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EVALUATION OF CONTACT TRACING OF INDEX TB CASES IN MUREWA DISTRICT, MASHONALAND EAST PROVINCE ZIMBABWE, 2024

BY

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Abstract

WHO highlighted that in 2023, there were approximately 10.8 million TB cases globally, with a quarter of the world's population having had TB infection. In 2022, among all incident TB cases, Africa had approximately 25% of the cases, with over 33% of deaths occurring in this region (World Health Organisation, 2022). According to the WHO, in 2021 alone, Zimbabwe had an estimated 29,945 people who developed TB, and of this population, only 16,541 were diagnosed and initiated treatment. There was an estimate of 7300 deaths, which included 5300 deaths among people living with HIV Tuberculosis (TB) remains a significant public health concern in Zimbabwe, with an estimated 211 cases per 100,000 population in 2023 (WHO, 2024). Approximately 14,000 TB cases were missed nationwide due to inadequate case detection and gaps in contact tracing (MOHCC, 2021). The percentage of contacts screened for TB in Zimbabwe decreased from 92.45% in 2021 to 88.29% in 2022 (WHO, 2023). The purpose of this study is to evaluate contact tracing for index TB cases in Murewa District, Mashonaland East, Zimbabwe, from January to December 2024, focusing on treatment outcomes, Presumptive and TB yields. This study utilised a cross-sectional analysis of the 2024 drug-sensitive TB cohort to evaluate TB contact tracing in Murewa District, Zimbabwe, from January 2024 to December 2024. It utilised secondary data from TB registers and facility records, complemented by quantitative interviews with healthcare providers involved in contact tracing. The study was conducted in Murewa District health facilities, one of the nine districts in Mashonaland East Province, Zimbabwe. The study population consists of: Index TB Cases, contacts of Index TB Cases and healthcare Workers (HCWs): involved in contact tracing, TB diagnosis, and treatment follow-up in Murewa District during the study period. On treatment outcomes of TB index cases, 58% were cured, 36% completed treatment 5% died, and 1% lost to follow-up. The treatment success rate was 94%. From the total index cases, 323 contacts were listed, and 260 were screened for TB. The coverage was 80.5% with 63(19.5%) contacts missed. Despite the 0% active TB yield found in the study, the presumptive TB yield was 36.2%. Among the health workers that participated in this study, 85% were trained in contact tracing. Staff shortage was highlighted by 17 out of 20 participants with 3 participants indicated that staff shortage did not affect contact tracing efforts. There is need to strengthened data driven and targeted support and supervision especially in areas where there if high staff attrition as need arise to implement this strategy. Mobilization of resources specific to the contact tracing program is crucial to ensure that there are no missed contacts to be screened.

Key words: Tuberculosis, Index Case, Contacts, Contact tracing, Murewa, Zimbabwe

Declaration

I, Chimedza Tanatsiwa, student number 221078, do hereby declare that this dissertation is my original work, except where sources have been cited and acknowledged. The work has never been submitted to another university for the award of a Bachelor of Science degree.

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Dedication

This study is dedicated to all those who supported me and above all the Lord Almighty for his peace and love.

Acronyms and Abbreviations

TB	Tuberculosis
WHO	World Health Organization
SDGs	Sustainable Development Goals
DRTB	Drug-Resistant Tuberculosis
EHT	Environmental Health Technician
EHO	Environmental Health Officer
CHW	Community Health Worker
MDR TB	Multiple Drug-Resistant Tuberculosis
MOHCC	Ministry of Health and Child Care of Zimbabwe
NTP	National Tuberculosis Program

Definition of key terms

Contact Tracing is a surveillance method that allows for gathering of data by scientists, on infections and how they may spread.

Index case is the initially identified case of new or recurrent pulmonary TB in a person of any age, in a specific household or other comparable setting in which others may have been exposed.

Contact is someone who has been exposed to MTB by sharing air space with a person with infectious TB.

Bacteriological confirmation of tuberculosis TB is when a biological sample tests positive for TB using a culture, smear microscopy, or a WHO-approved rapid diagnostic test, and clinically diagnosed TB is the clinical diagnosis of TB is made by a medical professional after a complete evaluation that includes Medical history, Physical examination, Chest x-ray, Laboratory tests, and TB blood test or TB skin test.

Pulmonary Tuberculosis (PTB) refers to any bacteriologically confirmed or clinically diagnosed case of TB involving the lung parenchyma or the tracheobronchial tree.

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CHAPTER 1 INTRODUCTION

1.1 Introduction

Tuberculosis (TB), an infectious disease caused by Mycobacterium, is a significant public health challenge, especially in resource-limited countries. The United Nations Sustainable Development Goals (SDGs) 3.3 states, "By 2030, end the epidemics of AIDS, tuberculosis, malaria, and neglected tropical diseases and combat hepatitis, waterborne disease, and other communicable diseases". TB is among the leading causes of death from a single infectious agent, as, according to the World Health Organisation in 2023, 1.25 million people died from TB. It is also the leading cause of death in individuals with HIV.

WHO highlighted that in 2023, there were approximately 10.8 million TB cases globally, with a quarter of the world's population having had TB infection. US$22 billion is annually needed to prevent, diagnose, and treat TB. This is especially true in drug-resistant tuberculosis, which occurs due to lack of adherence to treatment, poor quality of medicine or incorrect prescriptions. According to the Global Tuberculosis Report 2023, the number of individuals enrolled in treatment for MDR-TB increased from 161,843 in 2021 to 175,065 in 2022. The number of MDR-TB cases is falling slowly, with the burden stable (WHO, 2024a).

1.2 Background the Study

In 2022, among all incident TB cases, Africa had approximately 25% of the cases, with over 33% of deaths occurring in this region (World Health Organisation, 2022). According to the WHO, in 2021 alone, Zimbabwe had an estimated 29,945 people who developed TB, and of this population, only 16,541 were diagnosed and initiated treatment. There was an estimate of 7300 deaths, which included 5300 deaths among people living with HIV. However, Zimbabwe has transitioned out of the 30 high TB burden countries, with the incidence rate decreasing by 18% from 2015 to 2019.

However, Zimbabwe is still among the 30 countries with high TB/HIV burden and MDR/RR-TB burdened countries (World Health Organisation, 2021). In 2023, the estimated TB incidence was 211 per 100,000 population, an increase from 2022 (WHO, 2024a). Several individuals are often overlooked in the diagnosis and treatment of TB. According to the MOHCC in the Zimbabwe National TB and leprosy guidelines, in 2021 there were 14,000 missed cases, based on an incidence estimate of 190 per 100,000 population.

Factors contributing to this include limited resources, restricted access to healthcare services, limited capacity (Kakame et al., 2021), and discrimination (Courtwright & Turner, 2010). Hence, contact tracing should be prioritised to identify new TB cases early (Shah et al., 2013). This is effective in preventing further transmission of TB. Contact tracing is a public health strategy that involves identifying people who have been exposed to an infectious TB case, so they can be evaluated and treated to stop the spread of the disease (Centers for Disease Control and Prevention, 2021). In areas like Murewa District, where TB rates are high and health systems are limited, contact tracing helps allocate resources more effectively by concentrating on high-risk groups instead of screening entire communities.

While the general lifetime risk for an infected individual to develop active TB is 5-10%, this risk is significantly elevated among close contacts, particularly children under five and people with compromised immunity. In high-burden countries, the prevalence of TB disease among household contacts can be 3–5%, or even up to 12% among contacts of multidrug-resistant TB (MDR-TB) patients. (WHO, 2022).

Zimbabwe’s National Tuberculosis Program recognizes contact investigation as a critical pillar in its End TB Strategy and has tailored guidelines to incorporate contact screening as a priority (Ministry of Health and Child Care [MoHCC], 2023). The Zimbabwe National TB and Leprosy Guidelines emphasise that the primary objectives of TB contact investigation include identifying active TB disease among contacts and initiating early treatment. It also aims to prevent further community transmission of TB through the early detection and treatment of potential secondary cases.

Figure 1 illustrates the data flow in TB contact investigations, as outlined in the Ministry of Health and Child Care's (MOHCC) national guidelines for TB and Leprosy in Zimbabwe. The process begins with diagnosing an index TB case, at which point the nurses at the facility level list all the contacts associated with that case on a contact tracing form. This contact tracing form is submitted to the Environmental Health Technician (EHT), who will conduct further investigations. The EHT records each contact in the TB Contact Investigation Register, ensuring its maintenance and regular update. This investigation includes screening contacts by visiting households or workplaces within 72 hours of diagnosis. During these visits, they verify the list of TB contacts and use screening tools to assess them. Those contacts who show positive symptoms or present risk factors for progressing to TB are promptly invited to a health facility for essential assessment.

Furthermore, community health workers follow up with these contacts every 2 months to check whether individuals referred to the facility have attended their appointments. This report is provided to the EHT, which then updates the contact investigation register in accordance with the contact tracing form. The Clinician then updates the presumptive TB register and the health facility's TB register.

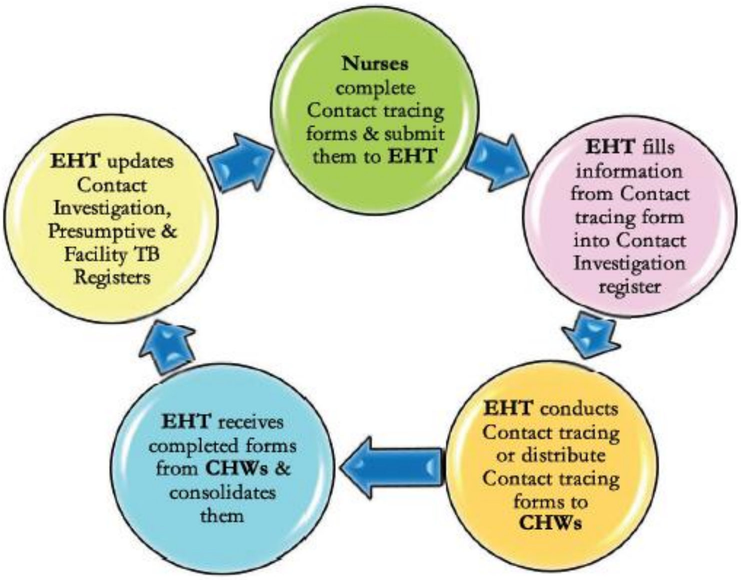

Figure 1: Data Flow Management in TB Contact Investigation

This study specifically evaluated the effectiveness of contact tracing for index TB cases in Murewa District. In this context, an "index TB case" referred to the initially identified TB patient from whom contact tracing efforts begin. Focusing on these index cases is critical as they serve as the primary source for identifying and investigating potential TB exposures within the community. Effective contact tracing among these cases significantly influenced transmission dynamics by ensuring that individuals who have been exposed are promptly identified, tested, and, if necessary, initiated on treatment.

The evaluation framework for this study assessed several key indicators:

- Timeliness of Contact Identification: The duration between the diagnosis of an index case and the tracing of their contacts.
- The proportion of Contacts Traced: The percentage of identified contacts successfully reached and evaluated.
- Treatment Initiation: The rate at which contacts who are diagnosed with TB commenced treatment.

By integrating global and national TB trends with localized data from the Murewa District, this study aimed to comprehensively evaluate current contact tracing efforts. It explored how broader challenges in TB control, evident in Zimbabwe and across Africa, manifest at the district level and affect the overall effectiveness of TB prevention and control strategies in Murewa District in 2024.

1.3 Statement of the Problem

Tuberculosis (TB) remain a significant public health concern in Zimbabwe, with an estimated 211 cases per 100,000 population in 2023 (WHO, 2024). Approximately 14,000 TB cases were missed nationwide due to inadequate case detection and gaps in contact tracing (MOHCC, 2021). The percentage of contacts screened for TB in Zimbabwe decreased from 92.45% in 2021 to 88.29% in 2022 (WHO, 2023). Despite national efforts to control TB, challenges persist in early detection and treatment initiation in resource-limited areas, particularly in rural areas such as Murewa (Mutembo et al., 2019). Murewa District, located in Mashonaland East, has 31 health facilities serving a predominantly rural population. Loss to follow-up is significantly higher in rural settings than in urban settings, thereby increasing the risk of creating MDR-TB cases (Mutembo et al., 2019). Challenges faced include shortages of trained health workers, limited diagnostic capacity and inadequate follow-up mechanisms for TB contacts. Effective contact tracing is paramount for breaking the chain of TB.

1.4 Research Objectives

1.4.1 Broad Objective

The purpose of this study was to evaluate contact tracing for index TB cases in Murewa District, Mashonaland East, Zimbabwe, from January to December 2024, focusing on coverage and treatment initiation rates.

1.4.2 Specific Research Objectives

The study specifically sought To:

1. determine the proportion of contacts successfully traced and screened for TB in Murewa District between January and December 2024.
2. determine the Presumptive TB and Active TB yield among contacts screened for Murewa District between January to December 2024.
3. determine the timeliness of contact tracing by measuring the time interval between the diagnosis of an index TB case and the screening of their contacts in Murewa District.
4. identify operational challenges and facilitators influencing the success of TB contact tracing in Murewa District.

1.4.3 Research Questions

1. What proportion of identified contacts were successfully traced and screened for TB in Murewa District (Jan–Dec 2024)?
2. What were the presumptive TB and active TB yields among the screened contacts?
3. What was the timeliness of contact tracing, measured by the interval between index case diagnosis and contact screening?
4. What operational challenges and facilitators influenced TB contact tracing in Murewa District?

1.5 Significance of the Study

Tuberculosis (TB) remains a public health concern in Zimbabwe, with an estimated 211 cases per 100,000 population in 2023 (WHO, 2024). Effective contact tracing is a critical strategy in reducing TB transmission; however, it remains inadequate due to low coverage, which leads to delays in diagnosis and treatment initiation. These gaps also hinder early case detection and increase the burden of TB on the healthcare system.

The study was justified for the following reasons

i. Addressing Gaps in TB Contact Tracing
ii. In Zimbabwe, current contact tracing efforts face challenges in coverage, timeliness and completeness; therefore, this study provided empirical evidence on the extent of these challenges in Murewa District
iii. Enhancing Data-Driven Decision Making
iv. Incomplete data hinders equitable resource allocation. This study evaluated how missing data affects TB control efforts and provided recommendations for improving data accuracy and utilisation for better program planning.
v. Strengthening TB case detection and treatment initiation
vi. This study highlighted the operational gaps and suggested ways to enhance early detection and reduce transmission through evaluating screening and treatment uptake among contacts.

1.6 Delimitation of the Study

This study was delimited to:

i. Geographical scope: The study focused on Murewa District, Mashonaland East Province, Zimbabwe, and covered 31 health facilities.
ii. Study population: This study included index TB cases diagnosed between January and December 2024, with their identified contacts within the same period.
iii. Time Frame: The study covered TB contact tracing activities conducted from January to December 2024, with data collection taking place in 2025.

iv. Scope of evaluation: The study assessed indicators of contact tracing, including coverage (percentage of contacts traced and screened), Timeliness (time interval between index case diagnosis and contact screening), Treatment uptake (percentage of contacts diagnosed with TB who initiated treatment) and operational challenges affecting contact tracing efforts.

1.7 Limitation of the Study

While this study aimed to provide valuable insights into the effectiveness of TB contact tracing in Murewa District, several limitations should be acknowledged.

i. Reliance of Retrospective Data

ii. This study relied on existing TB registers and health records, which contain incomplete or missing data, potentially affecting the accuracy of the findings. To mitigate this, this study triangulated data sources (e.g. healthcare workers' interviews) and used data imputation techniques where necessary.

iii. Limited Generalisation

iv. The findings from this study were specific to Murewa District and may not fully represent other regions in Zimbabwe, mainly urban areas with different healthcare dynamics.

v. Limited access to community-level perspectives

vi. The study focused on healthcare facility records and healthcare workers' perspectives, potentially excluding community-level challenges in contact tracing. Future research incorporated community-based studies to assess barriers to contact tracing from a patient's perspective.

1.8 Summary

Tuberculosis (TB) is a significant global public health issue, especially in resource-limited countries like Zimbabwe. TB, caused by Mycobacterium tuberculosis, remains one of the leading causes of death worldwide, with approximately 1.25 million fatalities reported in 2023 according to the World Health Organisation (WHO). Despite progress, TB persists as an epidemic largely driven by co-infection with HIV and the increase of drug-resistant strains such as multidrug-resistant TB (MDR-TB). The global disease burden necessitates comprehensive strategies aligned with Sustainable Development Goal 3.3 to eliminate TB, AIDS, and other communicable diseases by 2030.

The background highlights that Africa accounts for roughly 25% of global TB cases and over 33% of TB-related deaths. In particular, Zimbabwe estimated 29,945 TB cases in 2021, with only some diagnosed and treated, resulting in high mortality rates, especially among people with HIV. While Zimbabwe reduced TB incidence by 18% between 2015 and 2019 and has moved out of the highest-burden countries list, the challenges of TB/HIV co-infection and MDR-TB remain substantial.

A key challenge identified was the underdiagnosis of TB, with around 14,000 cases missed in 2021. This was mainly due to gaps in contact tracing, limited healthcare resources, access issues, capacity limitations, and stigma. Therefore, contact tracing is essential for early identification of exposed individuals, confirming infections, and starting treatment or preventive measures to curb transmission.

Contact tracing was a targeted method to identify and assess people exposed to infectious TB cases. This approach efficiently used resources by focusing on high-risk contacts instead of broad screening. Close contacts, particularly children under five and immunocompromised individuals, have a significantly higher chance of developing active TB, highlighting the need for prompt detection and treatment. Zimbabwe's National Tuberculosis Program includes contact investigation as a key part of its End TB Strategy, recommending systematic screening and early treatment for those identified.

The chapter elaborates on the national data flow and operational framework for contact investigations in Zimbabwe's Murewa District. After diagnosing an index TB case, facility nurses listed contacts using a contact tracing form, which Environmental Health Technicians then used to conduct household or workplace visits within 72 hours to screen contacts. Symptomatic or high-risk contacts are referred to health facilities for further evaluation. Follow-up by community health workers every two months ensured engagement and tracks referrals, with results recorded in registers that guided treatment and surveillance.

The study focused on evaluating contact tracing for index TB cases in Murewa District, using key indicators including timeliness from index diagnosis to contact tracing, the proportion of contacts traced and screened, and treatment initiation rates among diagnosed contacts. By contextualising these indicators within local program implementation and challenges, the study aimed to shed light on bottlenecks and areas for improvement.

The problem statement highlighted persistent high TB incidence (211 cases per 100,000 in 2023) and missed cases in Zimbabwe, compounded by a decline in contact tracing coverage from 92.45% in 2021 to 88.29% in 2022. Rural districts like Murewa faced amplified challenges due to limited trained personnel, low diagnostic capacity, insufficient follow-up mechanisms, and higher loss to follow-up, which collectively increased the risk of MDR-TB emergence. These gaps underscore the need to strengthen contact tracing to disrupt the TB transmission cycle.

The research objectives were to assess the proportion of contacts screened, the yield of presumptive and active TB among contacts, the timeliness of tracing, and the operational facilitators and barriers influencing contact tracing success in Murewa District during 2024.

The study's significance lied in addressing critical gaps in TB contact tracing coverage and data quality in Zimbabwe. Improving these areas enhanced early case detection, accelerated treatment initiation, and more effectively allocated limited healthcare resources. This study provided evidence-based recommendations for strengthening TB control at both district and national levels.

Limitations included reliance on retrospective data that was incomplete, limited geographic generalization beyond Murewa District, potential recall bias in qualitative interviews, and the absence of community-level perspectives, that suggested further research to be incorporated into patient-centred and community-based studies.

CHAPTER 2 REVIEW OF RELATED LITERATURE

2.1 Introduction

Tuberculosis (TB) remains a significant global public health challenge, especially in low- and middle-income countries. Contact tracing has become a vital strategy for early detection of TB cases, reducing transmission, and enhancing treatment outcomes. This chapter reviews existing literature on TB contact tracing, focusing on its effectiveness, implementation challenges, and current practices. This section synthesizes the latest evidence on contact tracing for pulmonary TB, particularly in high-burden, low- and middle-income settings. It highlights its implications for areas such as Murewa District in Zimbabwe. It also outlines the theoretical frameworks guiding this study and illustrates their relevance in assessing the effectiveness of contact tracing in Murewa District, Zimbabwe.

2.1.2 Global and Regional Burden of TB and Contact Tracing

According to the World Health Organization (WHO) Global Tuberculosis Report 2024, an estimated 13 million household contacts of people diagnosed with bacteriologically confirmed pulmonary TB worldwide in 2023. However, only 9.3 million were reported, and 7.9 million (85 %) were evaluated for both TB infection and disease. The same report underscores that, though contact tracing is a key strategy, extensive coverage and implementation gaps remain across many countries.

A systematic review and meta-analysis in sub-Saharan Africa (2023) found that the pooled prevalence of active TB among household contacts was 3.29% (95% CI: 2.35–4.23%). For children under 5 years, the prevalence was 2.60% (95% CI: 1.81–3.39%) (Seid et al., 2022). This suggests that considerable opportunities for detection exist through contact tracing and emphasizes its importance in high TB/HIV burden settings. It also highlights the increased risk faced by household contacts of TB patients, with about one in every thirty contacts developing active TB, underscoring the need for rigorous contact tracing and active case finding in these populations. In Zimbabwe's context, the national guidelines emphasize that contacts, particularly children and people living with HIV, are prioritized.

2.1.3 Effectiveness of Contact tracing: Recent Evidence

Active contact tracing involves healthcare workers systematically identifying and evaluating contacts of confirmed tuberculosis (TB) cases. It has proven consistently more effective than passive methods that depend on individuals seeking screening or diagnosis. A 2022 systematic review by Hossain et al. emphasised that active contact tracing enhances case detection by identifying TB cases earlier and reaching individuals who might otherwise remain undiagnosed due to barriers such as a lack of awareness or stigma. Moreover, active case finding promotes greater equity by detecting cases among women and asymptomatic individuals at earlier stages of the disease compared to passive methods (Saunders et al., 2019)

Research from high-burden nations like Ethiopia and Pakistan shows a 35% increase in TB detection with active case finding compared to passive methods (Shah et al., 2013). These improvements stem from proactive household visits, symptom screening, and focused testing, thereby reaching populations beyond those who visit health facilities. Likewise, studies reveal that household or community contact tracing identifies many more new TB cases than facility-based methods, which often miss cases due to dependence on self-reporting and health-seeking behaviour.

Community-based contact tracing, involving community health workers, enhances reach, trust, and timely case detection, especially in rural areas (Mosweunyane et al., 2015). Unlike facility-based tracing, which is more structured but less comprehensive because it depends on individuals visiting health facilities, community health workers can go door-to-door for screening, offer ongoing monitoring, and help connect people to care. This approach makes the intervention more acceptable and easier to access. Although facility-based tracing is more formal and organized, it often falls short in terms of reach and speed, relying heavily on contacts to visit healthcare centers, which can result in many potential TB cases being missed.

Both approaches help break transmission chains but combining active and community-based strategies has become the best practice for effective TB control in resource-limited, high-burden settings. These findings highlight the importance of strengthening health systems, including training CHWs, providing sufficient logistical support, and encouraging community involvement to maximise the impact of TB contact tracing programmes.

2.1.4 Yield and Coverage

About 1 in 30 household contacts in sub-Saharan Africa developed active TB. A study in South Africa (2023) among household contacts found a substantial proportion of subclinical pulmonary TB; in two provinces, many culture-positive cases among contacts had no symptoms.

A pragmatic cluster-randomised trial in rural South Africa compared contact tracing to facility-based screening (Carter et al., 2023). It found no statistically significant difference in the combined outcome of incident TB or death at 15 months: hazard ratio (HR) 0.90, 95% confidence interval (CI) 0.66–1.24. This shows that simply identifying and screening contacts is not enough to significantly improve outcomes unless paired with effective linkage-to-care and follow-up systems. Without proper follow-up, even well-conducted contact tracing may not markedly reduce TB transmission or mortality. This evidence highlights critical programmatic implications: while active contact tracing can yield more subclinical and asymptomatic TB cases, the ultimate impact on patient outcomes depends on timely treatment initiation and adherence, which are facilitated by robust health systems. Early diagnosis must be linked to prompt, effective treatment and sustained patient support, especially in rural and resource-constrained settings. Enhanced surveillance, integration of novel diagnostics, community engagement, and improved care pathways are vital components for realising the full potential of contact tracing interventions in high-burden regions like South Africa.

2.1.5 Role of digital technologies and innovation

A 2023 review on mHealth in Africa found that mobile health tools and digital apps can significantly enhance tuberculosis (TB) contact tracing, case detection, and data collection. These technologies overcome the limitations of paper-based systems by enabling more accurate, timely, and efficient data management throughout contact tracing (Mudzengi et al., 2024). Key benefits include reducing repetitive manual tasks, minimising data entry errors, and improving contact follow-up and monitoring via digital platforms, providing clear advantages over traditional approaches.

The review showcased various mHealth initiatives across African regions, including mobile applications, SMS communication, digital registries, and GPS-enabled devices for locating TB contacts in remote or inaccessible areas. Prominent programmatic efforts include Nigeria's Surveillance Outbreak Response Management and Analysis System (SORMAS), Kenya's AMPATH, and Tanzania's Tambua tuberculosis app. These solutions support real-time data collection, rapid reporting, and enhanced coordination among healthcare workers and supervisors, resulting in better coverage and timeliness of contact tracing.

The study also highlighted significant variability in the effectiveness and reach of these digital interventions. Barriers include unreliable network connectivity in rural areas, hardware and software failures, gaps in healthcare workers' digital literacy, and concerns about data privacy and security. To succeed, implementing mhealth solutions requires strong infrastructure, adequate training, and designs that suit the specific context.

For Zimbabwe, where rural districts face ongoing challenges with data quality, follow-up, and logistical support in TB programmes, integrating mHealth technologies could significantly enhance the efficiency and results of contact tracing. Digital tools can enable quick identification and screening of contacts, facilitate connection to care, and boost overall surveillance capacity. When combined with community health worker involvement and targeted resource mobilisation, mHealth can foster sustainable improvements in TB control at the community level.

In conclusion, while mHealth holds promise for transforming TB contact tracing in Africa, including Zimbabwe, attention to local implementation contexts and systematic evaluations is critical to optimise its full potential and scalability.

2.1.6 Timeliness and linkage to preventive therapy

The WHO screening guidance highlights that household contacts of TB patients should be quickly evaluated and, if suitable, started on preventive therapy without delay. This involves a systematic screening process that includes checking for symptoms, performing tuberculin skin tests or interferon-gamma release assays (IGRAs) for symptomatic individuals or those with positive test results, and assessing clinical risk factors for developing active TB. The goal is to detect TB infection early and prevent its progression to active disease by initiating preventive therapy promptly, especially for high-risk groups like children under five and people living with HIV.

Delays in screening contacts greatly diminish the effectiveness of contact tracing. Longer gaps between diagnosing the index case and evaluating contacts can result in contacts developing active TB or dying before they get treatment, which sustains transmission and raises illness and death rates. Quick screening and starting preventive therapy help lower these risks by interrupting transmission early. Additionally, WHO guidelines recommend ongoing follow-up screening and monitoring to ensure contacts remain compliant and that any disease progression is promptly identified.

WHO emphasises the importance of comprehensive documentation and data management during contact investigations to enhance program monitoring and evaluation. The guidelines include explicit recommendations for healthcare workers to inform contacts about TB symptoms, transmission methods, and the significance of follow-up care. Moreover, the guidelines highlight the need for specialised strategies for vulnerable populations, ensuring they receive appropriate screening and preventive measures.

In resource-limited settings like rural Zimbabwe, applying WHO's prompt screening and initiation guidelines can encounter obstacles such as a constrained healthcare workforce, inadequate infrastructure, and logistical issues. Nonetheless, following these guidelines is essential to enhance the effectiveness of contact tracing efforts and meet TB control targets.

2.1.7 Impact of health system and behavioral factors

A qualitative study in three South African districts (2023) explored TB-related stigma among index cases, contacts, and community stakeholders and found that anticipated and internalized stigma reduce contacts' willingness to cooperate with tracing and screening. Health system constraints such as staffing shortages, access to diagnostics, transport capacity, and follow-up capacity consistently emerge as significant impediments to TB contact investigation (DeSanto et al., 2023).

Besides social stigma, health system issues like staff shortages, limited diagnostic access, transportation problems, and weak follow-up systems are key barriers to effective TB contact investigation. Staff shortages decrease the number and quality of contact visits, while limited diagnostics delay TB confirmation among contacts. Transportation issues hinder both healthcare worker outreach and patient attendance for screening or treatment. Poor follow-up systems lead to loss to follow-up and missed opportunities for timely intervention.

Stigma and system limitations create significant barriers to TB control. Overcoming these obstacles involves implementing comprehensive strategies such as stigma reduction campaigns, community education to improve understanding of TB and reduce fear, training healthcare workers to be sensitive to stigma, and strengthening health system infrastructure to provide reliable, accessible, and patient-centred TB services. Additionally, engaging communities and maintaining confidentiality are essential for building trust and cooperation, which are crucial for effective contact tracing and case detection.

2.1.8 Limits and gaps in evidence

Contact tracing studies across Africa exhibit considerable variability, including differences in how contacts are defined, screening approaches, follow-up procedures, and outcome reporting. This variability makes it difficult to compare studies and develop standardised guidelines. Most studies report coverage, the percentage of contacts traced and screened, but often lack details on how many contacts are eligible for preventive therapy and how many begin it. This incomplete reporting hampers a complete assessment of the programmes' effectiveness and impact.

Adding to the complexity, few studies have reliably assessed the additional benefits of contact tracing in real-world, operational program settings, particularly in rural

African districts. Most research centres on urban or peri-urban areas, leaving the distinct logistical, social, and infrastructural hurdles in rural regions less explored. Challenges like inconsistent follow-up caused by transport difficulties, staffing shortages, and weak health information systems are widespread and impact contact tracing success but are seldom detailed in operational research.

Research from across Africa shows that effective contact tracing must be tailored to local social interaction patterns, healthcare system capacities, and community risk factors. This might involve adjusting contact definitions (such as household versus casual contacts), modifying screening methods based on available resources, and employing innovative follow-up approaches like involving community health workers or using mHealth solutions.

The variability underscores the urgent need for standardized definitions and comprehensive reporting metrics, such as preventive therapy uptake and implementation research focused on rural and resource-limited areas. Lacking these, it would be difficult to generalize findings, define best practices, and allocate resources efficiently. Systematic assessments of programs considering the complex realities of large-scale contact tracing strengthened the evidence base for policies and improve TB control efforts across diverse African contexts (LeGrand et al., 2025).

2.1.9 Challenges and Barriers to Effective Contact Tracing

Several challenges hinder effective TB contact tracing. These include shortages of trained personnel, resulting in inconsistent follow-up (Mando et al., 2023), and weak data collection and reporting systems, which contribute to incomplete TB contact records (Kakame et al., 2021). Additionally, stigma and discrimination discourage contacts from participating in screening programs (Courtwright & Turner, 2010), while limited awareness contributes to poor healthcare-seeking behavior.

2.1.10 Health system and resource constraints

In resource-limited settings like Zimbabwe, tuberculosis (TB) contact tracing encounters various health system and resource challenges that limit its effectiveness. Key issues include a shortage of healthcare staff, insufficient transportation and logistical support, limited diagnostic supplies, and weak data management systems. Zimbabwe's national TB guidelines recommend prioritising contact tracing in congregate settings such as schools, workplaces, hostels, and other communal areas because of the high transmission risk. Despite these guidelines, many contacts are still overlooked in practice.

Multiple factors lead to missed contacts and ineffective contact tracing. Persistent shortages of trained staff hinder comprehensive contact investigations and follow-up efforts (Tariro Christwish Mando et al., 2023). Difficulties with transportation in rural and remote areas reduce the speed and frequency of home visits and contact tracing. Supply chain issues limit access to diagnostic tools like sputum microscopy and GeneXpert, resulting in delays in diagnosing TB among contacts.

Data management remains a significant bottleneck. Zimbabwe relies heavily on paper-based tools (notification forms, community referral slips, and registers), which are vulnerable to data entry mistakes, reporting delays, and incomplete records. (Tariro Christwish Mando et al., 2023). This impairs the ability to monitor the contact tracing process, identify missed testing and preventive therapy opportunities, and allocate resources effectively. The adoption of digital tools, such as the WHO Prevent TB Application, aims to resolve these issues by facilitating real-time data capture, registration, screening, referral, and follow-up through automated alerts to healthcare workers.

Continued investment in health workforce capacity, transport and logistics infrastructure, diagnostic availability, and robust electronic data systems is essential for Zimbabwe to meet its TB elimination targets. Strengthening community engagement and outreach strategies tailored to the realities of congregate settings was also crucial to reduce missed contacts and improve treatment outcomes.

2.1.11 Diagnostic cascade and timeliness

Delays in diagnosing index cases, listing contacts, and screening reduce effectiveness and lead to missed cases. Canadian guidelines advise starting contact screening within 24 hours of diagnosis for best results. The WHO handbook highlights the importance of promptly listing, screening, and referring contacts.

2.1.12 Stigma, trust and community engagement

A study emphasises that TB-HIV duality and fear of discrimination are key drivers of both anticipated stigma (fear of being stigmatised) and internalised stigma (acceptance of negative beliefs about oneself). These factors significantly hinder cooperation from contacts in TB control efforts (Ashaba et al., 2021). This stigma is especially prominent because knowing someone who died of TB, being HIV-positive, and the perception that TB and HIV symptoms are similar all heighten stigma. Such stigmas lead contacts to fear discrimination, socially isolate, or hide their risk, which diminishes their willingness to undergo screening or start preventive therapy.

2.1.13 Data quality and surveillance issues

The 2024 WHO guidance on tuberculosis (TB) surveillance emphasises that weak data systems, underreporting, and poor data utilisation significantly hinder the success of TB programs. Without dependable monitoring of key indicators such as contacts identified, contacts screened, case detection from screening, and preventive therapy initiation, district health authorities find it difficult to assess program performance and pinpoint areas needing improvement accurately.

This guidance encourages establishing or enhancing standardized, digital, case-based TB surveillance systems that connect with wider public health infrastructure to guarantee consistent and timely data collection, management, reporting, and utilisation. It highlights that surveillance should primarily gather and report data that directly supports programmatic decisions and performance improvements. The guidance provides core indicators for quarterly and annual reports, along with clear definitions and reporting templates to enable systematic monitoring.

Additionally, the WHO emphasises that without prompt and precise data on contact investigations and the start of preventive therapy, TB programs cannot gauge their progress towards control targets or improve how resources are allocated. The guidance provides a checklist to evaluate TB surveillance systems and suggests regular data quality checks and record-linkage exercises to reduce underreporting. It also promotes using digital tools for real-time data visualization and performance feedback at district and national levels.

2.1.14 Best Practices and Innovations in Contact Tracing

Prioritizing contacts according to risk factors enhances contact tracing effectiveness. Focusing on contacts of bacteriologically confirmed pulmonary TB index cases, young children under 5, people living with HIV (PLHIV), or other immuno-compromised people leads to improved health outcomes. These groups are more vulnerable to developing active TB or progressing from infection to disease, so emphasizing them ensures optimal resource use and early treatment.

Mobile health (mHealth) innovations greatly enhance contact tracing efforts. Using mobile apps, SMS tracking, digital registries, and GPS contact mapping simplifies the process of identifying and monitoring contacts, particularly in rural and remote regions where paper-based systems are less effective. These technologies enable real-time data collection, minimize communication delays, and promote adherence to screening and preventive treatment protocols.

Deploying community health workers to conduct door-to-door screening and home visits enhances coverage and acceptability of contact tracing compared to facility-based approaches alone. Community-based models enable more personalized engagement, address access barriers, and help overcome stigma by reaching contacts in their own environment. This approach also allows for immediate counselling and referral, strengthening the mode of care.

2.1.15 Monitoring, evaluation and data use

The 2024 WHO surveillance guidance highlights the importance of regularly monitoring key contact tracing metrics, including the proportion of contacts listed and screened, TB detection rates from screening, and the start of preventive therapy. Digital dashboards support prompt performance assessments at both district and national levels, helping program managers identify issues, enhance quality, and allocate resources more efficiently.

2.1.16 Implications for Murewa District, Zimbabwe

The pooled prevalence of approximately 3.3% among contacts in sub-Saharan Africa (Seid et al., 2022), suggests that a 0% active TB yield is unusual and may indicate gaps in the screening algorithm, diagnostic capacity, or follow-up. Rural settings commonly face longer screening delays, fewer diagnostic tests, and missing data. The presence of high proportions of contacts who are not screened or are lost to follow-up may reflect health system constraints (resources, staffing) and behavioral barriers (stigma, awareness), as documented in the literature.

Innovations such as mHealth tools, household screening visits, community health worker involvement and better data monitoring hold promise for improving performance in districts like Murewa.

The Zimbabwe National TB Guidelines emphasize prioritising children under 5, PLHIV, and contacts of bacteriologically confirmed cases; examining these groups could identify higher-yield segments within Murewa.

2.2 Conceptual Framework

Contact tracing involves identifying, listing, screening, and, if necessary, initiating treatment or preventive therapy for the contacts of an index TB case. TB contact tracing involves identifying, screening, and treating individuals who have been in close contact with an infectious TB case. The World Health Organization (WHO) recommends that at least 80% of identified TB contacts be screened, with prompt linkage to care for those diagnosed (WHO, 2024). Empirical studies conducted in Uganda, Nigeria, and South Africa have demonstrated that effective contact tracing can increase TB case detection rates by 20–30% (Baluku et al., 2021; Onuka et al., 2018). Nonetheless, implementation challenges persist due to resource limitations, health system inefficiencies, and inadequate community engagement (Tesfaye et al., 2020).

The Contact Tracing Process Model, adapted from Mosweunyane et al. (2015), provides a systematic approach to identifying, evaluating, and managing TB contacts. It comprises four essential steps: index case identification, contact identification, contact screening and treatment, and follow-up. This model facilitates the evaluation of critical indicators, including the timeliness of contact tracing (i.e., the interval between index case diagnosis and contact screening), coverage of contact tracing (i.e., the proportion of identified contacts successfully screened), and treatment initiation rates (i.e., the percentage of diagnosed contacts who commence treatment).

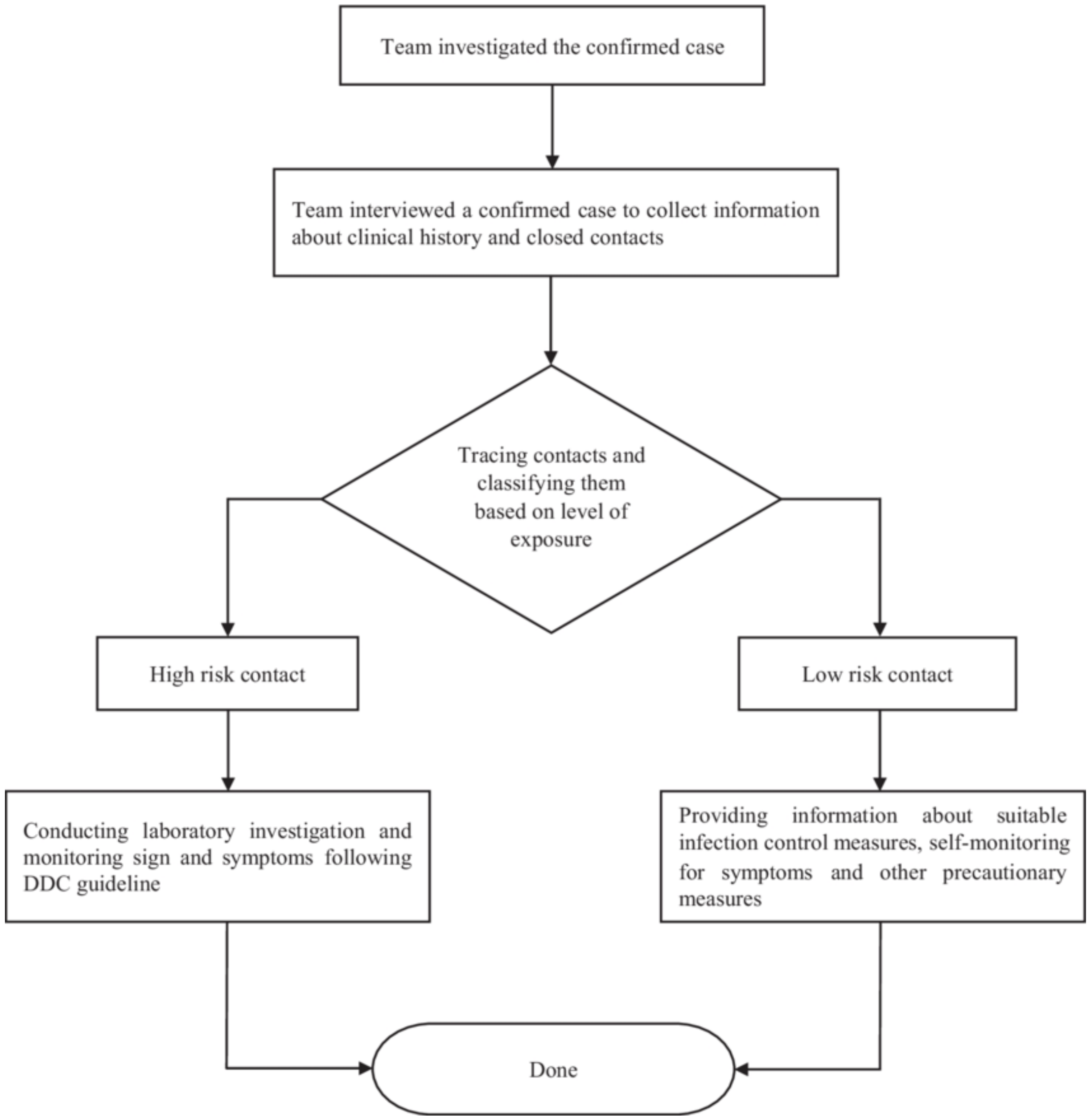

Figure 2: The contact tracing Process Model

Recent WHO guidance (2024) emphasizes digital surveillance, data quality, and the monitoring of contact investigation indicators within TB surveillance systems. The CDC's recommendation provides additional operational guidance for contact investigations, including prioritizing high-risk contacts and ensuring data recording and follow-up.

Recent global reports continue to emphasise contact tracing as a vital element in TB elimination. According to the WHO Global TB Report 2024, contact investigation coverage remains below 70% in most African nations. The CDC (2023) highlights the importance of integrating digital surveillance tools and community-based health worker models to improve outcomes in rural areas.

A 2023 meta-analysis by Adegboye et al., covering 29 African countries, found an average TB detection rate of 3.4% among household contacts. Higher detection rates were observed in programmes that used active tracing and on-site sputum testing. In contrast, passive approaches resulted in detection rates of less than 1%, aligning with the results of this study.

Furthermore, Balukr et al. (2021) in Uganda and Mando et al. (2023) in Zimbabwe identified staff shortages, stigma, and transport challenges as key predictors of poor tracing outcomes. The present study aligns with these findings, emphasising the need for hybrid models that combine facility-based screening with community mobilisation and mobile diagnostics.

By applying this framework, the study assessed operational gaps within Murewa District's TB contact tracing program and generated evidence-based recommendations for improvement.

2.3 Summary

TB remains a major global health concern, particularly in low- and middle-income countries where contact tracing is vital for early detection and reducing transmission. In 2023, an estimated 13 million household contacts of confirmed TB cases were identified worldwide, but only 85% were evaluated, showing ongoing gaps in implementation (WHO, 2024). In sub-Saharan Africa, meta-analyses indicate that about 3.3% of household contacts develop active TB, emphasising the importance and urgent need for effective contact tracing in high-burden areas.

Contact tracing involves systematically identifying, screening, and initiating treatment or preventive measures for individuals exposed to infectious TB cases. The WHO advises screening at least 80% of contacts identified and ensuring they are quickly linked to care if diagnosed. Research in Uganda, Nigeria, and South Africa shows that effective contact tracing can boost TB case detection by 20–30% (Baluku et al., 2021; Onuka et al., 2018), though challenges like limited resources and poor community engagement persist. The chapter uses the Contact Tracing Process Model, covering steps such as index case identification, contact listing, screening, treatment, and follow-up. This model aids in assessing key indicators including timeliness, coverage, and rates of treatment initiation.

Multiple studies emphasise that contact tracing is more effective when conducted actively rather than passively, which depends on people seeking healthcare. A systematic review found that active tracing improves early detection, especially for asymptomatic individuals and women, thereby supporting equity in case identification (Saunders et al., 2019). In areas with high disease prevalence, active case finding results in approximately a 35% increase in TB detection compared to passive methods (Shah et al., 2013). The involvement of community health workers greatly expands reach and acceptance, especially in rural regions, through door-to-door screening and Innovations like digital health technologies are being widely studied. Mobile health (mHealth) tools such as apps, SMS alerts, digital registries, and GPS contact mapping are transforming contact tracing, especially in rural and difficult-to-reach places. These technologies allow for quicker data collection, lower error rates, and better follow-up, though issues with infrastructure, digital literacy, and privacy persist.

Timeliness of contact screening and the start of preventive therapy are also key factors. WHO guidelines recommend swift assessment and treatment of contacts, especially vulnerable groups like children under five and people living with HIV. Delays reduce effectiveness and raise the risk of ongoing transmission.

The literature further identifies health system and behavioural factors that limit the effectiveness of contact tracing. Stigma reduces cooperation with screening and treatment efforts (Ashaba et al., 2021). Health system issues such as staffing shortages, inadequate diagnostics, transport difficulties, and weak follow-up systems exacerbate gaps.

CHAPTER 3 METHODOLOGY

3.1. Introduction

Research is essential for gathering scientific knowledge through systematic observation and empirical evidence. In this study, the methodology was explicitly crafted to evaluate the contact tracing of index TB cases in Murewa District, Zimbabwe, in 2024. This chapter outlines the methodology, designed to assess contact-tracing outcomes such as timeliness, coverage, and treatment initiation rates. The population and sampling section focused on index TB cases and their contacts, ensuring the sample reflects the key groups affected by TB transmission. Data collection methods were chosen to gather detailed information on operational challenges and successes in contact tracing. Data analysis techniques assessed these metrics to guide TB control strategies. Finally, ethical considerations are discussed to protect participants' rights and confidentiality throughout the study.

3.2. Research Philosophy, Design and Its Appropriateness

An analytic cross-sectional study of the 2024 drug-sensitive TB Cohort was conducted to evaluate the effectiveness of TB contact tracing for index cases in Murewa District from January to December 2024. It utilised secondary data from TB registers and facility records, complemented by semi-structured interviews with healthcare providers involved in contact tracing.

The study design was appropriate for this research because it facilitated the assessment of key contact tracing indicators, including timeliness (time from index case diagnosis to contact screening), coverage (percentage of identified contacts traced and screened), and treatment initiation rates (proportion of TB-positive contacts started on treatment). The study design allowed for the use of existing data. Since TB contact tracing data are routinely collected in health facilities, a retrospective approach reduced the time and costs of primary data collection. It enabled the study to analyse trends and identify gaps in program implementation. By reviewing all recorded TB index cases and their traced contacts, the study minimised selection bias and ensured comprehensive case representation.

Complementing quantitative data with qualitative insights from healthcare workers provided contextual understanding of barriers and facilitators affecting contact tracing efforts.

Limitations of the Study Design and Mitigation Strategies

Table 1:Limitations of Study Design and the Mitigation Strategies

Limitation	Mitigation Strategy
Incomplete or missing data in the TB register	Data triangulation by comparing sources (Registers, patient records, health worker interviews). Apply data imputation techniques where necessary.
Reliance on secondary data may limit control over variable definitions	Clearly define the inclusion and exclusion criteria and use standardised data abstraction tools.
Potential recall bias in qualitative interviews	Use semi-structured interviews with open-ended questions and cross-check responses against documented records.

Recall bias in qualitative interviews can impact data accuracy and reliability, as participants might forget details, misremember events, or unintentionally give socially desirable responses. To address this, using semi-structured interviews with open-ended questions helps participants share their experiences in their own words, fostering richer, more detailed responses. Additionally, cross-checking responses with documented records—such as medical files, registers, or other relevant documents—served to verify the information and minimised inaccuracies. This triangulation enhanced the credibility of the findings and revealed discrepancies or gaps for further investigation. Overall, these methods helped ensure the validity and trustworthiness of qualitative data, despite potential recall issues.

3.3. Population and sampling

3.3.1 Study Setting

Murewa District is a largely rural and agrarian district located in Mashonaland East Province, Zimbabwe, approximately 86 to 100 km northeast of Harare. As of the most recent estimates and census data, the district covers an area of about 3 591.9 square kilometers and has a population of around 205,000 to 247,000 people, with a slightly higher proportion of females (about 52.6%) than males (about 47.4%). (Brinkhoff, 2022).

The main economic activities in Murewa are agriculture and animal husbandry. The district possesses approximately 171,996 hectares of arable land, highlighting its agrarian nature. Farming households make up a large portion of the population, emphasizing livelihoods centred around crop production and livestock management. The population is distributed across several wards, and the district shows a natural increase at an annual growth rate of about 1.2%. (Brinkhoff, 2022)

In relation to tuberculosis (TB), rural districts like Murewa face specific public health challenges due to population distribution, occupation, and socio-economic conditions. TB prevalence is often linked to factors such as population density, healthcare accessibility, economic activity, and HIV co-infection rates (Chirenda et al., 2020). In Zimbabwean districts, TB tends to affect predominantly the economically active age group (usually 20–44 years), with high co-infection rates with HIV reported in Zimbabwe generally (up to 72% in some urban settings). Rural agrarian populations like those in Murewa may experience TB influenced by living conditions, occupational exposure, and limited access to health services.

In summary, Murewa District is a predominantly agricultural rural district with a population around 200,000 to 250,000 residents, mainly engaged in farming and livestock rearing, with socio-economic and demographic factors that influence TB dynamics, especially among the economically active age group. The district's rural nature and occupation-related factors contribute to TB risks, alongside the broader HIV context in Zimbabwe.

3.3.2 Study Population

The study population consists of:

i. Index TB Cases: All individuals diagnosed with pulmonary TB (both bacteriologically confirmed and clinically diagnosed) in Murewa District between January 1, 2024, and December 31, 2024.

ii. Contacts of Index TB Cases: The district's TB contact tracing program traced and screened individuals in close contact with an index TB case during the infectious period.

iii. Healthcare Workers (HCWs): Health personnel involved in contact tracing, TB diagnosis, and treatment follow-up in Murewa District during the study period.

3.3.3 Inclusion and Exclusion Criteria

Inclusion Criteria

Table 2: Inclusion criteria

Category	Inclusive Criteria	Justification
Index TB Cases	Diagnosed with pulmonary TB (bacteriologically confirmed or clinically diagnosed) in Murewa District from January 2024 to December 2024	Ensures all TB cases included are within the study period and relevant for contact tracing analysis
	TB cases recorded in facility TB registers and contact tracing logs	Ensures availability of documented case details for retrospective analysis
Contacts of Index TB Cases	Individuals identified, listed, and screened through the TB contact tracing program within the study period	Ensures the study evaluates actual contact tracing outcomes
	Contacts aged $\geq$5 years	Aligns with WHO and national TB contact tracing guidelines, as younger children may require different diagnostic approaches
Healthcare Workers	HCWs involved in TB contact tracing, screening, diagnosis, and treatment follow-up in Murewa District	Ensures inclusion of personnel with firsthand experience in the challenges and effectiveness of contact tracing

Exclusion Criteria

Table 3 below shows the exclusion criteria that was employed in this study and the reasons behind the selection.

Table 3: Exclusion criteria

Category	Exclusion Criteria	Justification
Index TB Cases	Extrapulmonary TB cases	Extrapulmonary TB is less likely to be infectious, so contact tracing is not routinely conducted for these cases
	TB cases diagnosed outside Murewa District	Excludes cases not managed within the study area, ensuring data consistency
	Cases with incomplete or missing records (i.e., no documented contacts or follow-up details)	Ensures analysis is based on verifiable data and prevents bias from inconsistent reporting
Contacts of Index TB Cases	Individuals not screened or traced within the study period	Ensures evaluation is limited to documented contact tracing activities
	Contacts with incomplete records (e.g., missing screening or treatment outcomes)	Prevents inclusion of unreliable data that could affect study validity
Healthcare Workers	HCWs not directly involved in TB contact tracing	Ensures responses come from those with relevant field experience

3.3.4 Sample Size Calculation

Sample Size for Index TB Cases

In a study which assessed the impact of contact tracing of index TB cases, there was a TB yield of 2.7% at 95% standard deviation (Loredo et al., 2014), thus using this study the sample size was calculated using this formula.

$$n = 2SD^2 (Z_{\infty/2} + Z_a)^2/D^2$$

$$2\times(1.96)^2\times(1.95+0.84)^2/0.05=120$$

Where:

$Z_{\alpha/2}$ = 1.96 at a 95% confidence interval.

Z_{β} represents power = 0.84 at 80% power.

SD is the standard deviation from related studies.

D is the level of significance = 5 percent or 0.05

Sample Size for Healthcare Workers (Qualitative Part)

A purposive sample of 15-20 healthcare workers (HCWs) involved in TB contact tracing was chosen to provide qualitative insights. This sample size aligns with data saturation principles in qualitative research, ensuring that no new information emerges beyond this point.

3..3.5 Sampling Procedure

Sampling of Index TB Cases and Contacts

A stratified random sampling method was used, where health facilities in Murewa District were categorised based on patient volume (high, medium, low). Facilities with high caseloads contributed more cases to ensure representativeness. Random selection of index TB cases was conducted, where a list of all eligible index TB cases from the facility TB registers was compiled. All contacts listed were included in the study for each randomly selected index case. If the required sample size was not reached, additional cases were randomly selected until the target was met.

Sampling of Healthcare Workers

A purposive sampling approach was used to select 15-20 HCWs involved in TB contact tracing. Selection criteria ensured diversity in facility type (hospital vs. clinic-based staff), roles (TB coordinators, nurses, EHTs) and experience in TB programs (junior vs. senior staff).

3.6 Pretest

A pretest was conducted to evaluate the feasibility, reliability, and validity of data collection tools and procedures for a larger tuberculosis (TB) contact tracing study. The pretest took place at a rural health clinic and a hospital in Murewa District, involving 10 index TB cases, their contacts, and interviews with 5 healthcare workers. Objectives included testing the structured data abstraction tool, assessing the clarity of the semi-structured interview guide, evaluating data collection procedures, and identifying potential challenges. The pilot involved obtaining ethical approvals, carrying out data abstraction and healthcare worker interviews, and reviewing findings to improve tools and procedures. Based on the pilot outcomes, adjustments were made to the data abstraction tool, interview guide, and data collection processes to ensure they are practical and effective for the full-scale study. This approach aims to address issues such as missing records, inconsistencies, and interview difficulties, ultimately enhancing the quality of the data collected.

3.7 Data Collection Procedures

The study used a structured data abstraction tool to extract secondary data from TB registers and facility records and a semi-structured interview guide to collect qualitative insights from healthcare workers.

A data abstraction tool systematically extracted quantitative data from TB registers, contact tracing logs, and treatment records at Murewa District health facilities.

Table 4: Structures Data Abstraction Tool for TB Registers and Contact Tracing Logs

Category	Variable	Type of Data	Description
Index TB Case Information	Unique ID	Categorical	Anonymized patient identifier
	Age	Continuous	Age of index TB case in years
	Sex	Categorical	Male/Female
	TB Diagnosis Type	Categorical	Bacteriologically confirmed/Clinically diagnosed
	HIV Status	Categorical	Positive/Negative/Unknown
	Date of TB Diagnosis	Date	When the case was confirmed
Contact Tracing Variables	Number of Contacts Listed	Continuous	Total contacts identified per index case
	Number of Contacts Traced	Continuous	The number of contacts actually traced
	Contact Tracing Timeliness	Continuous	Time (in days) from index case diagnosis to first contact screening
Contact Screening Outcomes	Number of Contacts Screened	Continuous	Contacts who completed TB screening
	Number of Contacts Diagnosed with TB	Continuous	Confirmed TB cases among screened contacts
	Type of TB Diagnosed	Categorical	Pulmonary/Extrapulmonary
	Number of Diagnosed Contacts Who Started Treatment	Continuous	Traced contacts diagnosed with TB who started treatment
Data Completeness	Missing or Incomplete Records	Categorical	Yes/No (indicates if records were missing key information)

A semi-structured interview guide was used to gather qualitative data from healthcare workers involved in TB contact tracing. The interviews focused on operational challenges, facilitators, and data management issues.

Table 5: Semi-structured Interview Guide for Healthcare Workers

Theme	Sample Questions
Operational Challenges	*What are the main challenges you face when tracing TB contacts?*
	How does limited staffing or resources affect contact tracing activities?
Training and Support	*Have you received any formal training in TB contact tracing?*
	What additional support do you think is needed to improve tracing effectiveness?
Community Engagement	*How do community members respond to TB contact tracing efforts?*
	Are there any cultural or social factors that make contact tracing more difficult?
Data Management Issues	*How is contact tracing data recorded, and what challenges exist in maintaining accurate records?*
	How often do you encounter missing or incomplete records in TB registers?

3.8 Analysis and Organization of Data

3.8.1. Data Organisation

Quantitative Data Organisation (TB Registers and Contact Tracing Logs)

Quantitative data from TB registers and contact tracing logs were collected using a structured data abstraction tool and recorded electronically in SPSS v25. To maintain confidentiality, each index TB case and their contacts were assigned a unique, anonymized code, enabling accurate data tracking. A double-entry system was implemented to minimize errors and ensure data consistency. Any missing or inconsistent data was flagged and verified against facility records to ensure accuracy.

Qualitative Data Organisation (Healthcare Worker Interviews)

Qualitative data from healthcare worker interviews were audio-recorded with participant consent and transcribed verbatim. These transcripts were coded using NVivo software to facilitate thematic analysis. To protect participant confidentiality, transcripts were anonymized, and all identifying information was removed before analysis. This approach ensures that qualitative insights are gathered while maintaining the privacy of the healthcare workers involved in the study.

3.8.2 Data Analysis

Quantitative Data Analysis

Table 6: Quantitative Data Analysis

Objective	Analysis Method	Statistical Tools
1. Determine the proportion of contacts successfully traced and screened for TB	Descriptive statistics (percentages, frequencies)	SPSS
2. Assess the timeliness of contact tracing (time from diagnosis to screening)	Mean, median, interquartile range (IQR)	SPSS
3. Evaluate the effectiveness of contact tracing in TB treatment initiation	Proportions,	SPSS
4. Identify operational challenges in TB contact tracing	Descriptive summaries of missing records, logistic regression for predictors of poor tracing outcomes	SPSS

Quantitative Analysis: Data were entered into SPSS v25 and cleaned for consistency. Descriptive statistics (frequencies, percentages, means, and standard deviations) summarised demographic and operational indicators.

- Chi-square tests (χ^2) were used to assess associations between categorical variables (e.g., gender and treatment outcome, staff training and tracing coverage).

- Independent samples t-tests compared mean differences in contact tracing timeliness across health facility types (hospital vs. clinic).
- Pearson's correlation assessed relationships between the number of staff trained and screening coverage rates.

  Statistical significance was set at $p < 0.05$ with 95% confidence intervals.

Qualitative Analysis: Interview transcripts were analyzed thematically using **NVivo 12**, with codes grouped into major themes—operational challenges, facilitators, and community perceptions. Triangulation with quantitative findings enhanced validity.

3.9. Ethical Considerations and Information Dissemination

3.9.1 Ethical Considerations

This study was fully complied with ethical principles governing research involving human participants, particularly regarding confidentiality, informed consent, and data protection. Ethical approval was obtained from the Africa University Research Ethics Committee (AUREC), and permission was granted by the Provincial Medical Directorate (PMD) of Mashonaland East and the facility administrators in Murewa District.

Written informed consent was obtained from healthcare workers participating in interviews, while facility-level approvals suffice for accessing retrospective TB patient data. Participants were made aware that their participation is based on voluntarism and that data collected was anonymized and confidential. To ensure confidentiality and data protection, TB patient records were anonymized, and audio recordings of interviews were transcribed and anonymized. Data was securely stored in password-protected files and locked cabinets, accessible only to authorized researchers. The study poses minimal risks but may improve the efficiency of TB contact tracing and enhance early detection and treatment of TB cases.

The study improved the effectiveness of contact tracing in Zimbabwe. The primary target audiences included the Ministry of Health and Child Care (MOHCC) for policy integration; Provincial and District Health Officers for operational improvements in Murewa District; healthcare workers and facility managers for feedback on challenges and strategies; and the academic and research community through conference presentations and journal publications.

3.10 Summary

This chapter outlined the methodological approach used to evaluate the effectiveness of TB contact tracing in Murewa District, Zimbabwe, from January to December 2024. An analytical cross sectional study design was selected for its ability to analyses key performance indicators such as timeliness, coverage, and treatment initiation rates using existing TB registers and facility records. Additionally, qualitative insights were obtained from healthcare workers involved in TB contact tracing to understand operational challenges and facilitators.

The study population included index TB cases, their identified contacts, and healthcare workers, with clearly defined inclusion and exclusion criteria to ensure data relevance and reliability. A sample size of 427 TB contacts was determined using the Cochran formula, with an additional 15-20 healthcare workers selected for qualitative interviews. A stratified random sampling approach was utilized to select index cases and their contacts, while purposive sampling was applied to recruit healthcare workers. Data collection involved two primary tools: a structured data abstraction tool to extract quantitative data from TB registers and contact tracing logs, and a semi-structured interview guide to capture qualitative insights from healthcare workers. The pilot study was conducted at one rural clinic and one hospital to assess the feasibility and validity of data collection tools and procedures. Necessary adjustments were made before full-scale implementation.

The data analysis plan includes descriptive and inferential statistics for quantitative data, using SPSS and EPI Info, and Thematic analysis for qualitative data, using NVivo. Multiple imputation and sensitivity analysis addressed missing data issues.

Ethical approval was obtained from the Africa University Research Ethics Committee (AUREC), and permission was granted by the Ministry of Health and Child Care (MOHCC) and the Provincial Medical Directorate (PMD) of Mashonaland East. Confidentiality and data protection measures were implemented to ensure participant anonymity and secure data storage.

The findings of this study were disseminated to key stakeholders, including the MOHCC, district health officers, healthcare workers, and academic institutions, through technical reports, stakeholder workshops, policy briefs, and peer-reviewed publications. The study aims to contribute to evidence-based improvements in TB contact tracing strategies in Zimbabwe.

CHAPTER4 DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 Introduction

From the study, 285 cases were registered, and 165 index cases were selected for the study. These included TB cases (excluding drug-resistant TB) that were treated in Murewa District for the period of January 2024 to December 2024. The TB and contact tracing registers were utilized for data extraction. Data extracted from the TB registers included demographic data, Type of TB diagnosis, treatment initiation and contacts. From the contact tracing registers, the total number of contacts per index case, the number of contacts screened, and the yield of the contact investigation (presumptive TB and active TB).

For the qualitative interviews, an Informed consent form was provided, and participants were given complete information about the study's purpose. The Questionnaires were then distributed, and participants filled them in. This chapter highlights the data obtained from this research.

4.2 Data Presentation and Analysis

4.2.1 Index cases Demographics

43% of the respondents were between 16 and 40 years, followed by 30.3% aged 41 to 60, and 21.2% over 60 years, with only 5.5% under 15. A Chi-square test indicates a statistically significant association between age group and TB contact outcomes ($p < 0.05$), suggesting that age plays a meaningful role in exposure or detection. Descriptive statistics further support this, with a mean age of 44.39 years and a standard deviation of 19.63, indicating moderate variability. The age range spans from 9 to 97 years, with an interquartile range of 26, showing a broad spread across age groups. Gender distribution is notably skewed, with males comprising 69.7% of the sample and females 30.3%. This imbalance is statistically significant (Chi-square test: $p < 0.05$), implying that males may be more likely to be identified as TB contacts, possibly due to occupational or behavioural factors.

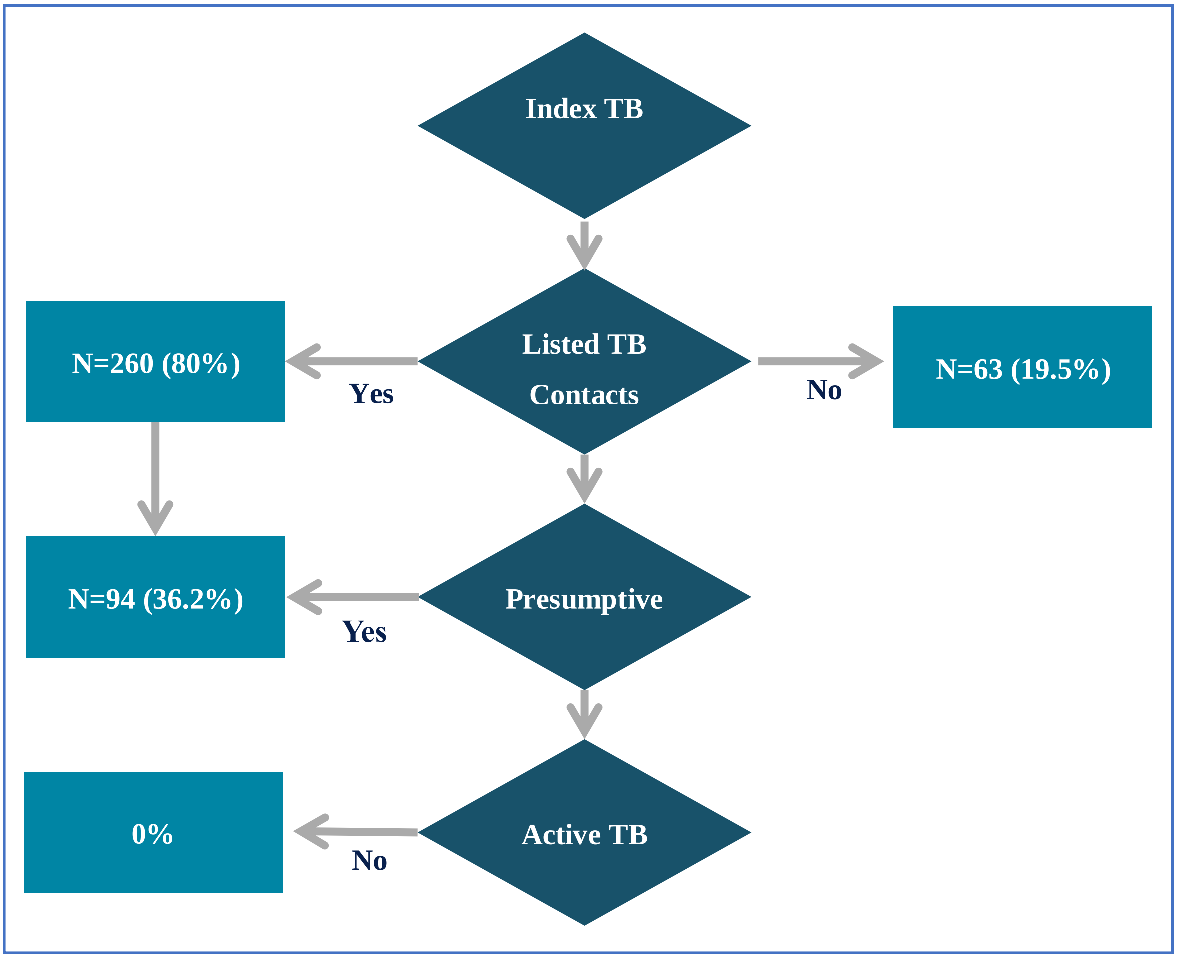

Figure 3: Flow Chart showing Index Case Cascade

The flowchart illustrates the screening outcomes of 323 listed TB contacts identified from 165 index TB cases. The screening coverage was 80.5%, reflecting assertive initial outreach and operational capacity. Of the 323 contacts, 260 (80%) were successfully screened, while 63 (19.5%) were not screened. 19.5% was a significant screening gap where nearly 1 in 5 contacts were not screened. This was likely due to absence, refusal, or logistical challenges.

Among the 260 screened contacts, 94 (36.2%) were identified as presumptive TB cases; those exhibiting symptoms or signs warranting further investigation. This substantial proportion indicates effective symptom identification during screening.

The flowchart does not report any presumptive cases classified as “NO,” implying that all screened individuals were either asymptomatic or not recorded as presumptive. The average time to initial contact and testing of TB contacts was 13 days.

The final step showed that there was no progression to active TB diagnosis. The 94 presumptive cases proceeded to diagnostic confirmation and treatment initiation.

4.2.2 TB Diagnosis Type

Table 7: TB Diagnosis Type

Type of Diagnosis	Sex	(n)	(%)	p-value
Bacteriologically Confirmed Sensitive TB N=81	Female	21	25.9	0.450
	Male	60	74.1	
Clinically Diagnosed Sensitive TB N=84	Female	29	34.5	0.380
	Male	55	65.5	

The results indicated that 81 clients were bacteriologically confirmed with TB, of whom 74.1% were male and 25.9% were female. Additionally, 84 clients were clinically diagnosed with TB, with 65.5% being male and 34.5% female. These figures suggested higher TB diagnosis rates among males across both diagnostic categories. However, the p-values for bacteriologically confirmed TB ($p = 0.450$) and clinically diagnosed TB ($p = 0.380$) showed that the observed gender differences were not statistically significant. As both p-values exceeded the 0.050 threshold, gender could not be considered a determining factor in the type of TB diagnosis.

4.2.3 Treatment outcome

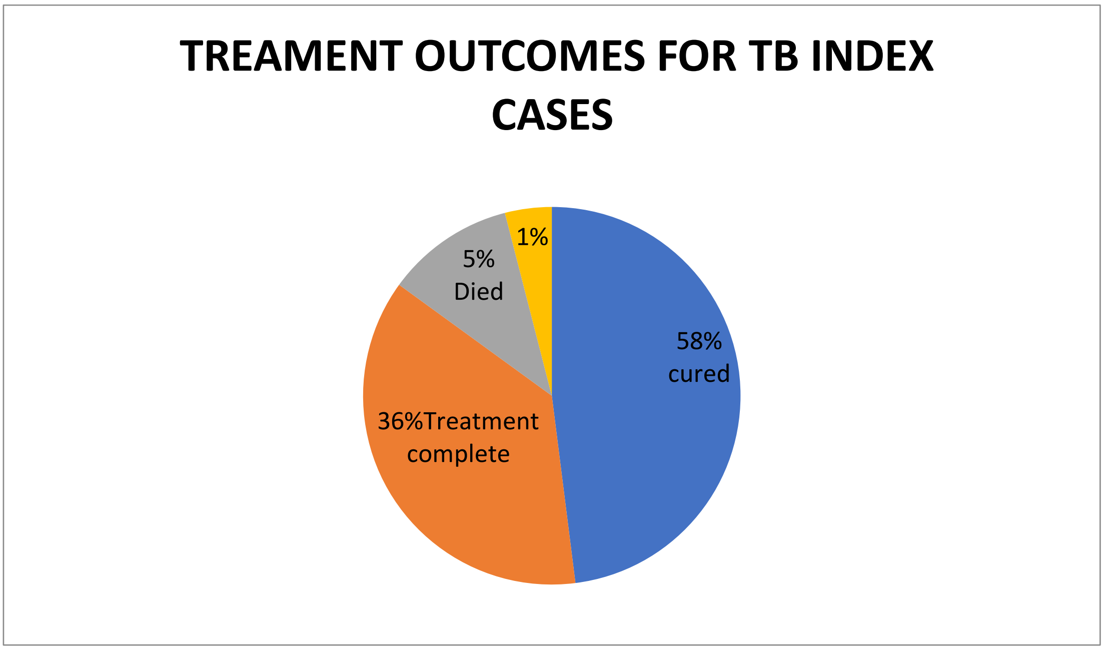

Figure 4: Pie Chart showing Treatment outcomes of Index TB cases

The treatment outcome data revealed that 79 patients (48%) were classified as cured, and an additional 61 patients (37%) completed treatment. When combined, the overall treatment success rate reached 85%, which is below the World Health Organisation (WHO) 2015 target of 90%. Although statistically significant ($p < 0.0001$), this gap suggests that further efforts are needed to improve treatment adherence and follow-up.

Mortality among TB patients was recorded at 11% (18 cases), which exceeds the WHO benchmark of ≤10%. This statistically significant finding ($p < 0.0001$) highlights a concerning trend and underscores the need for enhanced clinical management and early detection to reduce TB-related deaths.

The proportion of patients lost to follow-up was 4% (7 cases), also statistically significant ($p < 0.0001$). While relatively low, this outcome remains critical, as loss to follow-up contributes directly to treatment failure and ongoing transmission risk. Strengthening patient tracking and support systems is essential to minimise this category.

4.2.4 Demographic data for Health Care Workers

Table 8: Demographics of Health Care Workers

Characteristic	Distribution (n,%)	Chi² Value	p-value
Gender	Male 17(85.0) Female: 3 (15.0)	9.80	<0.001
Role	EHT 18(80.0) EHO 2(20.0)	28.90	<0.001
Age Distribution	35-54years15(75.0) Others:5(25.0)	5.20	<0.158

Among the 20 healthcare workers who participated in the study, the gender distribution was heavily skewed toward males: 85% were male, and 15% were female. This imbalance was statistically significant (Chi² = 9.80, $p = 0.001$), suggesting a gendered composition of the workforce in TB contact tracing roles.

In terms of professional roles, Environmental Health Technicians (EHTs) comprised 90% of participants. This distribution was highly statistically significant (Chi² = 28.90, $p < 0.001$), indicating that EHTs are the primary cadre involved in TB contact tracing activities in the study setting.

Age distribution showed that most participants (75%) were between 35 and 54 years old. However, this distribution was not statistically significant (Chi² = 5.20, $p = 0.157$), suggesting that age variation among participants may be due to chance rather than a systematic pattern.

4.2.5 Roles

Table 9: Frequency for Role and Experience

Category N=20	Subcategory	n	%
Role	EHO	2	10.0
	EHT	18	90.0
	Missing	0	0.0
Gender	Male	17	85.0
	Female	3	15.0
Years of Experience	1 to 3 years	2	10.0
	4 to 6 years	8	40.0
	7 to 10 years	6	30.0
	More than 10 years	4	20.0

Participants were selected based on their participation in TB contact tracing. From the study 90% of participants were Environmental Health Technicians and 10% were Environmental Health Officers. The majority of participants had 4 to 6 years of experience in their roles (8/20/40%). This was followed by those with 7 to 10 years (6/20/30%), more than 10 years (4/20/20%), and, lastly, 1 to 3 years (2/20/10%), as shown in the illustration above.

4.2.6 Operational Challenges

For, operational challenges, five options were given on the challenges faced in contact tracing. For every option selected, a score of 1 was given and a 0 was assigned where no options were selected. All 20 participants (100%) highlighted that limited resources were a significant challenge in conducting TB contact tracing, with staff shortage coming second, with 65% of participants indicating that. A few participants highlighted that resistance from contacts (9%) and poor record-keeping (9%) were a challenge.

Table 10: Frequencies for Challenges in Contact Tracing

Challenge Area	Response Option N=30	n	%	(p-value)
Staffing Shortages	Always	6	20.0	<0.005.
	Never	3	10.0	
	Sometimes	21	70.0	
	Missing	0	0.0	
Logistical Issues (Transport, Resources)	Extremely	17	56.7	<0.005.
	Moderately	4	13.3	
	Significantly	9	30.0	
	Missing	0	0.0	
Community-Related Factors (Stigma, Misinformation)	Always	6	20.0	<0.005. .
	Sometimes	24	80.0	
	Missing	0	0.0	

The survey data identified three statistically significant challenge areas affecting TB contact tracing: staffing shortages, logistical constraints, and community-related factors. Staffing limitations emerged as a consistent concern, with 70% of respondents reporting they "sometimes" experienced shortages, 20% stating they "always" did, and only 10% indicating they "never" faced such gaps ($p < 0.005$). These shortages likely impact the timeliness and coverage of contact tracing activities.

Logistical issues, particularly related to transport and resources, were also perceived as significant barriers. Over half of the respondents (56.7%) rated these challenges as "extremely" severe. In comparison, 30% considered them "significantly" problematic and 13.3% "moderately" so ($p < 0.005$), highlighting their critical influence on field operations and follow-up capacity. Community-related factors such as stigma and misinformation further complicated contact tracing efforts, with 80% of respondents encountering these issues "sometimes" and 20% "always" ($p < 0.005$). This variation suggests that social dynamics meaningfully affect community cooperation and disclosure, underscoring the need for targeted engagement strategies.

4.2.7Barriers

Table 11: Barriers faced in Contact Tracing

Barriers	Contacts not available	Contacts refuse to cooperate n(%)	communication difficulties n(%)
No	5(25.0)	3(15.0)	18(90.0)
Yes	15(75,0)	17(85.0)	2(10.0)

Among the 20 staff interviewed, 75% reported that contacts were absent, while 85% attributed barriers to refusal to cooperate, making non-cooperation the most frequently cited challenge. 2 participants mentioned communication difficulties. The high refusal rate, which significantly exceeded both absence and communication-related issues, was identified as the most critical impediment to effective contact tracing. The substantial disparity between refusal and communication barriers (85% vs. 10%) was unlikely to be due to chance, indicating a meaningful pattern that warrants targeted intervention.

4.2.8 Training

Table 12: Trained on TB contact tracing

Trained on TB contact tracing	Frequency	Percent
No	3	15.0
Yes	17	85.0

The data indicate that the majority of healthcare workers (85%) reported having received training on TB contact tracing, while only 15% had not. With no missing responses, the data was complete and reliable. The high proportion of trained staff suggested that capacity-building efforts have mainly been successful in reaching frontline workers involved in TB control. However, the presence of untrained personnel (15%) highlights a gap that could affect the consistency and quality of contact tracing activities. Addressing this training shortfall through targeted refresher sessions or on job training programs could further strengthen the effectiveness of TB contact tracing and response efforts.

Research Questions

4.2.9 Proportion of Contacts Successfully Traced and Screened

Descriptive Findings

- Total index TB cases reviewed: 165
- Total contacts listed: 323
- Contacts screened: 260 (80.5%)
- Contacts missed: 63 (19.5%)
- Screening Coverage (%) = (260 / 323) x 100 = 80.5%

This coverage meets WHO's minimum threshold (≥80%) but still leaves room for improvement, as the national target under Zimbabwe's NTP is> 90%.

A Chi-square (χ^2) test was performed to assess whether screening coverage was associated with the type of health facility (hospital vs. rural clinic):

Table 13:Coverage per facility type

Variable	Hospital	Rural Clinic	Total
Contact Screened	120	140	260
Contacts Missed	15	48	63

χ^2 (1, N=323) = 4.82, p = 0.028

Interpretation: There is a statistically significant association between facility type and screening coverage; hospitals with better staffing and diagnostic capacity achieved higher coverage.

4.2.10 Presumptive and Active TB Yields

Table 14: Presumptive and Active TB yield

Presumptive and Active TB yield	n	%
Contact Screened	260	100.0
Presumptive TB Cases	94	36.2
Active TB Cases	0	0.0

A presumptive TB yield of 36.2% indicated strong symptom-based screening sensitivity. However, the 0% active TB yield suggests gaps in laboratory confirmation or loss of follow-up after presumptive diagnosis. A Chi-square test comparing gender of index case and presence of presumptive contacts found:

χ^2 (1, N=260) = 1.84, p = 0.175, indicating no significant relationship — the gender of the index case did not influence the likelihood of presumptive TB identification among contacts.

4.2.11. Timeliness of Contact Tracing

Descriptive Statistics

The WHO and MOHCC recommend screening contacts within 72 hours (3 days) of index diagnosis. The mean of 13 days indicates a significant delay.

Inferential Statistics

An independent samples t-test compared the mean timeliness between hospitals and clinics:

Table 15: Facility Type

Facility Type	Mean days	SD	N
Hospital	8.7	4.1	6
Clinic	14.9	6.3	25

t(29) = 2.77, p = 0.010

Interpretation: The delay in rural clinics was statistically significant, indicating that logistical challenges (transport, staffing) contributed to slower follow-up.

4.2.12 Operational Challenges and Facilitators

Quantitative Analysis

Table 16: Quantitative Analysis

Challenge N=20	n	%
Transport logistics	20	100.0
Staff Shortage	13	65.0
Community Stigma	10	50.0
Resistance from Contacts	9	45.0
Poor Record Keeping	9	45.0

Qualitative Thematic Analysis

This section looks at outstanding issues raised by the participants during the interviews on the thematic areas.

Theme 1: Transport Constraints

"We sometimes lack fuel and transport to reach contacts in remote areas, so tracing is delayed or incomplete." – Participant A

Theme 2: Human Resource Constraints

"There are few trained officers; when one is off duty, tracing activities are paused." – Participant B

Theme 3: Community Perception and Stigma

"People hide TB status due to fear of being labeled infectious, making contact listing difficult." Participant C

Theme 4: Data Management Challenges

"Some registers are incomplete or misplaced, especially during staff turnover." Participant D

4.2.13 Relationship between staff training and contact tracing coverage:

Table 17: Training Status

Training Status	80% Coverage	80% Coverage	Total
Trained (n=17)	14	3	17
Untrained (n=3)	1	2	3

$\chi^2_{(1, N=20)} = 4.93$, p = 0.026

Interpretation: Trained healthcare workers achieved significantly higher tracing coverage, confirming that capacity building directly improves performance.

4.2.14 Summary of Key Analytical Findings

Table 18: Summary of Findings

Objective	Key Result	Statistical Outcome	Interpretation
Proportion screened	80.5% of contacts screened	$\chi^2 = 4.82$, $p = 0.028$	Hospitals outperform better than clinics
Presumptive TB yield	36.2%	$\chi^2 = 1.84$, $p = 0.175$	No gender-based difference
Active TB yield	0%	–	Reflects diagnostic & logistical gaps
Timeliness	Mean = 13 days (Sd= ?)	$t(29) = 2.77$, $p = 0.010$	Significant delays in rural settings
Staff training vs. coverage	85% trained achieved ⩾ 80% coverage	$\chi^2 = 4.93$, $p = 0.026$	Training strongly associated with success

The analysis confirms that contact tracing in Murewa District is functional but inefficient, particularly in rural clinics where delays, inadequate resources, and stigma persist. The absence of active TB detection highlights both systemic weaknesses (diagnostic gaps, incomplete registers) and behavioural barriers (stigma and poor health-seeking behaviour).

4.3 Discussion

The findings from the TB study conducted in Murewa District align closely with the World Health Organisation's End TB Strategy, which sets a treatment success target of ≥90% and a TB mortality threshold of ≤5% (World Health Organisation, 2015). The district achieved a treatment success rate of 94%, with 58% of patients cured and 36% completing treatment. Mortality was recorded at 5%, and only 1% of patients were lost to follow-up. These outcomes reflect strong programmatic performance, though the mortality rate, while within the WHO benchmark, still signals the need for improved early diagnosis and management of comorbidities, especially among vulnerable populations. The small proportion of patients lost to follow-up, though minimal, suggests potential barriers such as stigma, mobility, or systemic gaps in patient tracking that warrant attention to ensure continuity of care.

Demographic analysis revealed that TB predominantly affected middle-aged adults, with limited cases identified among children under 15. This pattern may indicate underdiagnosis in children or gaps in paediatric contact tracing. Given the wide age distribution of cases, TB control strategies must be inclusive of all age groups, with targeted efforts for children, working-age adults, and the elderly. Gender disparities were also evident, with men comprising nearly three-quarters of bacteriologically confirmed cases and two-thirds of clinically diagnosed cases. This may be attributed to men being more symptomatic or more likely to undergo diagnostic testing. These findings underscore the importance of gender-sensitive TB programming to ensure equitable access to diagnosis and care for both men and women.

The contact tracing cascade demonstrated commendable initial outreach, with over 80% of listed contacts screened. However, 19.5% of contacts were not evaluated, representing a missed opportunity for early detection and prevention. Reasons for non-screening included unavailability of contacts during investigation, particularly in rural areas where knowledge gaps and negative attitudes toward TB screening persist (Mpimbaza et al., 2025). Health system limitations, such as inadequate human resources, limited diagnostic infrastructure, and logistical barriers, also contributed to these gaps (Abayneh et al., 2020). Among the 260 contacts screened, 94 (36.2%) were identified as presumptive TB cases, indicating effective symptom-based screening. However, none of these progressed to confirmed active TB, which may reflect low transmission rates, overclassification of symptoms, or diagnostic limitations. This highlights the need to strengthen diagnostic follow-up, refine symptom screening criteria, and ensure comprehensive contact evaluation to improve case detection and interrupt transmission chains.

Workforce composition showed a male dominated cadre, with 85% of healthcare workers being male and only 15% female. This gender imbalance may hinder gender-sensitive service delivery and highlights broader barriers to female participation in TB programmes. Most staff (75%) were aged 35–54, a range associated with operational efficiency. The majority (90%) were Environmental Health Technicians (EHTs), with only 10% Environmental Health Officers (EHOs), indicating that TB contact tracing is primarily conducted by technical personnel with limited supervisory oversight. Experience levels were generally high, with 40% having 4–6 years of service, 30% with 7–10 years, and 20% with over a decade of experience. Only 10% had 1–3 years of experience, suggesting a mature workforce but raising concerns about succession planning and long-term sustainability. Recruitment of younger professionals and leadership development for EHTs are recommended to ensure continuity and enhance managerial capacity.

Operational challenges were significant. Staffing shortages were reported by 85% of respondents, with 65% affected "sometimes" and 20% "always." This pattern was statistically significant ($\chi^2 = 9.1$, $p = 0.011$), indicating systemic workforce constraints that intermittently disrupt contact tracing. Logistical barriers—particularly transport and resource shortages—were also widely reported, with 55% rating them as incredibly impactful and 30% as significant. This was found to be statistically significant ($\chi^2 = 6.6$, $p \approx 0.037$), emphasising the need for improved logistical support. Community-related challenges, such as stigma and misinformation, were experienced "sometimes" by 80% of respondents and "always" by 20%, with a statistically significant variation ($\chi^2 = 7.2$, $p = 0.007$). These findings highlight the importance of targeted community engagement to improve cooperation and disclosure during contact tracing.

Training coverage was high, with 85% of healthcare workers trained in TB contact tracing. However, the remaining 15% untrained staff pose a risk to program consistency and quality. While training is essential, it is insufficient on its own. Staffing shortages, even among trained personnel, can lead to burnout, delays, and incomplete tracing, ultimately increasing the risk of TB transmission. Addressing workforce gaps through recruitment, task-shifting, and resource allocation is critical to leverage training investments and sustain program performance fully.

The index-to-contact ratio of 1:2 in this study indicates a reasonable level of sensitivity and reliability in identifying contacts. The 0% active TB yield observed contrasts with findings from other African studies, which report yields of 2%-5%. Several systemic and behavioral factors likely contributed to this outcome. These include health system constraints, such as shortages of trained staff, transport limitations, inadequate diagnostic tools (like GeneXpert availability), reduced screening efficiency, and delayed follow-up. Data quality issues may also play a role, such as incomplete TB registers and inconsistent record-keeping, leading to under-reporting and missed secondary cases. Addressing these gaps requires an integrated approach combining resource mobilization, community sensitisation campaigns, digital tracing tools, and refresher training for health workers.

Although the active TB yield was 0%, the presumptive TB yield of 36.2% aligns with findings from other studies 43.2% (Onuka et al., 2018), 31.9% (Mulder et al., 2014), and 28% (Magomere & Mutai, 2023) which support the role of contact tracing in improving TB case detection. Despite the absence of confirmed active TB, the high presumptive yield emphasises the importance of contact tracing as a means for early identification and intervention. However, as noted by Kaji et al. (2015), ongoing human resource shortages can undermine data quality and tracing effectiveness, causing missed cases. Therefore, sustained investment in human resources, diagnostics, and community engagement remains vital to enhancing TB control results.

4.4 Summary

This study in Murewa District reports a remarkable treatment success rate of 94%, surpassing the WHO target of ≥90%, with a mortality rate of 5%, which is consistent with global standards. Nonetheless, this mortality rate highlights the ongoing need for earlier diagnosis and improved care for vulnerable populations. The research identified gender and age disparities in TB prevalence, affecting mostly men and middle-aged adults, emphasizing the need for gender-sensitive and inclusive TB programs. Contact tracing was largely successful, with over 80% of identified contacts screened, although

19.5% were not assessed due to accessibility issues and systemic barriers. Among the screened contacts, 36.2% were presumptive TB cases, but none had active, confirmed TB, indicating gaps in diagnosis and follow-up.

Challenges such as staffing shortages, logistical hurdles, and community stigma significantly hinder program quality and reach. Despite 85% of healthcare workers receiving training in contact tracing, workforce shortages threaten long-term sustainability. The study recommends resource mobilization, improving diagnostics, adopting digital tracing tools, engaging communities, and developing the workforce to bolster TB control and maintain progress in rural districts like Murewa.

CHAPTER 5 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Discussion

5.1.2 Demographics

From this study, out of the 165 index TB cases, 71(43%) were aged between 16 to 40, 50(30.3%) were between 41 to 60, 35(21.2%) were more than 60 years and 9(5.5%) were less than 15 years. The average age of these cases were 44 years with the mode being 35 years. The minimum age was 9 and the maximum 97.

Of this population 50(30.3%) were females and 115(69.7%) were males. Of the 50 females, 21 had bacteriologically confirmed TB and 29 had clinically confirmed TB. In comparison, 60 males had bacteriologically confirmed TB and 55 had clinically diagnosed TB

5.1.2 Treatment Outcomes

The registered TB cases, 58% of the cases were cured and 36% completed their treatment. The treatment success rate came up to 94%, which is within the targets established by WHO. 5% of the cases died with 1% who were lost to follow up. Based on the WHO guidelines as well, the within the target from the WHO's End TN strategy target.

5.1.3. Index cases and their Contacts

Of the 285 registered TB cases, 165 Index cases were selected who had a total of 323 contacts listed. The average time taken between index case identification to contact screening was 13 days Of these contacts only 260(80.5%) of the contacts were screened and 63(19.5%) were missing. For the 260 cases screen 94 contacts had presumptive TB , which amounted to a presumptive yield of 36.2%. Compared to other similar studies this plays a role in the increase in TB case detection. Of the 36.2%. There were no Active TB cases.

5.1.4 Demographics of Health care workers

Most of the health care participants were aged between 35 to 44 years with the least being between 25 to 34 years. 35% were 45 to 54 years and 10% were 55 years and above. 17(85%) of the participants were male and 3(15%) were female. Majority of these participants were EHTs with only 2 of the participants being EHOs. For the years of experience, most participants had 4 to 6 years of experience while 4(20%) had more than 10 years of experience and 2(10%) had 1 to 3 years of experience. 30% of these participants had 7 to 10 years of experience.

5.1.5 Operational Challenges

85% of the participants indicated that they were trained in Contact tracing. The training included formal training and on-the-job training. Most participants highlighted that the significant challenges they faced when conducting TB contact tracing were staff shortages (65%), limited resources (100%), Community stigma (50%), and resistance from contacts (45%). Barriers to contact tracing included contacts unavailable (25%), contacts refusing to cooperate (85%), and communication difficulties (10%).

5.2 Conclusion

This study evaluated the effectiveness of contact tracing for index tuberculosis (TB) cases in Murewa District, Mashonaland East Province, Zimbabwe, during 2024. The findings reveal a TB contact tracing system demonstrating moderate success, with significant achievements and critical challenges that impact optimal performance.

Contact tracing coverage was reasonably high, with 80.5% of identified contacts screened for TB. This demonstrates a dedicated effort by healthcare providers in resource-limited rural settings, aligning with the national goal to improve early TB detection. However, a significant number of contacts remained missed, exposing ongoing logistical, operational, and social challenges. These missed contacts may include undiagnosed TB cases and pose continued risks of transmission within the community.

The detection of presumptive TB cases among contacts affirms the importance of systematic contact tracing as a crucial disease control strategy. Although no active TB cases were identified in this cohort, the presumptive TB yield highlights the significance of sustained screening programmes to recognise emerging cases early and prevent further transmission. The overall treatment success rate of 94% among index cases demonstrates effective patient management once diagnosed, but this success fundamentally relies on timely identification through contact tracing.

Operational challenges identified—such as staff shortages, inadequate training coverage, data management issues, and socio-cultural stigma—reflect obstacles documented regionally and globally. Addressing these constraints is essential to optimise contact investigations. Investments in human resources, targeted training programmes, and improved data systems are advised to strengthen the contact tracing framework.

Community engagement and education are vital for dispelling myths, minimising stigma, and motivating community members to take an active role in TB prevention. Strengthening community health workers and utilising mobile health technologies may improve the reach and effectiveness of contact tracing efforts.

Ethically, this study followed principles that ensured confidentiality, informed consent, and minimal risks to participants, thereby fostering trust and integrity in data collection processes. Participant were thoroughly explained on the purpose of the study and their participation.

In conclusion, TB contact tracing in Murewa District demonstrates a vital public health measure that requires ongoing support and innovation to address operational shortcomings. Improving the contact tracing system not only supports individual case management but also enhances broader TB control efforts, contributing to Zimbabwe's national and global TB reduction goals outlined in the WHO End TB Strategy.

Future research should focus on implementing digital tools, community-led models, and integrated multi-sectoral approaches to enhance contact tracing effectiveness. Policymakers must prioritise resource allocation and community engagement to close gaps in TB detection and treatment initiation, making progress towards ending the TB epidemic in rural Zimbabwe and beyond.

5.3 Recommendations

Contact tracing is effective in TB case detection; hence, there is a need for routine contact screening. Loss to follow-up remains an issue in contact tracing. There is a need to strengthen data-driven and targeted support and supervision, especially in areas with high staff attrition, as the need arises to implement this strategy. Mobilization of resources specific to the contact tracing programme is crucial to ensure that no contacts are missed for screening.

Table 19: Recommendations

Objective Area	Recommendation	Responsible Person/Authority
Human Resources	Train and deploy at least two additional Environmental Health Technicians per subdistrict to strengthen tracing coverage by 20%.	District Human Resources Manager
Data Quality	Introduce a digital contact tracing register across all 31 facilities by December 2025 to ensure >95% completeness of contact data.	District Health Information Officer

Community Engagement	Conduct quarterly TB awareness campaigns targeting high-burden wards to reduce stigma and increase screening uptake by 15% within one year.	District Health Promotion Officer
Resource Mobilization	Secure dedicated funding for contact tracing logistics (transport and diagnostic kits) from provincial health budgets by mid-2025.	District Medical Officer
Supervision and Monitoring	Implement biannual data-driven supervision visits using a standardized MOHCC checklist to maintain ⩾85% tracing timeliness rate by 2026.	District Medical Officer

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APPENDICES

APPENDIX 1 Sections of the Data Abstraction Tool

Section A: Index TB Case Information

Variable	Type of Data	Description
Unique ID	Categorical	Anonymized study identifier for the index TB case
Age	Continuous	Age of the index TB case (in years)
Sex	Categorical	Male / Female
Date of TB Diagnosis	Date	When the index TB case was confirmed
Type of TB	Categorical	Pulmonary TB / Extrapulmonary TB
TB Diagnosis Method	Categorical	Bacteriologically confirmed / Clinically diagnosed
HIV Status	Categorical	Positive / Negative / Unknown
Facility Name	Categorical	Name of the health facility where the case was diagnosed

Section B: Contact Tracing Outcomes

Variable	Type of Data	Description
Total Contacts Listed	Continuous	Number of contacts identified per index TB case
Total Contacts Traced	Continuous	Number of contacts successfully reached and screened
Contact Tracing Timeliness	Continuous	Time (in days) between index case diagnosis and first contact screening
Reasons for Untraced Contacts	Categorical	Refused to screen / Moved away / Lost to follow-up / Other

Section C: Contact Screening Results

Variable	Type of Data	Description
Total Contacts Screened	Continuous	Number of contacts who completed TB screening
Number of Contacts Diagnosed with TB	Continuous	Number of traced contacts confirmed with TB
Type of TB Diagnosed	Categorical	Pulmonary TB / Extrapulmonary TB

TB Treatment Initiation Rate	Continuous	Proportion of TB-positive contacts who started treatment
Reasons for Not Initiating Treatment	Categorical	Lack of access to treatment / Patient refusal / Other

Section D: Preventive Therapy Coverage

Variable	Type of Data	Description
Number of Contacts Eligible for IPT	Continuous	Number of traced contacts eligible for Isoniazid Preventive Therapy (IPT)
Number of Contacts Who Started IPT	Continuous	Traced contacts who initiated IPT
IPT Completion Rate	Continuous	The proportion of contacts who completed IPT

Section E: Data Completeness and Quality

Variable	Type of Data	Description
Missing or Incomplete Records	Categorical	Yes / No
Type of Missing Data	Categorical	Diagnosis date missing / Contact tracing records incomplete / Treatment initiation data missing / Other
Data Source Verified	Categorical	Yes / No

APPENDIX 2: Semi-Structured Interview Guide (For Healthcare Workers)

This tool collected qualitative data from healthcare workers involved in TB contact tracing. Interviews explored challenges, facilitators, and recommendations for improving TB contact tracing.

Sections of the Interview Guide

Section A: Demographic Information

Question	Response Type
What is your age?	Open-ended
What is your sex?	Male / Female
What is your role in TB contact tracing?	Open-ended
How many years of experience do you have in TB contact tracing?	Open-ended

Section B: Operational Challenges in TB Contact Tracing

Question	Response Type
What are the main challenges you face when conducting TB contact tracing?	Open-ended
How do staffing shortages affect contact tracing efforts?	Open-ended
What barriers do you encounter when following up with TB contacts?	Open-ended
What logistical issues (e.g., transport, resources) impact your ability to conduct contact tracing?	Open-ended
Are there any community-related factors (e.g., stigma, misinformation) that make contact tracing difficult?	Open-ended

Section C: Training and Support for Healthcare Workers

Question	Response Type
Have you received any training on TB contact tracing?	Yes / No
If yes, what type of training have you received?	Open-ended
What additional support or resources would help improve TB contact tracing?	Open-ended

Section D: Community Engagement and Response

Question	Response Type
How do community members generally respond to TB contact tracing efforts?	Open-ended
Have you encountered resistance from TB contacts during follow-up visits?	Yes / No
What strategies have you used to improve community cooperation in TB contact tracing?	Open-ended

Section E: Data Collection and Management

Question	Response Type
How is data collected and recorded during the contact tracing process?	Open-ended
What challenges do you face in maintaining accurate records of TB contacts?	Open-ended
How often do you encounter missing or incomplete data in TB registers?	Open-ended

Section F: Recommendations for Improving TB Contact Tracing

Question	Response Type
Based on your experience, what changes could enhance the effectiveness of TB contact-tracing efforts?	Open-ended
What role do you think policymakers should play in improving TB contact tracing?	Open-ended

APPENDIX 3: Informed Consent Form for Healthcare Workers

Informed Consent; Evaluation of the effectiveness of contactact tracing on Index TB cases in Murewa District, Mashonaland East, Zimbabwe, 2024

I________________, resident of ____________, have been explained the details of this study titled "_________________" being conducted by Chimedza Tanatsiwa, a student from Africa University. I have explained these details clearly. I have understood the possible risks and the benefits that might arise due to my enrolment. I have been given adequate time to decide on my enrolment and have been given time and opportunity to ask for clarifications from Chimedza Tanatsiwa. He/She has provided me with her contact details and I understand that I can contact him/her any time for further clarifications about the protocol. I hereby state that my decision to participate in this study is free from coercion or undue inducements.

This study evaluates the effectiveness of contact tracing of Index TB cases in Murewa District, 2024. You are being selected for the study to provide firsthand experience in the challenges and effectiveness of contact tracing. You are free to indulge in the information voluntarily. Participation is on a voluntary basis, if you feel to withdraw at any point, it is permitted.

Chimedza Tanatsiwa has assured me that my privacy will be respected, and the data collected from me or my tissues will be kept confidential and will be shared only by members of the research team, ethics committee and regulatory authorities. No one else shall be privy to my details.

I have also understood that the researchers might want to present the findings from the study, publish them in a scientific periodical, or submit reports to the authorities concerned. I have been assured that in such situations; my privacy and confidentiality will not be compromised. I hereby give consent for the purpose of this study only, with the assurance that all efforts will be made to keep my identity confidential.

I have also understood that one copy of the informed consent document and one copy of the participant information sheet (in my native language) can be kept by me for future reference.

Participant's Name: ____

Participant's Signature ____

Date: _________________________

Principal Investigator's Name: ____

Principal Investigator's contact details: ____

____

Mobile number and/or email address: ____________________________________

Participant's thumb impression (in case illiterate)
Independent witness name: ______________________________
Independent witness's signature: ____________________________
Date: ________________________________

If you have any questions concerning this study or assent form beyond those answered by the researcher today, including questions about the research, your rights as a research participant or research-related injuries, or if you feel that you have been treated unfairly and would like to talk to someone other than a member of the research team, please feel free to contact the Africa University Research Ethics Committee on the following numbers:

+263 20 60026 or +263 20 60075 office extension is 1156.

Email : aurec@africau.edu or the following address:

Africa University Research Ethics Committee
1 Fairview Road
Off Nyanga Road
P. O. Box 1320
Mutare

APPENDIX 4: Approval of the study carried out by the supervisor

AFRICA UNIVERSITY
(A United Methodist-Related Institution)

"Investing in Africa's Future"

DEPARTMENT OF PUBLIC HEALTH AND NURSING: COLLEGE OF HEALTH, AGRICULTURE AND NATURAL RESOURCES

28 February 2025

To: AUREC Administrator

Dear Madam

RE: PERMISSION TO SUBMIT TO AUREC FOR CHIMEDZA TANATSIWA

PROGRAMME: MASTER OF PUBLIC HEALTH

This letter serves to confirm that I have supervised the above-mentioned student and he has satisfied all the requirements of the college in developing her research proposal and is ready for ethical review.

Your facilitation for the review of the proposal is greatly appreciated.

Thank you

E. Chikaka
Research Supervisor

APPENDIX 5: Budget

	Item	Cost (USD)	Total Costs (USD)
Travel Costs	Transport fee	10 X 14days	140.00
	Airtime	2 x 14 days	28.00
Data collection costs	Allowances	10.00 x 14 Days	140.00
	Lunch	10.00 x 14 Days	140.00
Stationery	Bond Paper	5.00 x 3rims	15.00
	Tonner	40.00 x 1 tonner	40.00
	Box Files	5.00 x 2 box files	10.00
	Pens	0.10 x 15 pens	1.50
	Pencils	0.10 x 15 pencils	1.50
Total			**516.00**

APPENDIX 6: Timeline

Activity	Feb				March				July				Aug				Sep				Oct				Nov
	Weeks				Weeks				Weeks				Weeks				Weeks								Weeks
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1 2 3 4
Finalisation of Proposal																									
Approval from AUREC																									
Data collection																									
Data analysis																									
Report writing																									
Results Feedback																									
Abstract writing and submission																									