PREVALENCE AND OCCUPATIONAL RISK FACTORS FOR TUBERCULOSIS AMONG HEALTHCARE WORKERS IN PUBLIC SUB COUNTY HOSPITALS IN SIAYA COUNTY, KENYA

BY

MARY JUMA WAMBURA

A thesis submitted in partial fulfillment of the requirements for the award of the Degree of Master of Public Health (Epidemiology & Disease Control) of Jaramogi Oginga Odinga University of Science and Technology

September 2024

DECLARATION

I hereby declare that this is my own original work and has never been presented in any other institution or elsewhere for whatever purpose.

Signature: …….. Date: …….

Mary Juma Wambura
Reg. No.: H152/4163/2017

This thesis is being submitted for examination with our approval as supervisors:

Dr. Daniel Onguru
Department of Biomedical Sciences
Jaramogi Oginga Odinga University College

Signature: …….. Date: …….

Dr. Patrick O. Onyango
School of Physical and Biological Sciences
Maseno University, Kenya

Signature: …….. Date: …….

Dr. Steve Wandiga
KEMRI/CDC Tuberculosis Program, Kisumu, Kenya

Signature: …….. Date: …….

DEDICATION

This thesis is dedicated to my family members for their moral support, encouragement, patience, prayers and for giving me time to read during my studies.

TABLE OF CONTENT

Comment [DO1]: Fix this TOC to align the page numbers accordingly…
…look at 2.3 and fix this and all such…

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

ACF	Active Case Finding
AIDS	Acquired Immunodeficiency Syndrome
ART	Anti-Retroviral Therapy
BCG	Bacillus Calmette-Guérin vaccine
CCC	Comprehensive Care Center
CDC	Centers for Disease Control and Prevention.
CDH	County Director for Health
CPT	Co-trimoxazole Preventive Therapy
CTLC	County TB and Leprosy Coordinator
DOT	Directly observed treatment
DST	Diagnostic Sensitivity Test
HCW	Health Care Worker
HIV	Human Immunodeficiency Virus
HTS	HIV Testing Services
IPC	Infection Prevention Control
IRIS	Immune Reconstitution Inflammatory Syndrome
KEMRI	Kenya Medical Research Institute
MDR	Multi-Drug Resistant
MOH	Ministry of health
MTB	Mycobacterium Tuberculosis
NACOSTI	National Commission for Science, Technology and Innovation
PCP	Pneumocystis Carinii Pneumonia
PJP	Pneumocystis Jiroveci Pneumonia
PLHIV	People living with HIV
PTB	Pulmonary Tuberculosis
SCTLC	Sub-County TB and Leprosy Coordinator
TB	Tuberculosis
WHO	World Health Organization
XDR	Extreme Drug Resistance
HRIO	Health Records and Information officer

DEFINITION OF TERMS

CD4 cells	white blood cells that are essential part of the human immune system
Co-infection	More than one infection in the body
Extra-pulmonary	(infection) occurring outside the lungs
Healthcare worker	person engaged in healthcare service provision in health facilities

ABSTRACT

An estimated global total of 10.6 million people had *Mycobacterium tuberculosis* infection, causing tuberculosis (TB) in 2022, equivalent to 133 cases per 100,000 people. Kenya remains a high-burden country for drug-susceptible TB, and human immunodeficiency virus (HIV), western Kenya bearing the highest burden of HIV. A 2016-2017 survey in Kenya demonstrated that the estimated burden of TB was 169,000 people against 85,188 cases diagnosed in 2016, implying more than 40% of adults were missing, and Siaya was among top 10 high TB burden counties in Kenya. For healthcare workers (HCWs), TB remains an occupational hazard, especially in countries with high TB burden, with HCWs having a 2-3-fold increased risk of developing TB compared with the general population. This cross-sectional study investigated the prevalence and occupational risk factors for TB among HCWs in Siaya County, using a sample size of 275 from the 10 level 4 hospitals. Sputum samples were collected from all participants for TB testing using Gene Xpert. Self-administered structured questionnaires and observation checklists were used to collect data from the HCWs. Out of the 275 respondents, 18 participants reported to have been diagnosed with TB in the previous five years, giving a period prevalence of 6.5%, while none of the participants who produced sputum for TB testing turned positive. Only 68 (24.7%) CHWs had been trained on TB, and health facilities that conducted health talks to patients at waiting bays and segregated coughers to be seen first were significantly associated with reduced TB occurrence among HCWs ($\chi^2 = 11.125$, $p = 0.012$). Potential occupational risk factors such as constant supply of N95 masks ($\chi^2 = 7.505$, $p = 0.069$), putting on N95 masks ($\chi^2 = 6.335$, $p = 0.135$), provision of designated cough corner/sputum sample collection place ($\chi^2 = 6.714$, $p = 0.116$), availability of functional infection prevention and control (IPC) measures ($\chi^2 = 7.796$, $p = 0.067$), availability of TB health talk schedules ($\chi^2 = 8.353$, $p = 0.052$), and availability of adequate lighting and cross ventilation in all waiting bays and clinical rooms ($\chi^2 = 6.065$, $p = 0.144$) were not significantly associated with TB incidence among healthcare workers. Unavailability of certain IPC interventions was associated with the occupational risk of TB among healthcare workers. The Ministry of Health should enhance the dissemination of relevant TB manuals to update staff on IPC and availing N95 masks to all healthcare workers, while facilitating frequent TB screening to identify HCWs with TB, and all put on early treatment.

CHAPTER ONE: INTRODUCTION

1.1 Background

Tuberculosis (TB) is one of the top 10 causes of death in the general population, and it is the leading cause of a single infectious agent, sitting above HIV/AIDS (Lee *et al.*, 2020). A total of 1.3 million people died from TB in 2022 (including 167 000 people with HIV). Worldwide, TB is the second leading infectious killer after COVID-19 (above HIV and AIDS). Countries in Africa bear a substantial proportion of the global burden of TB and HIV (WHO, 2023). In 2016, countries in eastern and southern Africa accounted for 52% of all PLHIV and 43% of all new HIV infections globally. Approximately 36% of all incident TB cases in 2022 occurred in countries in Africa (UNAIDS, 2023). The annual TB case detection rate (281 cases per 100,000) is twice the global average of 133 per 100,000 (Ntoumi *et al*., 2016). African countries also account for 74% of the global burden of TB/HIV co-infection (WHO, 2020).

Kenya remains a high-burden country for drug-susceptible TB, multi-drug resistant (MDR) TB and human immunodeficiency virus (HIV), ranking fourth cause of death among infectious diseases (Agaya *et al.*, 2015; WHO, 2020). Until recently, Kenya's burden was believed to be declining. However, the prevalence survey conducted in 2016 demonstrated that the estimated burden of TB was 169,000 people against 85,188 cases diagnosed and initiated on treatment. This translated to more than 40% of the adults missing. Therefore, concerted efforts must be put in place to ensure that strategies towards early identification and treatment initiation must be implemented to close the gap. The HIV-positive TB deaths have drastically reduced from slightly above 50 to about 32% of all deaths in 2016. Siaya County is among the top 10 high TB burdens in Kenya (MOH, 2017).

Tuberculosis (TB) is a bacterial infection caused by *Mycobacterium tuberculosis* and is spread through droplets. The infection is most likely to occur when an individual is exposed to someone with pulmonary TB daily, such as by living or working in close quarters with someone with active disease (Kumar *et al.*, 2019). The lungs are the predominant site that is affected though the bacteria can infect any other part of the body (Melsew *et al.*, 2019; Tiberi *et al.*, 2020; WHO, 2019). Tuberculosis is the leading cause of death from a single infectious agent. Once in the body of a person with strong immunity, the bacilli remain dormant, causing no illness, and is

called asymptomatic, latent TB (Ackley *et al.*, 2019). When a person's immunity goes down, the dormant TB in the lung reactivate, causing an infectious, active infection (Getahun *et al.*, 2015a; Getahun *et al.*, 2015b; Villa *et al.*, 2019). Approximately 12% of persons exposed to TB will develop the disease after a period ranging from two weeks to two years, after which chances decline if there is no more exposure (Getahun *et al.*, 2015b), and the disease may also recur after re-infection (Ackley *et al.*, 2019; Afshar *et al.*, 2019; Nematollahi *et al.*, 2020).

Transmission of tuberculosis is a risk in healthcare and other congregate settings where many people share the same space for extended periods (Di Bella *et al.*, 2019; Diel *et al.*, 2018; Rogerio *et al.*, 2015). There are scanty studies done to determine the prevalence of TB among healthcare workers (HCWs), yet they are at high risk of acquiring TB at their workplaces. All HCWs need to undergo TB training to equip them with knowledge of TB for their protection and treating TB patients and be aware of the risk factors of acquiring TB in the workplace.

Tuberculosis affects all groups of people in the community and is more rampant where there is overcrowding, poor ventilation, poor lighting, low socioeconomic status and with poor or weak immunity (Khan *et al.*, 2019; Sulis *et al.*, 2014). Tuberculosis in adults accounts for about 80% of all TB patient population (Khan *et al.*, 2019), and an adult with an open case of TB (active TB) can infect 10-15 people within a year (Dheda *et al.*, 2017; Khan *et al.*, 2019; Sulis *et al.*, 2014). While treatment of Latent TB Infection (LTBI) is an essential component of strategies to achieve global tuberculosis (TB) elimination, its implementation remains poor across the globe (Parvaresh *et al.*, 2018). Effective management of TB and reduction of its incidence depends significantly on the knowledge of where, when and to what degree the disease is present (Sifuna *et al.*, 2019).

Tuberculosis generally affects the lungs but can also affect other body parts through haematogenous spread. Most infections do not have symptoms, which is known as latent tuberculosis. About 10% of latent infections progress to active disease, which, if left untreated, kills about half of those infected (Getahun *et al.*, 2024; Hermes *et al.*, 2020). The classic symptoms of active TB are a chronic cough with or without blood-containing sputum, fever, night sweats, weight loss or failure to thrive in children. Infection to

other organs can cause many symptoms (Almohaya *et al.*, 2020; Khan *et al.*, 2019; Modi *et al.*, 2020).

The risk for TB transmission varies by setting, occupational group, local prevalence of TB, patient population, and effectiveness of TB infection control measures (Nishimura *et al.*, 2018). Prevention of TB involves screening of those who are at high risk, early detection and treatment of confirmed TB cases, and vaccination with the Bacille-Calmette-Guérin (BCG) vaccine. Those who are at high risk of contracting TB are the ones in contact with active TB clients, like household contacts, healthcare workers, and social contacts of people with active TB, such as people in prisons, refugee camps, and schools. Healthcare workers are at higher-than-average risk for TB. Therefore, suitable TB infection control measures should be implemented in all healthcare facilities with patients suspected of having infectious TB (Guo *et al.*, 2021). Transmission of tuberculosis (TB) in healthcare settings to patients and healthcare workers has been reported in virtually every country, regardless of local TB incidence (WHO, 2020). Healthcare workers have a 2-3-fold more significant risk of active tuberculosis than the general population (Wahab *et al.*, 2016). Healthcare staff shortage is an essential player in the transmission of TB among healthcare workers, especially given that settings like hospitals are essential foci for TB transmission due to overcrowding and generally poor health-seeking behaviour (Mbuthia *et al.*, 2018; Subbaraman *et al.*, 2020; Tesfaye *et al.*, 2020; WHO, 2019).

Kenya has laid down strategies for TB infection prevention and control (IPC) by coming up with a training package, supplying respirators for HCWs to use and Surgical masks for patients' use, encouraging support supervisions following up the same (MOH, 2017). Still, there is little evidence on the extent and contextual factors surrounding TB transmission among healthcare workers, especially in areas with high TB and HIV burdens, and the emergence of the COVID-19 pandemic.

1.2 Statement of the problem

Because TB is highly transmissible in areas with higher populations, like health facilities (Guo *et al.*, 2021; Wardani *et al.*, 2021; WHO, 2023), knowledge of its prevalence can facilitate effective management and reduction of its incidence in different sections of the population (Sifuna *et al.*,

2019), similarly, enhancement of prompt diagnosis and initiation of treatment for the infected clients (Garcia *et al.,* 2018; Parvaresh *et al.,* 2018; WHO, 2019). It has been reported that individual patient's health-seeking behavior can occasion delays in TB diagnosis, including among the healthcare providers shape the process of contact identification, invitation and investigation (Alotaibi *et al.,* 2019; Boeckmann *et al.,* 2019; Daniels *et al.,* 2019). Because the relationship between TB and HIV has been long established (Cuomo *et al.*, 2019; Ndakidemi *et al.*, 2019; Wa Ilunga *et al.*, 2018), the paucity in knowledge presents a bottleneck to TB management, given Siaya is among the regions with the highest HIV burden in Kenya (KNBS, 2022). Although healthcare workers are at an increased risk of acquiring TB infection (WHO, 2023), the prevalence of TB and the associated occupational risk factors among HCWs in Siaya County is not known. This study therefore, investigated these two aspects in the 10 public sub-county hospitals in Siaya County, with a view to not only understanding the patterns, but also gearing towards better prevention of TB spread between HCWs, and patients.

1.3 Objectives

Main objective

To investigate the prevalence and occupational risk factors for tuberculosis among healthcare workers in the public sub county hospitals in Siaya County

Specific objectives

1. To determine prevalence of TB among health care workers in the ten public Sub County hospitals of Siaya County
2. To identify the occupational risk factors for tuberculosis among health care workers in the ten public Sub County hospitals of Siaya County

1.4 Research questions

1. What is the prevalence of TB among healthcare workers in ten hospitals of Siaya County?
2. What are the occupational risk factors for tuberculosis among healthcare workers in public hospitals of Siaya County?

1.5 Justification

Tuberculosis is a known occupational hazard for any staff working in any given health institution, especially in countries with a high burden of tuberculosis with overcrowding (Peters *et al.*, 2020), typical of many resource limited settings like the situation in Siaya. The public sub county hospitals in Siaya County are the highest volume health facilities due to high patients turn up, with a lot of overcrowding due to space. Overcrowding is a contributing factor to the spread of TB. Unlike private hospitals and level 2 and 3 which have low number of patients.

It is estimated that health care workers have a 2- to 3-fold increased risk of developing tuberculosis compared with the general population. This risk is greater when larger numbers of infectious (smear-positive) TB patients are managed at a healthcare facility and can be reduced with implementation of effective infection-control measures. The risk situation is very different in low- and middle-income countries (LMICs), which account for more than 90% of the global TB burden. Because these countries have high TB rates and limited resources, they focus largely on case detection and treatment using the DOTS strategy. In these countries, even low-cost strategies to reduce TB transmission in health-care facilities are seldom implemented. Understanding the burden, knowledge of TB and occupational risk factors for TB among healthcare workers is therefore needed to guide targeted interventions.

1.6 Significance of the study

The study addressed a critical gap in the knowledge of the prevalence and occupational risk factors for tuberculosis (TB) among health care workers (HCWs) in Siaya County, Kenya. TB has been a major public health concern globally, and HCWs have been particularly susceptible due to their regular exposure to infected patients. Despite the significant risk of contracting TB among HCWs, there was a paucity of information on the prevalence and occupational risk factors for TB in this population in Siaya County, Kenya. The particular significance of this study lied in its potential to inform policy and practice by identifying the prevalence of TB and the occupational risk factors associated with its transmission among HCWs in Siaya County. This information can be used to develop effective interventions to prevent and control TB among HCWs, such as the implementation of infection control measures and the provision of regular screening and treatment. Furthermore, this study's findings can contribute to the broader

knowledge base on TB among HCWs in sub-Saharan Africa. The study's focus on Siaya County can provide insights into the local context, which can be used to inform policy and practice in other similar settings. The study's findings can also contribute to the global knowledge on TB by highlighting the importance of addressing the occupational risk factors for TB among HCWs, particularly in resource-limited settings.

1.7 Scope of the study

The study was rolled out only in the ten government sub county hospitals in Siaya County. An estimate of a total of 664 health care workers were present in the 10 sub county hospitals. All categories of heath care workers, both technical and non-technical staffs were given equal opportunity to be selected to participate in the study. In addition, sputum samples were collected from the participants for Gene Xpert tests in search of new TB infections.

1.8 Study limitations

During data collection (2021 & 2022) there was Covid-19 outbreak, which made the Ministry of Health to impose containment measures, like e.g. HCWs working in shifts to avoid overcrowding of staff in the facilities, some staff were released to work in the isolation wards and quarantine non-health facilities. Further, staff who were elderly, diabetic and hypertensive were relieved to stay at home and were not accessible.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Tuberculosis (TB) remains one of the leading causes of mortality and morbidity worldwide among infectious diseases (WHO, 2023). In 2017, the total new TB cases detected were 10.4 million people, and the global mortality from TB during the same period was 1,500,000 (WHO, 2019). Morbidity from TB has also been linked to changes in the rate of TB infection in the community, treatment defaulter rates, nutritional status, socio-economic and personal lifestyles or the rate of HIV infection (Dunbar *et al.*, 2018; Wardani *et al.*, 2021). Reports have shown that globally, there are about 40,000 new cases of TB, 5,000 deaths and 11,000 missed cases of TB every day (WHO, 2020, 2023).

Tuberculosis is most prevalent in Africa with 1,387 929 cases, especially in Sub-Saharan Africa (SSA) where it's ranked as number one cause of morbidity and mortality among infectious diseases. Estimated new TB cases in Africa hit over 2,720,000 in 2018, of whom about 740,000 (27%) died from related morbidities (WHO, 2023). This is way in excess of WHO recommended death rate of 5% or less (WHO, 2019). The WHO thus recommends the prompt tracing of TB patient contacts and putting those infected on immediate treatment, in order to reduce TB transmission within the community, as well as morbidity and mortality due to TB infection (WHO, 2014, 2016, 2019).

The emergence of HIV is an and multidrug resistant TB strains (MDR-TB) are important driver of the global TB epidemic (Ahmed *et al.*, 2016; Alene *et al.*, 2019; Diriba *et al.*, 2022b). While MDR-TB cases represent a small proportion of the overall TB burden, the growing and steadily increasing numbers is an urgent priority for TB control programs globally (Asgharzadeh *et al.*, 2020; Dunbar *et al.*, 2018). It is estimated that by 2030, there should be a reduction of TB deaths by 90% and TB incidence by 80% compared to 2015 (Floyd *et al.*, 2018). Measures must thus be applied to achieve these goals, because about 40% of TB patients contacts are missed and therefore not put on treatment (Kigozi *et al.*, 2020; MacPherson *et al.*, 2019), accounting for about 4 million untreated TB cases (Modi *et al.*, 2020).

It is believed that the higher the number of TB patients reporting to, or receiving care in health facilities, the higher the chance of the exposed healthcare workers contracting TB. In resource-rich countries TB began to be recognized as an occupational hazard in the 1950s; since then, effective infection control measures have been implemented to reduce the risk for nosocomial TB (Chen *et al.*, 2019; Diel *et al.*, 2018; R. Garcia *et al.*, 2020; Guo *et al.*, 2021; Sharma *et al.*, 2018).

Recent estimates of the global Tuberculosis (TB) epidemic suggested a higher burden than previously estimated. In 2022, the World Health Organization (WHO) reported 10.4 million TB cases. In the same year, TB was among the top ten causes of death resulting in 1.4 million deaths worldwide (WHO, 2023). Among people living with HIV (PLHIV), TB remains a leading cause of death accounting for one in every three AIDS-related deaths globally (Ndakidemi *et al.*, 2019; Wa Ilunga *et al.*, 2018). Inequity in access to TB diagnosis and treatment in African countries are reflected in high TB case fatality rates as high as 20%, where access to care for TB is further hampered by limited resources (Asgharzadeh *et al.*, 2020). In 2018, the Africa regions had the largest funding gap for TB control estimated at USD 0.4 billion in 2018 (WHO, 2023).

Kenya is one of 22 high TB burden countries, and transmission risk of TB is influenced by TB patient population characteristics, the setting, exposure risks such as occupation, and effectiveness by factors such as the local TB prevalence, TB infection control measures (Khan *et al.*, 2019; MOH, 2017). In a hospital setting, the risk of transmission from individuals infected with TB to other patients and to health care workers (HCWs) is well recognized (Ayana *et al.*, 2019; Nishimura *et al.*, 2020). Specific occupation cadres including medical doctors, nurses, clinical officers, paramedics, radiology technicians, patients and wards attendants have a higher risk of TB disease. Infection control practices, such as prompt diagnosis and treatment of infectious cases, effective ventilation systems, isolation rooms, cough corners, access to and use of personal protective equipment (PPE) and surveillance, are also factors in the spread of TB (Almohaya *et al.*, 2020; Chen *et al.*, 2019; Guo *et al.*, 2021; Modi *et al.*, 2020).

Kenya is ranked 13 among the 30 high burden TB countries in the world, and is number 5 in Africa behind Central African Republic, Angola, Congo, Ethiopia and DRC (WHO, 2019, 2020,

2023). The total number of newly diagnosed TB cases in 2017 was 183,105, with 29,000 associated deaths during the same period (MOH, 2017; Nduba *et al.*, 2020; Nduba *et al.*, 2019). A TB prevalence survey in Kenya revealed that individuals with TB symptoms in the community delay in seeking treatment, and up to three-quarters of people seeking care in health facilities with TB symptoms are often misdiagnosed (Mbuthia *et al.*, 2018). This consequently results to increased transmission, increased morbidity, mortality, and drug resistant TB (Abebaw *et al.*, 2023; Diel *et al.*, 2018; Getahun *et al.*, 2022).

Passive TB case finding that requires that affected individuals are aware of their symptoms, have access to health facilities, and are evaluated by healthcare workers or volunteers who recognize the symptoms of TB and who have access to a reliable laboratory (Amare *et al.*, 2023b), remains the predominant approach in Kenya (MOH, 2017), yet active case finding presents the best opportunity for diagnosis, treatment and initiation of isoniazid preventive therapy (IPT) among people living with HIV (PLHIV). Active case finding involves systematic screening for active TB is predominantly provider-initiated and may target people who do not seek health care because they do not have or recognize symptoms, because they do not perceive that they have a health problem that warrants medical attention, because there are barriers to accessing care, or for other reasons (Almohaya *et al.*, 2020; Dheda *et al.*, 2017; Diel *et al.*, 2018).

The Kenya National Tuberculosis, Leprosy and Lung Disease Program (NTLD-Program) has recommended the use of Gene Xpert machine as a first test for TB diagnosis for patients screening positive for TB symptoms (MOH, 2017). The WHO guidelines of 2013 on systematic screening of active tuberculosis recommend the implementation of active case finding (ACF) through symptomatic screening aimed at early diagnosis of TB (Amare *et al.*, 2023b). Symptomatic screening interventions are recommended at all service delivery points, including among PLHIV and contacts (Di Bella *et al.*, 2019; Ohene *et al.*, 2017; WHO, 2020). In 2016, the MOH (Kenya) adopted the use of Gene Xpert as the first diagnostic test for all presumptive TB cases and clinical diagnosis for those with a negative Gene Xpert test (MOH, 2017; WHO, 2020).

According to the National TB and Leprosy Annual report of 2016, there were a total of 1657 cases were notified in Siaya County, (964 new bacteriologically confirmed, 570 new clinically diagnosed, 123 previously treated, 216 EPTB, and 109 TB among children) with a TB/HIV confection rate of 63%. Siaya County ranked fourth among five counties with a high burden of HIV and has an estimated 126,411 PLHIV or 8.3% of all PLHIV in Kenya (MOH, 2017). A cross sectional survey conducted in Karemo Division in Siaya County showed that out of 5004 adolescents enrolled, 1960 (39.2%) were identified with suspected TB, including 1544 with a positive Mantoux (prevalence 1544/4808, 32.1%), 515 with symptoms suggestive of TB (10.3%), and 144 (2.9%) with household TB contact (MacPherson *et al.*, 2019; Nduba *et al.*, 2019; Wingfield *et al.*, 2019). These findings suggest the importance of active case finding interventions to identify any potentially missed TB cases in Siaya County. In 2013, Siaya County was among the counties which registered highest number of deaths among TB patients in Kenya, up to 227 out of 2194 (10%) TB cases died as compared to 6% national TB mortality rate. Majority of Siaya TB deaths being TB/HIV co-infected patients as 8% were HIV co-infected while only 2% were not co-infected.

2.2 Health care worker knowledge about tuberculosis

Healthcare workers (HCWs) appear to be at increased risk of TB compared with the general population, despite efforts to scale up infection control and reduce nosocomial TB transmission (Nishimura *et al.*, 2020; Nonghanphithak *et al.*, 2016; Peters *et al.*, 2020; Sabri *et al.*, 2019; Souza *et al.*, 2021). Arscott-Mills *et al.* (2017) found HCWs' knowledge about TB across rural and urban regions in Botswana varied significantly, with poor knowledge, diagnosis, screening and prophylaxis of TB in the community. Transmission of TB can occur between patients and visitors if not suspected in time, and knowledge about tuberculosis and correct infection control measures are therefore highly necessary in healthcare settings (Amare *et al.*, 2023a; Diel *et al.*, 2018; Manyazewal *et al.*, 2023; Prihatiningsih *et al.*, 2020; Vigenschow *et al.*, 2021).

Early diagnosis and appropriate management of TB cases by knowledgeable and skilled HCWs are key in improving patients' outcome and preventing transmission (Alotaibi *et al.*, 2019). Infection control remains a key challenge for TB control, with an increased risk of TB transmission among HCWs, especially in settings with inadequate TB infection control

measures. In addition, poor knowledge among HCWs and inadequate infection control practices may lead to the increased risk of nosocomial TB transmission, affecting HCWs, patients, or other visitors (Okeyo and Dowse, 2018; Ramathebane *et al.*, 2019; Shi *et al.*, 2018; Shrestha *et al.*, 2017). Proper TB control is more likely to be achieved if the level of knowledge regarding TB is increased among healthcare workers managing high-risk groups (Alene *et al.*, 2019; P. J. Garcia *et al.*, 2018; Noe *et al.*, 2017).

The use of the community health promoters (CHPs) has enhanced the effort to decentralize active TB case finding. This because their role is among other things, to educate communities about tuberculosis (TB), TB screening and its treatment (Dunbar *et al.*, 2018; Kigozi *et al.*, 2020; Okeyo and Dowse, 2018; Ramathebane *et al.*, 2019). In Gabon, healthcare workers were shown to exhibit intermediate knowledge, whereby apart from the profession, education level, type of employing healthcare facility, as well as former training on tuberculosis were significantly associated with high knowledge scores (Vigenschow *et al.*, 2021). Similar reports have also been made in Riyadh, Saudi Arabia, where HCWs had average knowledge regarding TB, in relation to the definition of Latent TB Infection (LTBI), smear microscopy results, length of standard TB treatment for drug-sensitive TB, 2nd line anti-TB drugs, BCG vaccination, and appropriate PPE to be used with active PTB patients (Alotaibi *et al.*, 2019).

A study to assess the knowledge and practice of healthcare workers about multi drug-resistant tuberculosis (MDR-TB) prevention and control in Ethiopia reported a below average level of knowledge. In particular, healthcare workers knowledge of MDR-TB was significantly associated with higher education (Alene *et al.*, 2019). Wahab *et al.* (2016) acknowledged that while some previous studies reported a fair level of knowledge on tuberculosis among HCWs, there remains disparities between regions, leading to an overall poor practice, hence the need for improved knowledge enhancement and communication. Rocha *et al.* (2015) revealed knowledge gaps in the identification of patients with pulmonary TB, the target public for DOT, and, in addition, that better knowledge was associated with time working as a CHW (OR = 2.3) in Belo Horizonte, Brazil.

A study in Maseru, Lesotho, found that only close to 50% of CHWs had a good level of knowledge about tuberculosis, which was associated with unsafe practices, such as not wearing protective masks and not referring to the MDR-TB treatment guidelines (Malangu and Adebanjo, 2015). This is obviously related to an increased risk TB transmission within the health facilities, especially to HCWs who handle directly or have adequate indirect contact with TB patients. In Nigeria, Isara and Akpodiete (2015) established that the knowledge of TB was poor among both TB patients and HCWs with low level of education. In Iran, TB laboratory staff were found to have relatively good knowledge of TB, but they scored lower in practice regarding. On the other hand, non-TB laboratory staff had lower scores than TB laboratory staff in knowledge, attitude, and practice (Doosti Irani *et al.*, 2015). A survey among HCWs in health facilities in two districts in Uganda reported that up to 62 % of the HCWs had adequate basic TB knowledge, and that non-clinical cadres were more likely to have poor basic TB knowledge, while 69% had adequate TB infection control knowledge (Buregyeya *et al.*, 2016).

2.3 Risk factors for tuberculosis among healthcare workers

Tuberculosis prevention is a major goal in the hospital setting, and, because of the possible progression or reactivation of latent disease, the screening of healthcare workers is an important component of the TB control program (Coppeta *et al.*, 2019). Personal and occupational factors have been positively associated with latent tuberculosis infection among healthcare workers, HCW (R. Garcia *et al.*, 2020; Peters *et al.*, 2020), and occupational screening for tuberculosis is not routine (Graves *et al.*, 2019). Health-care workers are susceptible to latent tuberculosis infection, LTBI (Almohaya *et al.*, 2020; Hermes *et al.*, 2020), especially in high burden tuberculosis countries like Kenya. Even though most of the HCWs acquire *Mycobacterium tuberculosis* but do not progress to the active disease, leading to LTBI (Belo and Naidoo, 2017). Screening for latent tuberculosis infection is important to identify healthcare workers (HCWs), who can then benefit from preventive therapy (Aksornchindarat *et al.*, 2021).

The high prevalence of LTBI among HCW emphasizes the need to continue pre-employment screening, especially for employed personnel from high endemic areas, with targeted annual screening for the same group and other identified high-risk groups (Almohaya *et al.*, 2020; Coppeta *et al.*, 2019; Erawati and Andriany, 2020). However, the heterogenic composition of

healthcare professionals in terms of nature of their work leads to the inconsistency in predicting the prevalence of LTBI among them (Guo *et al.*, 2021). A study to determine the prevalence of LTBI in a large heterogeneous HCW population and assess potential risk factors for LTBI in Riyadh, Saudi Arabia revealed that 24% of the HCWs had a positive test result, with the median age of 34.0 years, 71% being female. Here, nursing represented 57.7% of HCWs, and 24.7% were working in a non-clinical area, with only 20.3% working in TB-related departments. A higher risk of LTBI was present in HCWs who were older than 50 years (OR=1.95), working as a nurse (OR=2.7), allied health profession (OR=2.1), radiology technician (OR=3.1), or in the emergency room (OR=2.4) or intensive care unit (OR=2.1). In the binary logistic regression, independent predictors for positive QFT-Plus were age group older than 50 years (aOR=2.96), known TB exposure (aOR=1.97), and not receiving BCG at birth (aOR=3.08) (Almohaya *et al.*, 2020).

In, Mozambique, a cross-sectional study of healthcare workers found the prevalence of latent tuberculosis infection was 34.4%. Latent tuberculosis infection was highest in those working for more than eight years (39.3%), those who had no BCG vaccination (39.6%) and were immunocompromised (78.1%). Being immunocompromised was significantly associated with latent tuberculosis infection. Positive but non-significant associations occurred with working in the medical domain, length of employment over eight years and occupational contact with tuberculosis patients (Almohaya *et al.*, 2020; Belo and Naidoo, 2017). Another study in Mozambique identified the surgery department was most heavily affected by LTBI. In another study in Mozambique, from 690 screened healthcare workers, only 0.4% had active tuberculosis while 61.7% had latent tuberculosis infection. In this study, lower education, being aged 35-49 years, longer hospital service, and work in the surgery department were associated with increased likelihood of being tuberculosis infected at baseline ($p < 0.05$). on the other hand, sex, BCG vaccination, HIV infection, outside tuberculosis contacts, and professional category were not (Graves *et al.*, 2019).

In Semarang, Indonesia, the prevalence and demographic risk factors for latent tuberculosis infection (LTBI) among healthcare workers was conducted involving 195 healthcare workers from 34 primary health centers, and revealed a prevalence of 23.6%, and the only risk factor for

LTBI was comorbidities. Here, other demographic factors such as age, gender, smoking habits, and length of work were not significant risk factors for LTBI (Erawati and Andriany, 2020). These findings differ in certain aspects from a number of previous studies (Coppeta *et al.*, 2019; Erawati and Andriany, 2020; Goroh *et al.*, 2020; Hamada *et al.*, 2019), the main being the lack of association between duration of service and risk for LTBI, which was a key factor in the previous studies.

In China, the risk for LTBI in HCWs was found to be relatively high, with an average prevalence of 51.5%, and predisposed by the cumulative exposure to *Mycobacterium tuberculosis* from the community and the hospitals (Guo *et al.*, 2021). The prevalence of LTBI in Bengaluru City, India, was found to be 20.1% and it was significantly associated with age, place of residence, education, work commute time, and mode of transport. The incidence of LTBI was 19.4% and it was significantly associated with gender, place of residence, education, work commute time, and marital status (Kumar *et al.*, 2019).

2.4 Theoretical framework

This study was supported by the expanded health belief model (EHBM) which is described by Rosenstock *et al.* (1988), which says that *individuals will take a health-related action if they perceive that a negative health condition can be avoided, hold positive attitudes that taking a recommended action will result in avoiding the condition, and believe they can be successful in enacting the recommended action*.

The study considered healthcare workers' knowledge about TB and occupational risk factors as variables likely to influence the outcome, TB prevalence among health care workers. Socio-demographic, staff cadre and duration of service in health institutions, and healthcare workers' knowledge were deemed likely to influence TB diagnosis, transmission, treatment and MDR-TB as a complication. Under occupational risks, the study considered demographics, cadre commonly affected, duration of service in health institutions and level of exposure depending on period and level of interaction with patients.

Figure 2.5 Conceptual framework

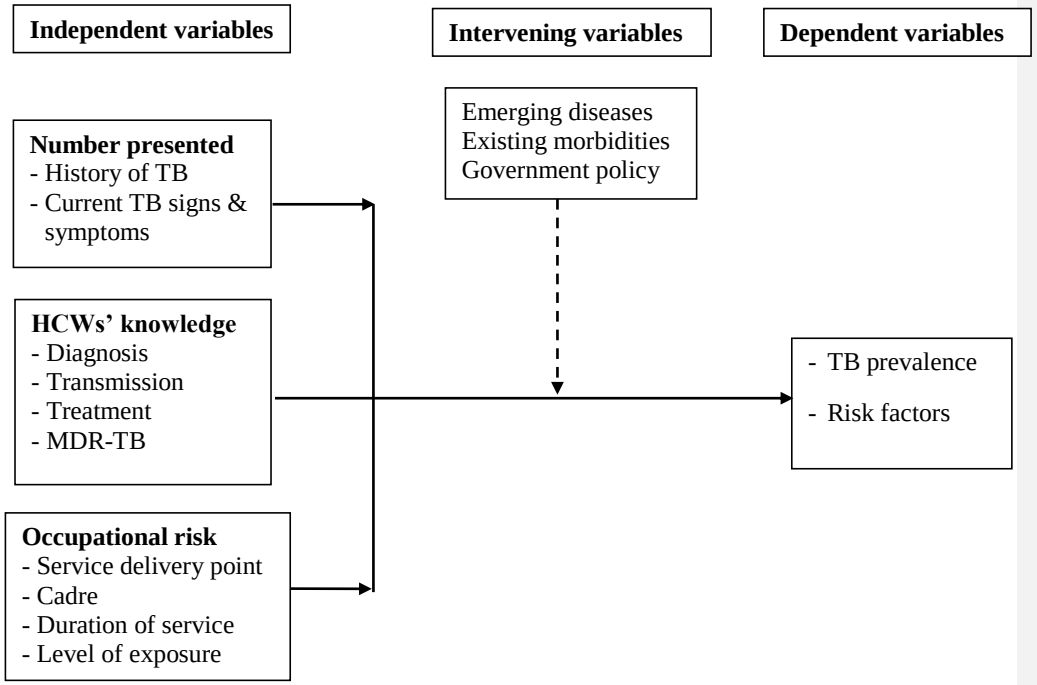


Figure 2.1 Conceptual framework (Source: Author)

CHAPTER THREE: METHODOLOGY

3.1 Research design

This was a quantitative descriptive cross-sectional study that determined the prevalence and risk factors for tuberculosis infection among healthcare workers in Siaya County.

3.2 Study area

The study area was in Siaya County, which lies within the northern part of Nyanza region, in western Kenya. It is one of the counties in this region, where about 30% of the total TB cases in the Kenya occur. Siaya situated in the southwest part of Kenya. It is bordered by borders Busia County to the north, Kakamega County and Vihiga County's to the northeast and Kisumu County to the southeast. It shares a water border (Lake Victoria) with Homa Bay County which is located to the south of Siaya County. The total surface area of the county is approximately 2,496.1 km² and lies between latitude 0° 26' to 0° 18' north and longitude 33° 58' east and 34° 33' west. Siaya has been split up into six Sub Counties (districts) under the new constitution. The capital town of the county is Siaya Town (www.countyedition.co.ke/counties/n-s/siaya.html. Siaya County has 10 public Sub County Hospital (Level 4 Hospitals).

3.3 Study population

The study area held a population of about 993,183, with a health care provider population of 3019, of whom 664 were in the 10 public hospitals in Siaya County as per the County health record and information report, with TB case notification rate of 306/100,000 population, compared to the Nation at 230/100,000 population. Both technical and non-technical staffs who had been working in health set up in Siaya County (Table 3.1):

Technical staff: Doctors, pharmacists & pharmaceutical technologists, laboratory technicians & technologists, nurses, clinical officers, health record & information officers, nutritionists, and public health officers were considered in the study.

Non-technical officers: Data clerks, receptionists, adherence counselors, peer educators, cleaners, cooks in the wards, HIV testing service officers (HTS), community-facility link assistants, community health volunteers, HIV mentor mothers participated among other staff.

Table 3.1: Sampled Health Care Workers in the 10 Public hospitals

Sub County	Level 4 Public Hospitals	Staff population	Sample
Alego Usonga	1. Siaya County referral Hospital	114	43
	2. Rwambwa Sub County Hospital	35	21
	3. Bondo Sub County Hospital	113	43
Bondo	4. Got Agulu Sub County Hospital	44	18
	5. Uyawi Sub County Hospital	34	15
Gem	6. Yala Sub County Hospital	78	33
Rarieda	7. Madiany Sub County Hospital	67	26
Ugenya	8. Ukwala Sub County Hospital	66	26
	9. Ambira Sub County Hospital	82	35
Ugunja	10. Sigomre Sub County Hospital	31	15
	Total	**664**	**275**

3.4 Inclusion and exclusion criteria

Not all the staff (664) working in the public Sub County Hospitals participated in this study:

3.4.1 Inclusion criteria

- Adult staff above 18 years
- Staff who had been working in Siaya County for more than 6 months
- Staff who consented to participate in the study

3.4.2 Exclusion criteria

- Staff with long term conditions affecting the chest e.g congestive cardiac failure.
- Students and staff who had stayed or worked in Siaya County for less than 6 months

3.5 Sample size determination

Sample size was calculated using Yamane (1967) formula; 10% of the calculated sample size was added to account for spoilt questionnaires

$$\mathbf{n = \frac{N}{1+N(e)^2}}$$

Where

n = Sample size N = Population size = 664 e = Margin of error (0.05; CI=95%)

$$n = \frac{664}{1 + (664 \times 0.05^2)}$$

$$n = 249.62 = 250$$

adjusting by 10% for non-response

n = 275

3.6 Sampling technique

A cross sectional study was conducted in 10 public sub county hospitals spread across the county, with an almost equal distance from one hospital to another, which was important for better representation of staff all over the county. The 10 hospitals were purposively selected and healthcare workers in each facility were selected by simple random sampling, after stratification by cadre. Total staff populations per cadre in all the facilities were picked from County Health Records and Information officer (HRIO). HCWs in each facility were selected by simple random sampling, after segregation per department in each facility. A proportion of 40% of the total staff per facility was calculated that summed to 265.6. Further calculation 10% of the result was considered to be added on the sum to cater for the spoilt questionnaires, hence a sample size of 275. At facility level, having known the number of departments, each facility sample size was spread equally to all departments. In some departments where fewer number of staff consenting contrary to the number anticipated, all were allowed to participate. However, in departments

having higher number consenting than the anticipated number, blinding “YES” & “NO” papers were used, where only those who picked yes were allowed to participate.

3.7 Data collection tools

Self-administered mixed questionnaires were issued to staff who consented to participate in the study. Observation checklists were used to report on the actual undertakings identifiable by the study team. The same participants were issued with filled TB request forms and falcon tubes. Sputum samples were collected using standard microbiological data collection techniques as recommended by the WHO (Shen & Sergi, 2020).

3.8 Reliability and validity

3.8.1 Reliability

- In addition to the supervisors, the thesis was reviewed by 2 TB experts (KEMRI-Kisumu & Department of Health Siaya County)
- The data collection tools were tested at Akala Health Center
- The areas that needed amendments were sorted before actual data collection

3.8.2 Validity

- To determine validity, Cronbach's alpha was calculated from the pretest to measure the internal consistency of the study questionnaire (Cronbach, 1951).
- A reliability index (α) of 0.83 was obtained, which was higher than the threshold (0.70), implying that the items of the questionnaire were consistent, and the tool was therefore reliable

3.9 Data collection procedures

This research used several questions organized in a 5-point Likert Scale to test the participants level of knowledge regarding tuberculosis. The questions were organized in two parts; training materials and Physical training facilities. Each part had four clear questions which intended to reveal the level of knowledge of HCWs regarding TB. The participants signed the consent forms willingly without coercion or undue influence. They were informed that they had a right to decline or withdraw any time even in the course of the study. There were self-administered

closed-ended questionnaires issued to healthcare workers to complete, with an intention of knowing who were passively diagnosed with tuberculosis in the past and potential risk factors for tuberculosis. Active case finding (ACF) for TB among the same healthcare workers was done. They were then being issued with filled codded request forms and codded falcon tubes which were readily available in the facilities supplied constantly by national TB program for sputum sample collection. All collected samples were sent to Gene Xpert sites available within the study facilities for TB investigation. Those who were unable to expectorate, were subjected to chest x-rays.

Participants were escorted to open air places or cough corners, where they were guided on sputum expectoration procedure as described by Shepherd (2017). Samples were collected and handed over to sample transporters who were taking them to the laboratories. Circumstances where the Gene Xpert machines within the facilities were non-functional, sample networking was done to other Gene Xpert sites for tests on daily basis. Participants who would tested TB positive were planned to immediately be referred to the Chest Clinics within the same facilities for TB treatment in line with MOH guidelines. Plans were that, the study team to follow-up review to the staff on TB treatment for 2 months (intensive phase) on the progress before they could be discontinued from the study. Unfortunately, none was found with active TB during the study period.

3.10 Data analysis

Data was entered into the computer, edited, coded, classified and analysis was done using SPSS version 23. Descriptive statistics was used to summarize the participant characteristics and TB prevalence, Chi-square test of association and logistic regression were conducted to test for the presence and/or strength of association between participant characteristics, HCW knowledge on TB, and TB prevalence ($\alpha = 0.05$). The results were presented inform of coefficients, ratios and percentages, and illustrated using tables, charts and graphs.

3.11 Ethical considerations

The study was approved by the Board of Postgraduate Studies, JOOUST. Authority to carry out research from JOOTRH Ethical Research Committee and NACOSTI permit obtained.

Permission to collect data from the study area was obtained from Ministry of Health, Siaya County. Research participants were taken through the consent process and we promised never to subjected them to harm in any way whatsoever, and respect for the dignity of research participants was prioritized. A written informed consent was obtained from the participants prior to the study where the willing participants voluntarily signed the consent forms before they were subjected to the study. The study ensured protection of the privacy of research participants by ensuring maximum level of confidentiality of the research participants' information. All collected data (filled questionnaires and sputum lab results) were kept under lock and key every day for privacy until the study was completed.

CHAPTER FOUR: RESULTS

4.1 Characteristics of the Respondents

In this study, a total of 275 (female = 155; 56.4%) healthcare workers were enrolled and their characteristics are presented in Table 4.1. The average age of the respondents was 35.3 (SD = 9.3) years, with the oldest being = 103 (37.5%) aged between 30-39 years. All the 275 (100.0%) study participants were Christians. Up to 154 (56.0%) of the study participants were married though majority not staying together and 56 (23.6%) of them resided in Alego Usonga Sub County. More than half (159; 57.8%) of the respondents attained college (diploma) education. Over two-thirds (196; 71.3%) of the healthcare workers were technical staffs. The median number of years the healthcare workers had worked in health care setting was 5 (IQR = 7) years. Slightly over half (141; 51.3%) of the participants had worked in health care setting for utmost five years (Table 4.1).

Table 4.1 Characteristics of respondents

Characteristics	n (%)
Gender	
Female	155 (56.4)
Male	120 (43.6)
Respondent's Age (years), mean (±SD)	35.3±9.3
< 30	87 (31.6)
30-39	103 (37.5)
40-49	59 (21.5)
50-59	24 (8.7)
60-69	2 (0.7)
Religion	
Christians	275 (100.0)
Marital status	
Single	67 (24.4)
Widow	23 (8.4)
Separated/Divorced	5 (1.8)
Married, staying together	26 (9.5)
Married, not staying together	154 (56.0)
Residence (Sub-county)	
Ugunja	38 (16.0)
Ugenya	50 (21.1)
Alego Usonga	56 (23.6)

Bondo	43 (18.1)
Gem	28 (11.8)
Rarieda	21 (8.9)
No data	1 (0.4)
Education	
Primary	9 (3.3)
Secondary	47 (17.1)
College (diploma)	159 (57.8)
University (undergraduate degree)	47 (17.1)
University (postgraduate degree)	13 (4.7)
Staff type	
Non-technical	75 (27.3)
Technical	196 (71.3)
No data	4 (1.4)
Cadres under technical staff	
Nurses	93 (47.45)
Clinical officers	42 (21.43)
Lab Techs	24 (12.24)
Health records	8 (4.08)
Pharm techs	14 (7.14)
Doctors	3 (1.53)
Nutritionists	6 (3.06)
Public Health Officers	6 (3.06)
Duration of service in health care setting (years), median (IQR)	
≤ 5 years	141 (51.3)
> 5 years	121 (44.0)
No data	13 (4.7)
Department commonly based (N=182)	
OPD	91 (50.00)
CCC	8 (4.40)
Chest/TB clinic	4 (2.20)
MCH	11 (6.04)
Special clinic	5 (2.75)
Laboratory	11 (6.04)
Radiology	6 (3.30)
Pediatric ward	12 (6.59)
Medical ward	23 (12.64)
Surgical ward	11 (6.04)
Maternity	0 (0.00)

4.2 Prevalence of tuberculosis

Of the 275 respondents, 18 (6.5%) reported to have ever been diagnosed with TB in the past five years (Table 4.2). Therefore, the period prevalence of TB among healthcare workers in Siaya county from 2017 to 2022 is 6.5% (95% CI 3.6%-9.4%). Out of the healthcare workers who reported having ever been diagnosed with TB, 18 (69.2%) were diagnosed using Gene Xpert, 5 (19.3%) using X-ray, 2 (7.7%) by clinical signs, while 1 (3.8%) was diagnosed using microscopy. All the 18 (100.0%) healthcare workers who ever tested positive for TB were treated for the disease. Majority (16; 88.3%) of the healthcare workers who were ever diagnosed for TB were registered in the health facility registers and 14 (80.8%) of them reported to have attended all their treatment schedules. Most (15; 84.6%) of the healthcare workers who ever tested positive for TB reported not to have been given whole pack of TB medication to take home, but were given return date of 1 week for the first two months and return date of 2 weeks in the last 4 months.

Table 4.2 Number of CHWs diagnosed with TB per department between 2017-2022

Department	**(N = 18) n (%)**
OPD	5 (27.78)
CCC	2 (11.11)
Chest/TB clinic	0 (0.00)
MCH	4 (22.22)
Special clinic	1 (5.56)
Laboratory	0 (0.00)
Radiology	1 (5.56)
Pediatric ward	1 (5.56)
Medical ward	2 (11.11)
Surgical ward	1 (5.56)
Maternity	1 (5.56)

4.3 Healthcare workers TB active case finding

Up to 194 (70.6%) of the healthcare workers did not report signs and symptoms like cough of any duration, weight loss, night sweats or chest pain at the time of the study. Over half (163; 59.3%) of the healthcare workers reported to have been in contact with someone coughing either at home or work place. Over three quarters (233; 84.7%) of the healthcare workers produced

sputum for TB diagnosis using Gene Xpert at the time of the study. All the healthcare workers who produced sputum, whose Gene Xpert testing of TB had negative results for TB (Figure 4.1). Therefore, the point prevalence of TB among healthcare workers was 0.0%.

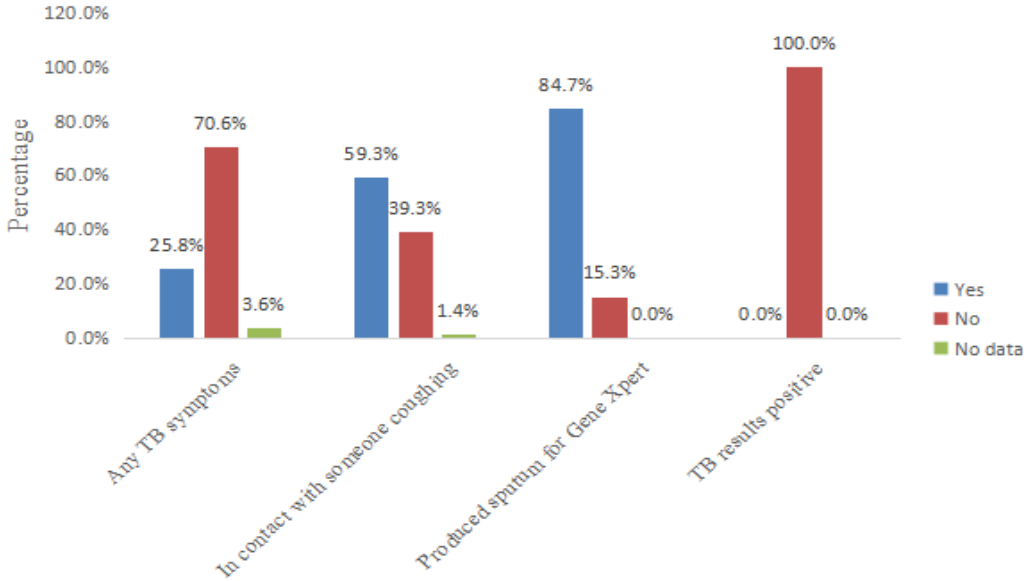


Figure 4.1: TB active case finding among healthcare workers

4.4 Knowledge level of healthcare workers on TB

The study results indicate that 87 (31.6%) healthcare workers strongly disagreed to have ever been trained on TB in the last two years. On whether the participants had been encouraged to interact during the TB training, 65 (23.6%) strongly disagreed. The highest proportion (83; 30.2%) of healthcare workers strongly agreed that the TB trainers were qualified and well prepared. About a quarter (66; 24.0%) of the healthcare workers strongly disagreed that good quality TB teaching aid materials were provided during TB trainings. Regarding adequacy and comfort of the lecture rooms used for TB trainings, 63 (22.9%) of the healthcare workers strongly agreed. About one-quarter (71; 25.8%) of the respondents strongly disagreed that TB related manuals were provided for reference back at their respective health facilities after undergoing TB training. Only 55 (20.0%) of the healthcare workers strongly disagreed that TB

trainings were helpful to them in patient management and TB infection prevention and control at work place (Table 4.3).

Table 4.3 Knowledge levels of healthcare workers on TB

Knowledge factors	n (%)
Attended at least a TB capacity building session	275 (100%)
Degree of satisfaction with capacity building	
Strongly disagree	87 (31.6)
Disagree	33 (12.0)
Neutral	34 (12.4)
Agree	42 (15.3)
Strongly agree	68 (24.7)
No response	11 (4.0)
Interactive TB training	
Strongly disagree	65 (23.6)
Disagree	23 (8.4)
Neutral	33 (12.0)
Agree	52 (18.9)
Strongly agree	65 (23.6)
No data	37 (13.5)
Well organized and easily understood TB training content	
Strongly disagree	65 (23.6)
Disagree	18 (6.5)
Neutral	32 (11.6)
Agree	48 (17.5)
Strongly agree	72 (26.2)
No data	40 (14.5)
Qualified and well-prepared TB trainers	
Strongly disagree	62 (22.5)
Disagree	26 (9.5)
Neutral	23 (8.4)
Agree	41 (14.9)
Strongly agree	83 (30.2)
No data	40 (14.5)
Good quality teaching aid materials provided	
Strongly disagree	66 (24.0)
Disagree	27 (9.8)
Neutral	32 (11.6)
Agree	58 (21.1)

Strongly agree	42 (15.3)
No data	50 (18.2)
Adequate and comfortable lecture room	
Strongly disagree	59 (21.5)
Disagree	22 (8.0)
Neutral	29 (10.5)
Agree	52 (18.9)
Strongly agree	63 (22.9)
No data	50 (18.2)
Provision of TB related manuals	
Strongly disagree	71 (25.8)
Disagree	27 (9.8)
Neutral	34 (12.4)
Agree	46 (16.7)
Strongly agree	44 (16.0)
No data	53 (19.3)
TB training in patient management and TB IPC at work place	
Strongly disagree	55 (20.0)
Disagree	23 (8.4)
Neutral	24 (8.7)
Agree	47 (17.1)
Strongly agree	73 (26.5)
No data	53 (19.3)

4.5 Occupational risk factors for TB infection among healthcare workers

In this study, the occupational risk factors related to TB infection were compared between healthcare workers who ever tested positive for TB and those who never tested positive for TB in the last five years. Table 4.4 shows the distribution of TB prevalence among healthcare workers in the last five years against occupational risk factors. Health facilities that conduct health talks with patients at waiting bays and segregate those who cough to be seen first were significantly associated with TB occurrence among healthcare workers ($\chi^2 = 11.125$, $p = 0.012$). Occupational risk factors such as constant supply of N95 masks ($\chi^2 = 7.505$, $p = 0.069$), putting on N95 masks ($\chi^2 = 6.335$, $p = 0.135$), provision of designated cough corner/sputum sample collection place ($\chi^2 = 6.714$, $p = 0.116$), availability of functional IPC ($\chi^2 = 7.796$, $p = 0.067$), availability of TB health talk schedule ($\chi^2 = 8.353$, $p = 0.052$) and availability of adequate lighting and cross

ventilation in all waiting bays and clinical rooms (χ^2 = 6.065, p = 0.144) were not significantly associated with TB prevalence among healthcare worker.

Table 4.4 Occupational risk factors associated with TB among healthcare workers

Variables	All N=275 n (%)	Ever diagnosed with TB			
		No (257) n (%)	Yes (18) n (%)	χ^2	*p* value
TB health talks and segregation of coughing patients				11.125	**0.012**
Strongly disagree	22 (8.3)	21(8.5)	1 (6.3)		
Disagree	18 (6.8)	15 (6.0)	3 (18.8)		
Neutral	34 (12.9)	34 (13.7)	0 (0.0)		
Agree	94 (35.6)	84 (33.9)	10 (62.5)		
Strongly agree	96 (36.4)	94 (37.9)	2 (12.5)		
No data	11	-	-		
Constant supply of N95 masks				7.505	0.069
Strongly disagree	128 (49.0)	117 (48.8)	11 (68.8)		
Disagree	33 (12.6)	33 (13.5)	0 (0.0)		
Neutral	19 (7.3)	17 (6.9)	2 (12.5)		
Agree	38 (14.6)	35 (14.3)	3 (18.8)		
Strongly agree	43 (16.5)	43 (17.6)	0 (0.0)		
No data	14	-	-		
Putting on N95 masks				6.335	0.135
Strongly disagree	106 (41.9)	97 (40.9)	9 (56.3)		
Disagree	32 (12.6)	32 (13.5)	0 (0.0)		
Neutral	37 (14.6)	34 (14.3)	3 (18.8)		
Agree	25 (9.9)	22 (9.3)	3 (18.8)		
Strongly agree	53 (20.9)	52 (21.9)	1 (6.3)		
No data	22	-	-		
Designated cough corner/sputum sample collection place provided				6.714	0.116
Strongly disagree	31 (11.9)	28 (11.4)	3 (18.8)		
Disagree	30 (11.5)	28 (11.4)	2 (12.5)		
Neutral	39 (14.9)	38 (15.5)	1 (6.3)		
Agree	58 (22.2)	51 (20.8)	7 (43.8)		
Strongly agree	103 (39.5)	100 (40.8)	3 (18.8)		
No data	14	-	-		
Functional IPC present				7.796	0.067
Strongly disagree	20 (7.8)	19 (7.9)	1 (6.3)		
Disagree	30 (11.7)	29 (12.0)	1 (6.3)		
Neutral	67 (26.1)	63 (26.1)	4 (25.0)		

Agree	69 (26.8)	60 (24.9)	9 (56.2)		
Strongly agree	71 (27.6)	70 (29.0)	1 (6.3)		
No data	18	-	-		
TB health talk schedule present				8.353	0.052
Strongly disagree	26 (10.3)	23 (9.7)	3 (20.0)		
Disagree	19 (7.5)	19 (8.0)	0 (0.0)		
Neutral	58 (23.0)	53 (22.4)	5 (33.3)		
Agree	65 (25.8)	59 (24.9)	6 (40.0)		
Strongly agree	84 (33.3)	83 (35.0)	1 (6.7)		
No data	23	-	-		
Adequate lighting and cross ventilation present				6.065	**0**.144
Strongly disagree	11 (4.2)	10 (4.1)	1 (6.3)		
Disagree	16 (6.2)	14 (5.7)	2 (12.5)		
Neutral	41 (15.8)	36 (14.8)	5 (31.3)		
Agree	79 (30.4)	75 (30.7)	4 (25.0)		
Strongly agree	113 (43.5)	109 (44.7)	4 (25.0)		
No data	15	-	-		

Bivariate analysis of the occupational risk factors shows that healthcare workers who disagreed ($_{C}$OR = 4.20; 95% CI 0.40-44.40) and agreed ($_{C}$OR = 2.50; 95% CI 0.30-20.63) that health facilities conduct health talks and segregate patients with cough were associated with higher odds of getting TB than those who strongly disagreed. However, those healthcare workers who strongly agreed on health talks and segregation of coughing patients were less likely to get TB (COR = 0.45; 95% CI 0.04-5.16). Compared to healthcare workers who strongly disagreed that health facilities have constant supply of N95 masks, those who were neutral were more likely to get TB infection (COR = 1.25; 95% CI 0.26-6.14) while those who agreed were less likely to be infected with TB (COR = 0.91; 95% CI 0.24-3.45).

Regarding staff who put on N95 masks when reviewing patients with cough or known TB patients, those who were neutral or strongly agreed with this statement had lower odds of TB infection (COR = 0.95; 95% CI 0.24-3.72, COR = 0.21; 95% CI 0.03-1.68), respectively, while those healthcare workers who agreed with the statement had increased odds of TB infection than the healthcare workers who strongly disagreed with the statement (COR = 1.47; 95% CI 0.37-5.88). Healthcare workers who disagreed (COR = 0.67; 95% CI 0.10-4.30), were neutral (COR =

0.25; 95% CI 0.02-2.49) or strongly agreed (COR = 0.28; 95% CI 0.05-1.46) that health facilities have designated cough corners/sputum collection sites had reduced odds of TB infection than those who strongly disagreed. On the other hand, healthcare workers who agreed that health facilities had designated cough corners/sputum collection sites were more likely to be infected with TB than those who strongly disagreed (COR = 1.28; 95% CI 0.31-5.35). The odds of TB infection among healthcare workers were lower among those who disagreed (COR = 0.66; 95% CI 0.04-11.12) or strongly agreed (COR = 0.27; 95% CI 0.02-4.45) and higher among those who were either neutral (COR = 1.21; 95% CI 0.13-11.45) or agreed (COR = 2.85; 95% CI 0.34-23.97) that health facilities had functional IPC compared to the healthcare workers who strongly disagreed. Healthcare workers who were neutral (COR = 0.72; 95% CI 0.16-3.28), agreed (COR = 0.78; 95% CI 0.18-3.38) or strongly agreed (COR = 0.09; 95% CI 0.01-0.93) that health facilities had TB health talk schedules were associated with reduced odds of TB infection than those who strongly disagreed that TB health talk schedules exist in health facilities.

Further, healthcare workers who disagreed (COR = 1.43; 95% CI 0.11-18.00) or were neutral (COR = 1.39; 95% CI 1.15-13.29) that health facilities have adequate lighting and cross ventilation in all waiting bays and clinic rooms increased their odds of TB infection than those who strongly disagreed. Finally, the bivariate analysis found that odds of TB infection were reduced among healthcare workers who agreed (COR = 0.53; 95% CI 0.05-5.26) or strongly agreed (COR = 0.37; 95% CI 0.04-3.61) that health facilities have adequate lighting and cross ventilation in all waiting bays and clinic rooms compared to those who strongly disagreed on the same.

After controlling for confounding variables in multivariate analysis, the occupational risk factors did not significantly contribute to TB infection among healthcare workers. However, healthcare workers who disagreed (AOR = 2.79; 95% CI 0.06-141.58) and agreed (AOR = 11.32; 95% CI 0.41-312.35) that health facilities conduct health talks and segregate patients with cough remained more likely to get TB infection than those who strongly disagreed when other factors were held constant. Similarly, those healthcare workers who strongly agreed on health talks and segregation of coughing patients remained less likely to get TB (AOR = 0.88; 95% CI 0.03-23.95) after controlling for confounding. When other factors remained constant, healthcare

workers who were neutral (AOR = 2.12; 95% CI 0.06-70.49) or agreed (AOR = 2.14; 95% CI 0.05-90.61) that health facilities have constant supply of N95 masks increased their odds of TB infection compared to those who strongly disagreed. Healthcare workers who were neutral (AOR = 0.61; 95% CI 0.03-11.94), agreed (AOR = 0.66; 95% CI 0.02-28.31) or strongly agreed (AOR = 0.09; 95% CI 0.01-3.66) that staff put on N95 masks when reviewing patients with cough or known TB patients were less likely to get TB than those who strongly disagreed after adjusting for other covariates. In the multivariate analysis, healthcare workers who disagreed (AOR = 0.51; 95% CI 0.01-48.17) or were neutral (AOR = 0.17; 95% CI 0.01-17.39) that health facilities have designated cough corners/sputum collection sites remained with reduced odds of TB infection than those who strongly disagreed. Healthcare workers who agreed or strongly agreed that health facilities had designated cough corners/sputum collection sites were more likely to be infected with TB than those who strongly disagreed after controlling for confounding (AOR = 12.17; 95% CI 0.28-531.64, AOR = 3.98; 95% CI 0.13-122.72) respectively. The odds of TB infection among healthcare workers were lower among those who were neutral (AOR = 0.95; 95% CI 0.01-78.54), agreed (AOR = 0.66; 95% CI 0.01-57.42) or strongly agreed (AOR = 0.34; 95% CI 0.01-73.86) and higher among those who disagreed (AOR = 7.17; 95% CI 0.05-1125.96) that health facilities had functional IPC compared to the healthcare workers who strongly disagreed when all other factors were constant.

Unlike in the bivariate analysis, healthcare workers who were neutral (AOR = 3.28; 95% CI 0.05-238.12) or agreed (AOR = 6.56; 95% CI 0.11-383.56) that health facilities have TB health talk schedules were associated with higher odds of TB infection than those who strongly disagreed after controlling for confounding. Healthcare workers who strongly agreed TB health talk schedules exist in health facilities remained less likely to get TB infection than those who strongly disagreed when all covariates were held constant (AOR = 0.40; 95% CI 0.01-54.29). As was seen in the bivariate analysis, in the multivariate analysis healthcare workers who disagreed (AOR = 4.06; 95% CI 0.01-1201.19) or were neutral (AOR = 1.13; 95% CI 0.01-139.05) that health facilities have adequate lighting and cross ventilation in all waiting bays and clinic rooms increased their odds of TB infection than those who strongly disagreed. Similarly, the multivariate analysis found that odds of TB infection were reduced among healthcare workers who agreed (AOR = 0.02; 95% CI 0.00-2.07) or strongly agreed (AOR = 0.52; 95% CI 0.01-

39.95) that health facilities have adequate lighting and cross ventilation in all waiting bays and clinic rooms compared to those who strongly disagreed on the same (Table 4.5).

Table 4.5 Occupational risk factors influencing TB occurrence among healthcare workers

Predictors	Ever diagnosed with TB		Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)	*p*-value
	No n (%)	Yes n (%)			
TB health talks and segregation of coughing patients					
Strongly disagree	21(8.5)	1 (6.3)	Reference		
Disagree	15 (6.0)	3 (18.8)	4.20 (0.40-44.40)	2.79 (0.06-141.58)	0.609
Neutral	34 (13.7)	0 (0.0)	N/A		
Agree	84 (33.9)	10 (62.5)	2.50 (0.30-20.63)	11.32 (0.41-312.35	0.152
Strongly agree	94 (37.9)	2 (12.5)	0.45 (0.04-5.16)	0.88 (0.03-23.95)	0.939
Constant supply of N95 masks					
Strongly disagree	117 (48.8)	11 (68.8)	Reference		
Disagree	33 (13.5)	0 (0.0)	N/A		
Neutral	17 (6.9)	2 (12.5)	1.25 (0.26-6.14)	2.12 (0.06-70.49)	0.674
Agree	35 (14.3)	3 (18.8)	0.91 (0.24-3.45)	2.14 (0.05-90.61)	0.691
Strongly agree	43 (17.6)	0 (0.0)	N/A		
Putting on N95 masks					
Strongly disagree	97 (40.9)	9 (56.3)	Reference		
Disagree	32 (13.5)	0 (0.0)	N/A		
Neutral	34 (14.3)	3 (18.8)	0.95 (0.24-3.72)	0.61 (0.03-11.94)	0.745
Agree	22 (9.3)	3 (18.8)	1.47 (0.37-5.88)	0.66 (0.02-28.31)	0.828
Strongly agree	52 (21.9)	1 (6.3)	0.21 (0.03-1.68)	0.09 (0.01-3.66)	0.199
Designated cough corner/sputum sample collection place provided					
Strongly disagree	28 (11.4)	3 (18.8)	Reference		
Disagree	28 (11.4)	2 (12.5)	0.67 (0.10-4.30)	0.51 (0.01-48.17)	0.769
Neutral	38 (15.5)	1 (6.3)	0.25 (0.02-2.49)	0.17 (0.01-17.34)	0.452
Agree	51 (20.8)	7 (43.8)	1.28 (0.31-5.35)	12.17 (0.28-531.64)	0.195
Strongly agree	100 (40.8)	3 (18.8)	0.28 (0.05-1.46)	3.98 (0.13-122.72)	0.430
Functional IPC					
Strongly disagree	19 (7.9)	1 (6.3)	Reference		
Disagree	29 (12.0)	1 (6.3)	0.66 (0.04-	7.17 (0.05-	0.445

			11.12)	1125.96)	
Neutral	63 (26.1)	4 (25.0)	1.21 (0.13-11.45)	0.95 (0.01-78.54)	0.981
Agree	60 (24.9)	9 (56.2)	2.85 (0.34-23.97)	0.66 (0.01-57.42)	0.856
Strongly agree	70 (29.0)	1 (6.3)	0.27 (0.02-4.54)	0.34 (0.01-73.86)	0.693
TB health talk schedule present					
Strongly disagree	23 (9.7)	3 (20.0)	Reference		
Disagree	19 (8.0)	0 (0.0)	N/A		
Neutral	53 (22.4)	5 (33.3)	0.72 (0.16-3.28)	3.28 (0.05-238.12)	0.587
Agree	59 (24.9)	6 (40.0)	0.78 (0.18-3.38)	6.56 (0.11-383.56)	0.365
Strongly agree	83 (35.0)	1 (6.7)	0.09 (0.01-0.93)	0.40 (0.01-54.29)	0.715
Adequate lighting and cross ventilation present					
Strongly disagree	10 (4.1)	1 (6.3)	Reference		
Disagree	14 (5.7)	2 (12.5)	1.43 (0.11-18.00)	4.06 (0.01-1201.19)	0.629
Neutral	36 (14.8)	5 (31.3)	1.39 (1.15-13.29)	1.13 (0.01-139.05)	0.962
Agree	75 (30.7)	4 (25.0)	0.53 (0.05-5.26)	0.02 (0.00-2.01)	0.097
Strongly agree	109 (44.7)	4 (25.0)	0.37 (0.04-3.61)	0.52 (0.01-39.95)	0.766

CHAPTER FIVE: DISCUSSION

5.1 Introduction

This chapter discusses the findings of this study, by presenting the findings on the three specific objectives. The discussion is therefore organized into four subchapters: the first subchapter discusses and interpret demographic results, the successive discussions are organized based on research objectives. These include tuberculosis prevalence in Siaya county, the level of knowledge of tuberculosis among healthcare workers in the 10 public sub-county hospitals, and the occupational risk factors for tuberculosis among healthcare workers in Siaya County.

5.2 Demographic characteristics of participants

The demographic results show that there are slightly more females' healthcare workers than males. Of the 275 participants who filled the questionnaire, 155 were females while 120 males, a fact that may be a reflection of the employment patterns of HCWs in Kenya, and by extension the training patterns for different HCW cadres. Because this study was conducted in Siaya County, it would look like gender disparity in the healthcare system is an exclusive problem of Siaya county, but the reality is that it is a problem in the Kenyan healthcare system, where, for example, only about 24% of nurses are male (KMPDC, 2024; KNBS, 2022). This implies that in every ten nurses, just about two are male. The problem with such disparity is that they can create differences in health outcomes especially for men. The secretary general of Kenya National Union of Nurses however played down the issues of gender disparity among Kenyan healthcare workers claiming that "the world doesn't need more men in the nursing profession but more professional nurses both male and female.

The average respondent age of 35.3 years is an indication that most healthcare workers in Siaya County are still young professionals, and therefore if they do not get transferred, they would offer healthcare service for a long period given that the mandatory retirement age for civil servants in Kenya is 60 years (KNBS, 2022). Another critical finding in regard to demographic analysis is the level of education of the healthcare workers in Siaya County. It is evident that more than half of the respondents have college diploma education, with only 47 of the participants having undergraduate education. Both undergraduate degree and college diplomas

are critical in the healthcare system, as these education levels are needed to increase efficiency in service delivery, career advancement and improved patient care (Doulla *et al.*, 2019). However, because each level requires different type of education, the data failed to show how many technical and non-technical staff had degrees or diploma. For example, whereas some healthcare workers like registered nurses and dental hygienists, may require a college diploma, it is better for doctors and pharmacists, to have undergraduate degree. The education and training requirements for doctors and pharmacists are designed to ensure that these professionals have the knowledge and skills necessary to provide high-quality care to patients (KMPDC, 2024). Besides this, the fact that over a half of the healthcare workers who participated in this research had worked in health care setting for utmost five years shows that most of healthcare staffs in Siaya are experienced to offer care services. Experience in the healthcare sector by healthcare practitioners is critical because it give healthcare professionals confidence, helps in the development of leadership skills and increase efficiency in the work of healthcare providers (Ababu *et al.*, 2022; Floyd *et al.*, 2018; Horter *et al.*, 2020).

5.3 Prevalence of tuberculosis among healthcare workers in public hospitals

The result provided above suggests that the prevalence of TB among healthcare workers in Siaya County, Kenya is relatively high, at 6.5%. This means that out of 275 healthcare workers surveyed, 18 reported having been diagnosed with TB in the past five years. Compared with a study done by (Kanyina EW, Tuberculosis infection among health care workers, August 2017) in Makindu and Kiambu, that had 91 and 450 HCWs respectively, where history of TB disease was taken and sputum smears were examined, 5 (5.5%) and 11 (2.4%) acid alcohol fast bacilli smear positive of TB among HCWs respectively.

The active case findings indicated relatively low prevalence, with 70.6% of HWCs not reporting having cough of at any duration, weight loss, night sweats or chest pain at the time of the study. Besides this, the findings can also be interpreted two ways. In the research by (Nonghanphithak *et al.*, 2016), it was revealed that healthcare workers appear to be at an increased risk of TB compared to the general population. That few HCWs in the county have been diagnosed with TB in the past five years does not mean that the HCWs in Siaya are not at risk of TB, it might imply that there is a general decline of TB among people who visits different healthcare facilities in

Siaya or the Healthcare workers have taken the necessary precautions in handling TB patients and therefore they do not get infected.

However, seen from above, a conclusion on the declining cases of TB among the general population in Siaya might not be accurate since data from the National TB and Leprosy Annual report of 2016 revealed that there were a total of 1657 TB cases in Siaya County. Besides this, the MOH ranked Siaya county fourth among five counties with a high burden of HIV and is has an estimated 126,411 PLHIV or 8.3%. And since people living with HIV/AIDs have compromised immunity, they are likely than others to become sick with tuberculosis. This therefore means that HCWs in Siaya have just taken precaution in handling TB patients and this has since reduced the incidences of TB infection amongst them. It is however important to note that that prevalence estimate stated above is based on self-reported data, which may be subject to bias and may not accurately reflect the true prevalence of TB among the healthcare workers in Siaya County. Self-reported data may be influenced by factors such as memory errors, social desirability bias, or underreporting. It is also possible that some of the respondents who reported never having been diagnosed with TB may have actually been infected with TB but were unaware of it or had not sought medical treatment. The confidence interval of 3.6%-9.4% provides a range of values within which the true prevalence of TB among the healthcare workers in Siaya County is likely to fall, based on the sample size and the precision of the estimate. In this case the confidence interval is narrow thus indicating a higher precision and a smaller margin of error in the estimated population. It is therefore safe to conclude that there is relatively low prevalence of TB among HCWs in Siaya County.

The findings from the method of diagnosis indicates that, Gene Xpert is the most common diagnosis method used among healthcare workers in Siaya County with TB like symptoms. Out of the 18 healthcare workers who reported ever having been diagnosed with TB, 69.2% were diagnosed using Gene Xpert, 19.3% were diagnosed using X-ray, 7.7% were diagnosed based on clinical signs, and 3.8% were diagnosed using microscopy. The results illustrate that Health facilities in Siaya County follows the recommendations by the Kenya National Tuberculosis, Leprosy and Lung Disease Program (NTLD-Program). The organ recommended the use of Gene Xpert machine as a first test for TB diagnosis for patients screening positive for TB symptoms.

As Floyd *et al.* (2018) further explained, the Gene Xpert machine is particularly useful in resource-limited settings where access to laboratory facilities and skilled personnel may be limited. The machine is important in contexts like Siaya County, where there are also high HIV incidences (Amare *et al.*, 2023a). The Gene Xpert machine can detect TB in HIV-positive individuals, who are at higher risk of developing TB and may have more severe disease (de Haas *et al.*, 2022; Diriba *et al.*, 2022a; Hamada *et al.*, 2021). But the popularity of the use of the Gene Xpert machine in Siaya County is also an indication that the County has limited health resources like laboratories and skilled personnel. The diagnosis data revealed that HCWs in Siaya County are exposed to several testing methods and this can help in faster diagnosis thus preventing incriminate transmission to patients or to other healthcare workers.

Delay in seeking treatment and misdiagnosis are the major causes of TB transmissions. his is because, it results to increased transmission, increased morbidity, mortality, and drug resistant TB (Djibuti *et al.*, 2019; Doulla *et al.*, 2019; Goroh *et al.*, 2020; Shamebo *et al.*, 2023). However, one of the most worrying trends noted with the data is that the majority (84.6%) of the healthcare workers in Siaya County who tested positive for TB reported not having been given a whole pack of TB medication to take home. This could have several implications for the diagnosis and treatment of TB among healthcare workers in Siaya County. One possible implication is that a significant proportion of healthcare workers may not be adhering to their TB treatment regimen as prescribed (Ababu *et al.*, 2022; Diriba *et al.*, 2022b; Graves *et al.*, 2019). Kenyan TB treatment guideline requires that TB clients be given return dates of every 2 weeks for the entire 6 months' treatment to ensure good adherence to TB treatment and early detection of adverse drug reactions. Issuing a whole 6 months' drug not recommended and having 84.6% of healthcare workers in Siaya not issued with a whole 6 months' drugs was good. It is important for individuals with TB to complete their full course of treatment in order to fully eradicate the infection and prevent the development of drug-resistant TB. Failing to take the full course of treatment as prescribed can result in incomplete treatment and an increased risk of treatment failure or relapse. Another possible implication noted by Almohaya *et al.* (2020) is that the lack of access to a full pack of TB medication may be a barrier to adherence and completion of treatment. Healthcare workers who do not have a full pack of TB medication may be more likely to miss doses or stop treatment prematurely, which can negatively impact their health and

increase the risk of transmission to others. Therefore, Floyd *et al.* (2018) suggested that healthcare workers need to have access to the necessary medication and support to complete their treatment as prescribed.

Concerning the active case findings shown in Figure 3, it can be deduced that the point prevalence of TB among healthcare workers in Siaya County is 0.0%. However, it's important to note that this data is only based on a sample of healthcare workers and may not be representative of the general population in Siaya County. Additionally, the data only includes healthcare workers who reported certain symptoms and those who were tested for TB using Gene Xpert. The high number of healthcare workers who reported to have been in contact with someone coughing either at home or work place, and the majority of the healthcare workers who produced sputum for TB diagnosis using Gene Xpert in figure 3 above, suggests although the prevalence of TB is low among healthcare workers in Siaya, there may be a higher prevalence of TB among the general population in Siaya county.

5.4 Health care worker knowledge on tuberculosis

Regarding whether participants were trained on TB in the past 2 years, majority of the participants interviewed strongly disagreed with statement. This means that most HCWs in Siaya do not have updated information regarding tuberculosis as a disease. This implies that HCWs in Siaya are not up-to-date on the latest advances in the field of TB, including new diagnostic techniques, treatment regimens, and infection control measures. This further leads to questioning their ability to provide highest quality care to patients if they do not often update their knowledge regarding the management of the disease. Alotaibi *et al.* (2019) contend that TB is a serious and potentially life-threatening infectious disease that requires specialized knowledge and skills to manage effectively. Continuous training is particularly important for healthcare workers who work with TB patients or who are at risk of exposure to TB. Lack of frequent training can disadvantage HCWs in Siaya in terms of diagnosis and management of the disease. Early diagnosis and appropriate management of TB cases by knowledgeable and skilled HCWs is key in improving patients' outcome and preventing transmission. However, in Siaya County, this cannot be assured as most healthcare workers do not update their knowledge on the diseases constantly. The result on training further corroborate with (Ramathebane *et al.*, 2019) study

findings that lack of training and education of healthcare workers especially in rural settings makes them have inadequate information on TB that is appropriate for personal use and in patient interaction and management of tuberculosis. Training and education therefore are identified by these findings as impediments to HCWs management of TB at both personal level and at patients' level. education remains a key challenge.

For the participants who agreed that they have had training, there was generally a contestation regarding the extent to which the training was interactive. About 23.6% of these participants strongly disagreed with the statement while the other half strongly agreed. On whether the content of training was well organized and easy to understand, 23.6% of the study participants strongly disagreed that the TB training content was organized and easy to understand. Besides this, the highest proportion of 30.2% of healthcare workers strongly agreed that the TB trainers were qualified and well prepared. About a quarter 66 (24.0%) of the healthcare workers strongly disagreed that good quality TB teaching aid materials were provided during TB training. The results above can be interpreted in several ways. Firstly, when training is not interactive, it becomes difficult for participants to be attentive and actively participate in the learning process. Interactive training leads to better understanding and retention of the material (Amare *et al.*, 2023a; Ndakidemi *et al.*, 2019; Vigenschow *et al.*, 2021). Therefore, it can be argued that the participants who reported that the training were not interactive understood and retained little helpful information in their work while those that reported training to be interactive understood and retain most of the information that they were taught.

Research by Vigenschow *et al.* (2021) found that interactive training on tuberculosis were significantly associated with high knowledge scores among healthcare workers. Alotaibi *et al.* (2019) emphasized the need for regular training for HCWs using the case of Riyadh, Saudi Arabia. In this case, he mentioned that the HCWs had average knowledge regarding TB. This affected their ability to understand concepts such as MDR -TB and LTBI, smear microscopy results, length of standard TB treatment for drug-sensitive TB, second-line anti-TB drugs, BCG vaccination, and appropriate PPE to be used with active PTB patients. However, training of HCWs is only effective if trainers are qualified, have proper organization and are interactive. In the case of Siaya County, data shows that although the trainers are considered by most of the

participants as qualified, they are not interactive and organized. This affects the extent to which HCWs understand and retain knowledge.

The physical training facilities in most of the ten hospital in Siaya County are not good enough, as participants felt specifically that there were no good quality teaching facilities and adequate and comfortable lecture rooms. The results further indicate that the participants were not provided with TB-related manuals for reference back at the facility. However, they generally agreed that the TB training they had attended were helpful in patient management and TB infection prevention and control at work. The lack of proper physical training facilities for HCWs in Siaya County might hamper their ability to offer the best care for patients and manage TB related illness among themselves. It is important for healthcare workers to have access to specific training on how to safely care for TB patients. This might include information on how to use personal protective equipment (PPE), how to properly administer TB medications, and how to manage respiratory isolation procedures. However, if even TB related manuals are not being provided to HCWs or when they are provided, it is only a few HCWs who receives might hamper the ability of these workers to offer the best care. The manuals are critical both for HCWs because they outline measures that a healthcare worker need to take in the management of both personal TB and that of the patients. According to Shrestha *et al.* (2017), uncomfortable or poorly-equipped lecture rooms can negatively impact the overall well-being of healthcare workers.

5.5 Occupational risk factors for TB infection among healthcare workers

Bivariate analysis examines the relationship between the occupational risk of tuberculosis (TB) among healthcare workers and various infection prevention and control (IPC) interventions in the healthcare facilities where they work. This study reports a moderate to strong relationship between the availability of these health interventions and the occupational risk of TB among healthcare workers, which has previously been reported elsewhere (Doulla *et al.*, 2019; Hamada *et al.*, 2021; Sharma *et al.*, 2018; Tiberi *et al.*, 2019). However, the availability of certain IPC interventions is associated with the occupational risk of TB among healthcare workers. For example, the data suggest that healthcare workers who work in facilities with designated cough corners/sputum collection sites and functional IPC measures may have a lower risk of TB

infection compared to those who work in facilities without these interventions. On the other hand, healthcare workers who work in facilities without constant supply of N95 masks or without TB health talk schedules may be at higher risk of TB infection. This results are similar to those of others, which indicated that healthcare workers who work in facilities with no designated cough corners/sputum collection sites and functional IPC measures are at a higher risk of contracting TB compared to others who work in facilities that have designated cough collection sites and functional IPC measures (Prado *et al.*, 2017; Weng *et al.*, 2016). It is also important to note that the strength and direction of the relationship between the IPC interventions and the occupational risk of TB varies. For example, the data from this study suggests that healthcare workers who strongly agree that their facility has designated cough corners/sputum collection sites have a lower risk of TB infection compared to those who strongly disagree, while those who agree have a higher risk of TB infection compared to those who strongly disagree. Besides this, it is also worth noting that the data discussed above are based on a bivariate analysis, which means that they are only examining the relationship between two variables (the occupational risk of TB and the availability of IPC interventions). This implies that other factors that may influence the occupational risk of TB, such as the healthcare workers' own personal risk factors or the prevalence of TB in the community, are not being taken into account (Coppeta *et al.*, 2019).

In this study, after controlling for potential confounding factors such as occupational risk factors such as age, gender, and TB knowledge, healthcare workers who agreed or strongly agreed with the following statements had a lower risk of TB infection: Health facilities conduct health talks and segregate patients with cough, Healthcare workers put on N95 masks when reviewing patients with cough or known TB patients, Health facilities have functional infection prevention and control measures, and Health facilities have TB health talk schedules. However, those that disagreed or were neutral with these statements had a higher risk of TB infection. Overall, these findings support others, who suggested that implementing and following proper infection prevention and control measures in health facilities may be effective in reducing the risk of TB infection among healthcare workers (Alene *et al.*, 2019; Nishimura *et al.*, 2018; Sharma *et al.*, 2018; Shi *et al.*, 2018). In this regard, it is important for health facilities in Siaya county to

prioritize the implementation and adherence to such measures in order to protect the health and safety of their staff.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

This study reports that about 6.5% of healthcare workers in sub-county county hospitals in Siaya County were diagnosed with tuberculosis (TB) between 2017 and 2022, suggesting that TB prevalence among healthcare workers in the county is relatively high. Regarding occupational risk factors among healthcare workers' adherence to infection prevention and control measures in health facilities remains a significant challenge to reduce the risk of TB infection among healthcare workers.

6.2 Recommendations

1. There is need for the Ministry of Health (national and Siaya County) and hospital administration to facilitate frequent TB screening to identify each healthcare worker with TB, and all put on appropriate early treatment.

2. All health facilities in Siaya County should prioritize the implementation of infection prevention and control (IPC) measures in all health facilities to prevent healthcare workers from acquiring tuberculosis while on duty.

3. The Ministry of Health (Siaya County) should provide sustained dissemination of knowledge about tuberculosis to all healthcare workers in the county. The training should also focus on the latest advances in the field of TB, including multi-drug resistant TB. In addition, healthcare workers should be provided with TB-related manuals and other necessary materials for reference.

6.3 Suggestion for future study

Future studies should delve into the reasons for the knowledge gap on TB among healthcare workers in Siaya County. Such studies should as such involve a more intensive data collection, involving more qualitative research approaches. Further, because the current study was only done in the Level 4 facilities, there is need to extend to lower levels, in order to also maximize the geospatial coverage of the study participants.

REFERENCE

Ababu, D. G., Gobena, W. E., & Getahun, A. M. (2022). Prevalence of Tuberculosis and the Determinants of Lose to Follow-Up the Treatment for Tuberculosis Patients in Case of Buno Bedele and Ilu Ababor Zones, Oromia, Ethiopia. *Infect Drug Resist, **15**,* 5321-5329. doi: 10.2147/IDR.S373230

Abebaw, Y., Abebe, M., Tola, H. H., Mehammed, Z., Getahun, M., Gamtesa, D. F., Diriba, G., Hailu, M., Yirgu, H., Sheth, A. N., Argaw, R., & Abegaz, W. E. (2023). Pulmonary tuberculosis case notification and burden of drug resistance among children under 15 years of age in Ethiopia: sub-analysis from third-round drug resistance tuberculosis survey. *BMC Pediatr, **23***(1), 418. doi: 10.1186/s12887-023-04240-6

Ahmed, M. M., Velayati, A. A., & Mohammed, S. H. (2016). Epidemiology of multidrug-resistant, extensively drug resistant, and totally drug resistant tuberculosis in Middle East countries. *Int J Mycobacteriol, **5***(3), 249-256. doi: 10.1016/j.ijmyco.2016.08.008

Aksornchindarat, W., Yodpinij, N., Phetsuksiri, B., Srisungngam, S., Rudeeaneksin, J., Bunchoo, S., Klayut, W., Sangkitporn, S., & Khawcharoenporn, T. (2021). T-SPOT(R).TB test and clinical risk scoring for diagnosis of latent tuberculosis infection among Thai healthcare workers. *J Microbiol Immunol Infect, **54***(2), 305-311. doi: 10.1016/j.jmii.2019.04.013

Alene, K. A., Adane, A. A., Yifiru, S., Bitew, B. D., Adane, A., & Koye, D. N. (2019). Knowledge and practice of health workers about control and prevention of multidrug-resistant tuberculosis in referral hospitals, Ethiopia: a cross-sectional study. *BMJ Open, **9***(2), e022948. doi: 10.1136/bmjopen-2018-022948

Almohaya, A., Aldrees, A., Akkielah, L., Hashim, A. T., Almajid, F., Binmoammar, T., & Barry, M. A. (2020). Latent tuberculosis infection among health-care workers using Quantiferon-TB Gold-Plus in a country with a low burden for tuberculosis: prevalence and risk factors. *Ann Saudi Med, **40***(3), 191-199. doi: 10.5144/0256-4947.2020.191

Alotaibi, B., Yassin, Y., Mushi, A., Maashi, F., Thomas, A., Mohamed, G., Hassan, A., & Yezli, S. (2019). Tuberculosis knowledge, attitude and practice among healthcare workers during the 2016 Hajj. *PLoS One, **14***(1), e0210913. doi: 10.1371/journal.pone.0210913

Amare, D., Getahun, F. A., Mengesha, E. W., Dessie, G., Shiferaw, M. B., Dires, T. A., & Alene, K. A. (2023a). Effectiveness of healthcare workers and volunteers training on improving tuberculosis case detection: A systematic review and meta-analysis. *PLoS One, **18***(3), e0271825. doi: 10.1371/journal.pone.0271825

Amare, D., Mengesha, E. W., Dessie, G., Shiferaw, M. B., & Getahun, F. A. (2023b). Effectiveness of home visiting on tuberculosis case detection: Systematic review and meta-analysis. *Indian J Tuberc, **70***(1), 29-36. doi: 10.1016/j.ijtb.2022.04.007

Arscott-Mills, T., Masole, L., Ncube, R., & Steenhoff, A. P. (2017). Survey of health care worker knowledge about childhood tuberculosis in high-burden centers in Botswana. *Int J Tuberc Lung Dis, **21***(5), 586-591. doi: 10.5588/ijtld.16.0668

Asgharzadeh, M., Rashedi, J., Poor, B. M., Kafil, H. S., Zadeh, H. M., & Ahmadpour, E. (2020). How Molecular Epidemiology Can Affect Tuberculosis Control in the Middle East Countries: A Systematic Review and Meta-Analysis. *Infect Disord Drug Targets*. doi: 10.2174/1871526520666200106123619

Ayana, T. M., Roba, K. T., & Mabalhin, M. O. (2019). Prevalence of psychological distress and associated factors among adult tuberculosis patients attending public health institutions in Dire Dawa and Harar cities, Eastern Ethiopia. *BMC Public Health, **19***(1), 1392. doi: 10.1186/s12889-019-7684-2

Belo, C., & Naidoo, S. (2017). Prevalence and risk factors for latent tuberculosis infection among healthcare workers in Nampula Central Hospital, Mozambique. *BMC Infect Dis, **17***(1), 408. doi: 10.1186/s12879-017-2516-4

Boeckmann, M., Warsi, S., Noor, M., Dogar, O., Mustagfira, E. H., Firoze, F., Zahid, R., Readshaw, A., Siddiqi, K., Kotz, D., Tb, & Tobacco, C. (2019). Health worker and patient views on implementation of smoking cessation in routine tuberculosis care. *NPJ Prim Care Respir Med, **29***(1), 34. doi: 10.1038/s41533-019-0146-6

Buregyeya, E., Kasasa, S., & Mitchell, E. M. (2016). Tuberculosis infection control knowledge and attitudes among health workers in Uganda: a cross-sectional study. *BMC Infect Dis, **16***(1), 416. doi: 10.1186/s12879-016-1740-7

Chen, B., Gu, H., Wang, X., Wang, F., Peng, Y., Ge, E., Upshur, R., Dai, R., Wei, X., & Jiang, J. (2019). Prevalence and determinants of latent tuberculosis infection among frontline tuberculosis healthcare workers in southeastern China: A multilevel analysis by individuals and health facilities. *Int J Infect Dis, **79***, 26-33. doi: 10.1016/j.ijid.2018.11.010

Coppeta, L., Pietroiusti, A., Neri, A., Janni, A., Baldi, S., Papa, F., & Magrini, A. (2019). Prevalence and Risk Factors for Latent Tuberculosis Infection among Healthcare Workers in a Low Incidence Country. *Open Respir Med J, **13***, 1-4. doi: 10.2174/1874306401913010001

Cuomo, G., Franconi, I., Riva, N., Bianchi, A., Digaetano, M., Santoro, A., Codeluppi, M., Bedini, A., Guaraldi, G., & Mussini, C. (2019). Migration and health: A retrospective study about the prevalence of HBV, HIV, HCV, tuberculosis and syphilis infections amongst newly arrived migrants screened at the Infectious Diseases Unit of Modena, Italy. *J Infect Public Health, **12***(2), 200-204. doi: 10.1016/j.jiph.2018.10.004

Daniels, B., Kwan, A., Pai, M., & Das, J. (2019). Lessons on the quality of tuberculosis diagnosis from standardized patients in China, India, Kenya, and South Africa. *J Clin Tuberc Other Mycobact Dis, **16***, 100109. doi: 10.1016/j.jctube.2019.100109

de Haas, P., Yenew, B., Diriba, G., Amare, M., Slyzkyi, A., Demissie, Y., Sherefdin, B., Bedru, A., Mengesha, E., Dememew, Z. G., Kebede, A., Getahun, M., Tiemersma, E., & Jerene, D. (2022). The Simple One-step stool processing method for detection of Pulmonary tuberculosis: A study protocol to assess the robustness, stool storage conditions and sampling strategy for global implementation and scale-up. *PLoS One, **17***(10), e0264103. doi: 10.1371/journal.pone.0264103

Dheda, K., Gumbo, T., Maartens, G., Dooley, K. E., McNerney, R., Murray, M., Furin, J., Nardell, E. A., London, L., Lessem, E., Theron, G., van Helden, P., Niemann, S., Merker, M., Dowdy, D., Van Rie, A., Siu, G. K., Pasipanodya, J. G., Rodrigues, C., Clark, T. G., Sirgel, F. A., Esmail, A., Lin, H. H., Atre, S. R., Schaaf, H. S., Chang, K. C., Lange, C., Nahid, P., Udwadia, Z. F., Horsburgh, C. R., Jr., Churchyard, G. J., Menzies, D., Hesseling, A. C., Nuermberger, E., McIlleron, H., Fennelly, K. P., Goemaere, E., Jaramillo, E., Low, M., Jara, C. M., Padayatchi, N., & Warren, R. M. (2017). The epidemiology, pathogenesis, transmission, diagnosis, and management of multidrug-resistant, extensively drug-resistant, and incurable tuberculosis. *Lancet Respir Med*. doi: 10.1016/S2213-2600(17)30079-6

Di Bella, S., Siroka, A., Antonello, R. M., Zignol, M., Maschio, M., Tominz, R., Cirillo, D., Migliori, G. B., Confalonieri, M., Raviglione, M., & Luzzati, R. (2019). Tuberculosis screening in outpatient healthcare workers: lessons from a high-income, low TB burden country. *Int J Tuberc Lung Dis, **23***(9), 1024-1028. doi: 10.5588/ijtld.19.0060

Diel, R., Niemann, S., & Nienhaus, A. (2018). Risk of tuberculosis transmission among healthcare workers. *ERJ Open Res, **4***(2). doi: 10.1183/23120541.00161-2017

Diriba, G., Alemu, A., Tola, H. H., Eshetu, K., Yenew, B., Amare, M., Dagne, B., Mollalign, H., Sinshaw, W., Abebaw, Y., Seid, G., Tadesse, M., Zerihun, B., Getu, M., Moga, S., Meaza, A., Gamtesa, D. F., Tefera, Z., Wondimu, A., Hailu, M., Buta, B., Getahun, M., & Kebede, A. (2022a). Detection of Mycobacterium tuberculosis and rifampicin resistance by Xpert(R) MTB/RIF assay among presumptive tuberculosis patients in Addis

Ababa, Ethiopia from 2014 to 2021. *IJID Reg, **5**,* 97-103. doi: 10.1016/j.ijregi.2022.09.001

Diriba, G., Alemu, A., Tola, H. H., Yenew, B., Amare, M., Eshetu, K., Sinshaw, W., Abebaw, Y., Meaza, A., Seid, G., Moga, S., Zerihun, B., Getu, M., Dagne, B., Mollalign, H., Tadesse, M., Buta, B., Wordofa, N., Alemu, E., Erresso, A., Hailu, M., Tefera, Z., Wondimu, A., Belhu, T., Gamtesa, D. F., Getahun, M., Kebede, A., & Abdela, S. (2022b). Pre-extensively drug-resistant tuberculosis among multidrug-resistant tuberculosis patients in Ethiopia: a laboratory-based surveillance study. *IJID Reg, **5***, 39-43. doi: 10.1016/j.ijregi.2022.08.012

Djibuti, M., Kasrashvili, T., & Zurashvili, T. (2019). Private primary health care provider delay in tuberculosis diagnosis and treatment in Georgia. *Public Health Action, **9***(3), 84-89. doi: 10.5588/pha.19.0001

Doosti Irani, A., Hashemi Shahraki, A., Ghaderi, E., Nasehi, M., & Mostafavi, E. (2015). Lack of optimum practice among health care workers regarding tuberculosis in Iran: A knowledge, attitude, and practice study. *Am J Infect Control, **43***(5), e7-12. doi: 10.1016/j.ajic.2015.01.020

Doulla, B. E., Squire, S. B., MacPherson, E., Ngadaya, E. S., Mutayoba, B. K., & Langley, I. (2019). Routine surveillance for the identification of drug resistant Tuberculosis in Tanzania: A cross-sectional study of stakeholders' perceptions. *PLoS One, **14***(2), e0212421. doi: 10.1371/journal.pone.0212421

Dunbar, E. L., Wroe, E. B., Nhlema, B., Kachimanga, C., Gupta, R., Taylor, C., Michaelis, A., Cundale, K., Dullie, L., Jumbe, A., Nazimera, L., McBain, R., Lilford, R. J., & Watson, S. I. (2018). Evaluating the impact of a community health worker programme on non-communicable disease, malnutrition, tuberculosis, family planning and antenatal care in Neno, Malawi: protocol for a stepped-wedge, cluster randomised controlled trial. *BMJ Open, **8***(7), e019473. doi: 10.1136/bmjopen-2017-019473

Erawati, M., & Andriany, M. (2020). The Prevalence and Demographic Risk Factors for Latent Tuberculosis Infection (LTBI) Among Healthcare Workers in Semarang, Indonesia. *J Multidiscip Healthc, **13***, 197-206. doi: 10.2147/JMDH.S241972

Floyd, K., Glaziou, P., Houben, R., Sumner, T., White, R. G., & Raviglione, M. (2018). Global tuberculosis targets and milestones set for 2016-2035: definition and rationale. *Int J Tuberc Lung Dis, **22***(7), 723-730. doi: 10.5588/ijtld.17.0835

Garcia, P. J., Hernandez-Cordova, G., Pourjavaheri, P., Gomez-Paredes, H. J., Sudar, S., & Bayer, A. M. (2018). Knowledge, attitudes and practices related to tuberculosis in pharmacy workers in a cross-sectional survey in El Agustino, Peru. *PLoS One*, ***13***(7), e0196648. doi: 10.1371/journal.pone.0196648

Garcia, R., Spiegel, J. M., Yassi, A., Ehrlich, R., Romao, P., E, A. N., Zungu, M., & Mabhele, S. (2020). Preventing Occupational Tuberculosis in Health Workers: An Analysis of State Responsibilities and Worker Rights in Mozambique. *Int J Environ Res Public Health*, ***17***(20). doi: 10.3390/ijerph17207546

Getahun, M., Ameni, G., Mollalign, H., Diriba, G., & Beyene, D. (2022). Genotypic and phenotypic drug-resistance detection and prevalence of heteroresistance in patients with isoniazid- and multidrug-resistant tuberculosis in Ethiopia. *IJID Reg*, ***2***, 149-153. doi: 10.1016/j.ijregi.2021.12.007

Getahun, M., Beyene, D., Mollalign, H., Diriba, G., Tesfaye, E., Yenew, B., Taddess, M., Sinshaw, W., & Ameni, G. (2024). Population structure and spatial distribution of Mycobacterium tuberculosis in Ethiopia. *Sci Rep*, ***14***(1), 10455. doi: 10.1038/s41598-024-59435-3

Goroh, M. M. D., Rajahram, G. S., Avoi, R., Van Den Boogaard, C. H. A., William, T., Ralph, A. P., & Lowbridge, C. (2020). Epidemiology of tuberculosis in Sabah, Malaysia, 2012-2018. *Infect Dis Poverty*, ***9***(1), 119. doi: 10.1186/s40249-020-00739-7

Graves, S. K., Augusto, O., Viegas, S. O., Lederer, P., David, C., Lee, K., Hassane, A., Cossa, A., Amade, S., Peleve, S., Zindoga, P., Massawo, L., Torriani, F. J., & Nunes, E. A. (2019). Tuberculosis infection risk, preventive therapy care cascade and incidence of tuberculosis disease in healthcare workers at Maputo Central Hospital. *BMC Infect Dis*, ***19***(1), 346. doi: 10.1186/s12879-019-3966-7

Guo, H. Y., Zhong, Q. H., Zhou, J., Zhao, Z. M., Zhang, X. L., Chen, Z. H., Qiu, X. C., & Wu, Z. L. (2021). Risk of prevalence of latent tuberculosis infection in health care workers-an idiographic meta-analysis from a Chinese perspective. *J Thorac Dis*, ***13***(4), 2378-2392. doi: 10.21037/jtd-20-1612

Hamada, Y., Getahun, H., Tadesse, B. T., & Ford, N. (2021). HIV-associated tuberculosis. *Int J STD AIDS*, ***32***(9), 780-790. doi: 10.1177/0956462421992257

Hamada, Y., Glaziou, P., Sismanidis, C., & Getahun, H. (2019). Prevention of tuberculosis in household members: estimates of children eligible for treatment. *Bull World Health Organ*, ***97***(8), 534-547D. doi: 10.2471/BLT.18.218651

Hermes, L., Kersten, J. F., Nienhaus, A., & Schablon, A. (2020). Risk Analysis of Latent Tuberculosis Infection among Health Workers Compared to Employees in Other Sectors. *Int J Environ Res Public Health, **17***(13). doi: 10.3390/ijerph17134643

Horter, S., Achar, J., Gray, N., Parpieva, N., Tigay, Z., Singh, J., & Stringer, B. (2020). Patient and health-care worker perspectives on the short-course regimen for treatment of drug-resistant tuberculosis in Karakalpakstan, Uzbekistan. *PLoS One, **15***(11), e0242359. doi: 10.1371/journal.pone.0242359

Isara, A. R., & Akpodiete, A. (2015). Concerns about the knowledge and attitude of multidrug-resistant tuberculosis among health care workers and patients in Delta State, Nigeria. *Niger J Clin Pract, **18***(5), 664-669. doi: 10.4103/1119-3077.154212

Khan, M. K., Islam, M. N., Ferdous, J., & Alam, M. M. (2019). An Overview on Epidemiology of Tuberculosis. *Mymensingh Med J, **28***(1), 259-266.

Kigozi, G., Heunis, C., & Engelbrecht, M. (2020). Community health worker motivation to perform systematic household contact tuberculosis investigation in a high burden metropolitan district in South Africa. *BMC Health Serv Res, **20***(1), 882. doi: 10.1186/s12913-020-05612-9

KMPDC. (2024). Kenya Medical Practitioners and Dentists Council registers. Retrieved July, 2024, from https://kmpdc.go.ke/registers-practitioners-php/

KNBS. (2022). *Kenya Demographic and Health Survey 2022: Key Indicators Report*. Nairobi, Kenya and Rockville, Maryland, USA: KNBS and ICF.

Kumar, M. G., Joseph, B., Goud, B. R., Joseph, M., & Rajitha, M. (2019). Risk of Tuberculosis Infection among Healthcare Workers in a Tertiary Care Hospital in Bengaluru City. *Indian J Occup Environ Med, **23***(2), 83-89. doi: 10.4103/ijoem.IJOEM_269_18

MacPherson, P., Webb, E. L., Variava, E., Lala, S. G., Milovanovic, M., Ratsela, A., Lebina, L., Kinghorn, A., & Martinson, N. A. (2019). Intensified household contact tracing, prevention and treatment support versus enhanced standard of care for contacts of tuberculosis cases in South Africa: study protocol for a household cluster-randomised trial. *BMC Infect Dis, **19***(1), 839. doi: 10.1186/s12879-019-4502-5

Malangu, N., & Adebanjo, O. D. (2015). Knowledge and practices about multidrug-resistant tuberculosis amongst healthcare workers in Maseru. *Afr J Prim Health Care Fam Med, **7***(1). doi: 10.4102/phcfm.v7i1.774

Manyazewal, T., Woldeamanuel, Y., Getinet, T., Hoover, A., Bobosha, K., Fuad, O., Getahun, B., Fekadu, A., Holland, D. P., & Marconi, V. C. (2023). Patient-reported usability and satisfaction with electronic medication event reminder and monitor device for tuberculosis: a multicentre, randomised controlled trial. *EClinicalMedicine, **56***, 101820. doi: 10.1016/j.eclinm.2022.101820

Mbuthia, G. W., Olungah, C. O., & Ondicho, T. G. (2018). Health-seeking pathway and factors leading to delays in tuberculosis diagnosis in West Pokot County, Kenya: A grounded theory study. *PLoS One, **13***(11), e0207995. doi: 10.1371/journal.pone.0207995

Modi, A. R., Miranda, C. C., Procop, G. W., Foster, C. B., Harrington, S., Evans, D., Johnson, L. T., & Gordon, S. M. (2020). Addressing the threat from within: Investigation of respiratory symptoms in a health care worker with untreated latent tuberculosis infection. *Am J Infect Control, **48***(1), 82-85. doi: 10.1016/j.ajic.2019.07.012

MOH. (2017). *National Tuberculosis, Leprosy and Lung Disease Program: Annual Report 2017*. Nairobi: GoK.

Ndakidemi, E., Emerson, C., Medley, A., Ngowi, B., Ng'eno, B., Munuo, G., Kohi, W., & Modi, S. (2019). Health care worker perspectives on TB case finding and HIV services among pediatric TB patients in Tanzania. *Int J Tuberc Lung Dis, **23***(7), 811-816. doi: 10.5588/ijtld.18.0445

Nduba, V., Kaguthi, G., Van't Hoog, A. H., Mitchell, E. M. H., & Borgdorff, M. (2020). The Incidence of Tuberculosis in Infants, Siaya District, Western Kenya. *Pediatr Infect Dis J, **39***(7), 591-597. doi: 10.1097/INF.0000000000002616

Nduba, V., Van't Hoog, A. H., de Bruijn, A., Mitchell, E. M. H., Laserson, K., & Borgdorff, M. (2019). Estimating the annual risk of infection with Mycobacterium tuberculosis among adolescents in Western Kenya in preparation for TB vaccine trials. *BMC Infect Dis, **19***(1), 682. doi: 10.1186/s12879-019-4314-7

Nishimura, T., Ota, M., Mori, M., Fujiwara, H., Takano, Y., Kato, S., Kawabe, H., & Hasegawa, N. (2018). Risk of tuberculosis infection among health care workers and nursing students in Japan. *J Infect Chemother, **24***(11), 921-924. doi: 10.1016/j.jiac.2018.08.006

Nishimura, T., Ota, M., Mori, M., Takano, Y., Fujiwara, H., Uwamino, Y., Uno, S., & Hasegawa, N. (2020). The annual risk of tuberculosis infection in newly hired researchers and healthcare workers using interferon-gamma release assay in Japan. *J Infect Chemother, **26***(8), 818-822. doi: 10.1016/j.jiac.2020.03.020

Noe, A., Ribeiro, R. M., Anselmo, R., Maixenchs, M., Sitole, L., Munguambe, K., Blanco, S., le Souef, P., & Garcia-Basteiro, A. L. (2017). Knowledge, attitudes and practices regarding tuberculosis care among health workers in Southern Mozambique. *BMC Pulm Med, **17***(1), 2. doi: 10.1186/s12890-016-0344-8

Nonghanphithak, D., Reechaipichitkul, W., Chaiyasung, T., & Faksri, K. (2016). Risk Factors for Latent Tuberculosis Infection among Health-Care Workers in Northeastern Thailand. *Southeast Asian J Trop Med Public Health, **47***(6), 1198-1208.

Ohene, S. A., Bonsu, F., Hanson-Nortey, N. N., Toonstra, A., Sackey, A., Lonnroth, K., Uplekar, M., Danso, S., Mensah, G., Afutu, F., Klatser, P., & Bakker, M. (2017). Provider initiated tuberculosis case finding in outpatient departments of health care facilities in Ghana: yield by screening strategy and target group. *BMC Infect Dis, **17***(1), 739. doi: 10.1186/s12879-017-2843-5

Okeyo, I. L. A., & Dowse, R. (2018). An illustrated booklet for reinforcing community health worker knowledge of tuberculosis and facilitating patient counselling. *Afr J Prim Health Care Fam Med, **10***(1), e1-e7. doi: 10.4102/phcfm.v10i1.1687

Peters, C., Kozak, A., Nienhaus, A., & Schablon, A. (2020). Risk of Occupational Latent Tuberculosis Infection among Health Personnel Measured by Interferon-Gamma Release Assays in Low Incidence Countries-A Systematic Review and Meta-Analysis. *Int J Environ Res Public Health, **17***(2). doi: 10.3390/ijerph17020581

Prado, T. N. D., Riley, L. W., Sanchez, M., Fregona, G., Nobrega, R. L. P., Possuelo, L. G., Zandonade, E., Locatelli, R. L., Souza, F. M., Rajan, J. V., & Maciel, E. L. N. (2017). Prevalence and risk factors for latent tuberculosis infection among primary health care workers in Brazil. *Cad Saude Publica, **33***(12), e00154916. doi: 10.1590/0102-311X00154916

Prihatiningsih, S., Fajar, J. K., Tamara, F., Mahendra, A. I., Rizqiansyah, C. Y., Adianingsih, O. R., & Suwandi, T. (2020). Risk factors of tuberculosis infection among health care workers: A meta-analysis. *Indian J Tuberc, **67***(1), 121-129. doi: 10.1016/j.ijtb.2019.10.003

Ramathebane, M. M., Makatjane, T. J., Thetsane, R. M., & Mokhethi, M. (2019). Assessment of tuberculosis knowledge among Lesotho village health workers and utilisation of their tuberculosis services by the communities they serve. *Afr J Prim Health Care Fam Med, **11***(1), e1-e7. doi: 10.4102/phcfm.v11i1.1944

Rocha, G. S., Lima, M. G., Moreira, J. L., Ribeiro, K. C., Ceccato, M., Carvalho Wda, S., & Silveira, M. R. (2015). [Community health workers' knowledge on tuberculosis, control measures, and directly observed therapy]. *Cad Saude Publica, **31***(7), 1483-1496. doi: 10.1590/0102-311X00112414

Rosenstock, I. M., Strecher, V. J., & Becker, M. H. (1988). Social learning theory and the Health Belief Model. *Health Educ Q, **15***(2), 175-183. doi: 10.1177/109019818801500203

Sabri, A., Quistrebert, J., Naji Amrani, H., Abid, A., Zegmout, A., Abderrhamani Ghorfi, I., Souhi, H., Boucaid, A., Benali, A., Abilkassem, R., Kmari, M., Hassani, A., Lahcen, B., Siah, S., Schurr, E., Boisson-Dupuis, S., Casanova, J. L., Lahlou, A., Laatiris, A., Louzi, L., Ouarssani, A., Bourazza, A., Aouragh, A., Mustapha, B., Messaoudi, N., Agader, A., Cobat, A., Abel, L., & El Baghdadi, J. (2019). Prevalence and risk factors for latent tuberculosis infection among healthcare workers in Morocco. *PLoS One, **14***(8), e0221081. doi: 10.1371/journal.pone.0221081

Shamebo, T., Gumi, B., Zewude, A., Gashaw, F., Mohammed, T., Girma, M., Zerihun, B., Getu, M., Mekasha, S., Getahun, M., Wondale, B., Petros, B., & Ameni, G. (2023). Molecular epidemiology and drug sensitivity of Mycobacterium tuberculosis in homeless individuals in the Addis Ababa city, Ethiopia. *Sci Rep, **13***(1), 21370. doi: 10.1038/s41598-023-48407-8

Sharma, D., Sharma, J., Deo, N., & Bisht, D. (2018). Prevalence and risk factors of tuberculosis in developing countries through health care workers. *Microb Pathog, **124***, 279-283. doi: 10.1016/j.micpath.2018.08.057

Shi, C. L., Xu, J. C., Chen, H., Ye, Z. J., Chen, X. N., Tang, P. J., Ma, L. L., Tang, Z. X., Wu, M. Y., & Xu, P. (2018). Risk factors of latent tuberculosis infection and immune function in health care workers in Suzhou, China. *J Thorac Dis, **10***(12), 6742-6752. doi: 10.21037/jtd.2018.10.112

Shrestha, A., Bhattarai, D., Thapa, B., Basel, P., & Wagle, R. R. (2017). Health care workers' knowledge, attitudes and practices on tuberculosis infection control, Nepal. *BMC Infect Dis, **17***(1), 724. doi: 10.1186/s12879-017-2828-4

Souza, F. M., Prado, T. N. D., Werneck, G. L., Luiz, R. R., Maciel, E. L. N., Faerstein, E., & Trajman, A. (2021). Classification and regression trees for predicting the risk of a negative test result for tuberculosis infection in Brazilian healthcare workers: a cross-sectional study. *Rev Bras Epidemiol, **24***, e210035. doi: 10.1590/1980-549720210035

Tiberi, S., Zumla, A., & Migliori, G. B. (2019). Multidrug and Extensively Drug-resistant Tuberculosis: Epidemiology, Clinical Features, Management and Treatment. *Infect Dis Clin North Am, **33***(4), 1063-1085. doi: 10.1016/j.idc.2019.09.002

UNAIDS. (2023). 2023 UNAIDS Global AIDS Update. Geneva: Joint United Nations Programme on HIV/AIDS (UNAIDS).

Vigenschow, A., Edoa, J. R., Adegbite, B. R., Agbo, P. A., Adegnika, A. A., Alabi, A., Massinga-Loembe, M., & Grobusch, M. P. (2021). Knowledge, attitudes and practices regarding tuberculosis amongst healthcare workers in Moyen-Ogooue Province, Gabon. *BMC Infect Dis, **21***(1), 486. doi: 10.1186/s12879-021-06225-1

Wa Ilunga, E. N., Muya, R. K., Kaponda, A. A., Kaput, C. M. A., Kalonji, S. M., Chiribagula, V. B., Nshikala, B. N., N'Sasi A, N., & Simbi, J. L. (2018). [Prevalence of HIV-Tuberculosis co-infection and HIV impact on patients with tuberculosis in the Lubumbashi Health Zone from 2014 to 2015]. *Rev Pneumol Clin, **74***(1), 9-15. doi: 10.1016/j.pneumo.2017.12.002

Wahab, F. A., Abdullah, S., Abdullah, J. M., Jaafar, H., Noor, S. S., Mohammad, W. M., Yusoff, A. A., Tharakan, J., Bhaskar, S., Sangu, M., Mahmood, M. S., Kassim, F., Rafia, M. H., Haspani, M. S., Alias, A., & Pando, R. H. (2016). Updates on Knowledge, Attitude and Preventive Practices on Tuberculosis among Healthcare Workers. *Malays J Med Sci, **23***(6), 25-34. doi: 10.21315/mjms2016.23.6.3

Wardani, H. R., Mertaniasih, N. M., & Soedarsono, S. (2021). Risk Factors of Latent Tuberculosis Infection in Healthcare Workers at Hospitals in Jember City Indonesia. *Afr J Infect Dis, **15***(1), 34-40. doi: 10.21010/ajid.v15i1.4

Weng, Y. H., Bhembe, P. T., Chiou, H. Y., Yang, C. Y., & Chiu, Y. W. (2016). Perceived risk of tuberculosis infection among healthcare workers in Swaziland. *BMC Infect Dis, **16***(1), 697. doi: 10.1186/s12879-016-2029-6

WHO. (2014). Recommendations for investigating contacts of persons with infectious tuberculosis in low-and middle-income countries. Geneva.

WHO. (2016). Recommendations for investigating contacts of persons with infectious tuberculosis in low-and middle-income countries. Geneva.

WHO. (2019). Global Tuberculosis Report 2019. Geneva: WHO.

WHO. (2020). Global Tuberculosis Report 2020. Geneva.

WHO. (2023). Global tuberculosis report 2023. Geneva: WHO.

Wingfield, T., MacPherson, P., Sodha, P., Tucker, A., Mithoo, J., Squire, S. B., & Cleary, P. (2019). Contacts of underserved tuberculosis patients have higher odds of TB disease in North West England: a cohort study. *Int J Tuberc Lung Dis, **23***(3), 337-343. doi: 10.5588/ijtld.18.0467

APPENDICES

Appendix 1: Informed Consent Form

Study Title: Prevalence and occupational risk factors for tuberculosis among healthcare workers in the Sub County hospitals in Siaya County, Kenya

Principal Investigator: Mary Juma Wambura
School of Health Sciences
Jaramogi Oginga Odinga University of Science and Technology
P.O Box 597 Siaya
0721998208
mary2.wambura@gmail.com

Purpose of study

You are being asked to take part in a research study. Before you decide to participate in this study, it is important that you understand why the research is being done and what it will involve. Please read the following information carefully. Please ask the researcher if there is anything that is not clear or if you need more information. The purpose of this study is to determine the number of healthcare workers who had contracted TB in the past years and investigate them for current TB infections, to evaluate the level of knowledge about TB among healthcare workers working in Siaya County and to identify occupational risk factors for tuberculosis among healthcare workers in Siaya County.

Study procedures

You will be issued with a self-administered, closed and open-ended questionnaires to complete, with an intention of knowing if you had been passively diagnosed with tuberculosis in the past and potential risk factors for tuberculosis. We shall also do Active Case Finding (ACF) for TB. Regardless of signs and symptoms you may have, you will be issued with filled request forms and falcon tubes for sputum sample collection. You will be escorted to a place or a cough corners where you will be guided on how to produce / expectorate quality sputum sample which will be sent to a machine called Gene Xpert for TB investigation. You will then be included in the follow-up for three months and your baseline findings will be included in the research analysis.

Sputum sample is the best for investigation, however, if you will completely be unable to expectorate, then you will be subjected to a chest x-ray as an optional investigation procedure.

Samples will be collected and handed over to sample transporters who will be taking them to the laboratories. In-case the Gene Xpert machines within the facilities will not be functional, sample networking will be done to other Gene Xpert sites for tests on daily basis. The results will be picked back by the same sample transporters the following day to be handed over to the study teams.

In case your test turns TB positive, you will immediately be referred to the Chest Clinics within the same facilities for TB treatment and further tests will be requested for immediately: Line Prob Assay, Culture and DST to pick any TB resistant pattern. The study team will be doing follow-up review to you on TB treatment for 2 months (intensive phase) on the progress before discontinuing you from the study. In case you will turn negative, you will repeat the tests on Monthly basis for two consecutive months. If you will constantly remain negative, then you will be discontinued from study.

If you participate in the whole course of the study, will be issued with a certificate of participation.

Benefits

There will be a probable early detection of TB disease in you and early TB treatment with better outcome as a direct benefit to you for your participation in this study. We also hope that the information obtained from this study may inform Ministry of health on level of risks among healthcare workers in acquiring TB and way forward.

Confidentiality

Your responses to this study will be anonymous. Please do not write any identifying information like your name on the study document. However, for the purposes of this research, your comments will not be anonymous. Every effort will be made by the researcher to preserve your confidentiality including the following: ensuring we sit with you in a private room, issuing you

with research codded consent forms, questionnaire, pre-filled TB request forms and falcon tubes not bearing your name.

All collected notes or data e.g. interview transcriptions and any other identifying participant information will be kept in a locked file cabinet in the personal possession of the researcher. The used hard copy tools will be discarded appropriately after the study.

Participant data will be kept confidential except in cases where the researcher is legally obligated to report specific incidents. These incidents include, but may not be limited to, incidents of abuse and suicide risk.

Contact information

If you have questions at any time about this study, or you experience adverse effects as the result of participating in this study, you may contact the researcher whose contact information is provided on the first page. If you have questions regarding your rights as a research participant, or if problems arise which you do not feel you can discuss with the Primary Investigator, please contact the Institutional Review Board at (865) 354-3000, ext. 4822.

Voluntary participation

Your participation in this study is voluntary. It is up to you to decide whether or not to take part in this study. If you decide to take part in this study, you will be asked to sign a consent form. After you sign the consent form, you are still free to withdraw at any time and without giving a reason. Withdrawing from this study will not affect the relationship you have, if any, with the researcher. If you withdraw from the study before data collection is completed, your data will be returned to you or destroyed.

Consent

I have read and I understand the provided information and have had the opportunity to ask questions. I understand that my participation is voluntary and that I am free to withdraw at any

time, without giving a reason and without cost. I understand that I will be given a copy of this consent form. I voluntarily agree to take part in this study.

Participant's signature _____ Date _____

Investigator's signature _____ Date _____

Appendix 2: Questionnaire for Health Care Workers

Part A: General information

Tick appropriately in the provided brackets.

1. Name of nearest health facility: ……
2. Gender: ☐ Male ☐ Female
3. Age in years……
4. Religion
   ☐ Christian ☐ Islam ☐ Hindu ☐ None
   ☐ Others (specify).....
5. Marital status
   ☐ Single; not married ☐ Married; staying together ☐ Married; not staying together
   ☐ Widowed ☐ Separated/Divorced
   ☐ Other (specify) .....

6. Residence:
   ☐ Location……. ☐ Sub-location……. ☐
   Village/estate……

7. Level of education
   ☐ Primary School ☐ Secondary school ☐ College (Certificate/Diploma)
   ☐ University (Degree) ☐ University (postgraduate)

8. Cadre: ☐ Technical staff (Specify)……
   ☐ Non-technical staff (Specify)……
   Years worked in this health facility……
   Years worked as a healthcare worker…….
   Years worked in this department……

9. Which departments are you commonly based in?
   ☐ OPD ☐ CCC ☐ Chest/TB clinic ☐ MCH ☐ Special clinic

☐ Eye clinic ☐ Laboratory ☐ Radiology ☐ Pediatric ward ☐ Medical ward

☐ Surgical ward ☐ Maternity ☐ Others specify ……

Part B: Prevalence of TB infection among healthcare workers

Please tick the appropriate box to indicate your degree of satisfaction

#	**Ratings**	**Yes**	**No**
1	Have you been diagnosed with TB in the past?		
2	If YES in 1, when was this?		
	How was the diagnosis done? *Tick all that apply* ☐ clinical signs ☐ microscopy ☐ culture ☐ Gene Xpert ☐ Other……		
3	Were you treated for the TB in the past?		
4	When you had TB, were you registered in a facility register?		
5	Did you attend all your treatment schedules?		
6	When you had TB, you were given a whole pack to take at home		

Part C: Staff TB active case finding (ACF)

Please tick the appropriate box to indicate if **Yes** or **No**.

Agree = Yes, disagree = No

	Ratings	**Yes**	**No**
1	You have any of these symptoms: Cough of any duration, weight loss, Night sweats or chest pain		
2	You have been in contact with someone coughing at home or at the facility		
3	If 1 and/or 2 above are ***yes***, you produced sputum for Gene Xpert in the past one week		
4	If you produced, the result turned positive		
5	If the result was positive, you were put on treatment		

6	If 1 & 2 are ***yes*** but you had not produced sputum in the past one week, or you had a sputum negative result, you are to do it today		
7	If you will have positive result, you will agree to be referred for treatment under confidentiality		

Part D: Knowledge of TB among healthcare workers

Please tick the appropriate box to indicate your degree of satisfaction.

Strongly disagree 1, disagree 2, neutral 3, agree 4, strongly agree 5

(1) Learning Materials

Strongly disagree=1, disagree= 2, neutral =3, agree =4, strongly agree =5

	Ratings	1	2	3	4	5
1	You have been trained on TB in the past 2 years?					
2	participates were encouraged to interact during training					
3	The content was well organized and easy to understand					
4	The trainers were qualified and well prepared					

(2) Physical training facilities

	Ratings	1	2	3	4	5
1	The teaching aid materials were provided and were of good quality					
2	The lecture room was adequate and comfortable					
3	TB related manuals were provided for reference back at the facility					
4	The TB training you attended has been helpful in patient management and TB infection prevention and control at work					

Occupational risk factors for tuberculosis among healthcare workers in Siaya County

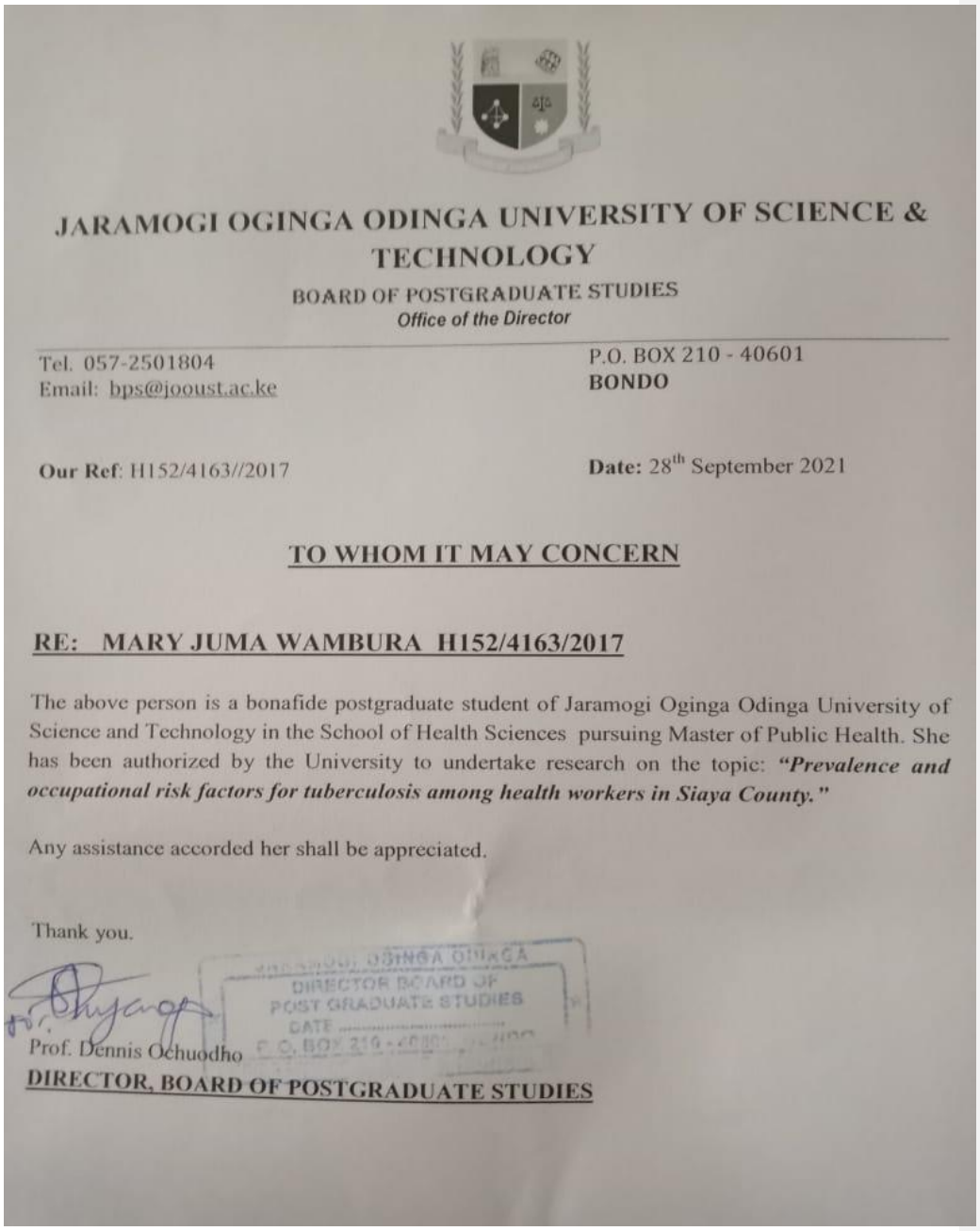
Part E: Occupational risk factors for TB at workplace

Please tick the appropriate box to indicate your degree of satisfaction.

Strongly disagree=1, disagree= 2, neutral =3, agree =4, strongly agree =5

	Ratings	1	2	3	4	5
1	The facility does health talks to patients at waiting bay and segregate those who cough to be seen first					
2	Facility has constant supplies of N95 masks to be used by staff in all departments					
3	N95 masks are only distributed/supplied in chest/TB clinic					
4	The staff put on N95 masks when reviewing patients who cough or known TB patients					
5	The facility has designated cough comer/sputum sample collection place					
6	The facility has IPC work plan and committee which meets every month with minutes					
7	The facility has a schedule for TB health talk to patients					
8	All waiting bays and clinical rooms have adequate light with cross ventilation					

Appendix 3: ERC approval letter



JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE & TECHNOLOGY

BOARD OF POSTGRADUATE STUDIES

Office of the Director

Tel. 057-2501804
Email: bps@jooust.ac.ke

P.O. BOX 210 - 40601
BONDO

Our Ref: H152/4163//2017

Date: 28th September 2021

TO WHOM IT MAY CONCERN

RE: MARY JUMA WAMBURA H152/4163/2017

The above person is a bonafide postgraduate student of Jaramogi Oginga Odinga University of Science and Technology in the School of Health Sciences pursuing Master of Public Health. She has been authorized by the University to undertake research on the topic: ***"Prevalence and occupational risk factors for tuberculosis among health workers in Siaya County."***

Any assistance accorded her shall be appreciated.

Thank you.

JARAMOGI OGINGA ODINGA
DIRECTOR BOARD OF
POST GRADUATE STUDIES
DATE
P. O. BOX 210 - 40601 BONDO

Prof. Dennis Ochuodho
DIRECTOR, BOARD OF POSTGRADUATE STUDIES

Appendix 4: BPS approval letter

COUNTY GOVERNMENT OF KISUMU
DEPARTMENT OF HEALTH

Telephone: 057-2020801/2020803/2020321
Fax: 057-2024337
E-mail: medsuptnpgh@yahoo.com
ercjootrh@gmail.com
Website: www.jaramogireferral.go.ke
When replying please quote

JARAMOGI OGINGA ODINGA TEACHING & REFERRAL HOSPITAL
P.O. BOX 849
KISUMU

Ref. No. IERC/JOOTRH/530/21

15th December, 2021
Date.....

RE: APPROVAL: STUDY TITLE:
PREVALENCE AND OCCUPATIONAL RISK FACTORS FOR TUBERCULOSIS AMONG HEALTH WORKERS IN THE SUB COUNTY HOSPITALS IN SIAYA COUNTY, KENYA.

REF: IERC/JOOTRH/530/21

TO: Principal Investigators: – Mary Juma Wambura

Dear Madam,

RE: STUDY TITLE

This is to inform you that JOOTRH IERC has reviewed and approved your above research proposal. Your application approval number is ***IERC/JOOTRH/530/21*** .The approval period is ***15th December, 2021 – 15th December, 2022.***

This approval is subject to compliance with the following requirements;

i. Only approved documents including (informed consents, study instruments, MTA) will be used
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by JOOTRH IERC.
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to JOOTRH IERC within 72 hours of notification
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to JOOTRH IERC within 72 hours
v. Clearance for export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days upon completion of the study to JOOTRH IERC.

1

viii. In case the study site is JOOTRH, kindly report to Chief Executive Officer before commencement of data collection.

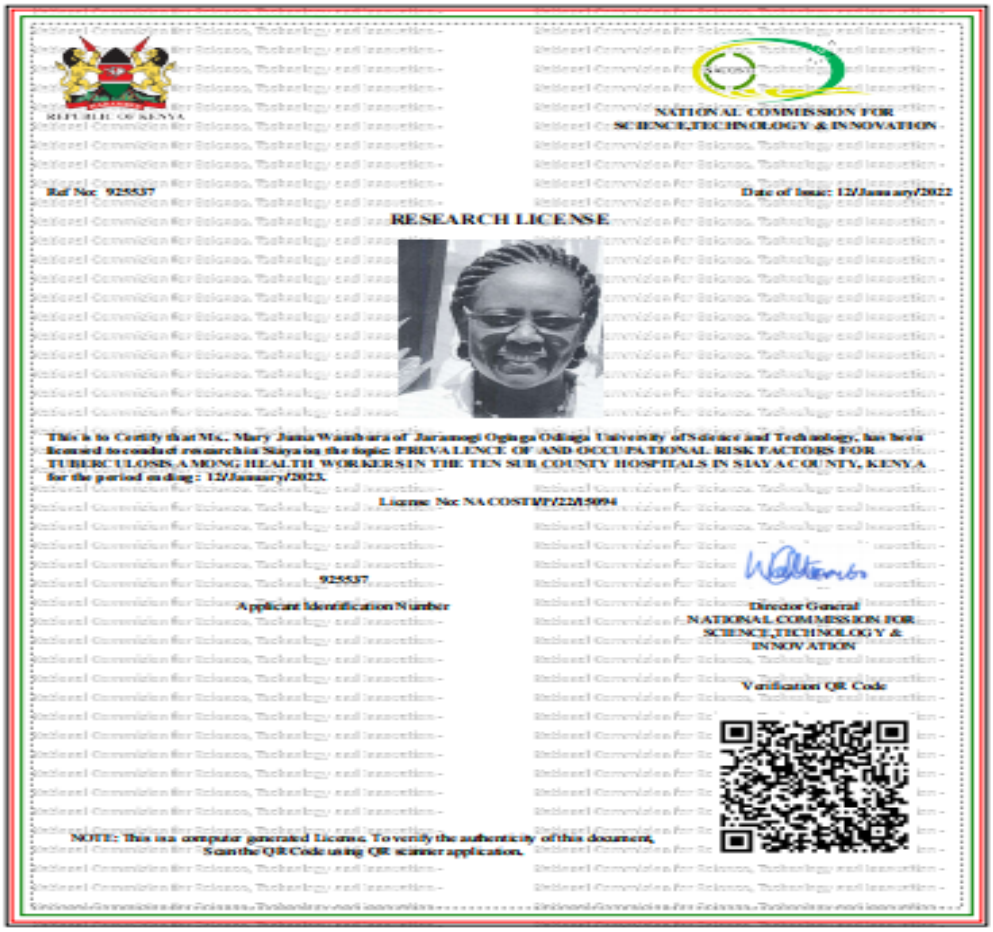
Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) and also obtain other clearances needed.

Yours sincerely,

NANCY MAKUNDA
SECRETARY – IERC
JOOTRH – KISUMU

JOOTRH ETHICS & REVIEW COMMITTEE
P. O. Box 849 - 40100
KISUMU
13 DEC 2021

Appendix 5: NACOSTI license



REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: 925537

Date of Issue: 12/January/2022

RESEARCH LICENSE

This is to Certify that Ms., Mary Jania Wambura of Jaramogi Oginga Odinga University of Science and Technology, has been licensed to conduct research in Siaya on the topic: PREVALENCE OF AND OCCUPATIONAL RISK FACTORS FOR TUBERCULOSIS AMONG HEALTH WORKERS IN THE TEN SUB COUNTY HOSPITALS IN SIAYA COUNTY, KENYA for the period ending: 12/January/2023.

License No: NACOSTI/P/22/15094

925537

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

THE SCIENCE, TECHNOLOGY AND INNOVATION ACT, 2013

The Grant of Research Licenses is Guided by the Science, Technology and Innovation (Research Licensing) Regulations, 2014

CONDITIONS

1. The License is valid for the proposed research, location and specified period
2. The License any rights thereunder are non-transferable
3. The Licensee shall inform the relevant County Director of Education, County Commissioner and County Governor before commencement of the research
4. Excavation, filming and collection of specimens are subject to further necessary clearance from relevant Government Agencies
5. The License does not give authority to transfer research materials
6. NACOSTI may monitor and evaluate the licensed research project
7. The Licensee shall submit one hard copy and upload a soft copy of their final report (thesis) within one year of completion of the research
8. NACOSTI reserves the right to modify the conditions of the License including cancellation without prior notice

National Commission for Science, Technology and Innovation
off Waiyaki Way, Upper Kabete,
P. O. Box 30623, 00100 Nairobi, KENYA
Land line: 020 4007000, 020 2241349, 020 3310571, 020 8001077
Mobile: 0713 788 787/ 0735 404 245
E-mail: dg@nacosti.go.ke / registry@nacosti.go.ke
Website: www.nacosti.go.ke

Appendix 6: Permission letter from CDH Siaya

REPUBLIC OF KENYA

COUNTY GOVERNMENT OF SIAYA

Department of Health and Sanitation

Correspondence should be addressed to:
The County Government of Siaya
Email: siayachd@gmail.com
In reply please quote:

County Health Headquarters
Adjacent to JCC Church
P.O. Box 597 – 40600
SIAYA

Our Ref: CGS/CO/CHD/RESEARCH/16/VOL.I(42)

3rd January, 2022

All Medical Superintendents
County Government of Siaya
SIAYA COUNTY

PREVALENCE AND OCCUPATIONAL RISK FACTORS FOR TUBERCULOSIS AMONG HEALTH WORKERS IN THE SUB-COUNTY HOSPITALS IN SIAYA COUNTY, KENYA

Mary Juma Wambura, is the Principal Investigator for the above referenced study. She has received authorization from Jaramogi Oginga Odinga Teaching and Referral Hospital Institutional Ethics Review Committee vide, REF: IERC/JOOTRH/530/21, to conduct the Research in our County.

Specific objectives

1. To determine prevalence of TB among health care workers in the ten public hospitals of Siaya County.
2. To establish level of knowledge of TB among health care workers working in ten public hospitals of Siaya County.
3. To identify occupational risk factors for tuberculosis among health care workers in the ten public hospitals of Siaya County.

It is expected that, dissemination of the results shall be conducted at relevant levels.

This is to notify you that the study has been approved by the office of the undersigned.

Kindly accord her necessary support.

COUNTY DIRECTOR OF HEALTH
SIAYA COUNTY
03 JAN 2022
P.O. Box 597-40600,
SIAYA.

Dr. Felix Tindi
Ag. County Director
Health and Sanitation

Copy to:
- CECM – Health and Sanitation
- Ag. Chief Officer of Health and Sanitation
  SIAYA COUNTY