Malawi (5%) and Ivory Coast (6%). (Nyangulu *et al.*, 1997; Koffi *et al.*, 1997; Noeske *et al.*, 2006; Habeenzu *et al.*, 2007). The observed prevalence of 3.8% is generally high. The observed high prevalence of TB and HIV calls for a strong cooperation between Prison Authorities, the National Tuberculosis Control Programme and the government at large to urgently develop locally appropriate interventions to reduce transmission of TB and HIV to prisoners and control the diseases in the general population.

5.1. Prevalence of Tuberculosis and HIV in Prisons

The overall prevalence of TB recorded in the current study (3.8%) was higher compared to the national TB status of 335 per 100 000 population (Corbett *et al.*, 2003). The study observed 14 AFB positive cases out of 370 prisoners screened in five different prisons is more than 1 000 folds higher than the national figure. The observed high prevalence of TB (3.8%) suggests that 1 362 Prison inmates of the estimated 36 000 total Prison population are infected with TB.

During start of a current TB survey in selected Prisons, it was noticed there were 71 (0.85 %) of TB prisoners out of all 8 330 in the selected prisons were under anti TB treatment. This could either suggest that the inmates had tuberculosis before they were incarcerated or they acquired the disease while in prison, since most of them had stayed in prison for more than 5 years under poor living conditions. Indeed, there were so many risk factors for TB under prison life such that acquiring or transmitting infection was easy. Meanwhile, prevalence rates of TB in prisons usually exceed the rates in the general population substantially and can reach up to 50 times higher than national averages (WHO, 2007; Baussano *et al.*, 2010).

Comparison between prisons, it was found that Ruanda had high prevalence (6.7 %) compared to other prisons. Butimba (which was previously reported to have up to 40.7% TB smear positives) had a prevalence of 4.1%. This was a very big discrepancy which can be explained as follows: sputum for AFB microscopy method probably has relatively low sensitivity to detect most of the TB cases as also was reported by Nyagosya *et al.* (2008). It is also known that with a high prevalence of HIV-infection in the general population (8%), there is the potential that a substantial number of TB patients will be smear-negative

possibly contributing to the current low smear positives at Butimba compared to the previous study by Rutta *et al.* (2001). Alternatively, there is a possibility that some control measures have been instituted at Butimba prison. However, the study by Rutta *et al.* (2001) used hospital records of almost 4 years with large sample size which could have contributed to the high prevalence recorded.

The overall prevalence of HIV in studied prisons was 5.4% and a significant association between prisoners with HIV having TB was observed in Isanga and Segerea Prisons suggesting an association of the two problems. It is known that HIV infections has a potential of debilitating the immune system of an individual hence become predisposed to many opportunistic infections like TB according to Reports by WHO (2008) and Moges *et al.* (2012). Similarly, this study confirms this association through observed TB/HIV co infections ($p<0.01$).

5.2. Risk Factors Associated with the Spread of TB in Prisons

The current study established several risk factors for TB in Prisoners which included; overcrowding in Prisons, poor infrastructure, inadequate knowledge about TB among Prisoners, poor ventilation of prison cells, lack of TB routine screening, sharing of utensils/meals and history of contacts to TB patients. Interestingly, each of the studied prison housed more than twice of its accommodation capacity.

The situation was even worse in Butimba prison whereby the prison housed almost three times of its capacity. It was realized that four out of five studied prisons were built during colonial rule (1940s and 1950s) whereby prison security were given first priority rather than prisoners' health thus, such prisons were constructed with small windows in dormitories or cells that do not allow good ventilation and sunlight.

Studies on prison population show that Ethiopia is among the countries in Eastern Africa having high prisoner population who are overcrowded with high TB prevalence (10.3%) in prisoners (Abebe *et al.*, 2011). All these are risk factors which cut across all studied Prisons thus predispose an individual to respiratory diseases including TB as was observed in the current study. Indeed, presence of prisoners with the history of TB contacts was observed during this study thus suggesting the possibility of transmitting the infection to the naive fellow inmates. A study by Abebe *et al.* (2011) in Ethiopian prisons also established similar kinds of risk factors for TB occurrence in prisoners and concluded that active transmission of tuberculosis in prisons was associated with overcrowding, poor living conditions, limited health care, including inadequate TB treatment and control strategies, and the spread of HIV infection.

Furthermore, the study indicated that sharing smoking was significantly associated with tuberculosis as noticed in Isanga, Segerea and Ruanda Prisons. The study has found that cigarette smoking was common among prisoners and because of illegally availability of such services under imprisonment, sharing of one cigarette was a common practice among smoking prisoners. This predisposed them to possibilities of infecting each other.

Studies report that smoking is associated with an increased risk of developing TB disease (Gupta *et al.*, 2003), a slow healing process, delayed sputum conversion (Gajalakshmi *et al.*, 2003), and a high death rate (Hassmiller *et al.*, 2006).

When the relationship of prisoners' BMI and PTB infection was assessed, the results showed that a highly significant ($P = 0.001$) PTB infection rate was found in the underweight prisoners ($BMI < 18.5$; $n = 24$). This suggested that underweight prisoners,

malnourished prisoners and debilitated ones are at great risk of contracting TB. Although, the study has also indicated that prisoners with normal weigh or obese also can contract the disease. Despite of the observed prisoners' BMI and TB relationship, it is difficult to translate the low BMI as a solely predisposing factor to PTB in this study; since low BMI may be due to PTB or may have predisposed to PTB.

CHAPTER SIX

6.0. CONCLUSION AND RECOMMENDATIONS

6.1. Conclusion

Based on the present study, the obtained results confirm the high prevalence of pulmonary tuberculosis in prison populations, thus suggest active transmission of the disease in the prison settings. The study has also considered the following risk factors to be associated with the occurrence of TB in prisons; overcrowding, poor ventilation, poor prison architecture, history of TB contact, HIV infection, absence of routine TB screening, Smoking, and limited prisoner's knowledge on TB.

6.2. Recommendations

Control of the disease in prisons will be achieved through:-

(i) Reduction of overcrowding in prisons.

(ii) Improvement of prison living condition including architecture.

(iii) Implementation of routine and systematic TB and HIV screening in all prisons.

(iv) Introduce sustainable health education sessions in prisons with emphasis on TB, HIV and risk behaviors such as; cigarette/tobacco smoking and sharing meals/utensils.

(v) TB contacts tracing and prompt treatment of TB cases (DOT).

(vi) The Government should set aside more funding for Prison health services including TB and HIV interventions.

(vii) Establishment of TB units in prisons and scale up case detection rate.

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APPENDICES

Appendix 1: Questionnaire for prisoners (Prison Inmates)

PREVALENCE STUDY OF TUBERCULOSIS IN CENTRAL PRISON PART A: RISK FACTORS PREDISPOSING THE SPREAD OF PTB IN PRISONS.

A. PARTICULARS

Date.....

Name of Prison.....Region.....

Name (Inmate I/D No).....

1. Gender... 1=Male 2=Female..... 1_____

2. Age (in years)..... 2_____

3. What is your highest Level of education ...1=None 2= Primary 3=Secondary 4= colleges.....3_____

4. State of inmate.....1=Convicted 2=Remand.....4_____

5. Duration of stay in prison 1= 0-30 Days 2= 1-12 Months 3=1-5years 4=Above5 Years.....5_____

B. INFORMATION REQUESTING

Regarding Risk factors

6. What do you think are risk factors for TB spread in this prison?

.....6._____

7. Had you ever been in contact /caring a TB patient before? 1=Yes 2=No 7.____

8. Whom had you been in contact/ caring with? 1= Family member 2= Relative 3= Prison/POLICE cell mate.....8._____

9. Do you smoke cigarette? 1=Yes 2= No.....9_____

10. Do you share meals with your colleagues? 1=Yes 2=No.....10_____

11. Is there enough ventilation in prison cell/ Dormitory?

1=Yes 2=No.....11_____

12. If the answer above is No, why there is no enough ventilation?. 12_____

D. Anthropometric Measurements

13. Weight (Kg)..... .....13 _____

14. Height (Cm)..... .....14_____

15. Body Mass Index (BMI)..... .....15_____

E. Laboratory Results

16. Sputum for AFB.....1= AFB Positive 2= AFB Negative.....16_____

17. HIV Test.....1= HIV Positive 2= HIV Negative.....17_____

Appendix 2: Questionnaire for Prison Staff

PREVALENCE STUDY OF TUBERCULOSIS IN CENTRAL PRISON

PART A: RISK FACTORS PREDISPOSING THE SPREAD OF PTB IN PRISONS.

A. PARTICULARS

Date.....

Name of Prison.....Region.....

Name(Respondent).....Gender...Male/Female

Job title /Designation .....

B. INFORMATION REQUESTING

General information

1. Accommodation capacity of the prison.....1_____

2. Total prison unlock..... 1=.Convicted___ 2=Remand..... 2_____

3. Does prison staff have a knowledge on TB/ Awareness of TB in Prison

   1=Yes2=No.....3_____

4. Is there any sick bay for TB patients? 1=Yes 2= No.....4_____

5. Is there TB Unit in this prison? 1=Yes 2=No .....5_____

6. Doe this prison carry out TB and HIV routine screening for prisoners? 1=Yes

   2=No. .....6_____

7. Does the Prison receive regular fund to support health services?

   1=Yes 2= No.....7_____

8. What do you think are risk factors for the spread of TB in this Prison?

   .....8 _____

Appendix 3: Clearance certificate for conducting research

THE UNITED REPUBLIC OF TANZANIA

National Institute for Medical Research
P.O. Box 9653
Dar es Salaam
Tel: 255 22 2121400/390
Fax: 255 22 2121380/2121360
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Ministry of Health and Social Welfare
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Tel: 255 22 2120262-7
Fax: 255 22 2110986

NIMR/HQ/R.8a/Vol. IX/1352

29th June 2012

Mr Wilson Emmanuel Rugamba
Sokoine University of Agriculture
Faculty of Veterinary Medicine
Dept of Public Health and Food Safety
P O Box 3151, MOROGORO

CLEARANCE CERTIFICATE FOR CONDUCTING MEDICAL RESEARCH IN TANZANIA

This is to certify that the research entitled: Prevalence study of Tuberculosis in selected central prisons of Ukonga, Segerea, Isanga, Butimba and Ruanda, in Tanzania, (Rugamba W E *et al),* has been granted ethics clearance to be conducted in Tanzania.

The Principal Investigator of the study must ensure that the following conditions are fulfilled:

1. Progress report is submitted to the Ministry of Health and the National Institute for Medical Research, Regional and District Medical Officers after every six months.
2. Permission to publish the results is obtained from National Institute for Medical Research.
3. Copies of final publications are made available to the Ministry of Health & Social Welfare and the National Institute for Medical Research.
4. Any researcher, who contravenes or fails to comply with these conditions, shall be guilty of an offence and shall be liable on conviction to a fine. NIMR Act No. 23 of 1979, PART III Section 10(2).
5. Approval is for one year: 29th June 2012 to 28th June 2013.

Name: Dr Mwelecele N Malecela

Signature

CHAIRPERSON
MEDICAL RESEARCH
COORDINATING COMMITTEE

Name: Dr Donan Mmbando

Signature

ACTING CHIEF MEDICAL OFFICER
MINISTRY OF HEALTH, SOCIAL WELFARE

CC: RMO
DMO