COST-EFFECTIVENESS OF PERIODIC SPUTUM EXAMINATION FOR ACTIVE CASE FINDING OF TUBERCULOSIS IN PRISONS OF MALAWI

By

NDINDI HENRY EMMANUEL

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DECLARATION OF ORIGINALITY AND CONFLICTS OF INTEREST

I, Ndindi Henry Emmanuel, do hereby declare that this thesis is a true work of my own original investigations and any contributions from other people are properly cited or acknowledged. Let me also declare that I do not have any conflict of interests in this thesis. Today, 29 May 2012, I submit this thesis to the Graduate School of Asia Pacific Studies, Ritsumeikan Asia Pacific University in Japan for the partial fulfillment of the requirements for the acquisition of the Degree of Master of Science in International Cooperation Policy (ICP), majoring in Public Health Management (PHM).

THESIS DEDICATION MESSAGE

I dedicate this thesis to my late mother, Maria for single handedly taking care of me when our father died. Her love, care and support encouraged me to be what I am today, a very reliable citizen in the society. What has been achieved today is another milestone in my life, which vindicates my hard working spirit and motivation imparted on me by my mother. May her soul rest in eternal peace.

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LIST OF ACRONYMS AND TERMS

ACF	Active Case Finding
AFB	Acid –fast bacilli
AIDS	Acquired Immune Deficiency Syndrome
ART	Antiretroviral Therapy
BCG	Bacillus -Calmette -Guerin
CDC	Center for Disease Control
DHMT	District Health Management Team
DOTS	Direct Observed Treatment Short Course
DPHS	Directorate of Preventive Health Services
DTO	District Tuberculosis Officer
EHP	Essential Health Package
EPTB	Extra-Pulmonary Tuberculosis
HIV	Human Immunodeficiency Virus
INH	Isoniazid
IPT	Isoniazid Preventive Therapy
MASP	Maximum Security Prison
MDG	Millennium Development Goal
MDR-TB	Multi Drug-Resistant Tuberculosis
MESP	Medium Security Prison
MKW	Malawi Kwacha
MoH	Ministry of Health
MPS	Malawi Prisons Service
NTP	National Tuberculosis Control Program
P-ACF	Periodic / Interval Active Case finding

PCF	Passive Case Finding
PCNR	Passive Case Notification Rate
PLWHAs	People Living with HIV/AIDS
PNP	Peripheral Neuropathy
PTB	Pulmonary Tuberculosis
SWAp	Sector Wide Approach
TB	Tuberculosis
TST	Tuberculin Skin Test
UNAIDS	United Nations Acquired Immune Deficiency Syndrome
US	United States of America
WHO	World Health Organization
XDR-TB	Extensively Drug-Resistant Tuberculosis
ZN	Ziehl- Nelsen

ABSTRACT

Tuberculosis is one of the major public health problems in prisons worldwide. Environmental and host risk factors propagate the spread of tuberculosis in prisons. Among these risk factors are high HIV rates, overcrowding, poor nutrition and ventilation in prisons.

In Malawi, case notification rates of smear positive tuberculosis of up to 442/100,000 in prisons against 63/100,000 in the general population have been reported.

A national tuberculosis policy for prisons was developed in 2007, which recommends screening of prisoners for TB upon entry to prisons, and also during incarceration of which only the latter has been started.

Screening for tuberculosis during incarceration, is resource consuming. Since the commencement of screening in Malawi prisons, no assessment on its utility in detecting smear positive tuberculosis, and its (screening) effect on passive case notification rates of smear positive tuberculosis has been conducted. This study assessed the utility of screening from 2009 to 2010.

This was a retrospective mixed descriptive and analytical study based on a quantitative approach. It was conducted in six prisons, which were grouped equally into maximum and medium security prisons. The study assessed the yield of smear positive TB cases diagnosed in three rounds of ACF in relation to extra (additional)

costs incurred. Additionally, it measured the effect of ACF on inter-rounds and final passive case notification rates (PCNR) of smear positive TB. Cough for one week was the only inclusion criteria during screening. The Pearson's chi-square test was used to look for statistical significance in change of PCNR.

During each round of active case finding, three times the number of smear positive TB cases diagnosed in medium security prisons were detected in maximum-security prisons for every additional MKW 100,000 spent during screening. However, the number of smear positive TB cases diagnosed was progressively reducing with each subsequent round of active case finding in both maximum and medium security prisons.

After each round of ACF, the PCNR of smear positive TB was reducing in both prison types and statistical significance reduction was seen after the second round, and it was only in the maximum security prisons where the PCNR of smear positive tuberculosis still remained significantly lower (alpha 5%) after the third round than of equal duration before commencement of ACF.

The study concludes that ACF is only cost effective in maximum-security prisons and only two rounds of ACF could suffice to significantly reduce the PCNR to levels below the pre-ACF commencement.

The study recommends a repeat of the same study at a later time to ascertain whether the average number of cases at 6, diagnosed per MKW100, 000 in MASP would still be the same as in the second round of ACF, so that a decision to conduct only two rounds of ACF would be made, and thereafter to continue with a strengthen passive case finding and contact tracing for progressive reduction or maintenance of low rates, of smear positive TB in prisons.

1.0 INTRODUCTION

Tuberculosis is an infectious bacterial disease caused by Mycobacterium tuberculosis (and occasionally by Mycobacterium bovis and Mycobacterium africanum). These organisms are also known as tubercle bacilli, because they cause lesions called tubercles, or as acid-fast bacilli (AFB) (Crofton, Horne & Miller, 1999, p.7).

The disease can affect most tissues and organs but especially the lungs. The most important source of infection is a patient with lung, or pulmonary TB (PTB), who is coughing.

Each year, tuberculosis affects nine million people and kills almost two million people, primarily in low and middle-income countries (World Health Organization (WHO), 2009, p.32). Tuberculosis control is one of the key priorities in the sixth Millennium Development Goal (WHO, 2006, p.8).

1.1 Transmission of tuberculosis

Tuberculosis is transmitted from an infectious source to susceptible persons primarily through the air (Crofton et al., 1999, p.9). Infection with Mycobacterium tuberculosis can occur at any age. An individual's risk of infection depends on the extent of exposure and his or her susceptibility to infection. The risk of infection in a susceptible individual is higher with close, prolonged, indoors exposures to a person with sputum smear positive PTB.

The risk of transmission of infection from a person with smear-negative PTB is low (20%), and even lower from someone with EPTB. "In non immune-compromised populations only about 5% of infected people develop the disease within a year and a further 5% develop the disease during their lifetime" (Nyirenda, 2006, p.147).

Most infected persons do not experience clinical illness and are usually asymptomatic and noninfectious. However, infection can persist for years, and infected persons can remain at risk for developing clinical TB at anytime, especially if the immune system becomes impaired.

The chance of developing disease is greatest shortly after infection and steadily lessens as time goes by (WHO, 2004, p.24). HIV infection has had a great impact in the progression to active TB in cases of recent infection with tuberculosis than that caused by reactivation of tuberculosis in an HIV positive individual; this was shown in a study where clustering was more common in patients who were HIV positive (Glynn et al., 2005, p.486). A recent study in Nigeria showed that at least 24% of people with HIV infection developed TB within one year of imprisonment (Chigbu & Iroegbu, 2010, p.331).

"Without treatment, by the end of 5 years 50% of PTB patients will be dead, 25% will be healthy (self cured by strong immune defense) and 25% will remain ill with chronic infectious TB" (WHO, 2004, pp.24-25).

The source of smear positive tuberculosis can be from new infections as well as reactivation of latent tuberculosis. Long-term studies in low-prevalence countries in Europe, the United States and Japan have used molecular strain typing to estimate the contribution of recent transmission on TB disease. Transmission rates of between 34% and 60% were responsible for new active TB cases (Fox & Marks, 2010, p.3). In other studies, in high incidence populations, 58% of TB cases in South Africa (Verver et al., 2004, p.354), and more than 65% of smear positive TB cases in Malawi (Glynn et al., 2005, p.484) were attributed to recent infections. However, a study in South Africa suggests that there may be an underestimation of the true proportions. The common risk factors for transmission of TB in the two studies were: smear positive TB, duration of residence and HIV positivity .The HIV prevalence was 13% in the population understudy in Malawi and most of the contacts leading to infection may have just been casual.

It is not clear which one of either transmission from new infections or reactivation leads to a considerable number of incident smear positive tuberculosis in prisons. A study within the prisons system in Catalonia, found that recent transmission of TB contributed substantially (51%) to the overall incidence of TB disease in Barcelona prisons. However, this finding was much lower than estimated in prison population of Madrid at 74% (March et al., 2000, p.532). “Nearly 50% of those inmates included in transmission chains, active transmission was documented to have occurred at a prison that was operating at 17% above designed holding capacity, and where a large

proportion of inmates are convicted to terms of more than 1 year. A further 39% of cases occurred at a prison that was characterized both by crowding with an occupancy rate of 167%," (March et al., 2000, p.532) and an extremely mobile population, but most contacts leading to infection may just be casual.

1.2 Diagnosis of tuberculosis

Definitive diagnosis is through isolation of the organism causing the disease, Mycobacterium tuberculosis. This can be done through culture or nucleic acid amplification. However, these methods are beyond the reach of low and middle-income countries. The DOTS strategy for diagnosis of tuberculosis recommends the use of microscopy smear through the Ziehl-Nelsen stain to find smear positive tuberculosis (WHO 2004, p.51).

A patient with a positive culture for the *Mycobacterium tuberculosis* complex or with two-sputum smear positive for AFB (where culture is not routinely available) is considered a "definite" case. See Table 1.0 for classification TB (WHO, 2002, pp.12-13). In addition, chest X-rays are used to diagnose smear negative tuberculosis, coupled with clinical signs**.**

Pulmonary Tuberculosis can be suspected if a patient presents with the following symptoms:

- Persistent cough for three weeks or more
- Fever
- Chest pain
- Shortness of breath
- Loss of weight
- Haemoptysis

Extra-pulmonary Tuberculosis (EPTB) can present with the general symptoms described above; however patients may complain of the following symptoms, depending on the affected organ:

- Swelling glands (TB Lymphadenitis)
- Headache (TB meningitis)
- Backache (TB spine)
- Abdominal pain or distension (TB peritonitis)

TABLE 1.0: CLASSIFICATION OF TUBERCULOSIS

Type	Description
Pulmonary Tuberculosis (PTB).	**Smear-positive PTB** A patient with at least two sputum specimens positive for acid-fast bacilli on microscopy. **Smear-negative PTB** A patient who has been coughing for > 3 weeks with at least two sputum specimens negative for acid-fast bacilli on microscopy
Extra-pulmonary tuberculosis.	Pleural effusion Pericardial disease Lymphadenopathy Peritonitis and/or gastrointestinal disease Meningitis Spinal or bone disease Genito-urinary disease Skin disease

1.3 Identifying tuberculosis suspects

TB suspects can be identified by different approaches. This can be done either actively or passively. However, active case finding requires more resources and the prevalence of TB in a particular community will determine which approach to use to diagnose a disease since screening for a disease is determined by the prevalence of the disease and resources availability. The WHO DOTS system recommends passive case finding of TB except in high-risk populations such as prisoners (WHO, 2006).

1.4 Screening

Screening is the presumptive identification of unrecognized disease by application of tests, examinations or other procedures, which can be applied rapidly. It seeks to identify positive or suspicious findings from apparently well people so that they are referred for diagnosis. Screening is provider initiated. Wilson and Jungner added, selective screening as screening of certain high-risk groups in the population through identification of symptoms and using tests (Holland, Stewart & Masseria, 2006, p.3). Screening also seeks to detect the disease earlier than it is advanced, and resulting into complications. Usually, screening is provided on a public health approach. In tuberculosis control, screening is referred to as active case finding.

1.4.1 Active case finding of smear positive tuberculosis

Active case finding in tuberculosis disease entails searching for disease among people exposed to an infectious case. Active case finding can have two functions: - primary and secondary prevention.

The rationale of active case finding as primary prevention, is that identifying and treating undiagnosed active tuberculosis cases earlier, will reduce further transmission of the tuberculosis infection to other population members (Etkind & Veen, 2000, as cited in Fox & Marks, 2010, p.3; Ward, Marciniuk, Pahwa & Hoeppner, 2004, p.595), hence cutting the transmission cycle.

Cases that are identified earlier, would be put on treatment to avoid complications, which would take a lot of time to rehabilitate, hence this is secondary prevention. The current WHO approach to the management of tuberculosis, the DOTS, does not promote routine active case finding in low and middle-income countries (WHO, 2006, p.12), except among high risk groups of HIV-infected individuals, prisoners and contact of smear positive TB.

Case detection and treatment success are core elements of TB control. If conducted promptly, effectively, and systematically, these elements could lead to the reversal of a growing TB incidence and to the reduction of TB prevalence (Song, Castillo-Chavez & Aparicio, 2002, as cited in Fox & Marks, 2010, p.3) and mortality. However, the reduction in tuberculosis prevalence might be slow (Fox & Marks, 2010, p3).

Consequently, DOTS, the Stop TB Strategy, and the Global Plan to Stop TB 2006–15 are all oriented toward the two fundamentals of case detection and treatment. In terms of case detection, DOTS traditionally relies on the passive detection of cases or passive case finding. Case finding methods should be directed towards identifying infectious TB patients if the TB epidemic is to be controlled.

Active case finding results in the diagnosis of additional undetected tuberculosis cases among chronic coughers. In Uganda, 33(18%) smear positive TB cases were diagnosed following an active case finding in a slum setting (Sekandi, Neuhauser, Smyth & Whalen, 2009, p.508); in Ethiopia, two different active case finding found similar results as in Uganda. Over 90% among the 23 cases (Demissie, Zenebere, Berhane & Lindtjorn, 2002, p.581) and 38(80/100,000) (Yimer, Holm-Hansen, Yimaldu & Bjune, 2009, p.1399) additional smear positive cases were diagnosed. In India, an active search for suspects for smear positive TB among community members, detected twice the number of cases (26 versus 13) diagnosed passively in

health centers in the same catchment area over one year (Aneja, Chandrasekhar, Seetha, Shunmuganandan & Samuel, 1984, pp. 72-73). The researchers concluded that active case finding could supplement DOTS to yield additional smear positive TB cases.

Active case finding, leads to early diagnosis and thus shortens the duration of infectiousness and prevents transmission to other members of the community (Verver, Bwire & Borgdoff, 2001, p.424; Sekandi et al., 2009, p.508; Yimer et al., 2009, p.1399; Boon et al., 2008, p.1348). As delays have been observed in passive case finding in prisons, ACF would avoid this.

Smear positive cases diagnosed through ACF, are less symptomatic or asymptomatic and infectious (Monney & Zellweger, 2005, p.469; Ward et al., 2004, p.594; Boon et al., 2008, p.1348) or have shorter duration of symptoms (Verver et al., 2001, p.419). Due to this fact, they are more likely to be missed on a smear microscopy. However, these cases are more likely to refuse or default from treatment (Cassels, Heineman & Le Clerq, 1982, p.175; Santha et al., 2003, p.262; Boon et al., 2008, p.1348), but proper supervision on intake of drugs, can result into the same treatment outcome as those passively detected (Monney & Zellwenger, 2005, p.472) or even better as the disease is not advanced.

Since a long time ago, different screening methods have been employed in active case finding. These are symptom screening, chest x-ray, tuberculin skin testing (TST) and Interferon gamma-release essay. Most of these apart from symptom screening have proved to be expensive (Golub, Mohan, Comstock & Chaisson, 2005, p.1199), and the selection of diagnostic methods and combination of passive and active case finding, including frequency of active case finding, largely depend on the prevalence of TB, HIV or both, in the community or prison setting and on availability of resources. Symptom screening and smear microscopy are the recommended methods in middle and low-income countries. However, TB symptom screening alone may be insufficient in some cases, as it may fail to detect some pulmonary cases (Sanchez et al., 2009, p.1250).

There are three case finding strategies that can be implemented in prisons. These are: Passive case finding (self referral) being implemented under DOTS, screening on entry to prisons and active case finding in the imprisoned (incarcerated) population. "Using one strategy in isolation is unlikely to effectively detect TB cases in prisons" (WHO, 2001, p.103).

Screening during entry is aimed at preventing prisoners from bringing the TB into prisons as many may come from background of high prevalence of TB (WHO, 2001, p.104). This has been evident where 2.7 %(46/1696) of prisoners entering prison in Brazil have been diagnosed with TB (Sanchez et al, 2009, p.1249).

Active case finding during incarceration, identifies prevalent TB cases from the existing reservoir among the incarcerated population thereby reducing the prevalence of active TB, through removal of the bulk of infectious cases following diagnosis and prompt treatment (WHO, 2001, p.104). Transmission is likely to be reduced, hence also reducing incidence of TB. However, with time, the prevalence begins to increase especially with HIV positive TB cases as they have a shorter duration to progress to active TB (Dodd, White & Corbett, 2011, p.1&4). Active case finding is difficult to continuously sustain in resource poor settings. Due to this, interrupted rounds are recommended hence called periodic active case finding.

Alternation of active case finding with passive case finding (PCF), can result into increased or fewer cumulative (total) cases diagnosed if the passive case finding is very strong (Dodd et al., 2011, p.6), however there is a tendency that total cases initially increase. The magnitude of total cases diagnosed is usually determined by the initial burden of TB, duration between each round of ACF and efficiency of each round. Dodd et al. (2011, p.5) suggested in the model "that the higher the initial case detection rate, the more likely that fewer total cases of TB would be diagnosed under the intervention period and vice versa." Dodd et al. (2011, pp. 6-7), further suggested that reductions in cumulative HIV infected TB caseload are more likely where more than 40% of TB incidence is due to recent infection than HIV uninfected people.

1.5 Passive case finding of tuberculosis

This is one of the components of DOTS as a means of case detection. It entails examining people who have a cough for 2 or 3 weeks (chronic cough), and spontaneously visit health facilities due to respiratory symptoms. Chronic cough had both high sensitivity and positive predictive value in the pre-HIV era for diagnosis of active TB and led to the DOTS strategy (Corbett et al, 2010, p.1251).

Passive case finding (PCF) relies on complete accessibility of TB diagnostic services and high health seeking behaviour of people. However, there is a risk of delays in seeking health. These delays might be from the health provider or the TB suspects' perspective. In places like prisons, corrupt practices and lack of health services may limit the ability of the prisoner to seek care (WHO, 2001, pp. 41-42) hence affecting passive case finding resulting into transmission of TB to other prisoners.

In prisons, passive case finding seeks to identify incident cases which develop into TB after entry to prisons and those missed through other case finding strategies such as entry screening (WHO, 2001, p.105).

Despite the fact that cases diagnosed through passive case finding are usually at advanced stage of disease and may have poor treatment outcome, PCF is less expensive and simpler for programs to implement.

1.6 Contact tracing (Investigation) of TB

Following up and investigation of contacts of index TB cases (smear positive TB cases) is one of the vital control measures for TB spread. It has led to detection of active TB in 1% of all contacts, and 10% of TB cases have been diagnosed due to contact tracing (Underwood, White, Baker, Law & Moore- Gillion, 2003, p.59). Contact tracing relies on prompt notification of the disease (Tuberculosis). A study done by Neely et al. (2009, p.50), following an outbreak of TB among IPT users in London, showed that contact tracing should be done in both household and casual contacts of smear positive TB and close contacts of smear negative TB. Most of the rates in prisons are similar to those in outbreak situations. So the above recommendations on contact tracing can be followed. The priority and urgency of conducting contact tracing should be guided by the risk of transmission, which is perceived to be so high in prisons due to overcrowding and poor ventilation. Since contact tracing is part of screening and the cases diagnosed through this approach are usually asymptomatic, extra efforts are to be made so that these cases complete their treatment and they are cured.

Active case finding in prisons can be done during entry into prison, mass screening during incarceration and through contact investigation, while self-referral is passive case finding. Usually active case finding in prisons is done as a supplement to passive case finding (Golub et al., 2005, p.1198).

1.7 Sputum microscopy

Diagnosis of Tuberculosis rests mainly on the identification of the tubercle bacilli either by sputum smear microscopy or by culture.

Two or three sputum smears need to be collected for each tuberculosis suspect. Patients with negative smears need further investigation (mentioned below) and should never be told that there is nothing wrong with them before such investigations are done.

Sputum collection should be done in open air or in a ventilated room, away from other people, to avoid infecting them.

Sputum specimens should be sent to the laboratory as soon as possible to ensure examination is done within one week of collection and stored in a refrigerator or in a cool, safe and dark place.

1.8 TB treatment outcome for smear positive pulmonary TB patient

There are six treatment outcomes for smear positive TB. These are: -

1. **CURED**: patient who is sputum smear negative in the last month of treatment and on at least one previous occasion.

2. **TREATMENT COMPLETED**: patient who has completed treatment but who does not meet the criteria to be classified as cured or failure.

3. **TREATMENT FAILURE:** patient who is sputum smear positive at five months or later during treatment.

4. **DIED:** patient who dies for any reason during the course of treatment.

5. **DEFAULTER:** patient whose treatment was interrupted for 2 consecutive months or more.

6. **TRANSFER OUT:** patient who has been transferred to another recording and reporting unit and for whom the treatment outcome is not known (WHO 2002, p.13).

TREATMENT SUCCESS: sum of patients cured and those who completed treatment.

1.9 Burden of tuberculosis in prisons

Tuberculosis is becoming concentrated among the high risk and difficult to reach populations. Among this population are prisoners. Each year, over 9 million people are incarcerated in prisons worldwide as either remand or sentenced prisoners (Walmsley, (n.d), p.1).

Higher rates of TB have been reported in prisons both in Africa (O'Grady et al., 2011, p.174) and in developed countries than in the general population. However, these rates are worse in developing countries than developed countries (Table1.1)

TABLE 1.1: SHOWING BURDEN OF TB IN PRISONS IN DIFFERENT COUNTRIES

COUNTRY	RATE per 100000	MEASURE	SOURCE
Ivory Coast	5800	Incidence of smear positive TB	Koffi et al, 1997
Brazil	2700	Prevalence of smear positive TB	Sanchez et al., 2005
Russia	2369 to 869 over 2 years	Incidence of TB	Lobacheva, 2005
Spain (Barcelona)	2766 to 174 over 13 years	Smear positive incidence rate	Rodrigo et al., 2002
Thailand	354.8	Prevalence rate of smear positive TB	Jittimanee et al., 2007
Botswana	3797	Point Prevalence of TB	CDC, 2003
Zambia	4005	Prevalence rate of culture positive TB	Habeenzu et al., 2007
Cameroon	3517	Prevalence rate of TB	Noeske, 2006
Pakistan	3900	Prevalence of TB	Shah et al., 2003
Turkey	341	Mean point prevalence	Kiter et al., 2003
Taiwan	208	Prevalence of TB	Chiang et al., 2002
Thailand	568	Prevalence of smear positive TB	Sretrirutchai, 2002
Georgia	5995	Prevalence of smear or culture positive TB	Aerts et al., 2000
France	215	Incidence of TB	Hanau-Bercot, 2000
USA	113	Prevalence of TB	Bock, Reeves, Marre& Voe, 1998

1.10 Risk factors for TB transmission and propagation in prisons

"Although close or household contacts have a greater individual risk of infection than the general population, this is not necessarily due to household exposure alone Other shared risk factors may also confer a higher risk of acquiring infection,"as argued by Aparicio, Capurro and Castillo- Chavez (2000, as cited in Fox & Marks, 2010, p.3). As most prisoners come from poor and minority groups with lower education levels (Rodrigo et al., 2002, p.1091), it is not surprising to see that prisons have higher rates of tuberculosis than the general population. The risk factors for transmission and propagation of tuberculosis in prisons are categorized into environmental and host factors (Table 1.2).

TABLE 1.2: Risk factors for transmission and propagation of active TB within prisons

ENVIROMENTAL RISK FACTORS	HOST RISK FACTORS
Poor ventilation in prison cells and congregate settings within the prisons	Poor nutrition and micronutrient deficiencies
Close contact between prisoners due to restricted prison compounds	Stress and anxiety
Close contact between prisoners and prison staff	Immune-suppression example HIV infection
Overcrowded sleeping quarters (many prisoners per cell)	Smoking and chronic obstructive airway disease
Close contacts between prisoners and visitors	Addictive drugs
Poor prison health services	Lack of sunshine and vitamin D deficiency.

Source: O'Grady J et al., 2011, p.175

From the table 1.2, it is seen that other risk factors apart from contact contribute to spread of tuberculosis. “The relative contribution of domestic exposure to an individual’s overall risk of acquiring disease will also depend upon disease prevalence in the population under study. Unsurprisingly, contact screening studies show that rates of active disease are higher among contacts of tuberculosis patients in high-prevalence countries” (Rieder, 2003, as cited in Fox and Marks, 2010, p.4).

1.11 Cost Effectiveness analysis

Cost effectiveness analysis (CEA) measures the effects against the resource inputs of two different approaches of implementing a program, which aims at one goal, hence assist in decision-making. When applied in health, it identifies areas (locations) or interventions of a health program that are efficient and also help in improving the program.

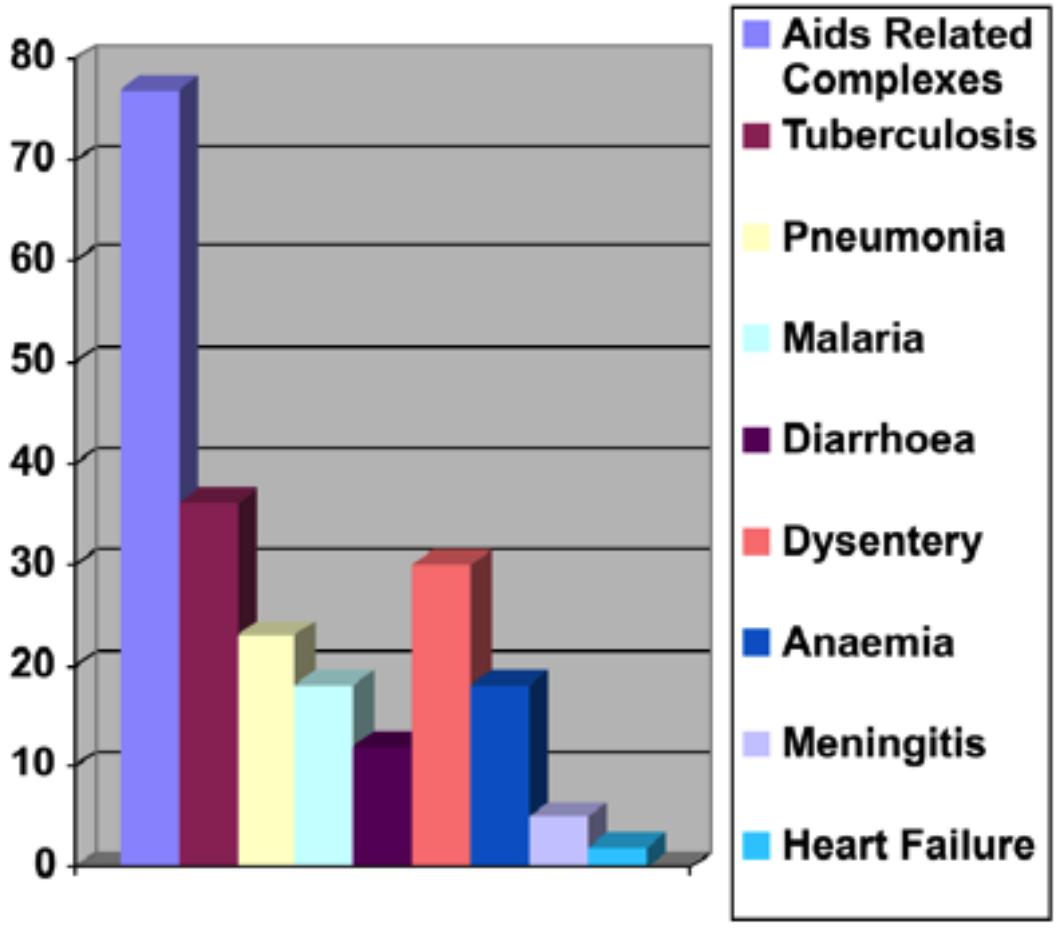
Results in cost effectiveness analysis can be expressed as cost per unit effect or effect per unit of cost, and the latter is important when the program is working within a budget constraint (Drummond, O’Brien, Stoddart & Torrace, 1997, p. 13). “ CEA may also compare two actions in health whose effects are not measured directly but may achieve other clinical objectives that can be clearly linked to improvements in patients outcome, for example treatment outcome of TB patients between actively and passively detected cases (Drummond et al., 1997, p. 13).

1.12 The research problem, scope and significance of the study

In Malawi, just like in other Sub-Saharan African countries, tuberculosis (TB) remains a huge public health problem. TB is one of the biggest causes of adult morbidity and mortality, whose greatest impact is on the poor, from backgrounds of overcrowding, poor nutrition and inadequate hygiene and sanitation. Since 1985, Malawi has experienced an almost six fold increase in TB case notification rates. Death rate has also been proportionally high. The escalating TB notification rate and the high death rate are largely attributed to the HIV epidemic, which fuels the TB situation (Malawi National TB Program, 2011, p.2).

Tuberculosis is one of the major public health problems in Malawi prisons. It is the highest cause of death from a single disease alone in Malawi prisons (Graph 1.0).

Graph 1.0: Causes of death in Malawi prisons in the year 2009



Source: Annual Report of Malawi prisons, 2009

In a prevalence study of pulmonary TB conducted in Zomba central prison, a rate of 5,142/100,000 (Nyangulu et al., 1997, p.1286) was registered, compared with 209/100,000 in the general population in 1996 and the prevalence of smear positive TB was at 2% (Nyangulu et al., 1997, as cited in Banda, Gausi, Harries & Salaniponi, 2009, p.1558).

As the study by Nyangulu et al. (1997), only focused on one large prison, another one was done but with special focus on smear positive TB using sputum microscopy. This time around, 18 out 22 prisons were studied. The study found a period prevalence of smear positive TB of 0.7% (54/7661) but main urban prisons of Zomba, Maula and Chichiri had a higher period prevalence at 1.1% versus 0.3% in district prisons (Banda et al., 2009, p.1558). Though the prevalence of smear positive TB in Zomba prison reduced from 2.0% in 1996 to 1.5% in 2005, the study found that the reduction was not statistically significant.

Through the years, the prevalence rate in prisons has decreased though still high as compared to that of the general population. This is being reflected through reduction in case notification rates. In a countrywide surveillance of tuberculosis of 2008 by Kanyerere et al. (2012, p.12), tuberculosis case notification rate in prison was 835/100,000 as compared to general population at 219/100,000.The case notification rate of smear positive tuberculosis was 442/100,000 compared to 63/100,000 in the general population. Smear positive cases contributed to 53% of all TB cases in the year 2007 while smear negative and Extra-pulmonary TB contributed to 29% and 18% respectively. The highest numbers of TB cases were recorded in central (urban) prisons of Zomba, Maula and Chichiri (Table 1.4). Most of the inmates who contributed to smear positive tuberculosis were convicts.

Table 1.3: Malawi Prison Tuberculosis Case Load in 2007

Name of Prison	Smear Positive		Smear Negative		EPTB		Total		Grand Total
	M	F	M	F	M	F	M	F	
Mwanza	6	0	1	0	4	0	11	0	11
Chitipa	0	0	0	0	0	0	0	0	0
Mulanje	3	0	6	0	8	0	17	0	17
Makande	0	0	0	0	0	0	0	0	0
Bvumbwe	0	0	0	0	0	0	0	0	0
Thyolo	0	0	0	0	1	0	1	0	1
Chichiri	33	0	13	0	5	0	51	0	51
Nsanje	2	0	4	0	0	0	6	0	6
Chikwawa	3	0	6	0	2	0	11	0	11
Ntchisi	0	0	0	0	0	0	0	0	0
Nkhotakota	2	0	1	0	2	0	5	0	5
Kasungu	4	0	0	0	2	0	6	0	6
Mzimba	7	0	1	0	1	0	9	0	9
Karonga	2	0	0	0	0	0	2	0	2
Mzuzu	1	0	0	0	0	0	1	0	1
Nkhatabay	0	0	0	0	0	0	0	0	0
Bzyanzi	0	0	0	0	0	0	0	0	0
Ntcheu	6	0	1	0	1	0	8	0	8
Mangochi	1	0	0	0	0	0	1	0	1
Mikuyu 2	0	0	0	0	0	0	0	0	0
Domasi	0	0	0	0	0	0	0	0	0
Mikuyu1	0	0	0	0	0	0	0	0	0
Mpyupyu	0	0	0	0	0	0	0	0	0
Kachere	0	0	0	0	0	0	0	0	0
Dedza	4	0	0	0	0	0	4	0	4
Zomba	45	0	23	0	18	0	86	0	86
Maula	27	1	25	0	5	1	57	2	59

Source: Malawi Prisons Annual report, 2008

Recognizing the high rates of TB in Malawi prisons, and existence of most risk factors (Table 1.1) for transmission and propagation of active TB in prisons, the National Tuberculosis Control Program (NTP) and Prison Medical Services established collaboration on control of tuberculosis in prisons in 1996. Among other things, the collaboration centers on referral of TB cases/suspects from prisons to Ministry of health facilities, supervision of prison medical staff by NTP staff**,** provision of free microscopes to the prisons, provision of free anti-TB drugs and laboratory supplies to the prisons and biannual TB review workshops with prison medical staff.

As one way of showing commitment to control of tuberculosis in Malawi prisons, the Ministry of Health together with the Ministry of Home Affairs and Internal security and other relevant stakeholders developed a policy document for tuberculosis control in Malawi prisons. This policy is a guiding tool for control of tuberculosis in Malawi prisons.

Early case finding is one of the activities integral to prevention of tuberculosis transmission as it expedites the treatment of tuberculosis. Integration of active and passive case finding with the priority to detect infectious cases is recommended for case finding in prisons (WHO, 2001, p.103). Periodic active screening of prisoners during incarceration and screening upon admission to prisons by asking for respiratory symptoms are some of the approaches to fast track the control of tuberculosis stipulated in the policy (Malawi Ministry of Health, 2007a, p.6).

However, a short communication by Harries et al. (2004, p.615), shows that during on entry active case finding of TB during the period 1999- 2002, from the available data on admission screening and smear positive PTB, 423 prisoners were diagnosed with smear positive PTB. Of these, 34 (8%) were identified through admission screening and 389 (92%) while already within the prison system. However, the duration of stay before diagnosis of TB was made is not available.

Nyangulu et al. (1997), also found that in all prisoners except one, symptoms of TB had developed after entering prisons and suggested that there was a possible active transmission of tuberculosis within prisons, an observation that was also done by other studies in a prison (Stead, 1978, p.2545; Bellin, Fletcher & Safyer, 1993, p.2228; Martin et al., 1994, p.929; Centers for Disease Control and Prevention (CDC), 1992; Jones, Craig, Valway, Woodley & Schaffner, 1999, p.557; Chaucer, 1955, p.684).

The Malawi prisons formally started implementing periodic active screening in 6 prisons in July 2009. The recommendation is to conduct periodic active screening biannually (Malawi Ministry of Health, 2007a, p.7). However, the activity has been done on eight monthly intervals due to logistical issues. Malawi just like most countries has not fully started implementing active case finding during admission to prisons due to logistical problems ranging from human resources to financial constraints. Implementation of active case finding during admission has to be considered carefully as little yield (34/423) was seen from the data of 1999-2002 as

reported by Harries et al. (2004, p.615). No official results are available for periodic screening during incarceration in Malawi prisons.

After considering cost and prevalence in different regions of the world, using models of three approaches of ACF, Murray and Salomon (1998, p.S14) concluded ACF strategies combined with DOTS would yield enormous benefits in areas with high TB prevalence and millions of cases and death could be averted. However, this would also depend on the diagnostic and screening method.

Periodic active case finding is aimed at removing a backlog of smear positive cases and a few incident cases that subsequently arise and missed by passive case finding. Studies in Malawi, Cameroon and Botswana showed that over half of prisoners with active sputum TB had been missed by routine diagnostic services and could potentially be transmitting TB.

Delays have been observed in passive case finding in prisons. In a prevalence study of TB in Malawi prisons, the median duration of cough before diagnosis was 4 weeks (2-52) (Nyangulu et al., 1997), and over 50% of TB suspects in prison were screened after 4 weeks of TB symptoms (cough) and 42% were screened within 2 to 4 weeks of onset of symptoms (Kanyerere et al., 2012). Hence, implementation of active case finding would avoid these gaps and delays in diagnosis and treatment initiation in prisons, an observation also made by Dara, Grzemska, Kimerling, Reyes & Zagorskiy (2009) and Kiter et al. (2003), who recommended that active case finding be

continued in prisons, as a supplement to passive case finding. In the context where there is very high prevalence of TB and HIV in prisons, more aggressive approach is required to detect smear positive TB and cure it.

However, active case finding has cost implications in the sense that, more resources are needed to perform ACF. The study will assist the Malawi prison in facilitating planning, management and efficient allocation of resources among prisons for active case finding to improve the cost effectiveness use of resources by identifying prisons or prison characteristic where periodic active case finding be of most value as the main purpose of active case finding is to identify more cases.

1.13 Research questions

1. How much improvement in TB diagnosis can be attributed to an added program of Active Case Finding for TB?
2. What is the added cost for implementing the associated Active Case Finding activity?
3. How many smear positive TB cases were diagnosed for the added costs during each session of active case finding in prisons?
4. What was the trend of passive case notification rates of smear positive TB following each round of active case finding (ACF) during the period under study?
5. Should active case finding be equally implemented in all prisons in Malawi?

1.14 Research objectives

1.14.1 Main Research objective

To determine the magnitude of smear positive TB cases detected for added cost during periodic active case finding, and its (active case finding) effect on the passive case notification rate (TB case rates) of smear positive TB in Malawi prisons.

1.14.2 Specific research objectives are to: -

1. Establish the absolute number of cases diagnosed during sessions of periodic active case finding in Malawi prisons from 2009 to 2010.
2. Identify the added costs spent on periodic active case finding in Malawi prisons from 2009 to 2010.
3. Calculate the number of smear positive TB cases diagnosed for added costs during periodic active case finding in Malawi prisons from 2009 to 2010.
4 Determine the passive case notification rates of smear positive tuberculosis after each round of active case finding.

1.15 Hypotheses

The extra costs of implementing three rounds of active case finding in prisons justify the added utility of the program by reducing passive case notification rates of smear positive TB.

I. **H_0** (*Null Hypothesis*): The extra costs of implementing three rounds of active case finding in prisons do not justify the added utility of the program as there **was no reduction** in passive case notification rates of smear positive TB.

II. **H_1** (*Alternative Research Hypothesis*): The extra costs of implementing three rounds of active case finding in prisons justify the added utility of the program **by reducing** the passive case notification rates of smear positive TB.

2.0 TUBERCULOSIS CONTROL AND PREVENTION IN MALAWI PRISONS

2.1 Tuberculosis control in Malawi

The Malawi National Tuberculosis Program (MNTP) has the whole responsibility to manage tuberculosis control activities in Malawi. A program manager who reports to the directorate of preventive health services (DPHS**)** heads it.

The directorate of preventive health services has the mandate of setting national standards for primary health care, which includes disease surveillance, immunization program, health promotion, inspection and environmental aspects related to health. It is also responsible for disease control, epidemiology and emergency/ epidemic preparedness. Lastly, the DPHS as a hub of prevention has the task of ensuring that there is multi-sectoral collaboration at national level among all health stakeholders in preventive medicine.

The MNTP has been implemented as a vertical program since 1964, until in 2005 when it started realigning its planning, approach and budgeting to be in line with the Malawi Joint Health Sector Wide Approach (SWAP).

The main responsibility of the MNTP is to ensure that the national standards in TB control in the country are adhered to through evidence based information and quality control. Collaboration of activities has been between national TB officers and district level until lately, following decentralized health policy structure where zonal TB offices have been established. The role of zonal TB officers is supervising and strengthening the district health management teams in terms of planning, implementation, diagnostic, quality control, monitoring and evaluation of all TB control activities in the district (Appendix 1).

Malawi is divided into 5 zones on health administration. Each zone has one zonal TB officer who is responsible for 4 to 6 districts and reports directly to the national TB office. The district health management team (DHMT), under the overall of the District Health Officer is responsible for resource mobilization, coordination of activities and operational research in TB control within the district. The DHMT appoints a district TB officer, who may either be a clinician/nurse or an environmental health personnel whose duties are to coordinate all the TB control activities at individual patient, community and district level on behalf of the DHMT.

The district TB officer supervises all the health cadres that are involved in the management of TB at both community and facility levels. These include clinicians, nurses, laboratory technicians, community health nurses, environmental health officers and health surveillance assistants (HAS). However, HAS are more involved

in community level surveillance (passive case finding) of TB, health education and promotion as well as follow up of both TB suspects and patients. Community members form community and health facility committees, which do also volunteer in TB activities.

An analysis of TB case finding statistics over the past 25 years shows that there was a five-fold increase in new TB case notifications between 1984 and 2000. There was also an increase in TB/HIV co-infected patients, reaching a maximum of 77% in 2000 (Malawi Ministry of health, 2000, p.42), which has now decreased to 63% in the 2010 cohort (WHO, 2011, p.62). Death rate has also been proportionally high.

Since 1984, Malawi has responded to the TB epidemic by adopting the World Health Organisation (WHO) advocated DOTS strategy which is based on five key elements:

1. Political commitment with increased and sustained financing
2. Case detection through passive case detection with quality-assured bacteriology.
3. Standardized short course chemotherapy with supervision and patient support.
4. An effective drug supply and management system.
5. Monitoring and evaluation system and impact measurement (WHO, 2006, p.4).

Delivery of this strategy in Malawi is through integration of tuberculosis control within the existing health services. To date, favourable treatment outcomes are being reported save for the high death rate currently at 15% (Malawi NTP, 2011a, p.3).

The Malawi National Tuberculosis Control Program is well established in delivery of TB services such that it has gained a very good reputation in Sub-Saharan African (SSA) region. The program has attempted to be responsive to the needs of different social groups through the development of community-based activities to intensify case finding among the poor (Simwaka et al., 2007).

However, there are a number of challenges that the program is experiencing. These challenges are: increase in number of TB cases due to HIV co-infection, under diagnosis of TB cases due to passive case finding strategy, persistent poverty and malnutrition, gender inequity, lack of human resources and emergence of MDR-TB. Although the country is yet to register an extensive drug-resistant TB (XDR-TB) case, however, 1320 cases of MDR-TB cases have since been reported, with 871 new cases in 2010 and 449 being on retreatment (WHO, 2011, p.141).

The Malawi Government started implementing a three-year plan of joint TB and HIV/AIDS services consistent with WHO/UNAIDS recommendations in 2002, with the aim of reversing the burden of TB. Following the declaration of TB as an emergency in Africa by African Ministers of health in October 2005, the Malawi

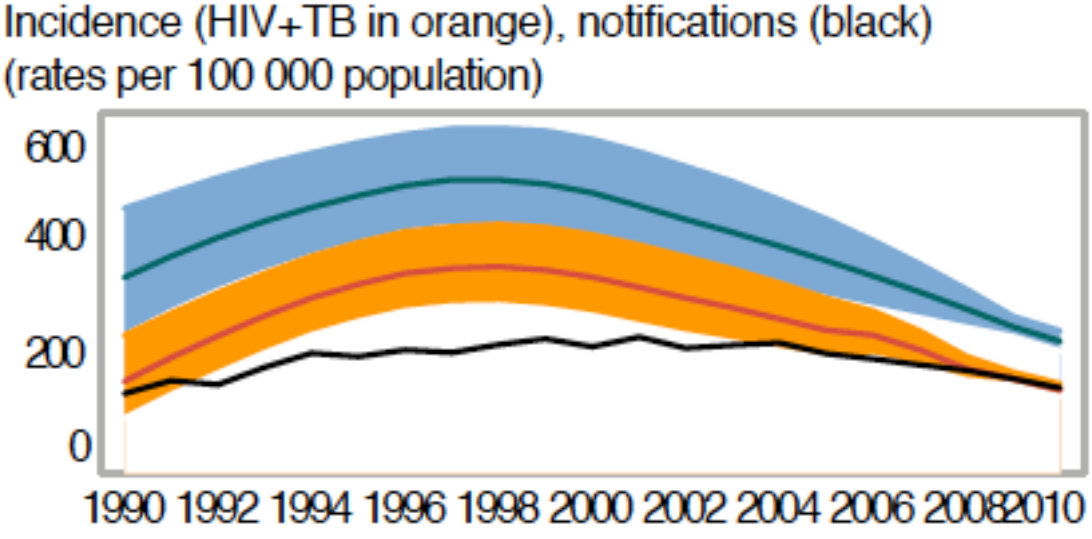
Government was the second country in Africa to declare TB an emergency in the year 2007 (Malawi NTP, 2011a, p.4), and the National TB Control program came up with a 5 year development plan for 2007-2011.

The main objectives of the plan were to promote early health seeking behaviour of TB suspects through advocacy, communication and social mobilization (ACSM), equitably improve and maintain case finding and good diagnostic practices, strengthen NTP capacity to monitor and support the delivery of effective TB treatment, including TB/HIV control, increase and maintain collaboration with health training institutions and the private sector, conduct sustained relevant operational research in TB control, and improve and maintain human resources capacity at all levels to effectively manage, monitor and evaluate the NTP(Malawi Ministry of Health, 2007b, p.6).

2.2 Burden of Tuberculosis in Malawi

According to World Health Organization's Global TB report of 2011, there was an estimated incidence of 33000 cases (all forms) of TB in Malawi at the rate of 219 cases per 100000 populations. However, case notification in the year 2010 has been well more than the estimated case detection rate of 65%, with 22536 cases notified (WHO, 2011, p.124). The TB case notifications then stabilized between 2001 and 2005, before showing a 1% decline in the past 4 years **(**Malawi NTP, 2011a, p.7)(Graph 2.0).

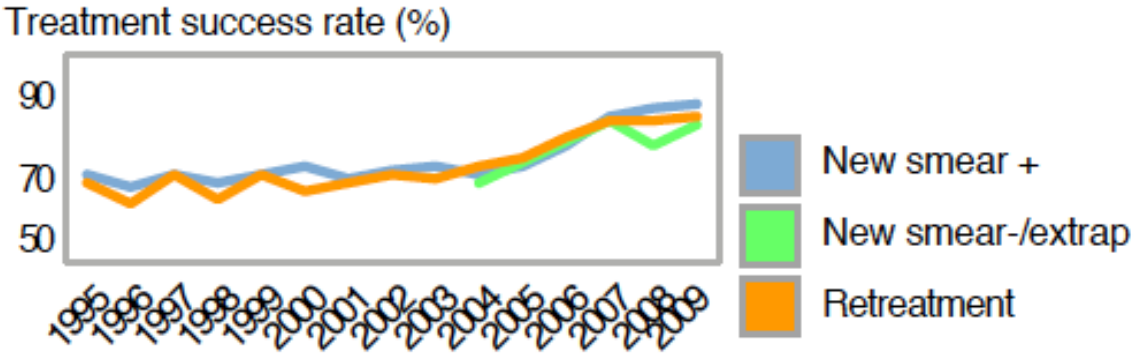
Graph 2.0: Trend of case notification and incident rate in Malawi over the last 20 years from 1990



Source: WHO 2011

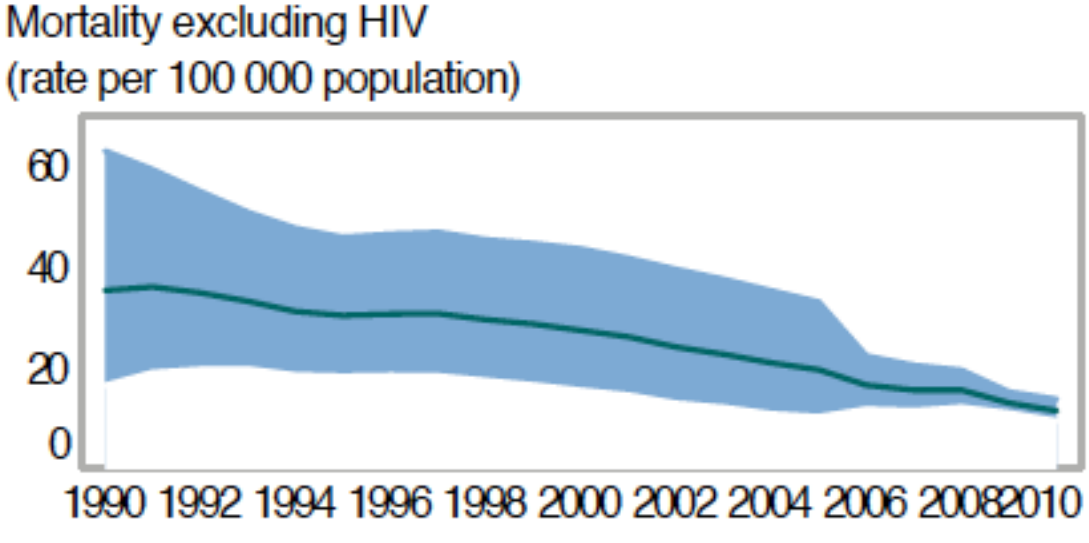
Prisons contribute less than 1% of the total notified cases towards national figures as seen following a surveillance of tuberculosis in Malawi prisons in 2008 and only 2% towards smear positive TB cases in 2006 and 2007(Malawi NTP, 2011b), despite having very high rates than the general population. The country program has made progressive tremendous improvement in treatment success rate over the years (Graph 2.1) and achieving an 88% treatment success rate for smear positive cases in 2009.Following improvements in treatment success rates, there been a resultant reduction in mortality rate (Graph 2.2).

Graph 2.1: Treatment success rate of TB in Malawi from 1995 to 2009



Source: WHO 2001

Graph 2.2: Trend of mortality rate due to TB in Malawi from 1990 to 2010



Source: WHO 2011

The National TB Control program plans to do a prevalence survey towards end of year 2012(Malawi NTP, 2011, p.5). Once this is done, correct figures of incidence will be determined as the current ones are just estimates by W.H.O.

2.3 Tuberculosis and HIV/AIDS Co- infection

The introduction of Antiretroviral (ART) treatment in 2004 in Malawi may also have played a significant role in reducing the case notifications in Malawi. Up to end of June 2011, there were 287089 people who were alive and on ART (Malawi Ministry of Health, 2011, p.3) out of the estimated 1 million infected people (Prevalence of HIV at 12%).

ART patients undergo routine TB screening at every visit so that undetected TB could be diagnosed, as it is believed to be responsible for a good proportion of early deaths. Out of the current population alive on ART, 261251(91%) were screened for TB and 356 were TB suspects while 1889(1%) were confirmed as current TB patients of which 1569(83%) were already on TB treatment and 320 were yet to start (Malawi Ministry of Health, 2011, p.3). In 2010, 46% of TB patients in Malawi were started on ART (WHO, 2011, p.62).

2.4 Other Interventions for Tuberculosis control in Malawi

Other interventions implemented by the NTP in the control of TB are: Vaccination of infants with BCG immediately after birth, disseminating information, educating the communities and communication (IEC) to improve the community's health seeking behavior. BCG vaccination whose national coverage is at 97% is aimed at preventing children from TB and also severe forms of TB, example TB Meningitis. In the year 2010, only 153 cases of TB were notified in the population less than 15 years old.

BCG vaccination falls under the prevention and treatment of vaccine preventable diseases in the Malawi Essential health care package (EHP), while IEC is part of the support activities in the POW to achieve the EHP (Malawi Ministry of Health, 2004, p.20).

Apart from BCG vaccination and IEC, the NTP also promotes better clinical practice with isoniazid preventive therapy (IPT) for people living with HIV (PLWHA) and children who are household contacts of index smear positive pulmonary TB cases, cotrimoxazole prophylaxis to reduce morbidity/mortality among HIV- infected TB patients, safe TB case management within the healthcare facilities to prevent transmission to healthcare workers and active TB case finding among high risk groups, PLWHA and prisoners inclusive. However, the screening of TB among prisoners is not through chest X-rays and isonoazid preventive therapy is not routinely offered to prisoners.

2.5 Treatment of Tuberculosis in Malawi

The Malawi government changed the treatment of TB to fixed drug combination in the year 2007. Several drugs are combined into one to three tablets.

2.5.1 Anti-tuberculosis drugs used in Malawi

New TB patients are treated with first line anti-tuberculosis drugs. This comprise a combination of rifampicin, isoniazid, pyrazinamide and ethambutol tablet, abbreviated as RHZE in the first 2 months, followed by 4 months treatment with a combination of rifampicin and isoniazid (RH). Relapse TB cases are treated with second line anti-tuberculosis drugs RHZE for the first 3 months followed by a 5 months continuation phase of RHE. Therefore, it should be noted that the duration of treatment are 6 and 8 months for new PTB and relapse cases respectively (Malawi Ministry of Health, 2012, pp.39-41).

2.5.2 Side effects of anti-tuberculosis drugs

Anti-tuberculosis drugs have side effects. These side effects are grouped into major and minor. Some side effects are common while others are rare. Every drug has its own side effects despite being in fixed combination. Other side effects like peripheral neuropathy (PNP) are preventable.

Peripheral neuropathy is due to use of isoniazid (INH) and is very common in HIV positive TB patients and in alcoholics (WHO, 2004, p.129). Apart from peripheral neuropathy, joint pains are one of the common side effects that are observed in

patients who are on TB treatment, which also needs medication treatment. An incidence of 2% of peripheral neuropathy has been reported in one study (Mandel, 1959, p.293). Deficiency of vitamin B complex, more specifically pyridoxine has been suggested as the cause of peripheral neuropathy. However, other studies have suggested that isoniazid has inhibitory effect on pyridoxine (Mandel, 1959). In situations where malnutrition is endemic like in prisons, possibility of a higher incidence of peripheral neuropathy in patients on isoniazid should be expected. The incidence of PNP also increases up to 30 to 40 %(Mandel, 1959, p.293) with increased amount of INH above the normal amount of 300mg.Most other common side effects require discontinuation of the drug responsible for side effects and introduce the drugs later in small doses after the side effect has resolved.

Prevention of peripheral neuropathy requires daily intake of pyridoxine 10mg through out the use of INH. If a patient develops peripheral neuropathy, 75 mg daily of pyridoxine is used. Usually, peripheral neuropathy is common in the first 2 months of TB treatment.

2.6 MALAWI PRISONS SERVICE

The Malawi Prisons Service (MPS) is a government department constitutionally mandated under Chapter XVII of the Republican Constitution, and, operates within the statutory parameters of Chapter 9:02 of the Laws of Malawi to keep and rehabilitate offenders under lawful, humane custody.

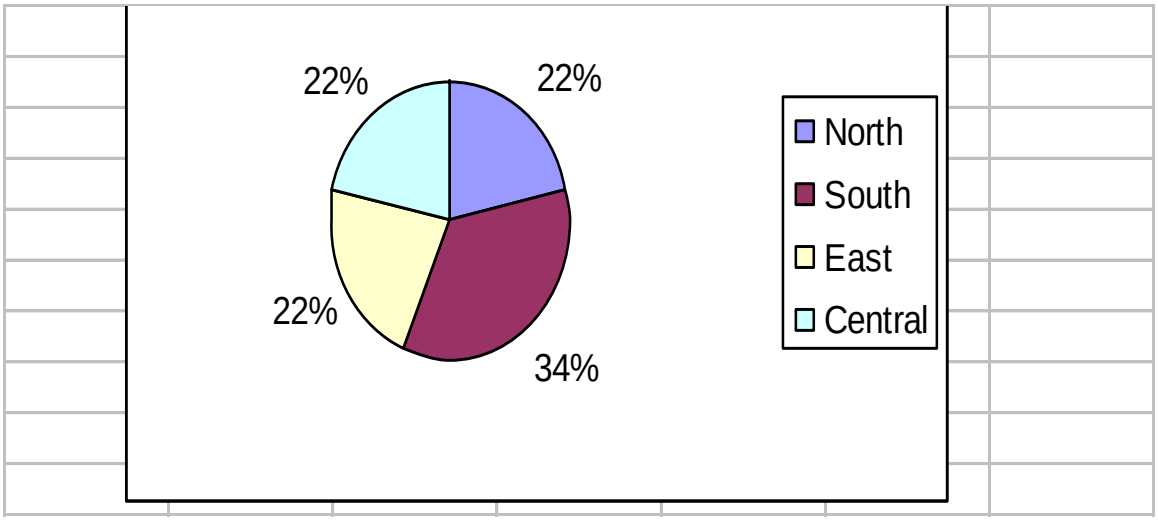
2.6.1 Establishment of Malawi prisons

The MPS is divided into 4 regions administratively. These are northern, central, eastern and southern regions (Figure 2.0).

Figure 2.0: Map of Malawi showing regions and districts that prisons in the study are located

The MPS has currently 32 prison stations that are distributed in all the regions (Appendix 2). The southern region has more prisons (34%) while there is equal number of prisons in the other regions, each contributing 22% (Graph 2.3).

Graph 2.3: PIE CHART SHOWING DISTRIBUTION OF PRISONS BY REGION



The stations are categorized into maximum, medium and low security prisons, based on security risk prisoners in the respective prisons pose. The prisons have different section for the safe keeping of females and young offenders. Malawi prisons, has 4 prisons which are regarded as maximum-security prisons. These are Zomba, Chichiri in Blantyre, Maula in Lilongwe and Mzuzu in the Northern region. These prisons, house prisoners with long sentences and also those remanded on serious offences such as homicide, armed robbery and others. However, Zomba prison is the only one that house prisoners on life or death sentences.

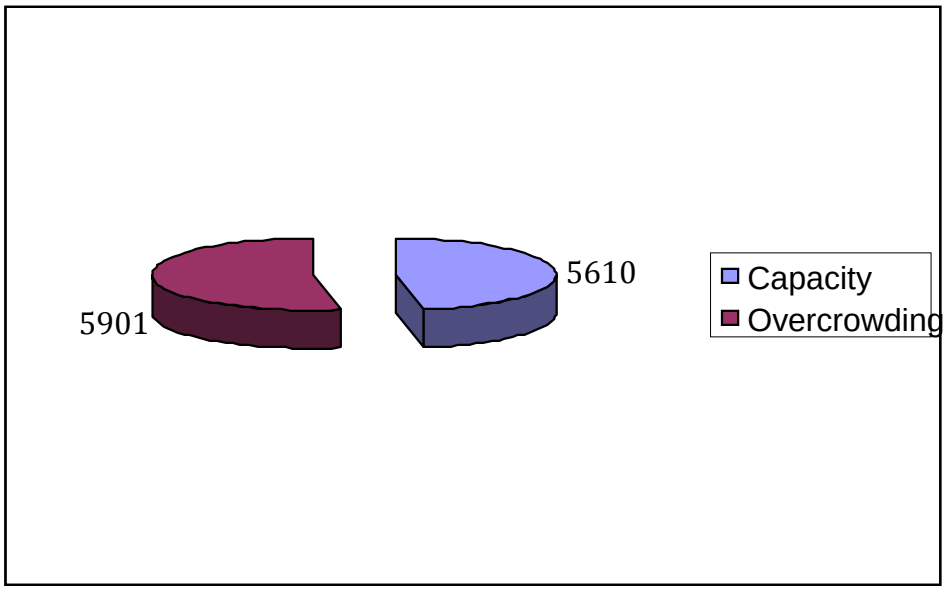
Medium and low security prisons are usually found in districts. Some of these are prison farms where different crops are grown. Among the medium security prisons are Chikwawa, Ntcheu and Mzimba district prisons. These district prisons have farms. Prisoners, whose sentences are not beyond 4 years, are in principal housed in medium or low security prisons. If their sentences are more than 4 years, prisoners are sent to maximum-security prisons. However, this is not always the practice (Chirwa, 2001, p.5), as isolated cases were found where they are not supposed to be.

2.6.2 Prison population in Malawi

Currently, the Malawi prisons house between 11500 and 12500 prisoners on the daily basis (Malawi Prisons Service, 2009). The prison population has been increasing over the years. In the year 1997, it was 5557, rose to 7728 in the year 2000 and in June 2001, it was 7800(Chirwa, 2001, p.6).

All the prisons in Malawi are faced with the problem of congestion. The total holding capacity for Malawi prisons is 5610 prisoners but as of December 2009, the prison had 11511prisoners. This represented a 205% occupancy rate. (Graph 2.4)

Graph 2.4: TOTAL HOLDING CAPACITY VERSUS EXCESS BODIES IN MALAWI PRISONS AS OF 31 DECEMBER 2009.



Source: Malawi prison report, 2009

The situation of overcrowding is worse in the maximum-security prisons of Zomba, Chichiri, Maula and Mzuzu where occupancy rate is more than 250% (Table 2.0).

Table 2.0: Malawi prisons holding capacity and occupancy rate

Prison Station	Prison population	Number of cells	Holding Capacity	Occupancy Rate (%)
Chitipa	120	3	60	200
Karonga	122	5	80	153
Mzuzu	439	3	90	488
Nkhatabay	142	5	80	178
Mzimba	527	8	400	132
Byanzi	36	1	30	120
Dedza	278	4	120	232
Kachere	73	9	54	135
Kasungu	320	8	240	133
Maula	1759	12	480	366
Ntchisi	111	2	60	185
Nkhotakota	334	3	120	278
Ntcheu	256	2	80	320
Mangochi	120	5	90	133
Domasi	318	8	240	133
Mikuyu 1	385	10	240	160
Mikuyu 2	166	7	210	79
Mpyupyu	204	10	200	102
Zomba central	2294	108	756	303
Chichiri	1513	19	570	265
Bvumbwe	189	3	90	210
Chikwawa	477	8	240	199
Makande	182	1	360	51
Mulanje	412	8	240	172
Mwanza	311	4	160	194
Thyolo	102	3	90	113
Makhanga	61	1	30	203
Nsanje	150	6	120	125
Rumphi	110	2	80	138
Total	11511	268	5610	205

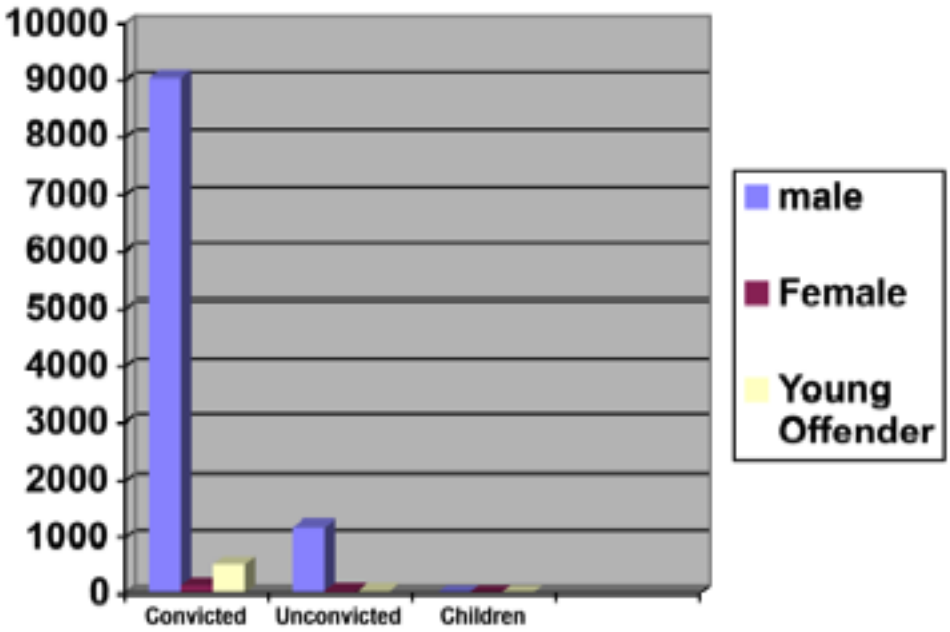
Source: Malawi prisons Services annual report, 2009

In 2001, Zomba,Maula and Mzimba prisons were densely populated with a prisoner having 1 square meter of space for accommodation. The situation was worse in Chichiri and Mzuzu prisons (Chirwa, 2001, p.9), where a prisoner had on average of 0.5 and 0.8 square meters of space respectively. As at this time, the prison population was only 7800. This situation is expected to have worsened as the prison population has increased to 11511 in the year 2009.

There has been a steady decrease in offenders remanded to prisons over the past 4 years (Malawi Prisons Service, 2009, p.24). In 2009, there were around 1400 offenders awaiting trial while those convicted were around 9700. This implies that more offenders are still slapped with custodial sentences. Offenders remanded to prisons, are segregated from convicted prisoners as practically as possible. However, this is not to the maximum due to lack of space.

Female prisoners are the least group, among the prisoners category (Graph 2.5). They constitute less than 2% of the prison population in Malawi; hence they are less congested in their section.

Graph 2.5: Categories of inmates within prisoners' population in Malawi



Source: Malawi prisons report, 2009

2.7 Structural description of prisons where the periodic active case finding was implemented

These prisons were in two categories of maximum and medium security prisons.

2.7.1 Maximum security prisons

1. Zomba central prison

It was built in 1939 in the colonial period. It has 6 sections. These are first offender, female, aged over 65, block A and B, and condemned criminals' sections. It is built out of burnt bricks and has a tall perimeter brick fence (Figure 2.1a). There are a total of 108 cells (Table 2.0) of different dimensions, with habitable area of 1814.4 square meters (m).

Most cells have 2 to 4 windows that are high up, and each window measures 0.5m by 0.5m or less than that (Figure 2.1b). Cells in the condemned criminal section have 1 window each but are usually occupied by one prisoner. There is usually mixing up of prisoners during day time, on an open ground (Chirwa, 2001, p.8) and there is no available shade such that most prisoners spent their time under shade within cells.

Figure 2.1a: Part of the perimeter brick wall fence measuring 12 meters around Zomba central prison

Figure 2.1b: Depicting one of the cells at Zomba central prison with small windows close to the roof

2. Chichiri prison

This prison is in Blantyre city, southern region of Malawi, and was built in the postcolonial era. It has both female and male sections. The male section has remand and convicted sections. Like Zomba central prison, Chichiri has a high (10 meters) perimeter brick wall fence around the prison. The whole prison has a total of 19 cells. Unlike in Zomba, these cells are bigger though a total surface area is 948.5 square metres. On average, each cell has 3 or 4 windows of 1.5 m by 1.2m. Usually, prisoner on the male section mix up and some spend their time within cells, during daytime, as there is no proper shade to protect them from sunlight. The sleeping within the cells is on the floor (Figure 2.2).

Figure 2.2: Inside a sleeping cell at Chichiri prison

3. Maula prison

Maula prison is in Lilongwe city, central region. Initially was built to be a remand prison only, but due to lack of space in other prison, it started admitting convicts as well. This was built in the 1960s. The prison does not have a perimeter brick wall fence. It has several fences of barbed wire around it (Figure 2.3a). The prison has 12 cells with a total area of 1069 square meters. Each cell has 4 windows of 1.5m by 1.2m and another 4 measuring 1 m by 0.5m on the front and back respectively (Figure 2.3b). The prison has a very vast ground where prisoners spent time during day. It has female and male sections. Remand prisoners and convicts sleep in different cells.

Figure 2.3a: Perimeter fence around Maula prison

Figure 2.3b: Showing outside of a prison cell at Maula prison

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2.7.2 Medium security prisons

1. **Chikwawa prison**

   This prison is in the southern region. Most features are similar to Zomba central prison in the sense that it has a perimeter brick wall fence and has cells with 4 windows on both front and back of cells, measuring 1m by 0.5m, but very close to the roof such that ventilation is compromised. There are 8 cells with a total area of 480 square meters. As a medium security prison, it has a farm where prisoners usually go out to farm.

2. **Ntcheu and Mzimba prisons**

   Both Mzimba and Ntcheu prisons have more recent structures. They both have a perimeter brick wall fence around the prison. The new Mzimba prison was opened in the year 2007 while for Ntcheu, there has just been replacement of old tiny structures.

   Both prisons have farms where prisoners work during day. Each cell has 4 to 6 well ventilated windows, measuring 1.5m by 1.2 m. Mzimba prison has 8 cells with a total area of 912 square metres while Ntcheu has only 2 cells with 226 square metres.

   Mzimba has both male and female sections. Like Chikwawa, both Mzimba and Ntcheu as district prison have some remand prisoners who await court trial in their respective districts.

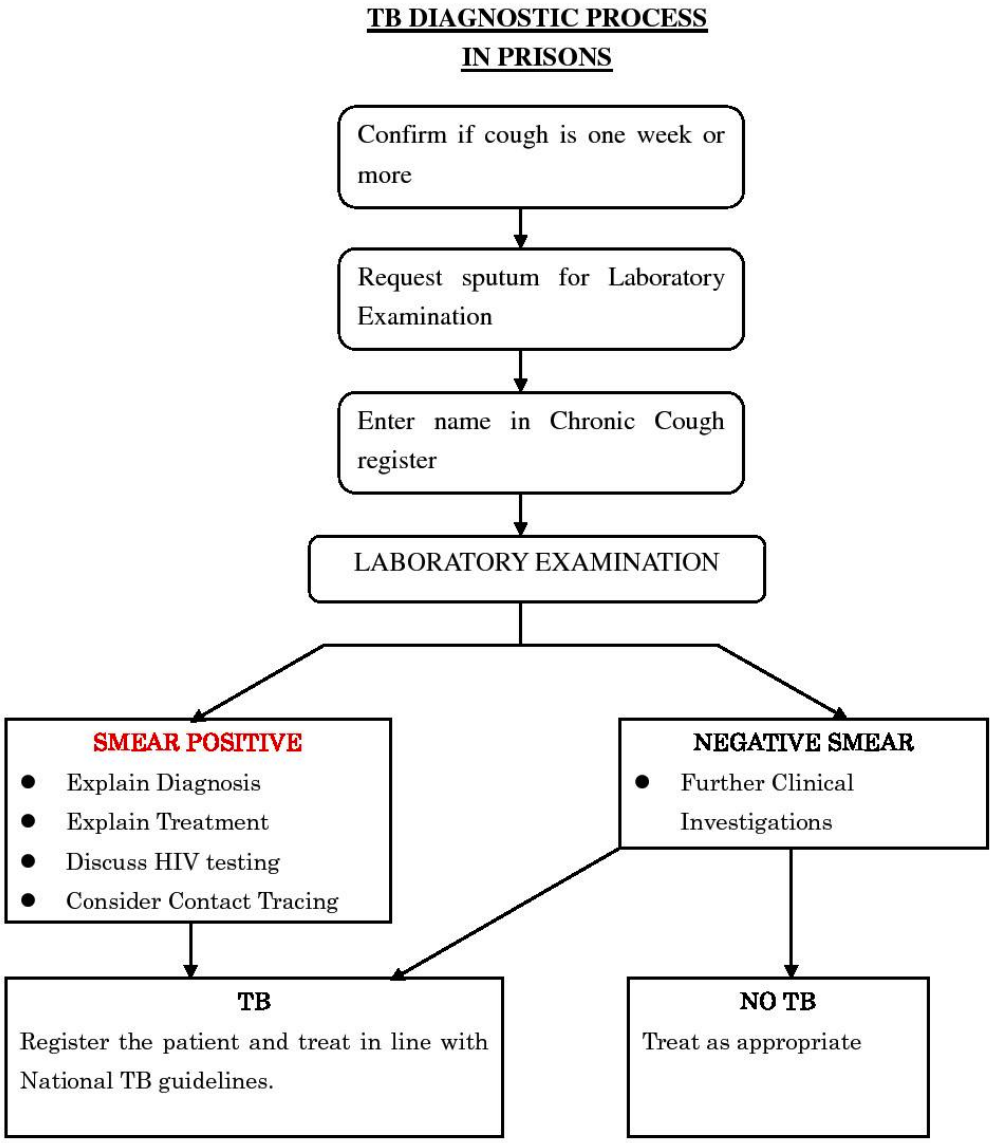
Figure 2.4: Aerial view of the modern Mzimba prison

2.8 Tuberculosis case finding in Malawi prisons

Tuberculosis control takes place in all the prisons of Malawi. The Malawi prisons adopted the DOTS system of management of tuberculosis cases. Prisoners do self-referral to the clinic or report to head of cell that report them to authorities within prisons. Prisoners with cough for 1 week are asked to submit 3 sputum specimens, which undergo direct microscopy. Sputum specimens collected at the prison are examined at the prison itself (if the prison has microscopy facilities) or are sent to the nearest health facility by the prison staff (if the prison does not have microscopy facilities).

Below is a practical pathway for the diagnosis of TB cases in Malawi prisons (Figure 2), however this is not usually followed during passive case finding.

FIGURE 2.5


TB DIAGNOSTIC PROCESS
IN PRISONS
Confirm if cough is one week or more
Request sputum for Laboratory Examination
Enter name in Chronic Cough register
LABORATORY EXAMINATION
SMEAR POSITIVE
Explain Diagnosis
Explain Treatment
Discuss HIV testing
Consider Contact Tracing
NEGATIVE SMEAR
Further Clinical Investigations
TB
Register the patient and treat in line with National TB guidelines.
NO TB
Treat as appropriate

The decision to screen all prisoners with cough for 1 week or more follows local research by Banda et al, 2009 where by 10% of patients with short duration of cough 1 week or more had smear positive TB. This decision was also vindicated by Harries et al where 164(39%) of 423 prisoners who were diagnosed with smear positive TB between 1999 and 2002 had cough for 1 to 3 weeks.

Screening of new prisoners is not routinely done in prisons, as was the case in the years 1999 to 2002.Even in those prisons where it is done; the screening is not performed routinely due to some operational problems.

In prisons with no medical staff, the general warden does the screening otherwise the prison medical staff does the screening.

Prisoners suspected of having active TB are registered in the chronic cough register at the prison. Prisons with medical staff are provided with TB patient registers (equivalent to the district TB register) and TB treatment cards into which details of the TB patients are entered.

Prisoners diagnosed with smear-positive PTB at the prison are registered and treated in the prisons according to national guidelines; including HIV treatment and care services (Malawi Ministry of Health, 2012). For prisons with no medical staff, prisoners diagnosed with smear-positive PTB used to be referred and treated at the nearest prison with medical staff. But this system stopped since 2008 as every prison now has a warden designated as a medical staff. Prisoners with chronic cough and negative smears or with symptoms and signs suggestive of extra pulmonary TB (EPTB) are referred to the nearest

district hospital for further investigations according to national guidelines (Malawi Ministry of Health, 2012)

All patients diagnosed at each prison are also registered in their respective district hospital's TB registry in order for the district TB coordinator to keep track of these patients.

In a surveillance of tuberculosis in Malawi prisons done in 2008 by NTP, it was found that the prisons had 5 microscopists and these were in the 3 central prisons of Zomba, Maula and Chichiri, and also at Mzimba district prison

The highest numbers of TB cases were recorded in central prisons such as Zomba, Chichiri and Maula. The surveillance also observed that the presence of prison medical staff is a determinant of TB identification in Malawi prisons

Tuberculosis microscopists, underwent a 3 weeks TB microscopy training in 2007 and thereafter, the NTP supplied microscopes and all necessary supplies for these microscopist to start their work.

The NTP and Central reference laboratory does quarterly quality control supervision of prisons TB microscopy centers. This is done by blindly checking the slides that were already prepared and read by microscopist and then the results are cross-matched.

2.9 Treatment of Tuberculosis in prisons

Prisoners diagnosed with all form of TB, are treated according to national guidelines. Prisoners are admitted at the nearest hospital during the first 16 days of TB treatment unless have very severe major side effects, and thereafter return to prison for continuation of treatment under supervision of prison medical personnel.

When an inmate is still on TB treatment at the time of his discharge, the prison medical personnel notifies the district TB officer who follows the inmate to the center where the inmate is referred to continue with treatment. The treatment outcome of TB treatment is sent to the specific prison where the prisoner was initiated on treatment. However, there have been cases where prisoners are lost due to provision of fake addresses or identities while in prison. A study done in Georgia also showed that prisoners on TB treatment were also missed following their release from prisons (Bock et al., 1998, p.361). In Malawi, this is expected to end or minimize when the country fully implement national identity cards (Malawi Ministry of Health, 2007a, p.9).

According to the regulations of Malawi prisons, no prisoner is supposed to keep drugs of any kind in a cell, hence all drugs including those of TB, are kept by prison personnel and a prisoner is asked to report daily to come for medication and take drugs before the prison personnel thereby ensuring that DOTS is followed. If the prisoner does not report for medication, it is the responsibility of the prison personnel to follow up to the cell of the prisoner and make sure that medication is taken as recommended.

2.10 HIV/AIDS situation in prisons

Human immunodeficiency virus (HIV) is one of the risk factors for the progression of TB infection into active TB.HIV also increases the susceptibility of an individual to TB. The majority of published studies have found higher HIV prevalence in prison inmates.

In west Africa, where HIV prevalence is less than 5% in the general population, prisoners were found to have markedly higher HIV prevalence in Ghana (19.2%)(Adjei et al., 2008, p.34), Cameroon (10.4% to 25% depending on whether they had TB)(Noeske, Kuaban, Amougou, Piubello & Pouillot, 2006, p.27) and Nigeria (18%)(Adoga et al., 2009, p.541).

In Southern Africa, where HIV prevalence is greater than 10% in the general population, the prevalence was found markedly higher in Malawi (36.6%) (Chimphambano, Komolafe & Muula, 2007, p.226) though the sample size was small, Zambia (27%)(Simooya et al., 2001, p.1742) and South Africa (43.5%)(Goyer &Gow, 2001, p.130). The only exception was a Mozambican study conducted in 1990-91, which found a very low HIV prevalence in prison, at 0.6% (Vaz, Gloyd, Folgasa & Kreiss, 1995, p.42).

Most of these studies were done in Central/urban prisons, where incarcerated prisoners have more serious offences and the prevalence may not be generalized to all the prisons within the countries. However, this still reflects that the general problem of HIV is high in prisons, as there are transfers of prisoners within prisons.

In Malawi, a study found an HIV prevalence of 74% in both TB and non-tuberculosis diagnosed prisoners in Zomba central prison in the year 1996(Nyangulu et al., 1997, p.1286), however this was not a systematically done research. Out of 278 TB patients in the year 2007, 269(97%) patients underwent HIV testing and counseling and 176(65%) of the total TB patients were HIV positive (Kanyerere et al., 2012, p.11). Lower rates of HIV infection in TB patients were observed in prisons of Ivory Coast at 30% (Koffi et al., 1997, p.250) and Tanzania at 25.9% (Rutta, Mutasingwa, Ngallaba & Mwansasu, 2001, p.704).

Following a prevalence survey of HIV, TB and Sexually-Transmitted infections in Malawi prisons done in 2011, the HIV rates were 41%, 23% and 19% in central, mid size and small size prisons respectively, with and average of 27% (Malawi Prisons services, 2011, p.21). This HIV prevalence was more than 50% higher than in the adult general population (15-49 years), which stand at 12 %(Malawi Ministry of Health, 2007c).

The evidence coming out shows that most sub Saharan Africa prisons are faced with the problem of overcrowding. Besides facilitating TB transmission, the close sleeping arrangement in prison cells and inadequate blankets result in prisoners sharing blankets, thereby increasing the risk of engaging in consensual and coercive sex (Jolofani & DeGabriele, 1999). This facilitates the transmission of sexually transmitted infection including HIV, with very high risk especially for the receptive partner. Cases of rape or sodomy have also been reported in prisons (Goyer & Gow, 2001; Jolofani & DeGabriele,

1999), which are likely to result in anal mucosa trauma that further increases the risk of HIV acquisition by the victim.

The risk of sodomy in sub Saharan African prisons is made worse due to lack of basic commodities like food, soap, blankets and other supplies hence prisoners who have no external support from friends and relatives are particularly vulnerable to sexual abuse by fellow prisoners in exchange for food and other basic necessities.

Homosexual practices have been reported in the majority of African studies in prisons. In Ghana, 30.8% and 22.7% of male and female prisoners reported homosexuality, respectively (Adjei et al., 2008, p.39), while in Nigeria, less than 10.7% male prisoners reported engaging in this practice (Adoga et al., 2009, p.541).

In Southern Africa, a lower proportion of prisoners reported engaging in homosexuality; 3.8% (Simooya et al., 2001, p.1742) and 8.4% (Simooya, Phiri, Sanjobo & Sichilima, 1995, p.1388), in Zambia; 5.5% in Mozambique (Vaz et al., 1995, p.42) and 2.1% in Malawi (Chimphambano et al., 2005). However, a recent study done in 2011 in Malawi prisons, has reported that 9.8% and 4.1% of prisoners in maximum and medium security prisons respectively, are involved in homosexuality (Malawi Prisons services, 2011, p.28).

It is highly likely that homosexuality was grossly under-reported due to the illegality of the practice in these countries and severe punishment that prisoners undergo if found to be engaged in homosexual practices. It is apparent that the majority of prisoners engaging in homosexual practices does not have homosexual orientation before incarceration but simply engage in the practice due to prison environment (Jolofani & DeGabriele, 1999;Goyer & Gow, 2001).

Factors associated with homosexual practices include long stay in prison, use of alcohol and illicit drugs, the need for protection against bullying or for food and basic necessities (Simooya et al., 1995; Malawi prisons services, 2011). In Malawi, three more studies apart from the recently conducted in 2011, have reported the existence of homosexual practices and sodomy (Chimphambano et al., 2005; Jolofani & DeGabriele, 1999;Zachariah et al., 2002, p.617). One of these studies inferred the existence of this practice based on the findings of new sexually transmitted infections and ruptured peri-anal abscesses in male prisoners only (Zachariah et al., 2002, p.617).

However, most prisoners are already at risk of HIV due to their background and lifestyle, and might get into prisons already infected as a study in Mozambique showed that inmates had very high frequency of sexual partners' change and high reported history of sexually transmitted infection and low (9%) reported use of condoms (Vaz et al., 1995, p.42).

3.0 METHODOLOGY

3.1 Research type and design

This was a retrospective mixed descriptive and analytical study based on quantitative approach. The study evaluated data and additional costs during a period of about 1.5 years, from June 2009 to December 2010, when periodic active case finding of smear positive TB were implemented (three rounds).

Screening (ACF) was implemented every 8 months in the selected prisons. Each round of active case finding was done in 4 days. Afterwards, all TB suspects were reverting back to the routine passive case finding as stipulated by DOTS.

Comparisons on passive case notification rates (PCNR) of smear positive TB during inter-active case finding rounds were compared. Passive case notification rates of smear positive TB for 8 months before June 2009 and after December 2010 were also calculated. These were also compared with inter-active case finding rounds rates (PCNR). An equal duration was deliberately chosen.

The inclusion criteria for prisoners into the study were cough for one week or more. Prisoners who were already known TB patients were excluded from the study.

3.2 Study site and population

The study was conducted in six of thirty-one prisons in Malawi. These six prisons composed of three maximum prisons, which are: Chichiri prison in Blantyre, Zomba central prison in Zomba and Maula prison in Lilongwe. The other three prisons were medium security prisons in the following districts: Ntcheu, Chikwawa and Mzimba.

The six prisons keep about six tenth (6/10) of the whole prison population. Usually, the prison population fluctuate around 11500 prisoners. Each of the three maximum-security prisons has a daily prison population of between 1500 and 2100 prisoners and there is not much difference in the prisoners turn over each year.

Data was reviewed regardless of a prisoner being a convict or on remand.

3.3 Study period

Data collection was undertaken from February to September 2011. Thereafter, a validation was done in March 2012.In the initial data collection period, the researcher was fully involved on the ground with two assistants who were briefed on what was to be collected. Thereafter, the assistants continued with feeding the researcher with data.

3.4 Sources of data

The Malawi prison maintained a manual information management system until the year 2011 when some stations started acquiring computers and are changing to a computerized system.

There is easy access to high quality demographic, admission history, place of accommodation and health records including tuberculosis data records despite the system being manual. However, difficulties are encountered if a prisoner is discharged from prison, as it may be hard to retrieve a file from old records.

All prisoners are issued with a unique number and have files that facilitate access to their individual information on admission dates, case committed and duration of imprisonment. Health records and drugs for each patient are kept in the clinic or improvised room at prison as clinic.

Other sources included vouchers from accounts department, where costs for fuel and allowances for staff doing the ACF were accessed.

The following were the records that were reviewed in the prison information management system:

3.4.1 Prisons admission register

Demographic record of prisoners is stored in this book. The date of birth, duration of the sentence and date of committal to prisons, area of origin and tribe are all recorded here against the prison number accorded to each prisoner.

3.4.2 Medical information system

There is a special register available at the registry of every prison which records information on sickness of prisoners who have been taken to the hospital for treatment if a prison does not have a clinic.

The member of staff who is assigned to look at the health of all prisoners updates this, upon return from hospital. The diagnosis and treatment are recorded in this book.

If the prison has a clinic, as is the case with the 4 maximum prisons, all patient records are entered in registers at the clinic.

3.4.2.1 Documentation in TB control in Malawi prisons

It is very important to have good record keeping and reporting system in Tuberculosis control. The following records are kept in prison.

(a) Chronic Cough Register

This is kept at every prison where information on a TB suspect is recorded and those given sputum containers are also indicated. When a chronic cough register is properly used, it helps the prison to assess their case detection.

(b) Tuberculosis Treatment Card

This is kept in all prisons giving treatment or keeping drugs for a prisoner. When treatment has been completed, the card should be returned to the district hospital and retained by the DTO in his office.

(c) District Tuberculosis Register

This is maintained at all treatment centres. It is a requirement to register all TB patients started on treatment. These include new cases, relapses, failures, and treatment after default, and recurrent cases. All prisons that have health personnel have this register. The good thing is that every prison has at least one health worker since August 2008

(d) Tuberculosis Outpatient Identity Card

As drugs are collected from a district hospital for each prisoner patient, the prison health personnel keep this as a TB personal identification card for each prisoner. Health workers at the hospital use this card to identify TB patients and assist them appropriately, e.g. supplying drugs and collecting follow up sputum specimens. Health workers fill in the date of next appointment in the appropriate column.

(e) Request Form for Sputum-Smear Examination

This form is filled whenever a patient has submitted specimens for sputum examination. Health workers write patients particulars, district TB registration number (for follow-up cases) and reason for examination in the appropriate spaces. This form is kept in all health units.

(g) Quarterly Report on Case Finding

This form is used for reporting all TB cases registered at each prison in each cohort. Prisons health personnel fill it and sent to the district TB officers (DTO) for aggregation, record keeping and analysis who in turn send this information to the zone TB officer.

(h) Tuberculosis Referral/Transfer Form

This form is filled when transferring patients from prison to another treatment centre upon discharge from prison or within the prisons. Four copies of this form should be filled. One to be kept by the prison in a special file, the other to be taken by the patient to where the patient is referred, one to be mailed to where the patient is referred, and the fourth one is mailed to the DTO where the patient is going. Prison health personnel follow up all transfer out patients to ensure that they continue receiving their treatment. This form is kept at all prisons.

3.5 Data collection

3.5.1 Data collection process

Data collection was done through review of the above records. These records were accessed from the information management systems records in prison. The accounts section of Malawi prisons provided information from vouchers on finances spent on allowances for staff and fuel to travel them to respective prisons to conduct the active case finding.

3.5.2 Type of data collected

The following data was collected:

a) The number of prisoners' population at risk during each of the one and half year periods.
b) The number of prisoners whose sputum was tested
c) The number of prisoners diagnosed as Smear positive pulmonary TB
d) The extra finances spent on active screening which includes staff allowances and fuel costs in each prison.

3.5.3 Ethical considerations

No formal request was made to the Malawi National Health Sciences Committee (MNHSC) as the work only involved looking at data that was already recorded during normal operations of TB control in prisons.

However, permission was sought from the Malawi prison authorities to use the data and also have access on financial records spent during periodic active case finding

3.6 Research data analysis

3.6.1 Research paradigm

The research paradigm in this study assumes that there will be a lot of benefits by implementing periodic active case finding of TB as supplement to DOTS (Golub et al., 2005; Murray & Salomon, 1998)(See figure 3).

It is believed that the prevalence of smear positive TB is high in Malawi prisons but case detection still low to moderate, together with a moderate completion rate.

The assumption is that through active case finding, smear positive cases will be diagnosed earlier and prevent transmission to other prisoners considering the prevailing conditions, which favour the spread of TB in prison.

It is assumed following transmission reduction; there will be reduction in both suspects and cases. After years of implementing ACF and controlling transmission, resources will be saved after preventing future cases with resultant reduction in treatment and rehabilitation costs (Golub et al., 2005), hence cost savings incurred.

3.6.2 Outcome variables (Units of data analysis)

a) Smear positive TB case diagnosed for added costs during active case finding

b) Passive case notification rate (TB case rates) of smear positive TB.

3.6.2.1 Smear positive cases diagnosed for added costs during active case finding

In this study, the main focus is to diagnose more cases so that they are put on treatment to reduce or stop transmission to other prisoners. Since the budget is a constraint, the results will be expressed as smear positive TB cases diagnosed for added costs. This will be expressed as cases diagnosed for every Malawi Kwacha (MWK) 100000 spent. 1 US dollar is equal to about 150 Malawi Kwacha. This will be done for every round of active case finding and also overall during the intervention for both maximum and medium security prison types

3.6.2.2Passive case notification rate of smear positive TB

In the course of reducing transmission of TB, a clinical objective of reducing TB case rates will is achieved. This will result in cost saving, as less microscopy of sputum will be done following reduction of suspects, and also saving on treatment. An intermediate measure of TB rates is passive case notification rates (PCNR).

3.6.3 Data Validity

To improve data validity, the researcher intends to revisit the data mainly on duration of incarceration. However, where there were inconsistencies on the data, the researcher was verifying with the health worker at the source of data through telephone.

The research data was also entered on the computer to track down if there was repetition of capturing same subjects more than once. The researcher did these entries into the computer.

3.6.4 Data analysis tools

Case notification rate of smear positive cases was calculated using formula provide in the Manual of program managers for TB (Appendix 3).

Odds ratio (OR) was calculated to compare the change in case notification rate of smear positive TB before and after implementation of a round of active case finding.

The Pearson's Chi-square was calculated for each OR. The graphs were drawn using Microsoft Excel 2007 software.

The total added costs for implementing periodic active case finding were calculated for each prison using the frequency of rounds of screening. During this intervention, 3 rounds of active case finding were done.

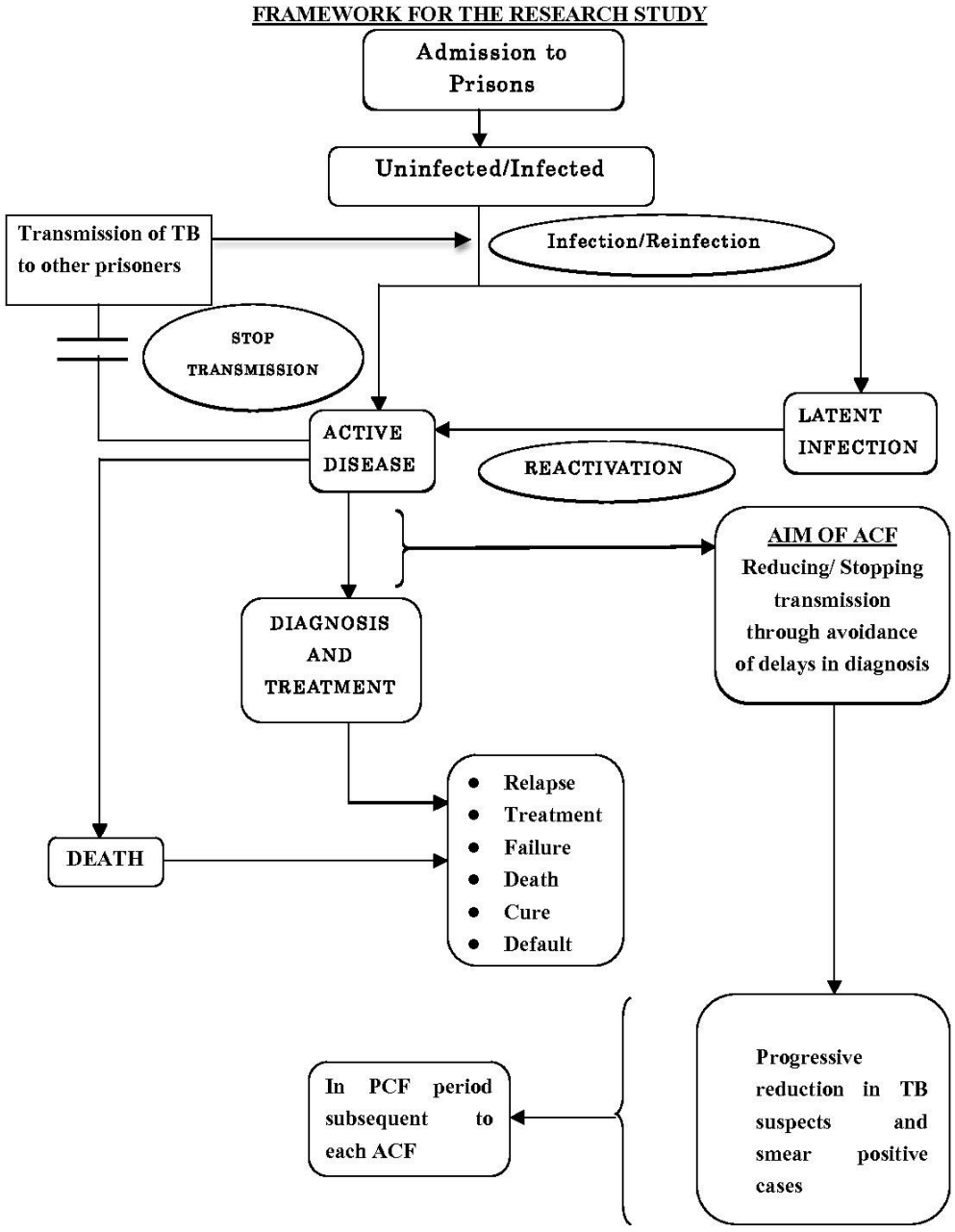
3.6.5 Limitations of the research study

The study could not determine the person years of prisoners as the records are mostly manual. If person years were established, it would have been possible to calculate the incidence of smear positive TB within the study period. The use of cough for one week as the only inclusion criteria might have also led to missing of some cases.

3.6.6 Pearson's Chi-squared tests and testing the hypothesis

Since the data being analysed in the study is categorical, looking at cases diagnosed out of the exposed population, the Pearson's chi-squared test was used in testing differences in consecutive passive case notification rates. Statistical significance was tested at alpha of 5%.

FIGURE 3.0


FRAMEWORK FOR THE RESEARCH STUDY
Admission to Prisons
Uninfected/Infected
Transmission of TB to other prisoners
Infection/Reinfection
STOP TRANSMISSION
ACTIVE DISEASE
LATENT INFECTION
REACTIVATION
AIM OF ACF
Reducing/ Stopping transmission through avoidance of delays in diagnosis
DIAGNOSIS AND TREATMENT
Relapse
Treatment
Failure
Death
Cure
Default
DEATH
In PCF period subsequent to each ACF
Progressive reduction in TB suspects and smear positive cases

4.0 RESULTS

A total of 35673 and 8419 prisoners went through the maximum and medium security prisons respectively over a period of two and half years under study. This population was predominantly males (99.5%). There was very high turnover of prisoners during the period.

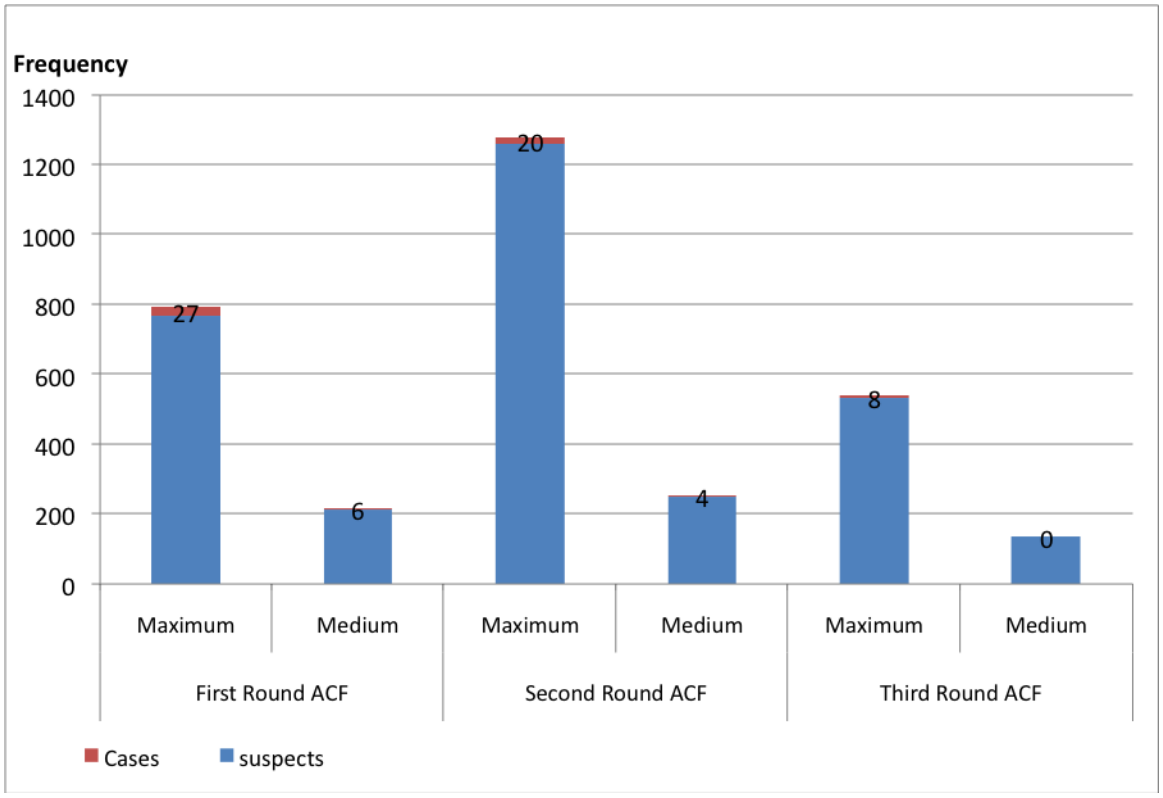
4.1 Contribution of ACF towards total smear positive TB cases diagnosed during the period of supplementing PCF with ACF

Following three rounds of active case finding, fifty-five (55) cases out of 2614 suspects were diagnosed with smear positive TB in maximum security prisons while 10 cases out of 607 suspects were diagnosed from medium security prisons. This implies that to diagnose 1 case of smear positive TB in maximum-security prisons, 48 suspects had to have their sputum examined as opposed to 60 in the medium security prison. However, there was no statistical significant difference in the number of suspects who had their sputum examined to diagnose 1 case of smear positive TB between maximum and medium security prisons (chi-squared = 0.520; $p < 0.50$).

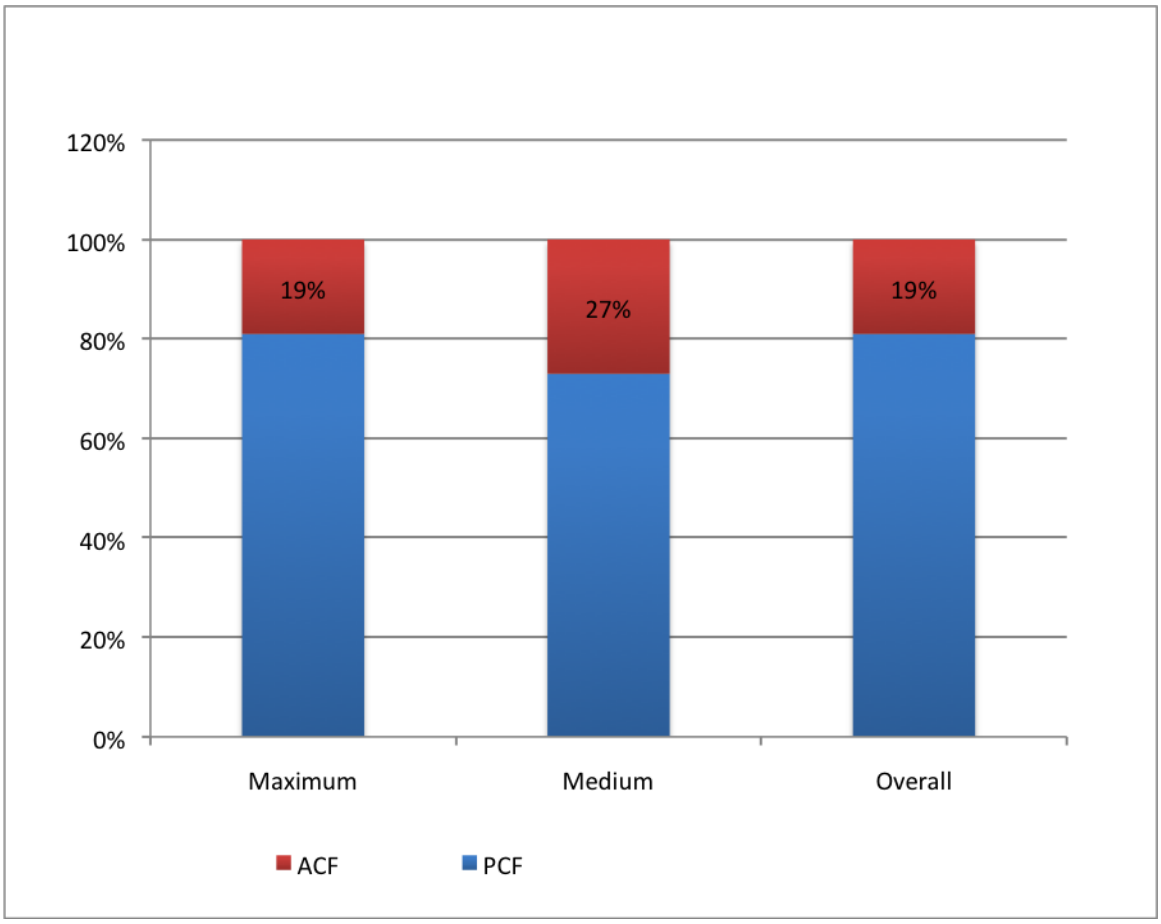
From graph 4.0, it is seen that the number of smear positive TB cases reduce with each subsequent round of active case finding in both the maximum and medium security prisons, but the number of suspects was higher in the second round of ACF than in the first and third rounds more markedly in maximum security prisons.

During supplementation of PCF with ACF, 55 out of 297 (19%) smear positive TB cases in MASP were diagnosed through ACF while only 10 of 37 (27%) in MESP were from ACF. Overall 65 of 334 (19%) smear positive TB cases from both prisons types were diagnosed through ACF (Graph 4.1).

Graph 4.0: TB cases diagnosed against suspects during ACF in prisons from 2009 to 2010



Graph 4.1: Showing Percentage contribution of TB cases diagnosed through ACF as Supplement to PCF from 2009 to 2010



4.2: Trend of passive case notification rates of smear positive TB following introduction of P-ACF

After initiating ACF in the selected prisons, TB case notification rates during intervals of passive case finding (PCNR) were decreasing following each round of ACF in both maximum and medium security prisons. However, statistical significant decrease was noted after second round of ACF in both types of prisons (Table 4.0).

Eight month after a third round of ACF, there was a statistical significant increase in passive case notification rate (PCNR) in both maximum and medium security prisons as compared to the period before the third round of ACF, but the PCNR of eight months after the third round of ACF was still significantly lower only in maximum security prisons than that of a similar duration, before the first round of ACF. (OR= 0.47; Chi-squared= 21.936; $p< 0.0005$).

TABLE 4.0: Trend of Passive case notification rates of smear positive TB on an 8 months interval after introduction of P-ACF in prisons from 2009 to 2010

PERIOD OF PCF	MAXIMUM SECURITY PRISON			CHI-SQUARED (p-value)	MEDIUM SECURITY PRISON			CHI-SQUARED (p-value)
	TB CASES	POPULATION AT RISK	PCNR		TB CASES	POPULATION AT RISK	PCNR	
Before first ACF	115	8498	1353		16	1917	835	
Before second ACF	96	9249	1038	3.713 (<0.10) OR= 0.76	10	2190	457	2.317 (<0.20) OR= 0.55
Before third ACF	31	9352	331	34.221 (< 0.0005) OR= 0.32	1	2363	42	8.098 (<0.005) OR= 0.09
After third ACF	55	8574	641	9.008 (<0.005) OR= 1.94	20	1949	1026	21.341 (<0.0005) OR=24.49

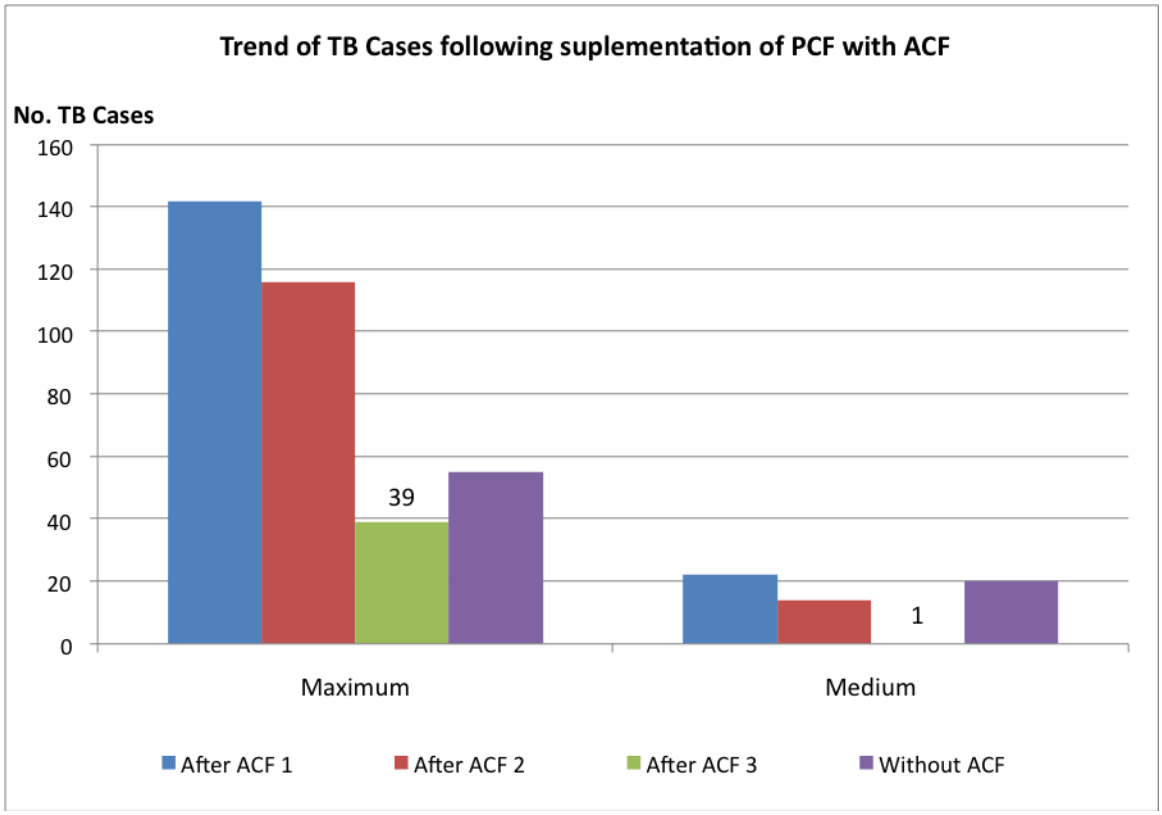
PCNR= Passive Case Notification Rate per 100,000 prisoners. OR = Odds Ratio

Significance tested at alpha < 0.05

4.3 Trend of sum of active and passively diagnosed smear positive TB cases during every 8 monthly interval

Following an eight monthly interval supplementation of PCF with ACF, there was an improvement in smear positive TB case notification at each interval due to additional cases diagnosed during ACF. However, an increase in the sum of actively and passively diagnosed cases was initially noted but was progressively reducing with each preceding eight months interval in both MASP and MESP (Graph 4.2). Interestingly, was an increase in smear positive TB cases diagnosed passively within eight months after a third round of ACF in both prison types than in the third interval which comprise of cases from a third ACF and PCF (After ACF 3 on the graph 4.2).

Graph 4.2: Trend of the sum of actively and passively diagnosed smear positive TB Cases from 2009 to 2010



NOTE

Each bar in this graph represents a sum of smear positive TB cases diagnosed during a round of ACF and in an 8 months PCF period before that round of ACF.

4.4 Additional costs to implement ACF in the study from 2009 to 2010

The only additional costs in implementing active case finding were the direct non-medical costs, which were on allowances for personnel and fuel, as additional personnel had to travel to other prisons to perform the screening since during this time, a lot of manpower is needed.

All the other costs remained constant, as they would still have been incurred with passive case finding, since the study was happening in the same institutions.

Allowances and fuel costs were accessed from vouchers in the accounts department of Malawi prison headquarters. Maximum-security prisons needed more personnel than the medium security hence more financial resources in allowances spent at maximum-security prisons.

Expenditure on allowances was the same in each maximum-security prison as the same number of personnel and days were allocated in these prisons. The same applied to medium security prisons. The only difference among same category of prisons was on fuel costs due to different distances as all personnel had to operate from Zomba or Lilongwe (Figure 1). Those from Zomba, were travelling to Chichiri, Chikwawa, Ntcheu and Lilongwe (Maula), while those from Maula were travelling to assist with screening at Mzimba prison.

The total additional cost of conducting 3 rounds of ACF in all 3 maximum-security prisons was MKW935, 370 while for all medium security prisons was MKW 552,360 (Table 4.1). All the costs were in local currency, Malawi Kwacha (MKW)(1 US dollar = 151 MKW).

TABLE 4.1: SHOWING ADDITIONAL COSTS SPENT (IN MWK) SPENT IN CONDUCTING ACF IN PRISON FROM FROM 2009 TO 2010

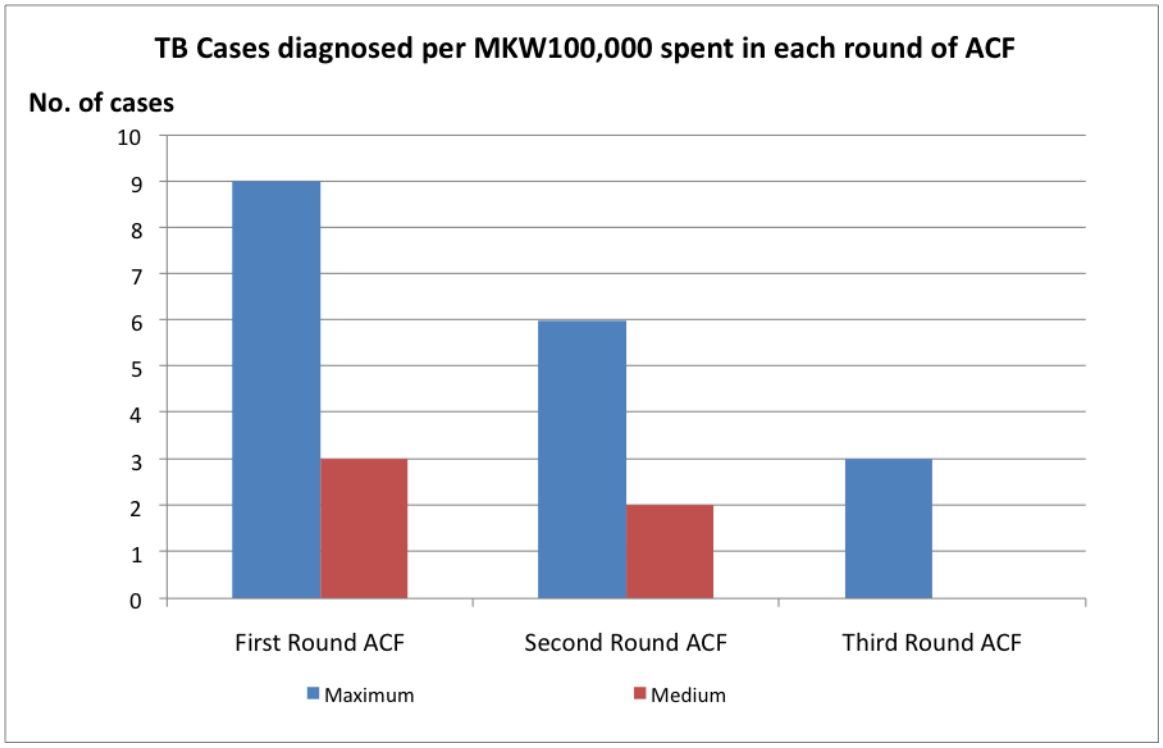
PRISON TYPE	PRISON NAME	ALLOWANCES PER ROUND OF ACF	FUEL PER ROUND OF ACF	TOTAL COST PER ROUND OF ACF	TOTAL COST FOR 3 ROUND OF ACF	TOTAL
Maximum	Zomba	92000	4800	96800	290400	935370
	Chichiri	92000	7600	99600	298800	
	Maula	92000	23390	115390	346170	
Medium	Chikwawa	50000	5850	55850	167550	552360
	Ntcheu	50000	8780	58780	176340	
	Mzimba	50000	19490	69490	208470	

4.5 Additional smear positive TB cases diagnosed for the added costs during periodic active case finding

Clear differences of additional smear positive TB cases diagnosed for added costs following three rounds of ACF were seen in maximum and medium security prisons. Overall, 6 smear positive TB cases were diagnosed in maximum prisons for every added MKW 100000 spent as opposed to 2 in the medium security prisons.

A varying trend was observed in each round of active case finding in both maximum and medium security prisons (Graph 4.3). The number of cases diagnosed per every MKW 100000 added, was progressively reducing in each subsequent round of ACF in the order of 9, 6 and 3 for maximum security prisons while for medium security prisons was 3, 2 and 0. Tuberculosis cases diagnosed per MKW 100000 spent in the first round in MESP are the same like that of the third round in the MASP. The average TB cases diagnosed per MKW 100000 spent in MASP are the same as that from the second ACF round in the same MASP. One striking thing was that in the first two rounds of ACF, three times smear positive cases in medium security prisons per MKW 100000 added were diagnosed in maximum-security prisons and also a third round of ACF in medium prisons yielded no case (Graph 4.3).

Graph 4.3: Additional TB Cases diagnosed per every added MKW 100000 spent in each round of ACF in prison from 2009 to 2010



5.0 DISCUSSION

5.1 Contribution of ACF towards total smear positive TB cases diagnosed as supplementation of PCF

Three round of ACF of smear positive TB using microscopy in prisons done at intervals of 8 months apart, yielded additional 55 and 10 smear positive TB cases in maximum and medium security prisons respectively which represents an average of 19% of total case load within study prisons and period. This phenomenon has also been seen before in slum communities in Uganda (Sekandi et al., 2009), Ethiopia (Yimer et al., 2009), India (Santha et al., 2003) and also from Zomba prison in Malawi (Nyangulu et al, 1997), where undiagnosed smear positive TB cases were detected among chronic coughers.

Malawi prisons being among the highly congested community where the infrastructure is so poor coupled with very poor ventilation and other risk factors that lead to TB infection and propagation (Table1.2), prevalence rates of TB are expected to be higher than in the general population. Higher prevalence rates of smear positive TB in Malawi have been reported in Chichiri, Maula and Zomba (maximum security) prisons at 1.1% (Banda et al., 2009) than in small prison (0.3%) which here are referred to as medium security prisons.

HIV/AIDS, leads to fast progression of TB infection to active disease. Recent prevalence survey for HIV in prisons has shown higher rates of HIV in maximum-security prisons of Chichiri, Maula and Zomba at 40.6% (Malawi Prisons Service, 2011) than in medium security prisons at 22.9%. Apart from differences in TB and HIV prevalence rates between the two kinds of prisons, maximum-security prisons (MASP) accommodate larger population of prisoners (Table 2.0) than medium security prisons (MESP), so it is not surprising to diagnose a more additional cases in maximum-security prisons than in medium security prisons. This has been already witnessed in the prison tuberculosis caseload the years before ACF was introduced (Table 1.3). However, no statistical significant differences were noted in the number of TB suspects whose sputum was examined to get 1 case of smear positive TB (48 in MASP and 60 in MESP).

Most of the factors such as structure and congestion, which influence the spread, and propagation of TB disease in Malawi prisons need enough time to be dealt with and involve several stakeholders. In this situation, prisons will still be affected by high prevalence rates of smear positive TB, hence there would still be need to periodically conduct active screening of prisoners apart from the routine passive case finding in prisons.

The trend observed in graph 4.2, is similar to the one modelled by Dodd et al. (2011), who hypothesized that alternating ACF with PCF could result in diagnosis of increased or decreased cumulative TB cases. However, Dodd et al. (2011), further hypothesized that there is a tendency of an increased cumulative sum of cases following supplementation of PCF with active case finding in the initial rounds, which later progressively reduces with the subsequent rounds of ACF. The evidence from the study shown in Graph 4.2 shows the peak of cumulative sum of smear positive TB cases from PCF and ACF after the first round of ACF in both prison types.

5.2 Reduction in passive case notification rates of smear positive TB following introduction of P-ACF

A progressive decrease in passive case notification rate in between rounds of ACF was noted, though this decrease was only significant after second round of ACF in both prison types. Since transmission of TB was noted to be taking place in prisons (Stead, 1978; Nyangulu et al., 1997) and Styblo hypothesized that one prevalent case of smear positive TB could lead to between 8 and12 tuberculosis new infections (Van Leth, van der Werf & Borgdorff, 2009), though it has shown that these infections might be fewer in developed countries, early diagnosis through ACF would prevent transmission to other prisoners as it shortens duration of infectiousness (Verver, 2001; Sekandi, 2009; Yimer, 2009). This will finally result in progressive reduction in incident cases during PCF period hence resulting into reduction in passive case notification rates of smear positive TB as depicted in Table 4.0

The initial cumulative smear positive TB cases diagnosed by both rounds of ACF and through routine services (PCF) were higher due to diagnosis of a backlog of cases diagnosed from ACF. As most cases are believed to be from recent transmission due to fast progression following high HIV prevalence in prisons than the general community, it was not surprising that after the first round of ACF, the incident cases might have reduced due to prevention of transmission as Dodd et al. (2011), suggested that there would be reductions in cumulative HIV co-infected smear positive cases following ACF where more than 40% of incident TB cases are attributed to recent infection. This reduction in incidence cases was also observed in prisons of Russia (Lobacheva et al., 2005) and Spain (Rodrigo et al, 2002) following periodic and entry screening. This reduction in passive case notification rates, may also indirectly show that the prevalence rates at that time, might have reduced as well as they are interrelated, a thing that was also found in Zimbabwe after conducting a series of active case finding in a community (Corbett et al., 2010).

Following three rounds of ACF, passive case notification rates of smear positive TB remained statistically lower than that of the first 8 months before the first round of ACF in MASP only, unlike in the MESP where the only reduction was after the second round of ACF. This may be attributed to removal of a backlog of cases, hence interruption of transmission among contacts of smear positive TB in MASP. It is expected that there would be high transmission among prisoners in MASP as they do not go out of the fence to do some work as is the case in MESP. In this situation, removal of a backlog of cases would quickly reduce the incidence hence a sustained reduction in PCNR.

The rise in PCNR coming up after a third round of ACF might be due to diagnosis of cases that are HIV negative that were infected earlier before the start of ACF, since it has been seen that many prisoners develop TB on an average of 19 months in Tanzania (Rutta et al., 2000) and 12 to 18 months in Russia (Lobacheva et al., 2005) after entry to prison or after being infected.

5.3 Variations in additional costs for conducting ACF in prisons

Cumulatively, almost two times costs as in MESP were incurred in MASP due to more personnel allowances in MASP. This was so, as more personnel were needed in MASP due to larger population being accommodated and screened in MASP. The variations in costs in similar types of prisons are brought up due to different distances to be travelled by personnel conducting ACF, hence different costs in fuel (Table 4.1).

5.4 Additional TB cases per extra MKW 100,000 spent on ACF

During active case finding, more cases per every MKW 100,000 added were diagnosed in MASP through out all the 3 rounds than in MESP. An average of 6 smear positive TB cases were diagnosed in the MASP as opposed to 2 in MESP. The three times number of cases per MKW 100,000 as in MESP diagnosed in MASP can be attributed to the high prevalence of smear positive TB in MASP as reported by Banda et al. (2007), a thing which is also manifesting in this study as it has been seen from higher rates of passive case notification of TB in MASP (Table 4.0), since case notification rates are proportional to the prevalence rates. This observation is in line with recommendations by Golub et al. (2005), who suggested that ACF need to be considered where the prevalence of TB is high, as the resources incurred in ACF would correspond well with the yield. The worst existing conditions such as overcrowding, poor ventilation and high HIV/AIDS in MASP than in MESP contributes to higher prevalence rates of TB in MASP than in MESP

After carefully assessing additional costs for conducting ACF in MESP, it may be observed that the basic amount incurred might be too high for the ACF to match the yield per MKW100, 000 spent in MASP. However, this may be inevitable due to the minimum number of staff categories required to conduct ACF. The observations from this variable, shows that there is no relevance in continuing with ACF after doing a second round of ACF in MASP, and also that ACF would be more effective in MASP.

5.5 Interpretation of research results from the hypothesis testing

The study results show the evidence of rejecting the null hypothesis (H_0) with less than 0.05% probability of making an error. However, this is only evident in maximum-security prisons while in medium security prisons, the null hypothesis would be accepted. Therefore, the extra costs of implementing three rounds of active case finding in prisons justify the added utility of the program by reducing the passive case notification rates of smear positive TB only in maximum security prisons of Malawi.

5.6 Research Results Generalization

The research results from this study would only be generalized to prisons of similar nature and conditions in Africa where prevalence of HIV and smear positive TB are the same or similar to that of Malawi. This would be reliably seen in sub-Saharan Africa countries where conditions of imprisonment are as in Malawi.

5.7 Research results dissemination

The researcher intends to disseminate the results of the study first to management of Malawi prisons when it is passed thereafter to national conference like the Malawi College of Medicine research dissemination conference of 2013. There are also plans to have the findings published in a reputable journal. The whole findings can influence on the policy of TB in prisons.

6. CONCLUSION AND RECOMMENDATIONS

The study has shown that implementation of periodic active case finding sustainably reduced the passive case notification rate of smear positive tuberculosis in maximum-security prisons from 2009 to 2010.

Despite a minimal increase in PCNR after the third round of ACF, PCNR still remained statistically significant lower at p-value 0.05 (alpha 5%) than the one of similar duration of 8 months before the first round of ACF.

On the other note, it was found that during each round of ACF, three times smear positive TB cases diagnosed in MESP were detected in MASP, which shows that conducting ACF in MASP was more cost effective than in MESP as the whole aim of conducting ACF was to diagnosed more cases earlier so that they be initiated on treatment to stop further spread. This being the case, it would be more efficient to limit periodic active case finding to maximum security prisons only as it is where more cases are diagnosed and there is also significant reduction in case notification rates of TB.

Having seen that the number of smear positive TB cases diagnosed per additional MKW100, 000 spent on ACF were reducing with each subsequent round of ACF conducted and that the average number (6 cases per MKW100, 000) in MASP was the same as that of the second round of ACF in the same prison types, the study would recommend a repeat of the same study at a later time to ascertain whether the average

number of cases would still be the same as in the second round, so that a decision to conduct only two rounds of ACF would be enough , and there after a strengthen passive case finding and contact tracing would take over to continuously reduce or maintain low rates of smear positive TB.

The challenge encountered in the study was the diagnosing method for TB used during screening. As rates for HIV are so high in Malawi prisons, it was more likely that some cases would not be detected, as the smear positivity is often very low in HIV positive people.

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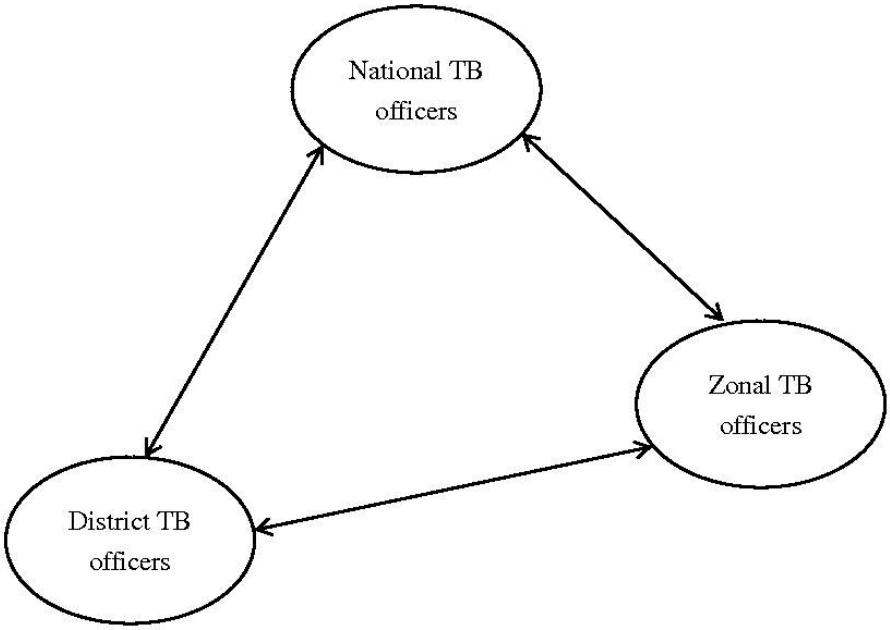
APPENDICES

Appendix 1.0

COLLABORATION OF INFORMATION AND ACTIVITIES OF TB MANAGEMENT IN MALAWI



Appendix 2

LIST OF PRISON STATIONS IN MALAWI

EASTERN REGION	SOUTHERN REGION	CENTRAL REGION	NORTHERN REGION
1. Domasi	8. Chichiri	19. Byanzi	26. Chitipa
2. Mangochi	9. Bvumbwe	20. Dedza	27. Karonga
3. Mikuyu 1	10. Chikwawa	21. Kachere	28. Mzimba
4. Mikuyu 2	11. Makande	22. Kasungu	29. Mzuzu
5. Ntcheu	12. Mulanje	23. Maula	30. Nkhatabay
6. Mpyupyu	13. Mwanza	24. Ntchisi	31. Rumphi
7. Zomba central	14. Nsanje	25. Nkhotakota	32. Old Mzimba
	15. Thyolo		
	16. Makhanga		
	17. Luwani		
	18. Bangula		

Appendix 3: Formula for calculating PCNR

Case Notification rate for Smear positive TB

= (Number of smear positive TB cases diagnosed over the period <u>divide by</u> the population at risk over same period of time) <u>multiply</u> by 100000.