PREVALENCE OF PULMONARY TUBERCULOSIS AND ASSOCIATED FACTORS AMONG TANZANITE MINEWORKERS IN MERERANI, TANZANIA

Bakari Omary

MSc. (Epidemiology and Laboratory Management) Dissertation

Muhimbili University of Health and Allied Sciences

October, 2017

Muhimbili University of Health and Allied Sciences

Department of Epidemiology and Biostatistics

PREVALENCE OF PULMONARY TUBERCULOSIS AND ASSOCIATED FACTORS AMONG TANZANITE MINEWORKERS IN MERERANI, TANZANIA

By

Bakari Omary

A Dissertation Submitted in (partial) Fulfilment of the Requirement for the Degree of Master of Science (Epidemiology and Laboratory Management) of

Muhimbili University of Health and Allied Sciences

October 2017

CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance by Muhimbili University of Health and Allied Sciences a dissertation entitled **Prevalence of pulmonary tuberculosis and associated factors among tanzanite mineworkers in Mirerani, Tanzania,** in (Partial) fulfilment of the requirements for the degree of Master of science of (Epidemiology and Laboratory Management) of Muhimbili University of Health and Allied Sciences.

……..……

Prof. Mecky Matee

(Supervisor)

Date……

……..

Dr. Ahmed Abade Mohamed

(Supervisor)

Date……

DECLARATION AND COPYRIGHT

I **Bakari Omary**, declare that this **dissertation** is my own original work and that it has not been presented and will not be presented to any other University for a similar or any other degree award.

Signature…… Date……

This dissertation is a copyright material protected under the Berne Convention, the Copyright Act 1999 and other international and national enactments, in that behalf, on intellectual property. It may not be reproduced by any means, in full or in part, except for short extracts in fair dealing, for research or private study, critical scholarly review or discourse with an acknowledgement, without the written permission of the Directorate of Postgraduate Studies, on behalf of both the author and the Muhimbili University of Health and Allied Sciences.

ACKNOWLEDGEMENT

This work has been accomplished through the efforts of many people and organizations that deserve mention. First and foremost I would like to thank my supervisors Professor Mecky Matee, Dr. Ahmed Abade Mohamed, Forrest K. Jones. I wish to express my sincere gratitude to Mfaume Said (CTRL), Dr. T. Kondo (UDOM), Togolani Maya (KTNH) Omary John, Hamisi Daffi, Thobius Chacha Dr.Reginard S.Msaki, Dr. Neema, Dr. Taseni Mbwambo and the entire staff of Mererani Health Centre (MHC) for their support towards this work.

My appreciation goes to Alio Hussein–Technical manager for TB in Mining Sector in Southern Africa (TIMS) project for her incredible wisdom, support and her encouragement.

I would also like to appreciate the timely support and encouragement from the FELTP Members of Staff and Muhimbili University of Health and Allied Sciences (MUHAS). My colleagues in FELTP were an encouragement to me and constructively critiqued this study making it better.

I wish to thank the Ministry of Health, Community Development, Gender, Elderly and Children for supporting and encouraging me to conduct this study.

Finally, I wish to thank my family for the constant support and encouraging words during the depressing moments of the study, I am truly grateful to my wife Farida her encouragement and support were exceptional; taking fully responsibilities to care the family when I was away for field and laboratory work. I am very thankful for all their support and may Allah continue to bless them today and always.

DEDICATION

I dedicate this work to my wife Farida Mohamed Shomary, my daughter Barke B. Rutengwe, and my entire family for support and encouragement they accorded me throughout this study.

ABSTRACT

Background: Tuberculosis remains an important public health problem in developing country especially in this era of HIV/AIDS. Mineworkers have been shown to have a very high risk of becoming infected with tuberculosis (TB), especially in Sub-Saharan Africa. However there is paucity of information on the prevalence of PTB among Tanzanite mineworkers that can be used to guide intervention and inform policy. This study aimed at assessing prevalence of PTB and its associated characteristics. .

Method: Across-sectional study was conducted in Mererani mining site between March and June2017.Mineworkers, who met inclusion criteria were randomly selected and interviewed using a standard questionnaire to obtain information regarding socio-demographic and potential risk factors. Sputum samples were collected and analysed using AFB and Gene Xpert while blood samples were subjected to HIV rapid test, using SD Bioline HIV 1/2 3.0 as a screening test and Uni-gold as confirmatory test. Data was analysed using Epi Info version 3.5.1 and Microsoft excel soft ware. Univariate, bivariate multivariate analysis was carried out where frequency, measure of central tendency and dispersion were used to summarize data and odds ratio was used as measure of association.

Results: A total of 293 mineworkers were recruited. Their median age (±SD) was (35years±9.98), with a range of 18 to 73 years. Of 293 sputum samples, 26 (8.9%) were positive for PTB while 13 (4.5%) of the 291 blood samples were positive for HIV infection, while 5(1.7%) of the miners had PTB/HIV co-infection. None of the PTB positive sputum samples were resistant to rifampicin. The odds of developing PTB was 10.2 (AOR 10.2 95% CI 1.38-75.44) times higher among those who were exposed to silica dust, 9.1 among those infected with HIV (AOR 9.09 95% CI 2.39-34.06), 2.1 among smokers (AOR 2.07 95% CI 0.78-5.52), and 2.8 among those without knowledge of TB transmission (AOR 2.76 95% CI 0.95-8.00).

Conclusion: The prevalence of PTB in mineworkers was high (8.9%) and was significantly associated with HIV infection, smoking and exposure to silica of TB transmission. Control of TB in Mererani would need to address these factors.

TABLE OF CONTENTS

Table of Contents

CERTIFICATION....ii

DECLARATION AND COPYRIGHT....iii

ACKNOWLEDGEMENT....iv

DEDICATION....v

ABSTRACT....vi

Table of Contents....viii

LIST OF TABLES....xi

LIST OF FIGURES....xi

LIST OF ABBREVIATIONS....xii

CHAPTER ONE....1

1.0 INTRODUCTION....1

1.1 BACKGROUND....1

1.1.1 General Information on Tuberculosis....1

1.2 STATEMENT OF THE PROBLEM....2

1.3 RATIONALE OF THE STUDY....3

1.4 RESEARCH QUESTIONS....3

1.5 OBJECTIVES....3

1.5.1 Broad Objective....3

1.5.2 Specific Objectives....3

1.6 CONCEPTUAL FRAMEWORK....4

CHAPTER TWO....5

2.0LITERATURE REVIEW....5

2.1.1 Tuberculosis among mineworkers 5

2.1.2The intersection of TB and Mining in Tanzania 6

2.1.3Tuberculosis in Mererani 6

2.1.4 TB Diagnosis and Treatment 7

2.1.5Prevention and control of TB 8

CHAPTER THREE 9

3.0 METHODOLOGY 9

3.1 Study Design 9

3.3 Study Population 11

3.3.1 Sample size estimates; 12

3.3.2 Selection Criteria 12

3.3.3 Sampling technique 12

3. 4 Data collection and management 13

3. 5. 1 Laboratory AFB Microscopy 13

3. 5. 2 Laboratory HIV rapid diagnostic test 15

3.7 Ethical consideration 16

CHAPTER FOUR 18

4.0 RESULTS 18

CHAPTER FIVE 28

5.0 DISCUSSION. 28

CHAPTER SIX 32

6.0 CONCLUSION AND RECOMMENDATION 32

6.1 Conclusion 32

6.2 Recommendations 32

REFERENCE 33

Appendix 1a: INFORMED CONSENT FORM- English Version 35

Appendix 1b: Informed consent form- Swahili version 39

Appendix 2a - Questionnaire English version 42

Appendix 2b - Dodoso (Kiswahili) 45

Appendix 3: Steps in the Ziel Nielsen (ZN) Staining Procedure 47

Appendix 4: HIV test Algorithm for Tanzania. 48

LIST OF TABLES

Table 1: Socio-demographic distribution of the Mererani mine workers by working blocks...18

Table 2: Occupational related characteristics of the Mererani mine workers by working block 19

Table 3: Comparison of putative risk factors between PTB cases and non-cases.....23

Table 4: Multivariate logistic regression analysis of exposure variable as associated characteristics of PTB.....26

LIST OF FIGURES

Figure 1: Conceptual framework of TB transmission in mineworkers 4

Figure 2: Map of study Area.....10

Figure 3: ZN-AFB microscopy slide smear: 14

Figure 4: Distribution of signs and symptoms among PTB+ in mineworkers.(N=26). 21

Figure 5: Pie chart shown number of PTB sputum smear positive corresponding with sign and symptoms they have. 22

LIST OF ABBREVIATIONS

AFB	Acid Fast Bacilli
AIDS	Acquired Immunodeficiency Syndrome
CTRL	Central Tuberculosis Reference Laboratory
DOT	Direct Observed Treatment
DST	Drug Susceptibility Test
2RHZE/4RH	R-Rifampicin H-Isoniazid Z-Pyrazinamide E-Ethambutol/Rifampicin-R Isoniazid-H
EQA	**External Quality Assessment**
EPTB	Extra Pulmonary Tuberculosis
ELISA	Enzyme Linked Immunossorbent Assay
HIV	Human Immunodeficiency Virus
IOM	International Organization for Migration
KNTHL	Kibong'oto National Tuberculosis Hospital Laboratory
LPA	Line Probe Assay
MDR	Multi-Drug Resistant
MoHCDGEC	Ministry of Health Community Development Gender Elderly and Children
MTB/RIF	Mycobacterium Tuberculosis/Rifampicin
MUHAS	Muhimbili University of Health and Allied Sciences
NTLP	National Tuberculosis and Leprosy Programme
PCR	Polymerase Chain Reaction
PLHIV	People Living with HIV
PTB	Pulmonary Tuberculosis
QC	Quality Control
RIF	Rifampicin
SADC	Southern African Development Council
TB	Tuberculosis
TFELTP	Tanzania Field Epidemiology and Laboratory Training Programme

VCT	Voluntary Counselling and Testing
VVU	Virusi vya Ukimwi (HIV in Swahili)
WHO	World Health Organization
XDR	Extensive Drug Resistance

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND

1.1.1 General Information on Tuberculosis

Tuberculosis (TB) is an infectious disease of lungs and other parts of the body which is caused primarily by *Mycobacterium tuberculosis* and occasionally by *Mycobacterium bovis* or *Mycobacterium africanum* (1). The three types of TB include latent TB, active pulmonary tuberculosis (PTB) and active extra-pulmonary tuberculosis (EPTB). No symptoms accompany latent tuberculosis, which can eventually progress to active TB. PTB affects the lungs while EPTB affects other parts of the body such as pleura, lymph nodes, pericardium, spine, joints, abdomen or genito-urinary tract (1).

TB is primarily transmitted from one person to another through inhalation of respiratory droplets after an infected person coughs. The concentration of infected droplets in the air and the length of time a person breathes that air determines an individual's risk of exposure. TB is usually spread from person-to-person through the air by droplet nuclei (<5 microns) that are produced by a person with pulmonary or laryngeal tuberculosis (2). If individuals with TB are on treatment, they are less likely to transmit TB infection. Also TB is transmitted from one person to another through inhalation of droplets during coughing, laughing, talking, sneezing, and singing; however, coughing remains the most common means of transmission. Untreated smear-positive patients who are in the community are the potential source of infection. The concentration of infected droplets in the air and the length of time a person breathes that air determines an individual's risk of exposure reference. The risk of acquiring the infection is higher for individuals close to the index case. The risk of transmission of TB is lower from persons with smear-negative or extra-pulmonary tuberculosis. TB is usually spread from person-to-person through the air by droplet nuclei (<5 microns) that are produced by a person with pulmonary or laryngeal tuberculosis. The transmission of these tubercle bacilli occurs by airborne spread of infectious droplet (2).

TB kills over 2 million people annually worldwide and is primarily a disease of poverty, often affecting young adults in their most productive years(3).TB has risen markedly in sub-Saharan African nations over the past 2 decades, with reported annual incidence doubling from 173.6 to 351.7 per 100, 000 population between 1990 and 2007. Although TB surveillance is poor in this region, the most recent estimates of TB data from the World Health Organization (WHO), which reflect the current TB burden

among these countries, indicate that TB incidence declined in only 10 of 46 African countries between 2000 and 2007(4).Early treatment of HIV is a critical part of averting TB deaths and continued transmission of TB. Substantial evidence has demonstrated that treating HIV infection at higher CD4+ count thresholds in individuals than was previously believed to be appropriate, along with more aggressively extending antiretroviral uptake and coverage within communities, helps reduce the incidence of opportunistic infections (including TB), reduce morbidity and mortality associated with HIV, and prevent HIV transmission to uninfected individuals in endemic settings such as South Africa (5). Given how significantly HIV infection increases the risk of progression from latent to active TB, and given how prevalent both conditions are among South African mine workers, it is imperative that HIV testing and early treatment initiation be included as an essential component of the struggle against TB.(6)

Tanzania is one of the countries with the highest burden countries of TB in the world with approximately 295 TB cases per 100,000 adults, and ranks 15th among 22 high burden countries of tuberculosis in the world 2011(1). About 5% of adults in Tanzania are living with HIV or AIDS which according to the World Health Organisation, makes them 26 or 31 times more likely to become sick with TB due to their impaired immune system. The number of TB cases notified in the country has remained stable since 2000, after the rapid increase observed in the 1990s. TB case notification increased almost three-fold from 1989 (19,516 cases) to 1999 (52,437 cases), with an average annual increase of 10%. Between 2000 and 2010, the average annual increase was only 2%. According to the 2011 NTLP annual report, Tanzania notified a total of 63,892 TB cases (1). Among these, 25,138 were new smear-positive PTB cases while 21,393 were new smear-negative PTB cases. Additionally, 14,595 were EPTB cases, 1,052 were relapses, and 1,714 were retreatment cases, excluding relapses. Forty-seven percent of all reported cases were male (5).

1.2 STATEMENT OF THE PROBLEM

TB is one of the world's most deadly diseases; killing three people every 1minute(7).The mining industry is one of TB vulnerable sector in the world(7).Despite TB cases being reported among mining workers in Tanzania, little is known about the magnitude of the disease and its associated characteristics (7). Furthermore, relatively little is known about MDR-TB among people living in Mererani (8). To

bridge this gap, this study was conducted to determine the prevalence of pulmonary TB and associated characteristics among Tanzanite mineworkers in Mererani**.**

1.3 RATIONALE OF THE STUDY

Mining industry is one of the potential sectors in Tanzania that contributes3.5 percent of Gross Domestic Product (GDP) of the country economy and plays a vital role in job creation. To have good and sustainable productivity, the mineworkers should be healthy to perform their duties (9)**.** Since TB is one of the diseases causing morbidity and mortality among mineworkers, its burden, risk factors have been determined and interventions have been instituted in different countries, this has been done in Tanzania where the burden of the disease is not well known (8).Therefore, this study provides information on TB burden and its associated factors among mineworkers in Tanzania. By so doing, the study will contribute to prevention and control of the disease to enhance high productivity in the mining sector in the country.

1.4 RESEARCH QUESTIONS

1. What is the prevalence of pulmonary tuberculosis and its associated characteristics among mine workers in Mererani?

1.5 OBJECTIVES

1.5.1 Broad Objective

Determining the prevalence of pulmonary TB and associated characteristics among Tanzanite mineworkers in Mererani**.**

1.5.2 Specific Objectives

i) To determine the prevalence of pulmonary TB among mineworkers in Mererani.

ii) Identifying potential risk indicators associated with TB transmission among mineworkers in Mererani.

iii) To determine the proportion of PTB+ mineworkers with rifampicin drug resistance in Mererani.

1.6 CONCEPTUAL FRAMEWORK

The conceptual framework of this study is shown in Figure 1. In this framework, the existence of higher prevalence of tuberculosis (TB) in mining areas together with associated characteristics (risk indicators) such as HIV/AIDS, silicosis, lack of health services, overcrowding, smoking and migration influence the possibility of developing pulmonary tuberculosis (PTB) among mineworkers.

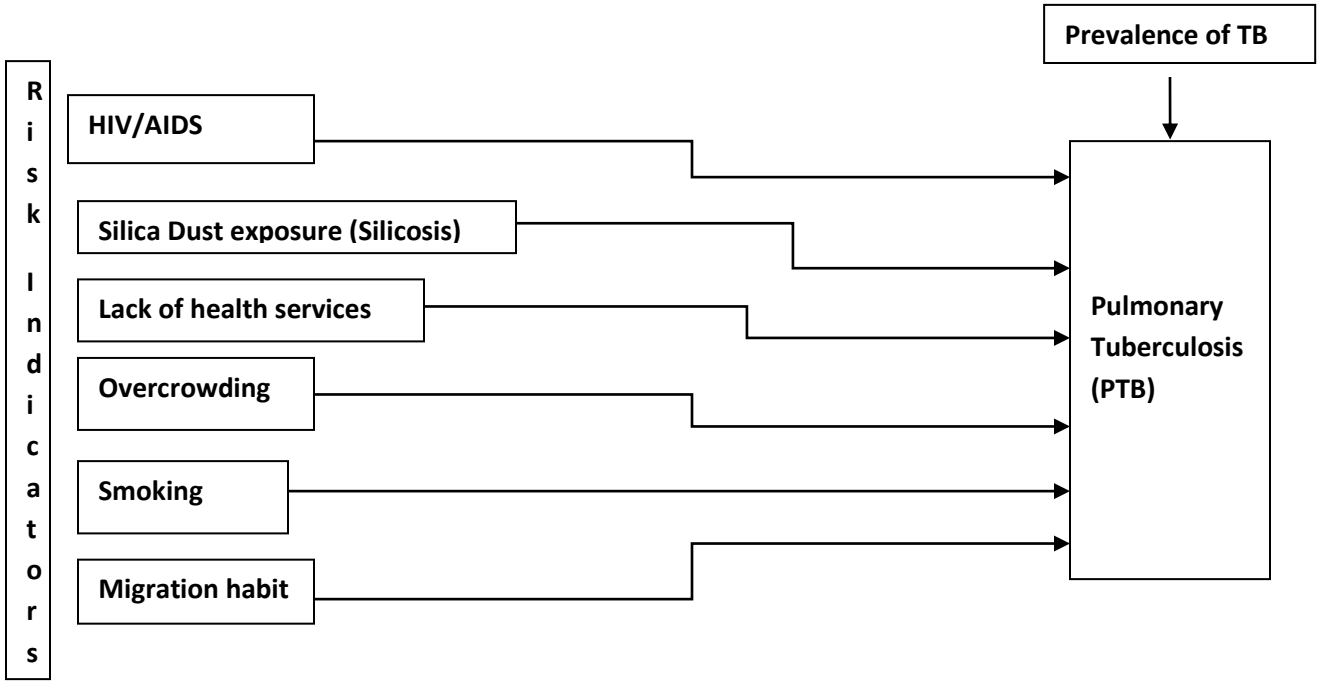


Figure 1: Conceptual framework of TB transmission in mineworkers

CHAPTER TWO

2.0LITERATURE REVIEW

2.1.1 **Tuberculosis among mineworkers**

Over the last decade the role of mining in the global economy has grown rapidly. This is especially true in Africa, where 52/54 countries have discovered minerals and there are over a half-million mineworkers (4). TB incidence among mineworkers is higher than any other working group and is estimated to be as much as 3 to 8 times higher than in the general population (4). For instance, TB incidence rate in the general population of South Africa is 950 cases per 100,000 while the incident rate in mining is 2500-3000 per 100,000 population of South Africa (11). This is ten times the emergency threshold set by WHO.

The mining sector is hardest hit by TB due to several factors including higher rates of HIV, possible silicosis resulting from prolonged exposure to silica dust in mine shafts, poor access to routine health services, accommodation in overcrowded hostels and poor working environment (5). Good ventilation removes nuclei droplets and so reduces the risk of infection following exposure to an infectious person. Direct sunlight kills tubercle bacilli within minutes, but they can survive in the dark for many hours (24-48 hours).

The issue of TB in the mining sector is complex due to the fact that: i) TB is a health issue ii) mining is regulated by the department of minerals, iii) mining is private sector led; and iv) mine workers come from different countries with varying health systems (11). Therefore addressing TB in the mining sector requires innovative, collaborative approaches among public and private sectors as well as civil society. Immediate intervention is required because the disease can be controlled and cured through early diagnosis and treatment; this is even more important because mineworkers migrate frequently, extending transmission to the general population (8). The late Enna Lutengano, a Migration Health Consultant for International Organization for Migration (IOM) Tanzania said, “A major challenge in the mining communities is the lack of education about TB, which is compounded by the lack of social support structures and the inability to access or afford health services.”

2.1.2The intersection of TB and Mining in Tanzania

Tanzania is one of the countries with highest burden of TB in the world with approximately 295 TB cases per 100,000 adults. According to WHO Tuberculosis rank, Tanzania ranked 15th among 22 high burden countries in 2011. Approximately 5% of adults in Tanzania are living with HIV or AIDS which according to the World Health Organisation, makes them 26 or 31 times more likely to become sick with TB due to their impaired immune system (12). The number of TB cases notified in the country has remained stable since 2000, after the rapid increase observed in the 1990s(13). TB case notification increased almost three-fold from 1989 (19,516 cases) to 1999 (52,437 cases), with an average annual increase of 10%. Between 2000 and 2010, the average annual increase was only 2%. According to the 2011 NTLP annual report, Tanzania notified a total of 63,892 TB cases. Among these, 25,138 were new smear-positive PTB cases while 21,393 were new smear-negative PTB cases. Additionally, 14,595 were EPTB cases, 1,052 were relapses, and 1,714 were retreatment cases, excluding relapses. Forty-seven percent of all reported cases were male (14).

Tanzania has several extracted industry sites and different forms of mining. The exact magnitude of TB in the mining sector is not well known, however Simanjiro district data show that 60-70% of TB patients there originate from Mererani mining area (14).

2.1.3Tuberculosis in Mererani

The Mererani mining site includes numerous small-scale mining operations, which are involved in the mining of the precious gemstone tanzanite. The mines are run with low level mechanization, use approximately 8,000 transient workers, and are situated in a community of approximately 200,000 people with inter dependence on the mining industry (14). During World TB Day on 24 March 2016, the International Organization for Migration (IOM) in Tanzania worked together with the Ministry of Health and Social Welfare (MOHSW) to carry out TB testing in the Mererani Health Center in Manyara region. A team of 15 participants consisting of representatives from IOM and the MOHSW, ex-TB patients and medical staff organised the activities, almost 300 people were screened for TB in three mobile clinics, of whom 27 cases of TB were diagnosed (15).

2.1.4 TB Diagnosis and Treatment

Diagnosis of tuberculosis and monitoring of treatment progress rely heavily on bacteriological examination of clinical specimens. Microscopic examination of stained sputum smears remains a cornerstone for TB diagnosis in Tanzania. Other methods include culture inoculation of decontaminated sputum and Drug Susceptibility Testing (DST); and chest X-rays. Culture and DST technique are used in big health facilities with high workload (15). In 2010 the WHO endorsed the use of Xpert MTB/RIF as one of the screening tools for TB disease in Tanzania. The Xpert MTB/RIF assay is a new test that is revolutionizing tuberculosis (TB) control by contributing to the rapid diagnosis of TB disease including drug resistant. The test simultaneously detects *Mycobacterium tuberculosis* complex (MTBC) and resistance to rifampicin (RIF) in less than 2 hours. In comparison, standard cultures can take 2 to 6 weeks for MTBC to grow and conventional drug resistance tests can add 3 more weeks. The information provided by the Xpert MTB/RIF assay aids in selecting treatment regimens and reaching infection control decisions quickly. Line Probe Assay (LPA) is a molecular technique used to detect MDR – TB from smear positive sputum and from TB positive isolates. Genotypic (molecular) methods have considerable advantages for scaling up programmatic management and surveillance of drug-resistant tuberculosis (TB), offering speed of diagnosis, standardised testing, potential for high through-put, and fewer requirements for laboratory biosafety. Molecular tests for (henceforth called MTBDR*sl*) have shown promise for the diagnosis of drug-resistant TB. These tests are rapid (can be performed in a single working day) and detect the presence of mutations associated with drug resistance. MTBDR*sl* belongs to a category of molecular genetic tests called second-line line probe assays (SL-LPA).

Effective treatment is of paramount importance in TB care and control, as it terminates the transmission chain and eventually leads to a reduction of the disease burden in the community. Effective TB treatment depends on use of the right anti-TB drug combinations in both the intensive and continuation phases, prescribed and taken in the correct doses according to the schedule and for the required length of time. Specifically, TB treatment aims to: cure the patient and restore quality of life and productivity, prevent relapse of TB, reduce transmission of TB to others, prevent the development and transmission of drug-resistant tubercle bacilli, prevent death from active TB or its late effects. New adult TB patients should receive a six-month regimen containing rifampicin: 2RHZE/4RH. The regimen

requires direct observed treatment (DOT) by a health care worker or treatment supporter throughout the six months (6).

The current status of the TB epidemic has become more complex with the spread of drug resistant TB and TB-HIV co-infection, making the public-health risk of unchecked disease an economic and environmental. In Lesotho, about 30% of multidrug-resistant (MDR) and extremely or extensive drug-resistant (XDR) TB cases are in miners or ex-miners from South Africa. However, these figures likely under estimate the true burden of MDR-TB as less than one in four cases were detected in 2012 (6).

2.1.5Prevention and control of TB

TB infection control measures intend to prevent the spread of TB within mining setting. The infection control measures are based on three hierarchical levels: administrative, environmental control, and use of personal protective equipment. Monitoring and evaluation of TB infection prevention control when implemented effectively reduce TB transmission. Mineworkers who are HIV positive should be provided with ART and IPT if eligible, and they should be offered an opportunity to work in settings that have the least risk of TB transmission(6).

Administrative control measures: Administrative control measures are intended to reduce the exposure of mineworkers and patients to *M. tuberculosis.* Firstly, develop and implement a TB infection control plan: Assign a responsible person to oversee implementation of the TB infection control plan(6). Outline a protocol for early identification of TB suspects and patients, including prompt treatment and separation of infectious TB patients(16).Educate mineworkers on TB and infection control.

Environmental control measures: Environmental control measures complement administrative control measures to ensure a safe working environment for mineworkers by reducing the concentration of the infectious droplet nuclei. Keep windows open to ensure ventilation during sleeping. Emphasize natural ventilation in and use of blowers instead of complexer in mines caves(17).

Personal protection: This is an infection control measure which is based on the use of respiratory protective equipment to prevent mine workers from inhaling infectious droplet nuclei and silica dust(18).

CHAPTER THREE

3.0 METHODOLOGY

3.1 Study Design

This was a cross sectional study conducted between March 2017 and June 2017 among mineworkers in Mererani, Manyara, Tanzania.

3.2 Study Area

Mererani is situated in Simanjiro District, Manyara Region, about 70 km south of Arusha town and16 km south of Kilimanjaro International Airport. Simanjiro District has a population of about 178,693 people according to 2012 census. Mererani, remain the only place in the world where tanzanite is extracted. Simanjiro is part of the Maasai Steppe; an area that has traditionally been dominated by the pastoralist Maasai tribe since it was not suitable for traditional cultivation. The landscape is dominated by dry bush land and rocky hills. Lack of water and deforestation is a large issue, especially in the areas surrounding the mining sites. Approximately one third of the Simanjiro district population lives in Mererani.

Mining is an important sector in Mererani. Geological data reveals that in Manyara Region they're plenty of minerals namely, tanzanite, tsavolites, red lite, green garnet, green tourmalines, ruby, and red garnet.

There are large and small scale miners who engage in mining extraction(19). All these attracted big companies to engage and operate at Mererani which include Tanzanite One Co Ltd from South Africa, Kilimanjaro mines Co. Ltd and Tanzanite Africa Ltd and all of them engage in the production and marketing of tanzanite gemstones.

This study was conducted at Mererani mining area where one TB clinic has a laboratory for performing TB diagnosis for AFB smear microscopy (specifically Mererani Health Center Laboratory) :

(i) Sputum collection and HIV testing has been done in working mining area field site.

(ii)ZN sputum smear technique for AFB microscopy has been performed in Mererani Health Center Laboratory (MHCL)



Figure 2: Map of study Area

Study Period

The study was conducted between March 2017 and June 2017.

3.3 Study Population

The study population comprised of current/former tanzanite mineworkers that work / worked in the Mererani mining area.

3.3.1 Sample size estimates;

The estimated sample size n was computed using the formula below,

$$n = \frac{z^2\, p\,(1-p)}{\varepsilon^2}$$

Where

Z = level of confidence (1.96 for 95% confidence level)

p = proportion of the population = 6.6% (according to study done by Mayala et al)(17)

ε = margin of error = 3

n = number of sample size = ?

$n = 1.96^2 \times 6.6 \times 93.4/3 \times 3$

263.12samples.

n = 264

Adjustment for non-response rate of 10% is n×1/R

Where R=response rate of 90%

264×1/0.9 =

Then, adjusted sample size is 293 Tanzanite mineworkers.

3.3.2 Selection Criteria

Eligibility criteria for study participants included the following:

1) Current mineworkers (minimum of 6 month since stop working)
2) Work or previously (6 months after leaving mining work) worked in the mines of Mererani
3) Age ≥18 years
4) Obtaining an informed consent

3.3.3 Sampling technique

The tanzanite mining area in Mererani has four blocks (A, B, C, and D). Blocks A and C are reserved for mining by large companies (Tanzanite One and Kilimanjaro Mining) while Blocks B and D are reserved

for thousands of (small scale) mineworkers. Average numbers of miners for each block was determined before beginning the study and used to allocate sample size for each block using Probability Proportional to Size (PPS). Current or former mineworkers were randomly recruited into the study until the sample size for each block was attained.

3. 4 Data collection and management

Recruitment: All participants were tested for sputum and screened for HIV documented in a log book. Study code numbers were used during recruitment.

Questionnaire: A pre-tested questionnaire was used to obtain information regarding demographic and risk factors for PTB. The demographic characteristics included age, sex, marital status and work block (A, B, C or D), while putative risk factors were HIV, smoking, crowding, silica dust exposure and lack of health services (Detailed questionnaire Appendix 2a).

3. 5 Laboratory Testing

Laboratory testing for PTB and HIV followed the National Guidelines for TB and HIV.

3. 5. 1 Laboratory AFB Microscopy

i) Collection of specimen: Two spot quality sputum specimens with volume of 3-5ml were collected to avoid the risk of not returning for morning investigation due to their work category. Sputum was collected in the open air in a well-ventilated space away from other people to avoid undue transmission of TB**.**

ii) Quality assurance of specimens*:* Laboratory investigation form is used to request for sputum examination. Study code number written on the lid of a sputum container and the same number was written on the laboratory investigation form. Contamination of the outside of the sputum container with sputum was avoided by giving appropriate instructions to participants. If a specimen was not suitable (insufficient or salivary) the participant was requested to repeat the procedure for collecting sputum until a sufficient amount of the best possible sputum was been obtained (about 3-5ml).

iii) Preparation of smear: Slides were labelled properly using the study questionnaire serial code number written on the sputum container. Smear was prepared by taking small portion of selected purulent or mucopurulent material. Material was spread carefully on the center of the slide to an area equal to 2cm by 1cm. Heat was applied to fix slide by passed on frame for 2 minutes. Too much specimen on slide that could compromise smear quality (thickness of a smear) was avoided.

iv) Ziel Nielsen (ZN) Stain

Ziehl-Neelsen (ZN) method of acid fast staining technique was used to stain smears for the detection of acid-fast bacilli (AFB) to provide the bacteriologic evidence of the presence of mycobacteria in a clinical specimen. Smear microscopy is the quickest and easiest procedure that can be performed. In brief, a slide was placed on staining rack, flooded with primary stain (1%Carlbolfuchsin) and then heated for approximately 5 minutes, rinsed with water and decolorized with 20% sulfuric acid and counter stained with 0.1%Methylene blue.

v) Examination of smear

The slide examined for acid-fast bacilli which appeared red and a background was blue.

The prepared QC slides by using sediment from a clinical specimen have been maintained as preferable. A known positive and known negative smear was used to read in each run and when new reagent used. QC smears were prepared in advance, heat-killed, and stored unstained. The QC slides should be stained serially together with participant's specimen. The record of **stain lot number, expiration date**, **results of the control slides** (positive and negative), and **technician name** has been documented. Patient smears were examined and reported only when control slides were accepted. Appearance was generally long and slender but some appeared bent. Bacilli might contain heavily stained areas called beads. Clump of bacilli that are touching was counted as one. Debris, some species of the genera *Nocardia* and *Corynebacterium*, and some fungal spore may appear as acid fast.

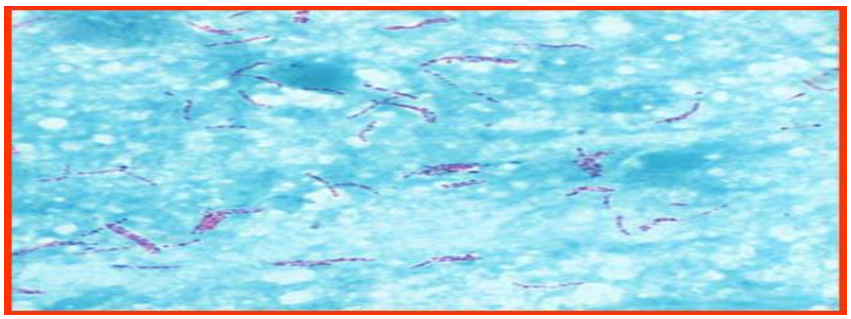


Figure 3: ZN-AFB microscopy slide smear:

vi) AFB Grading:

- No AFB seen was reported if at least 100 fields was Negative (0)
- 1–9 AFB per 100 fields (Scanty) actual number was reported
- 10–99 AFB per 100 fields 1+
- 1–10 AFB per field in at least 50 fields 2+
- More than 10 AFB per field in at least 20 fields 3+

Vii) Quality assurance of AFB Smear microscopy (slides).

Quality assurance for AFB smear microscopy was conducted in such a way that a trained laboratory scientist who met AFB smear microscopy test standards examined all slides. The slides were stored serially after examination and were prepared for blinded re-checking of a random sample that was conducted at the end of study.

The lot quality assurance sampling system was introduced in 2008 for external quality assurance (EQA) of sputum smear microscopy in Tanzania. The technique is based on blinded rechecking of ten randomly selected slides per quarter from each of the participating TB diagnostic centers. The purpose is to check the accuracy of the microscopists and performance of the diagnostic centers as judged by the reference reader at the district level or higher. If done properly, it helps to monitor the performance of diagnostic centers in a given district and implement corrective measures.

viii) Testing for rifampicin resistance

All sputum smear positive specimens were sent to Kibong'oto National Tuberculosis Hospital (KNTH**)** for rifampicin resistance testing, which is regarded as a proxy for MDR-TB. The Xpert MTB/RIF, which is a cartridge based nucleic acid amplification test, automated diagnostic test that can identify *Mycobacterium tuberculosis* (MTB) DNA and resistance to rifampicin (RIF) by nucleic acid amplification test (NAAT) was used for testing resistance to rifampicin..

3. 5. 2 Laboratory HIV rapid diagnostic test

Collection of specimen: The study participant's finger was pricked to obtain a whole blood sample for each HIV rapid diagnostic test (RDT) performed.

Testing Procedure: The national algorithm for HIV RDT in (Appendix 4) was followed. The two tests used for HIVRDT were SD Bioline HIV 1/2 3.0 (initial screening test) and Uni-gold (confirmatory test).
Results reporting: If test 1(SD Bioline) was non- reactive, the test was reported as **negative**. But if test 1(SD Bioline) was reactive and test 2(Uni-Gold) was also reactive the test was reported as **positive.** Incase test 1(SD Bioline) was reactive and test 2 was non - reactive, the test was targeted to reported as **inconclusive** result. However none of the HIV results were inconclusive**(20).**

Counseling and referral procedure: Pre and post – HIV test counseling was performed. Those tested positive, were referred to the nearest Care and Treatment Clinic (CTC) for management according to the National Guidelines for Management of HIV and AIDS**(21).**

3.6 Data Analysis plan

Data were cleaned and analyzed using EPI INFO 3.5.1. Descriptive statistics were summarized by measure of central tendency (median), measure of dispersion (range, standard deviation) while characteristics associated with TB were assessed by prevalence Odd Ratio with 95% CI. The prevalence Odds Ratio (POR) was used as measure of the association between dependent and independent variable.Multivariate unconditional logistical regression model was used to determine characteristics that were independently associated with TB. Significance level was at p value < 0.05 and factor with P value ≤ 0.2 in bivariate qualified for multivariate analysis (a logistic regression model).

3.7 Ethical consideration

Ethical clearance to conduct the study was obtained from senate of institutional review board of Muhimbili University of Health and Allied Sciences Ethical Review Board. Permission to do the study was obtained from Manyara Regional Administrative Secretary/Simanjiro District Administrative Secretary/ Mererani Resident mines Officer.

Informed consent to participate in the study was sought from potential study participants. These participants were also assured of confidentiality and the questionnaire did not have any client's name. Only codes were used. An appropriate protocol used was after writing the code number in questionnaire form and the separate sheet was used the code number of questionnaire, name of correspondent (subject) and mobile phone was documented to make link for those who tested positive in order to get required

health services. Documents were only handled by the investigators and kept in a secure place to ensure confidentially. The benefits and risks of participants were stated clearly in the consent form.

Consent process: Clients, who have received information about study during routine TB clinic services or worksite visited and agree, was signing an informed written consent. This means participants were provided with information on potential risks and benefits of participating. The consent form was addressing the purpose of the study and their willingness to participate in the study. It was also be made clear that, acceptance or refusal to participate in the study were no outward consequences and that they were free not to participate in the study at any time and they were also free not to answer a question if they feel uncomfortable about the question.

Confidentiality: Clients were assured of confidentiality and the questionnaire did not have any client's name. Only the unique identifiers that are generated for the study was used to identify participants, therefore assuring that information provided was confidential.

Risk and benefit of participation: The anticipated risks included: 1) Precipitation of an emotional crisis. To address this risk, the study was carried out in the worksite where trained health professional were available to provide appropriate intervention if the need arose.

All clients were informed that, there were no financial gain to be obtained by participating in study but they had an opportunity to provide information that could be used to develop interventions in mining area.

CHAPTER FOUR

4.0 RESULTS

A total of 291 study participants were enrolled from March-May 2017. The median age was 35year's ± 9.98 SD with a range of 18- 73 years. All the study respondents were male (N=291), with age group of 40+ years and above constituting 27.8% (N=81). Majority 60.5% (176) were married and 47.1 % (N=137) resided in block D (Table 1).

Table 1:Socio- demographic distribution of the Mererani mine workers by working blocks.

Variable	Block A(n=44)	BlockB(n=85)	BlockC(n=27)	Block D(n=137)	Total(N=293)
Age					
Average	39.52	32.66	31.92	31.92	
Std. Dev.	12.51	8.85	8.36	9.47	
Range	18-73	21-63	21-56	19-68	
Sex					
Male	44 (100%)	83(100%)	27 (100%)	137 (100%)	
Female	0	0	0	0	
Age group					
18-24	5(11.5%)	14(16.8%)	4(14.8%)	17(11.9%)	40(13.8%)
25-29	3(6.9%)	24(28.8%)	8(29.6%)	27(18.9%)	62(21.3%)
30-34	7(16.1%)	8(9.6%)	6(22.2%)	22(15.4%)	43(14.8%)
35-39	7(16.1%)	17(20.4%)	4(14.8%)	37(25.9%)	65(22.3%)
40+	22(50.6%)	20(24%)	5(18.5%)	34(23.8%)	81(27.8%)
Marital status					
Married	33(75.0%)	45(54.2%)	14(51.9%)	84(61.3%)	176(60.5%
Not married	11(25.0%)	38(45.8%)	13(48.1%)	52(38.0%)	114(39.2%
Divorced/Separated	0	0	0	1(0.7)	1(0.3%)

Region of origin					
Arusha	15(34.1%)	30(36.1%)	7(25.9%)	61(44.5%)	113(38.8%
Kilimanjaro	8 (18.2%)	19 (22.9%)	8(29.6%)	30 (21.9%)	65(22.3%
Manyara	5 (11.4%)	11 (13.3%)	3 (11.1%)	9 (6.6%)	28(9.6%)
Tanga	12 (27.3%)	10 (12.0%)	5 (18.5%)	10 (7.3%)	37(12.7%)
Other regions[1]	4(9.1%)	13(15.7%)	4 (14.8%)	27(19.7%)	48(16.5%)

A total of 197(67.7%) participants are working within 3metres while at a place occupied by greater or equal to 10people.People live within household in term of less or equal to 8people are 253(86.9%) whose effect of overcrowded has been reduced. Number of participants working without wear masks increased by 286(98.3%), while participants working without heavy machinery were 233(80.1%).

Table 2: Occupational related characteristics of the Mererani mine workers by working block

Variables	Block A	Block B	Block C	Block D	Total
	n=44	n=85	n=27	n=137	N=293
Workwithin3metres					
≤10people	11(25.3%)	27(32.4%)	9(33.3%)	47(32.9%)	94(32.3%)
≥10people	33(74.7%)	56(67.6%)	18(66.7%)	90(67.1%)	197(67.7%)
Overcrowding					

≤8people	**42(96.6%)**	**71(85.6%)**	**20(74.0%)**	**120(84.0%)**	**253(86.9%)**
≥8people	**2(3.4%)**	**12(14.4%)**	**7(26.0%)**	**17(16.0%)**	**38 (13.1%)**
Silica dust exposure					
Wearing mask	0 (0%)	0 (0%)	0 (0%)	5 (3.6%)	5 (1.7%)
Without wear mask	44(100%)	83(100%)	27(100%)	132(96.4%)	286(98.3%)
Operate machinery					
Machinery work	6(13.4%)	20(24.1%)	2(7.4%)	30(21.9%)	58(19.9%)
No machinery work	38(86.4%)	63(75.9%)	25(92.6)	107(78.1%)	233(80.1%)
Type of job					
Heavy machinery	6(13.6%)	20(24.1%)	3(11.1%)	29(21.2%)	58(13.1%)
Hand work	38(86.4%)	63(75.9%)	24(88.9%)	108(78.8%)	233(86.9%)
Type of working environment					
Above the cave	1(2.3%)	4(4.8%)	0(0%)	12(8.8%)	17(5.8%)
	43(97.7%)	79(95.2%)	27(100%)	125(91.2%)	274(94.2%)

Down the cave

The majority of PTB smear positive participants have signs and symptoms of chest pain were 21participants, followed by fever 15participants, coughing within 2weeks or greater were 14 participants and the least is cough with blood was 1participant while 4participants were PTB smear positive and asymptomatic.

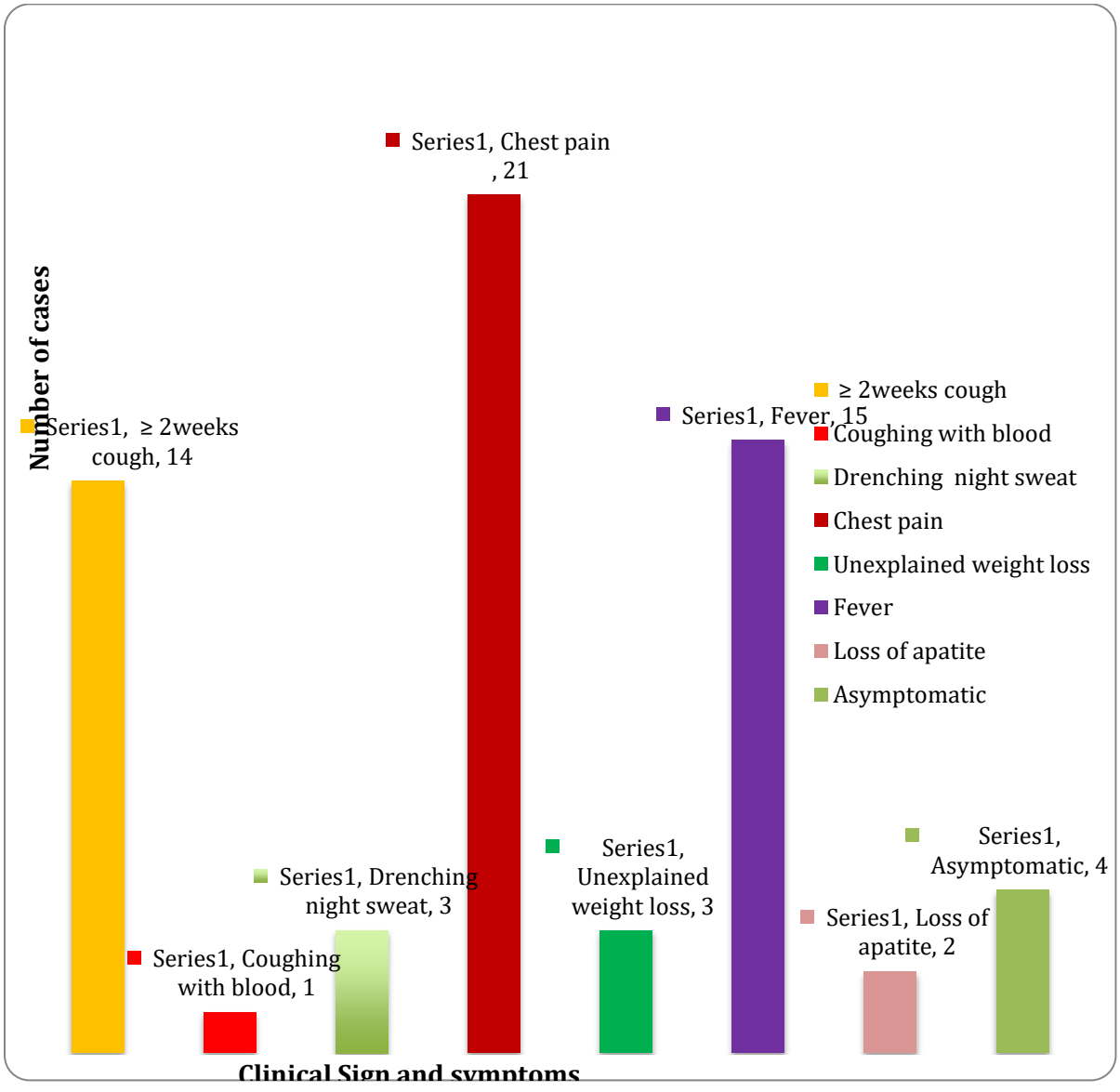


Figure 4: Distribution of signs and symptoms among PTB+ in mineworkers (N=26).

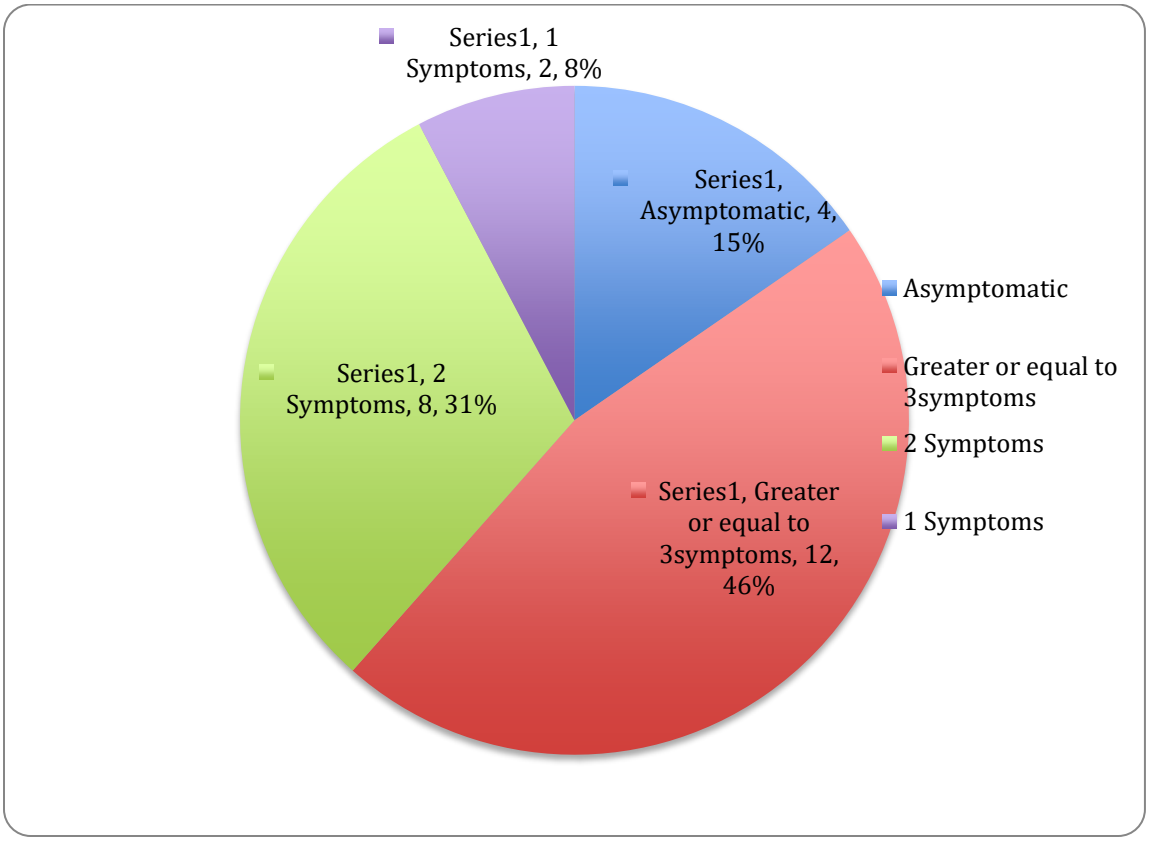


Figure 5: Pie chart shown number of PTB sputum smear positive corresponding with sign and symptoms they have.

Total of 26 positive PTB cases and 267 negative PTB were found. The mean age ±(SD) were 41.7±(9.84) for the PTB cases and those who wear mask were 2(7.69%) with PTB cases are few in number.HIV infection positive were 13(4.5%) participants while 5(1.7%) were TB/HIV Co-infection.

Table 3: Comparison of putative risk factors between PTB cases and non-cases

Characteristics	PTB cases (n=26)	No PTB (n=267)
Average Age ,Mean (SD)	41.7(9.8)	33.8(9.7)
Smoking status		
Non-smokers n, (%)	8 (37.9 %)	143 (54.0 %)
Smokers n, (%)	18 (62.1 %)	122 (46 %)
Silica dust exposure		
Non –mask wearing n, (%)	24(92.3%)	262 (98.9%)
Mask wearing n, (%)	2(7.7%)	3(1.1%)
HIV status		
Non-Reactive n, (%)	21(80.8%)	257(97.0%)
Reactive n, (%)	5(19.2%)	8(3.0%)
Availability of health services		
Tested TB previously n, (%)	12(46.2%)	70(26.4%)
Not tested for TB previously n, (%)	14(53.9%)	195(73.6%)
Type of environment at work		
Above the cave n, (%)	1(3.8%)	16(6.0%)
Down the cave n, (%)	25(96.2%)	249(94.0)
Type of job in mining work		
Handwork n, (%)	17(65.4%)	216(81.5%)
Heavy machinery work n, (%)	9 (34.6%)	49(18.5%)
Previously PTB tested		
Yes n, (%)	12(46.2%)	70(26.4%)
No n, (%)	14(53.8%)	195(73.6%)
History of contact with TB patient		
Yes n, (%)	16(61.5%)	167(63.0%)
No n,(%)	10(38.5%)	98(37.0%)
Previously tested for HIV		
Yes n, (%)	17(65.4%)	198(74.7%)
No n, (%)	9(34.6%)	67(25.3%)
Previously treated for TB		
Yes n, (%)	12(46.2%)	70(26.4%)
No n, (%)	14(53.8%)	195(73.6%)
Understand how TB is transmitted		
Yes n, (%)	21(80.8%)	184(69.4%)

No	n, (%)	5(19.2%)	81(30.6%)

In multivariate analysis, all variables resulting from bivariate analysis which qualified were carried on for further analysis. Results from multivariate analysis indicate that the associated characteristics HIV status 9.09 (95% CI 2.39-34.06) and smoking status 2.07(95% CI 0.78-5.52).Silica dust shows and availability of health services factors remain modifiable factors while others do not qualified for the model determination.

Table 4: Multivariate logistic regression analysis of exposure variable as associated characteristics of PTB

Variables	Crude Odds Ratio(95% CI)	Adjusted Odds Ratio(95% CI)
HIV status		
Positive	7.65 (2.30-25.46)	9.09 (2.39-34.06) **
Negative	1	1
Silica dust exposure		
Mask wearing	7.28 (1.16-45.7)	10.2 (1.38-75.44)**
Non-mask wearing	1	1
Smoking status		
Smokers	2.63 (1.11-6.28)	2.07 (0.78-5.52)**
Non smokers	1	1
Availability of health services		
Tested TB previously	2.39 (1.05-5.41)	2.76 (0.95-8.00)
Not tested TB previously	1	1
Overcrowding		
Yes	0.42(0.36-2.45)	-*
No	1	
Type of job in mining work		-*
Heavy machinery	2.33(0.98-5.54)	
Hand working	1	
Type of environment at work		-*
Above the cave	1.61 (0.20-12.63)	
Down the cave	1	
Previously tested TB		-*
Yes	2.39 (1.05-5.41)	
No	1	
History of contact with TB patient		-*
Yes	0.94 (0.41-2.15)	
No	1	
Previously tested HIV		-*
Yes	0.64 (0.27-1.50)	
No	1	
Previously treated TB		-*
Yes	1.26 (0.45-3.53)	
No	1	
Understand how TB is transmitted		-*
Yes	1.85 (0.67-5.07)	
No	1	

-*Not qualified to logistic regression

**Qualified to logistic regression $p \leq 0.2$

CHAPTER FIVE

5.0 DISCUSSION.

The prevalence of pulmonary tuberculosis in mineworkers in Mererani is high. Overall, 26 out of 293 (8.9%) participants were found to have pulmonary tuberculosis disease, which was significantly associated with **HIV infection and smoking.** HIV infected individuals were 9.09(95% CI2.39-34.06) times more likely to have PTB, where smokers had 2.7(95% CI 0.78-5.52) times more likely to have PTB (Table 4).

Other factors were not significantly associated with PTB are silica dust, overcrowding, lack of health services (Table 4). In this study we found silica dust effect increased by 10.2(95% CI 1.38-75.44) but insignificant risk of PTB associated with not wear masks during working hours. Silica dust effect has been shown to be neither a confounder nor a mediator in this data. It is mostly a simple marker of substantial silica dust exposure, explained the frequent report in literature of silicosis as a risk factor for PTB(22). Given the association of silica dust exposure misclassfication, it might be due to fact that few participants were observed to wear mask 5(1.7%) compared to PTB positivity. But it is understandable that the silica effect on PTB independent of the presence of silicosis has been less clearly linked to silica exposure than the relationship between silicosis and PTB(10).

No rifampicin drug resistance detected among all AFB smear positive samples tested for Gene expert drug resistance.

The study established a prevalence of PTB in mineworkers in Mererani, Tanzania of 8.9%.The higher prevalence of PTB found in gold mines 9.5% in Zambia than in the present study in tanzanite mineworkers(8.9%)this could probably due to differences in the eligibility of the study, and in the associated characteristics of PTB between the gold mines and tanzanite mines(3). Pulmonary tuberculosis (PTB) is currently epidemic on South African goldmines, being associated with silica dust and HIV which running 19.4% prevalence in the gold mines which is so high compared to this study which is 8.9% with the associated factor of HIV and smoking, this is due to different occupational hazards and mines processing procedures between these two mines.(24). But similarity has been shown in copper mines in Zambia 9.5% which is almost similar although it is different mines(3).This study is unique, in such a way that participants mined tanzanite which is not found anywhere else in the world.

The prevalence of PTB in mineworkers is almost nearly agreed to the finding of Ngosa study done in Zambia (3). However, a higher proportional PTB positive was found in a study done by *Ehrlich PR in South Africa* (9). ZN- AFB microscopy for PTB was common technique for fieldwork, but it is less sensitive compared to Gene expert done by Pinyopornpanish North Thailand (7).

The associated characteristic of PTB in mineworkers in Tanzania is not well known compared to South Africa and Zambia. The participants exposed with, HIV status and smoking are less with PTB than infection reported in South Africa gold mines. Mineworkers with risk of HIV status show association with PTB(25).This finding have been shows that a patient with HIV positive having a 9.09(95% CI 2.39-34.06) times higher risk of PTB than their HIV negative counterpart. This has not been shown previously in Tanzania especially in tanzanite mineworkers that might be different to other setting mines. Merits of the study, is the first study to look on relationship between PTB and associated characteristics among mineworkers in Mererani, Tanzania. HIV-positivity and smoking are known risk-factors for PTB; we were not surprised to find statistically significant associations with PTB in the multivariate model(26).In 2015, 61,000 cases of TB were presented and 93% had a known HIV status. Of this group, 36% were co-infected with HIV, of whom 86% were on antiretroviral treatment. This reflects to the study finding in such that HIV is still associated characteristics for PTB. The government have prioritised the integration of TB services with HIV services to minimize the burden of these two co-morbidities. Ensuring that people living with HIV are on antiretroviral treatment means that they are in a better place to fight off TB infection. Integrating these two services will also ensure greater access to TB treatment(27).The number of people living with HIV who presented with TB and received treatment for HIV and TB increased from 25.9% in 2012 to 54% in 2013. However, this still leaves a large portion of people with HIV/TB co-infected without comprehensive treatment. Findings not concur with this study because TB/HIV co-infected is still low by 5(1.7%).

Smoking increases an individual's risk of developing tuberculosis and makes the infection worse -- because it causes vital immune cells to become clogged up, slowing movement and impeding ability to fight infection. Smoking as an associated characteristics with 2.7(95% CI 0.78-5.52) it is among significant factor to PTB.

This study also found some factors which do not associated with PTB in mines like number of people working within 3 metres, operate in machinery work, type of environmental workplace (above or down), previous PTB tested, history of contact with TB patient, understanding on how TB is transmitted, previously treated for TB, crowding and internal migration (from one region to another) were not significant when tested in bivariate analysis. Duration of services factor in Mererani mines are non-significant in contributing to PTB infection according to bivariate analysis. Although silica dust exposure and lack of health services were shown association in bivariate analysis with significant, but after adjusted (Multivariate level) does not show significance.

Out of the 26 smear positive samples sent for rifampicin resistance tests, none of them was found drug resistance. The high treatment success rate obtained in Mererani shows the decrease of drug resistance incidence of a new resistance TB cases. Health promotion and education related to PTB and the importance of completing treatment needs to be improved especially in mineworkers(28).Though this sample is too small to provide a meaningful drug resistance susceptibility TB in Mererani, nonetheless, it is noteworthy that no samples came back resistant.

It should be noted that, the study contains some important limitations. These findings are relevant to tanzanite mineworkers only, therefore cannot necessarily to be generalizable to other types of mineworkers (e.g. gold mineworkers) which may have different occupational hazards. The study employed only one drug resistance focus by GeneXpert technique due to limitation of time and resources, meanwhile culture and sensitivity technique might have complemented the findings. Also absence of culture and Gene expert technique for PTB is a limitation in such a way that ZN-technique is less sensitive than culture and Gene expert technique. As a cross-sectional study, it is liable to biases in determining the associated characteristics; causality is impossible establish due to issues of temporality .Lack of specific test concerned silicosis diagnosis (examination) as a known risk for PTB could be a limiting factor.

The study provides a platform to further examine the useful of mentioned risk indicators (silica dust exposure limit) in term of quantity as a source of increasing pulmonary tuberculosis in mineworkers. Regarding on the limitation of time and resources which hinder the use of MTB culture and sensitivity technique for those positive smear, we recommend to conduct further study design specifically, a cohort study which will make follow up of PTB treatment, co-infection treatment and lost to follow-up trend

will draw valid conclusion about temporal association between independent and dependent variables as well as follow up of the TB/HIV cases. Further research needed for other drug resistances rather than rifampicin drug existing in Mererani.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Our finding indicated prevalence of PTB among mineworkers is higher (8.9%) than PTB in general community due to risk factors of smoking and HIV status. Silica dust exposure may also be a risk factor since very few mineworkers use mask during working hours. No rifampicin drug resistance detected among all AFB smear positive samples tested for Gene expert drug resistance.

6.2 Recommendations

Based on findings in order to contained PTB in mineworkers, advocacy campaign for TB infection prevention control (IPC) measures is prior needed. Also emphasizing behaviour change and practices on stop or minimize smoking habit which shows significant factor in PTB infection, should be implemented to all mining blocks (A, B, C and D). As shown few mineworkers wear masks, so we recommend all mineworkers to wear mask as a respiratory personal protective from silica dust.

REFERENCE

1. United Republic of Tanzania Ministry of Health and Social Welfare National Tuberculosis and Leprosy Programme Manual for the Management of Tuberculosis and Leprosy. Dar es Salaam, Tanzania; 2013.
2. Barnes D. TB control in the South African Gold Mining Industry. In: TB contol in the South Africa.
3. Ngosa K, Naidoo RN. The risk of pulmonary tuberculosis in underground copper miners in Zambia exposed to respirable silica : a cross- sectional study. 2016;1–7.
4. Stuckler D, Basu S, Mckee M, Lurie M. Mining and Risk of Tuberculosis in Sub-Saharan Africa. 2011;101(3):524–30.
5. Mogeni T, Bank W. Addressing TB in the Mines : A Multi- Sector Approach in Practice. 2015;(March).
6. Integrating community based TB and TB/HIV activities in to the work of CSOs National Operational Guidelines. 2013.
7. Dharmadhikari A, Smith J, Nardell E, Churchyard G, Keshavjee S. aspiring to zero tuberculosis deaths among southern africa ' s miners : is there a way forward ? 2013;43(4):651–64.
8. Mpagama SG, Heysell SK, Ndusilo ND, Kumburu HH, Lekule IA, Kisonga RM, et al. Diagnosis and Interim Treatment Outcomes from the First Cohort of Multidrug-Resistant Tuberculosis Patients in Tanzania. Kranzer K, editor. PLoS One. Public Library of Science; 2013 May 13;8(5).
9. Magai PS, Márquez-velázquez A, Magai PS, Márquez-velázquez A. Tanzania ' s Mining Sector and Its Implications for the Country ' s Development Tanzania ' s Mining Sector and Its Implications for the Country ' s Development. 2011;(4).
10. Ehrlich PR. The crisis of tuberculosis and silicosis in the South African mining industry The crisis and tuberculosis and silicosis in the South African mining industry 1 . What is the current epidemiology of pulmonary tuberculosis (PTB) in miners ?
11. Corbett EL, Marston B, Churchyard GJ, Cock KM De. Tuberculosis in sub-Saharan Africa : opportunities , challenges , and change in the era of antiretroviral treatment. 2006;367.
12. Stop TB Partnership: Operational Strategy, 2013-2015. 2015.
13. Mpagama SG, Lekule IA, Mbuya AW, Kisonga RM, Heysell SK. The Influence of Mining and Human Immunodeficiency Virus Infection among Patients Admitted for Retreatment of

Tuberculosis in Northern Tanzania. 2015;93(2):212–5.

14. Ministry of Health and Social Walfare. Annual Report on TB, Tanzania. 2015.
15. Chonde TM, Doulla B, van Leth F, Mfinanga SG, Range N, Lwilla F, et al. Implementation of a national anti-tuberculosis drug resistance survey in Tanzania. BMC Public Health. BioMed Central; 2008 Dec 30;8(1):427.
16. Need T. Tuberculosis and Mining. 2013;1–3.
17. Mayala LP, Veiga MM, Khorzoughi MB. Assessment of mine ventilation systems and air pollution impacts on artisanal tanzanite miners at Merelani, Tanzania. J Clean Prod. 2016;116:118–24.
18. Ministry of Health and Social Walfare. hat trick. Dar es Salaam, Tanzania; 2012.
19. Factors affecting_logistics_of_mining_waste disposal and their impact to the environment:a case of Mererani tanzanite mining sites 2014.(1). Seleman H. Kilima; 2014.
20. HIV Laboratory Diagnosis: New Tests and a New Algorithm [Internet]. [cited 2017 Oct 23]. Available from: https://education.questdiagnostics.com/.
21. MOH. National Comprehensive Guidelines for HIV Testing and Counselling [Internet]. National AIDSControlProgram.2013.Availablefromhttps://aidsfree.usaid.gov.
22. Eisler R. health risks of gold miners : a synoptic review. 2003;(June 2002):325–45.
23. The B, Committee I, Cross R. Literature Review on Tuberculosis in Prisons. 2008;1–16.
24. Thompson ML, Myers JE. Tuberculosis and silica exposure in South African. 2006;187–92.
25. Nathan K. TB Prevalence in Zambia. p. 1–19.
26. Getahun H, Gunneberg C, Granich R, Nunn P. HIV Infection – Associated Tuberculosis : The Epidemiology and the Response. 2010;50:201–7.
27. Tackling TB and HIV co-infection in Tanzania. 2005.
28. Woimo TT, Yimer WK, Bati T, Gesesew HA. The prevalence and factors associated for anti-tuberculosis treatment non-adherence among pulmonary tuberculosis patients in public health care facilities in South Ethiopia : a cross-sectional study. 2017;1–10.

Appendix 1a: INFORMED CONSENT FORM- English Version

MUHIMBILI UNIVERSITY OF HEALTH AND ALLIED SCIENCES - DIRECTORATE OF RESEARCH & PUBLICATIONS.

ID-NO _____

Consent to participate in this study

Greetings! My name is …..... from Muhimbili University of Health and Allied Sciences, Dar es Salaam. I am a laboratory scientist carrying out a study titled: Determination of pulmonary tuberculosis prevalence and associated characteristics among mineworkers Mererani, Tanzania.

Purpose of the study

This study has the purpose of collecting information on magnitude of the problem in pulmonary tuberculosis and associated characteristics among mineworkers in Mererani town, Simanjiro district council in Manyara Region. You are being asked to participate in this study because you have involved and experiences issues in mining that will be important to the study.

What participation involved

If you agree to participate in this study, you will be required to answer series of questions that have been prepared for the study through sputum testing and interviewing in order to obtain the intended information regarding risk factors associated in pulmonary tuberculosis burden among miners in Mererani Simanjiro district council in Manyara Region.

Confidentiality

I assure you that all the information collected from you will be kept confidential. Only people working in this research will have access to the information. We will be compiling a report which will contain responses from all mine workers from Blocks (A, B, C and D) in Mererani and the results of sputum will be given individually. We will not put your name or other identifying information on the records of the information you provide.

Risks

You will be needed to collect sputum samples and asked questions about factors that are associated with the increase of pulmonary tuberculosis in mining area. Some question could potentially make you feel uncomfortable. You may refuse to answer any particular question and stop the interview at any time. We do not expect any harm to happen to you because of participation in this study

Right to withdraw and alternatives

Taking part in this study is completely your choice. If you choose not to participate in the study or if you decide to stop participating in the study you will not get any harm. You can stop participating in this study at any time, even if you have already given your consent. Refusal to participate or withdrawal from the study will not involve penalty or loss of any benefits to which you are otherwise entitled.

Benefits

The information you provide will help to increase our understanding on magnitude of the tuberculosis and risk factors associated in tuberculosis infection as well as health services utilization especially Pulmonary Tuberculosis among miners in Mererani, Simanjiro district council in Manyara Region and communicate the findings to policy makers in the council and ministries for improvement of

tuberculosis health services and reduce associated risk factors in the mining.

Responsibility of Investigator

In the case where the mine worker who his or her sputum result will be positive he or she will be needed to visit the health facility for HIV counseling / testing and to refer them for treatment and management of the disease.

In case of injury

We do not anticipate that any harm will occur to you or your family as a result of participation in this study.

Who to contact

If you ever have questions about this study, please don't hesitate to contact:

Bakari Omary, (0717956168). The **Principal Investigator** Muhimbili University of Health and Allied Sciences (MUHAS), P.O. Box 65001, Dar es Salaam (Tel. no. 0714220769 or 0755094464). If you ever have questions about your rights as a participant you may call Dr. Joyce Rose Masalu, **Ag. Chairperson of the Senate Research and Publications Committee**. P. O. Box 65001, Dar es Salaam. Tel: 2150302-6, 2152489.

Prof. Mecky Matee,(0713081162) The supervisor of this study.

Signature

Do you agree?

Participant agree…… Participant does not agree……..

I …….have read the content in this form, my questions have been answered, I agree to participate in this study

Signature of Participant…….……

Signature of Research assistant……

Date of signed consent……

Appendix 1b: INFORMED CONSENT FORM- Swahili version

CHUO KIKUU CHA AFYA NA SAYANSI YA TIBA CHA MUHIMBILI

KURUGENZI YA UTAFITI NA UCHAPISHAJI

FOMU YA RIDHAA

ID-NO _____

Ridhaa ya kushiriki

Hujambo? Ninaitwa…….. Ninafanyakazi ya kutafitihali ya ugonjwawakifuakikuunasababuzinazochangiaongezeko la ugonjwawakifuakikuukwawachimbamadinikwenyemgodiwamadini Mererani, wilaya ya Simanjiro, mkoawa Manyara.

Madhumuni ya utafiti

Utafitihuuunakusudiakuchunguzahali ya kifuakikuunasababuzinazochangiaongezeko la ugonjwawakifuakikuumiongonimwawachimbajimadinikwenyemgodiwa Mererani. Unaombwakushirikikwenyeutafitihuukwasababuunaoujuziamaunafahamuwamatukioamba yo ni ya muhimu.

Ninikinahitajikailikushiriki

Ili kushirikikatikautafitihuuinabidikukubalinakujiungakwakujibumaswalitokakwenye dodoso kwaajili ya utafitihuu.

Usiri

Ninakuhakikishiakuwataarifazitakazokusanywakutokakwakokupitia dodoso hilizitakuasirinahakunamtuyeyoteambayehafanyikazikwenyeutafitihuuatakayeambiwaulichosema. Itaandaliwataarifa ya utafitihuuambaohautamtaja mshiriki yeyote.Jinalakowalautambulishomwinginewowotehautawekwakwenyetaarifaunazozitoa.Tarifazakozitaingizwakwenyengamizikwakutumianambazautambulisho

Hatari

Hakunahatariyeyoteitakayotokeakwakokutokananaushirikiwakokwenyeutafitihuu

Haki ya kujitoa au vinginevyo

Ushirikikatikautafitihuu ni hiari .Kutokushiriki au kujitoakutokakwenyeutafitihakutakuanaadhabuyeyotenahutapotezastahilizakoendapoutaona ni vemakufanyahivyo.

Faida

Kama utakubalikushirikikwenyeutafitihuuitakuanifanakakwa vile utafitihuuunalengo la kuboreshahudumazakifuakikuukwakubainisababuzinazochangiaongezeko la ugonjwawakifuakikuumgodini Mererani kwenyewilaya ya Simanjiro, mkoawa Manyara.

Waajibuwamtafiti

Endapomchimbajimadiniatakutwanavimelea vya ugonjwawakifuakikuu /virusi vya Ukimwi au vyotekwapamoja, elimuitatolewajuu ya faidazakujuahali ya afyayakonaatashauriwaaendekatikazahanati/kituo cha afyakinachotoahudumastahikizatibahiyoiliaanzematibabu.

Endapoutapatamadhara au la

Hatutegemeikupatamadharayoyotekutokananaushirikiwakokatikautafitihuu.

Naniwakuwasilianana ye

Kama kunaswalikuhusianana utafitihuuitakubidikuwasilianana mtafitimkuu**Bakari Omary** wa Chuo Kikuu cha AfyanaSayansi ya Tiba Muhimbili, S.L.P. 65001 DSM.**Simu (Tel: 0714220769).**Kama unamaswalizaidiunawezakuwasilianana Dr. Joyce Rose Masalu**,KaimuMkurugenziwaKamati ya UtafitinaUchapishaji, Chuo Kikuu cha Muhimbili Tel:2150302-6,2152489 Prof. Mecky Matee** ambaye ni msimamiziwautafitihuu.

Je, Umekubali?

Mshiriki amekubali…… Mshiriki hajakubali……

Mimi……...nimesomamaelezo ya fomuhii, maswaliyanguyamejibiwananimeridhika. Nakubalikushirikikatikautafitihuu.

Sahihi ya Mshiriki……

Sahihi ya mtafitimsaidizi……

Tarehe ya kushiriki……

Appendix 2a - Questionnaire English version

Prevalence of pulmonary tuberculosis and associated characteristics among mineworkers in Mererani, Tanzania.

Please fill the correct answer.

Date: {...../...../2017} Questionnaire/interviewee code no: .....

Name of interviewer: .....

I. Demographic data

1. Date of birth.....

2. Sex of respondent i.Male..... ii. Female.....

3.What is your marital status? i.Marriedii.Unmarried.iiiDivorced/separate iv.Widow

4. Which district and region do you live in?i.District.....ii.Region.....

5. In which region and country were you born? i.Region.....ii.Country.....

II. Socio economic status/General life

6. When did you first begin working in mines? (Monthand Year).....

7. Where (region, country) have you worked in mines previously?.....

8.If former mine, when did you stop mining?...../.....

9. Which block do you work in Mererani? i.Block A ii.Block B iii.Block C iv.Block D

10.Which days of the week do you work?.....

11.How many hours per day do you work?.....

12.Have you ever smoked cigarettes regularly?(1pack per week)iYes.....ii. No.....

13. In last 6monthshow many cigarettes have you smoked in the last year(<10 vs, >10)

III.Clinical characteristics /health services in place

14. Do you know TB disease?.....

15. Do you know how TB disease is trasmited?.....

19.Which type of TB was it? i. pulmonary ii. extra-pulmonary

20. Have you ever contact with TB patient?

21. Have you ever been treated for TB previously?.i. Yes.....ii. No.....

22. Which medicines were used?.....

23. Have you ever been tested for HIV previously? i.Yes.....ii.No.....

24. Which year? .....

25. TB sign and symptoms

i.Cough within 2 weeks or greater Yes.....No.....

ii.Coughing blood Yes.....No.....

iii.Drenching night sweat Yes.....No.....

iv.Chest pain Yes.....No.....

v.Unexplained weight loss Yes.....No.....

vi.Fever Yes.....No.....

vii.Loss of appiteYes.....No.....

IV.Living characteristics

26. How many rooms do you have in your living space?.....

27. How many individuals live in your household?.....

28.How many of the individuals that live with you are mineworkers?.....

29.Is anybody in your people living with have diagnosed for PTB?.....

V.Occupational Hazards

30.Do you operate machinery that produces dust while mining?i.Yes....ii.No....

31.How many people do you work within 3 metres radius?.....

32. What type of job do you have in mining worksite?

i. Heavy machinery work.....ii. Hand work.....

33.Do you wear a mask when performing your work? i.Yes.....ii.No.....

34.What type of environment do you work (in caves).....

Thanks for acceptance.

Appendix 2b - Dodoso (Kiswahili)

Hali ya kifuakikuunaviashiriavinavyochocheaugonjwawakifuakikuukwawachimbaji,mgodiwa Mererani, Tanzania

Tafadhari jaza jibu lililo sahihi.

Tarehe ya mahojiano: {...../...../2017} Namba ya dodoso/mshiriki .....

Jina la msaili: .....

I.Demographic data

1.Tarehe ya kuzaliwa .....

2. Jinsia ya mshiriki ni ipi? i.Mume.....ii.Mke.....

3.Nini hali yako ya ndoa i.Nimeoa/Nimeolewa ii.Sijaoa/Sijaolewa iii.Tumeachana/Tumetengana iv.Mjane

4.Unaishi wapi hapa Mererani?Mkoa.....Wilaya.....

5.Umezaliwa wapi? Mkoa.....Nchi.....

II.Hali ya kiuchumi/Maisha kwa ujumla

6. Ni muda gani umepita tangu ulipoanza kazi hizi mgodini?(Mwezi na Mwaka)...../.....

7. Wapi ulifanyakazi hizi za migodini kabla ya hapa?Nchi.....Mkoa.....Mwezi....Mwaka.....

8.Tangu lini uliacha kazi hizi za migodini?(Mwezi na Mwaka)...../.....

9.Unafanyakazi kwenye block ipi?i.Block A ii.Block B iii.Block C iv.Block D

10.Siku zipi katika wiki ambazo hufanya kazi hapa mgodini?.....

11.Unafanyakazi kwa muda wa masaa mangapi hapa mgodini kwa siku?.....

12. Je, Una vuta sigara mara kwa mara?(pakiti moja kwa wiki 1).....

13.Katika kipindi cha miezi 6 umevuta sigara ngapi?(chini ya 10 au zaidi ya 10).....

III.Dalili na viashiria vya Kifua kikuu /huduma za afya

14.Unafahamu ugonjwa wa kifua kikuu?.....

15.Unafahamu ugonjwa wa kifua kikuu unavyoambukizwa?.....

16. Umewahi kupima kipimo cha utambuzi wa kifua kikuu?

17.Kama ndiyo umepimwa kipimo kipi?.....

18.Ni mwezi na mwaka gani...../.....

19.Ni aina ipi ya ugonjwa wa kifua kikuu i.Kifua kikuu cha mapafu ii. Nje ya mapafu

20.Umewahi kumuuguza mgonjwa wa kifua kikuu.i.Ndiyo ii.Hapana

21. Umetibiwa ugonjwa wa kifua kikuu katika kipindi cha miezi 6? i.Ndiyo ii.Hapana

22. Kama ndiyo ulitumia dawa zipi?.....

23.Umewahi kupata uchunguzi wa vipimo vya kutambua maambukizi ya VVU?.....

24.Kama ndiyo taja tarehe?.....

25.Dalili za kifua kikuu alizonazo

i.Kukohoa kwa wiki mbili Ndiyo.....Hapana.....

ii.Kukohoa damu Ndiyo.....Hapana.....

iii.Kutokwa na jasho jingi usiku Ndiyo.....Hapana.....

iv.Maumivu ya kifua Ndiyo.....Hapana.....

v.Kupungua uzito kwa ghafla. Ndiyo.....Hapana.....

V.Hali ya maisha na malazi

26.Nyumba unayoishi inavyumba vingapi?.....

27.Unaishi na watu wangapi kwenye nyumba hiyo?.....

28.Watu wangapi mnaishi wote ambao wanafanyakazi mgodini?.....

29.Kati ya watu ambao unaishi nao kuna yeyote ambaye amepimwa kifua kikuu?.....

VI.Uhatarishi sehemu za kazi.

30.Unafanyakazi kwenye mashine ambayo hutoa vumbi hapa mgodini?i.Ndiyo...ii.Hapana...

31.Unafanyakazi na watu wangapi katika eneo lisilozidi mita 3?

32.Unafanyakazi ya aina gani hapa mgodini?

i.Unatumia machine kubwa.....ii.Kazi za mikono.....

33.Je,unavaa mask wakati wa kufanyakazi hapa mgodini?i.Ndiyo.....ii.Hapana.....

34.Unafanyakazi katika mazingira yapi(kwenye handaki).....

Ahsante!

Appendix 3: Steps in the Ziel Nielsen (ZN) Staining Procedure

1. Place slides on staining rack; slides should not touch

2. Flood slides with primary stain (1%Carlbolfuchsin) stain; apply heating. Follow protocol or package insert for timing.

3. Rinse with water; aim flow at edge of slide

4. Decolorize with 20% Sulfuric acid solution, Follow protocol or package insert for timing.

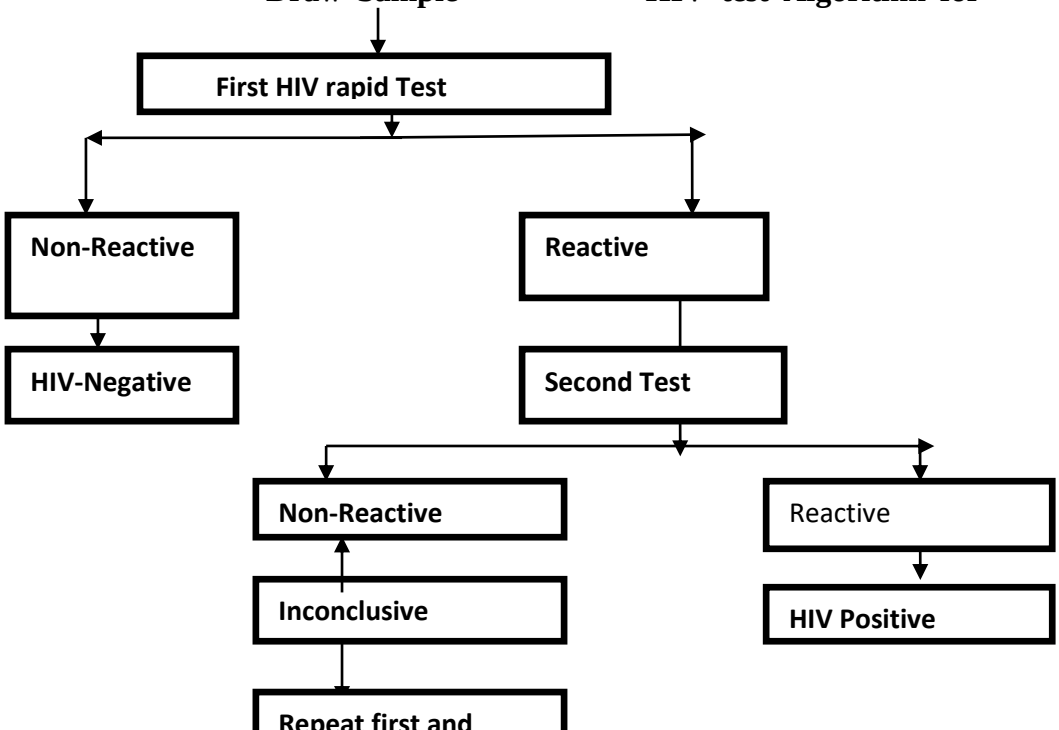
5. Rinse with water; drain excess

6. Flood slide with counter stain; (0.1%Methylene blue) Follow protocol or package insert for timing.

7. Rinse with water; drain excess

8. Air-dry stained slide; do not blot

Draw Sample **HIV test Algorithm for Tanzania**



Appendix 4: HIV test Algorithm for Tanzania.

SD Bioline™ HIV1/2 3.0 Test

For use with whole blood, serum or plasma
Store Kits: 1 - 30° C

- **Check kit before use. Use only items that have not expired or damaged.**
- **Bring kit (if stored at 4°C) and stored specimens to room temperature prior to use.**
- **Always use universal safety precautions when handling specimens. Keep work areas clean and organised.**

This outline is not intended to replace the product insert or your standard operating procedure (SOP).



1. Collect test items and other necessary laboratory supplies



2. Remove device from package and label device with client identification number



3. 3A. Using disposable pipette draw 20 µL of whole blood up to fill line



3B. Using a micropipette collect 10 µL of serum or plasma



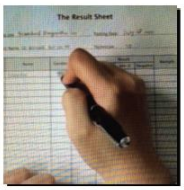
4. Apply the specimen to the sample well of the test device



5. To whole blood/serum/plasma: ADD 4 drops of the assay diluent to the sample well



6. Whole blood/serum/plasma: Read result within 10-20 minutes (DO NOT READ AFTER 20 MINUTES)



7. Read and record the results and other pertinent information on the worksheet

REMEMBER
At all times use protective measures including appropriate safe work and safe disposal practices

SD Bioline™ HIV 1/2 3.0 Test Results

Reactive
Presence of 2 ("C", "1" and "2") or more lines within the Result window.

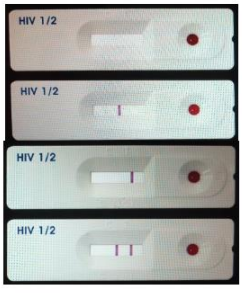
HIV 1 **HIV 2** **HIV 1/2**



Non-reactive
1 line appears in the control ("C") area and no line in the Test area.



Invalid
Type 1: Invalid – No Control Line, Type 2: Invalid – No Control Line but line appear in HIV2 test area, Type 3: Invalid – No Control Line but line appears in HIV1 test area or Type 4: Invalid – No Control Line but lines appear in HIV1 and HIV2 test areas



Uni-Gold™ *HIV* Rapid Test

For use with whole blood, serum, or plasma
Store Kits: 2 - 30° C

- **Check kit before use. Use only items that have not expired or been damaged.**
- **Bring kit and previously stored specimens to room temperature prior to use.**
- **Always use universal safety precautions when handling specimens. Keep work areas clean and organized.**

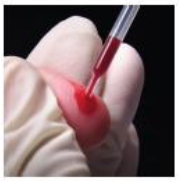
This outline is not intended to replace the product insert or your standard operating procedure (SOP).



1. **Collect test items and other necessary lab supplies.**



2. **Remove device from package and label device with client identification number.**





3. **Collect specimen using the disposable pipette.**



4. **Add 2 drops (approx. 60µl) of specimen to the sample port in the device.**



5. **Add 2 drops (approx. 60µl) of the appropriate wash reagent to sample port.**



6. **Wait for 10 minutes (no longer than 20 min.) before reading the results.**



7. **Read and record the results and other pertinent info on the worksheet.**

Uni-Gold™ *HIV* Rapid Test Results

Reactive

2 lines of any intensity appear in both the control and test areas.



Non-reactive

1 line appears in the control area and no line in the test area.



Invalid

No line appears in the control area. Do not report invalid results. Repeat test with a new test device even if a line appears in the test area.



Use of trade names and commercial sources is for identification only and does not imply endorsement by WHO, the Public Health Service, or by the U.S. Department of Health and Human Services (2005).

Appendix 5: Images from study site



