BIOCHEMICAL AND HEMATOLOGICAL CHANGES AMONG PEOPLE WITH ACTIVE PULMONARY TUBERCULOSIS INFECTION LIVING IN DENSELY POPULATED AREAS IN NAIROBI COUNTY

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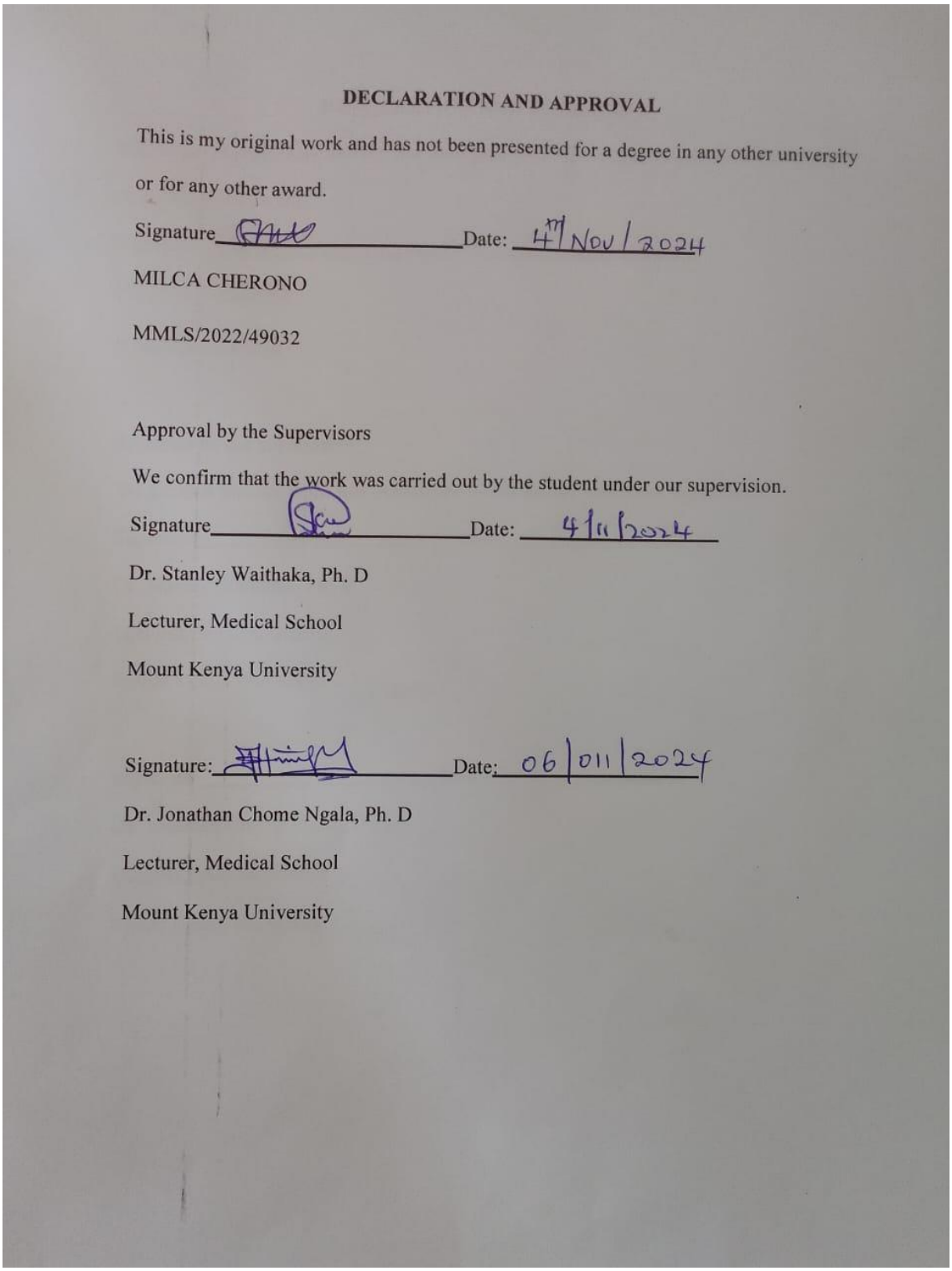
DECLARATION AND APPROVAL



DECLARATION AND APPROVAL

This is my original work and has not been presented for a degree in any other university or for any other award.

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DEDICATION

I dedicate this research to my family who have supported me financially, emotionally, and with unshakable love in to accomplish my academic goal.

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ABSTRACT

People living in Kenyan slums are at a higher risk of developing tuberculosis than people who don't live in densely populated areas. The risk includes infection with multi-drug-resistant tuberculosis strains. With the latest data reported in the year 2021 on Kenya's tuberculosis prevalence, the survey identified a prevalence of 251 per 100,000 adult populations. It is important to continuously update knowledge on the prevalence of tuberculosis to ensure 2030 tuberculosis end strategy control measures are effectively leading to a decrease. This study aims to estimate the prevalence of active pulmonary tuberculosis among people living in densely populated areas in Mukuru Kwa Njenga and Pipeline slums of Nairobi County. Sputum was analyzed for *Mycobacterium tuberculosis*; The study's methodology involved performing tests for the identification of bacteria using the GeneXpert technique. Positive GeneXpert results was counted against negative results and hence the prevalence of tuberculosis was determined. Hematological and biochemical alterations associated with tuberculosis infection was also done. Complete blood count and erythrocyte sedimentation was performed to determine hematological changes and liver function test to determine biochemical changes. The liver functions test was performed using a biochemistry auto analyzer where manufacturers' instructions was followed. Sensitivity of anti-TB drugs was accessed. Culture and sensitivity of anti-tuberculosis drugs was performed to rule out drug resistant tuberculosis infection. Quantitative data was analyzed using descriptive statistics which entails measure of frequency including mean, mode and median. This study helps to identify tuberculosis control techniques and implement necessary preventive measures to stop the spread of tuberculosis.

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LIST OF ABBREVIATIONS AND ACRONYMS

WHO-World Health Organization

LTBI-Latent Tuberculosis Infection

TB-Tuberculosis

ESR- Erythrocyte Sedimentation Rate

LFTS- Liver Function Tests

ALT-Alanine Transaminases

ALP- Alkaline phosphatase

AST- Aspartate Amino-Transaminases

UECS- Urea, Electrolytes and Creatinine.

K – Potassium

NA- Sodium

CL- Chloride

HIV-Human Immuno-Deficiency Virus

DNA-Deoxyribonucleic Acid

RNA-Ribonucleic Acid

MDR-TB -Multidrug Resistant Tuberculosis.

XDR-TB- Extensively Drug Resistant Tuberculosis

INH- Isoniazid.

RIF- Rifampicin.

ETH- Ethambutol

EDTA- Ethyldiaminetetracetic Acid

LIS- Laboratory Information System

HBC-High Burden Countries

MTB- *Mycobacterium tuberculosis*

IPT- Isoniazid preventive therapy.

DOTS- Directly Observed Therapy Short course

DST- Drug Susceptibility Testing

AST- Antimicrobial Susceptibility Testing

MGIT- Mycobacteria Growth Indicator Tube

CDC- Centre for Disease Control

LSD- Least Significant Difference

MPV- Mean Volume

MCV- Mean Cell Volume

HCT- Hematocrit count

HBG- Hemoglobin

RBC- Red Blood Cells

WBC- White Blood cells

PLT- Platelets

CRP- C-Reactive Proteins

DEFINITION OF OPERATIONAL KEY TERMS

Tuberculosis- Infection caused by bacteria that mainly affects the lungs and other parts of the body.

Active tuberculosis- Tuberculosis infection where clinical signs and symptoms are not manifested.

Latent Tuberculosis-Tuberculosis infection where signs are not manifested yet and the person is not ill or infective

Mycobacterium tuberculosis- Causative agent of tuberculosis infection.

Resistance- Inability of an organism to respond to drugs it normally does due to reduced effectiveness of the medication.

Adherence- Ability to respond by attachment.

Mortality- State of being subjected to death

Morbidity- Condition of suffering from a disease.

Pandemic- Disease that spreads all over the world.

Multidrug resistance- Simultaneous resistance of two potent drugs for tuberculosis, isoniazid, and rifampicin,

Chemoprophylaxis- Use of drugs to prevent disease.

CHAPTER ONE

INTRODUCTION

1.1 Background

Tuberculosis is a contagious, infectious disease of the upper respiratory tract caused by a pathogen called *Mycobacterium tuberculosis* complex (Cohen *et al*., 2019). *Mycobacterium tuberculosis* is classified under gram-positive acid-fast bacilli (Khan *et al*., 2019). Tuberculosis majorly affects the upper respiratory tract and the lungs (Bisht *et al.*, 2015). It can occasionally extend to the spine, brain, and kidney, among other bodily regions (Dey *et.al*, 2022). Tuberculosis can either be active or latent (Carranza *et al.*, 2020). Active tuberculosis is a serious multi-organ disease that majorly affects the lungs (Choudhary *et al.*, 2021). It results from primary infection or reactivation of latent tuberculosis (Jilani *et al.*, 2018). In Active tuberculosis, signs and symptoms are clinically manifested (Sia *et al.*, 2011). Active tuberculosis makes a person sick and can spread the disease to other people in close contact.

Transmission of the bacteria *Mycobacterium tuberculosis* occurs between individuals through tiny droplets of air when the person sneezes, or coughs they propel these tiny air droplets (Tellier *et al.*, 2019). It is then taken up by alveolar macrophages, which thereafter block phagolysosome formation. This formation gives the ability to replicate unhindered intracellularly (Du Plessis *et al.*, 2020). The immune system is ineffective since it is hidden inside host cells. It forms a protective granuloma to sustain a long-term infection (Pathak *et al* 2021). Delayed seeking of medication leads to further spread to others. Tuberculosis manifests in several ways including cough, fevers, night sweats, and weight loss (Stuck *et al.*, 2015).

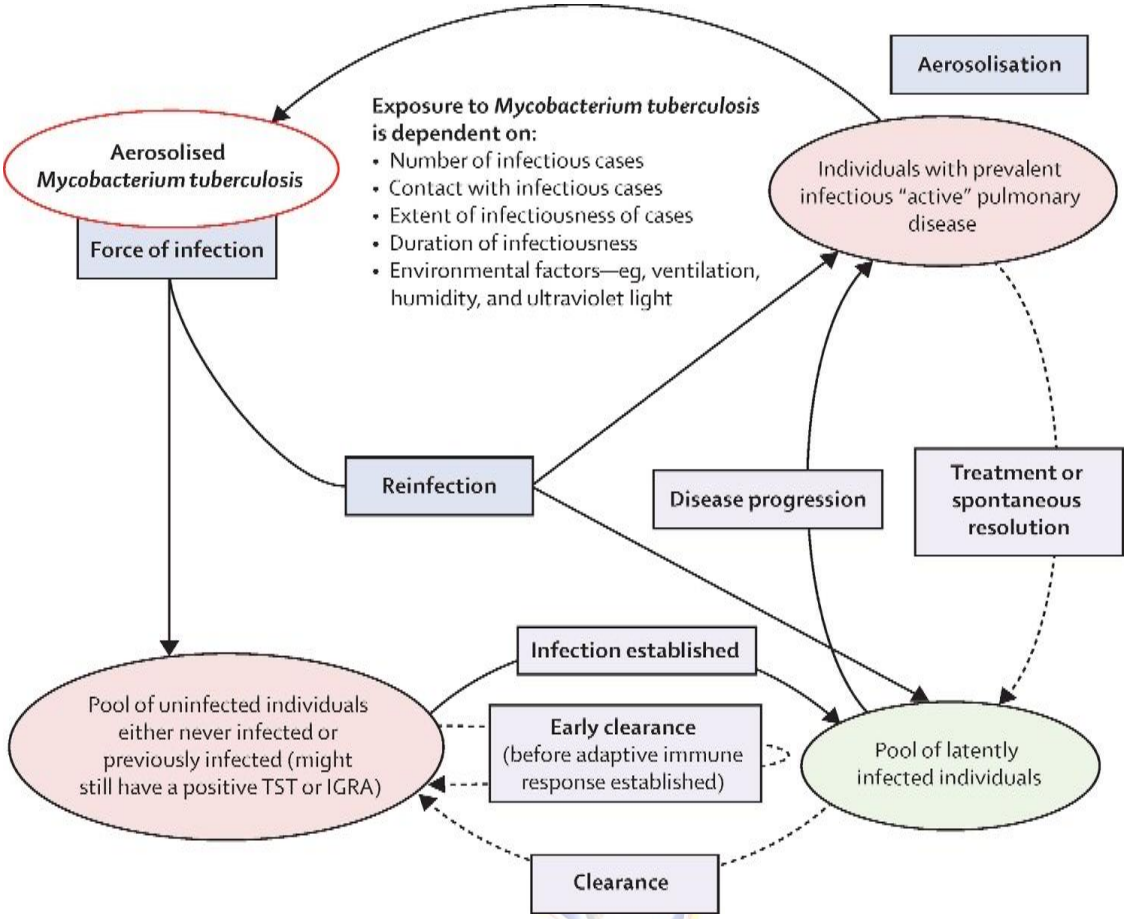


Figure 1: The transmission pattern of Mycobacterium tuberculosis

Source; adapted from Tom *et al*., (2015)

Tuberculosis is one of the top 10 diseases that kill people worldwide today (Sandhu *et al.*, 2011). It is the leading cause of mortality and morbidity (Raviglione *et al.*, 2016). The 2020 Global tuberculosis report estimated 9.96 million new patients with tuberculosis in 2019 and estimated 10 million persons in 2021 by the World Health Organization (Qui *et al.*, 2021). Of these statistics are 6 million men, 3.4 million women, and 1.2 million children. The global morbidity rate of tuberculosis was estimated at 1.6 million (Glaze *et al.*, 2015). Koch *et al.*, (2018) estimated a quarter of the world's population 1.7 million people are latently infected with *Mycobacterium tuberculosis*. People with asymptomatic tuberculosis infection have a 5-10% lifetime risk of developing active tuberculosis (Haas *et al.*, 2019). Niare et al., (2023), 2.5 million people contracted tuberculosis in Africa which is a quarter of the new tuberculosis infection

worldwide. An estimated 417,000 people died from the disease and over 25% of tuberculosis death occurs in Africa.

According to estimates from the WHO (2016), Kenya has an estimated 80% of all tuberculosis (Enos *et al.,* 2016). This ranks the country among the top 30 high-burden countries, which signifies that active pulmonary tuberculosis infection is a significant public health issue. In 2015, the estimated prevalence of all tuberculosis cases was 233 per 100,000 people while mortality cases were 20 per 100,000 WHO (2016). There was an estimated 9% relative rise in case detection of tuberculosis to the year 2021(Mungai *et al.,* 2021). However, tuberculosis's prevalence, morbidity, and mortality rates have not been reported in Nairobi County, especially in densely populated areas (Oppong *et al.,* 2015). In this study, the prevalence of tuberculosis infection in Mukuru Kwa Njenga and pipeline slums, Nairobi County was determined.

Infection with tuberculosis has a devastating impact on the hematopoietic system (Firdaus *et al.,* 2020). All hematological cellular components are produced and have a shorter lifespan as a result of tuberculosis (Oyer *et al.,* 2021). Additionally, plasma coagulation factors may be impacted, leading to consequences that can be fatal (Shayam *et al.,* 2016). The metabolism of iron, folate, and vitamin B12 is disrupted as a result. Hematological alterations are also a side effect of the drugs used to treat tuberculosis infection (Minardi *et al.,* 2021). Hematological alterations can occasionally help make a diagnosis, determine the prognosis, identify the complications of an underlying infection, and determine the need for and effectiveness of treatment (Bala *et al.,* 2015).

In individuals with tuberculosis, biochemical alterations are another important issue that should be taken into account (Sales *et al.,* 2023). Examining the signs of liver toxicity before and after starting anti-TB medication is crucial (Chaves *et al.,* 2015). The majority of documented instances of hepatic dysfunction are said to transpire during the initial

three months of initiating medication (Gafar *et al.,* 2019). These result from anti-tuberculotic medication effects. With the long-term use of antituberculotic medications such rifampicin, isoniazid, ethambutol and streptomycin. Adverse drug reactions have grown to be a significant clinical issue, particularly when used in combination (Amir *et al.,* 2016). The biochemical and hematological alterations in tuberculosis infection will be evaluated in this investigation.

Antibiotics can be used to both treat and prevent *Mycobacterium tuberculosis* (Sulochana *et al.,* 2022). The stage or kind of tuberculosis infection determines how it should be treated. *Mycobacterium tuberculosis* infection cannot be effectively treated with antibiotics in high-prevalence environments because of treatment toxicity, uncertain treatment durability, and extensive treatment regimens (Young *et al.,* 2020). Medication used to treat active pulmonary tuberculosis includes rifampicin, ethambutol, streptomycin, and isoniazid. Because of its potent early bacterial activity, isoniazid is a crucial first-line antibiotic (Jhun *et al.,* 2020).

However, the bacteria have been reported to develop resistance to conventional medication (Fair *et al.,* 2014). Drug-resistant tuberculosis has a treatment efficacy below 50% and can develop into a progressive untreatable disease (Salhotra *et al.,* 2020). The most typical form of resistance to anti-tuberculosis treatments nowadays is isoniazid (INH), either alone or in combination with other medications. The prevalence of INH resistance without concomitant rifampicin (RIF) is 7.9% in cases of *Mycobacterium tuberculosis* that have not yet been treated and 7.1 % in instances that have (Zhang *et al*., 2020).

Rifampicin is a well-known antibiotic for tuberculosis and latent tuberculosis infection (Keijzer *et al*., 2016). This is due to its mode of action, which involves blocking DNA-dependent RNA polymerase. There is no status report on either case of WHO-

recommended medication for tuberculosis in Nairobi slums Mukuru Kwa Njenga and pipeline. Therefore, this study will determine the efficacy of rifampicin, ethambutol, streptomycin, and isoniazid on *Mycobacterium tuberculosis.*

1.2 Problem statement

Tuberculosis is an infectious disease affecting a quarter of the world's population. The prevalence of tuberculosis survey was conducted last in the year 2016 (Masini *et al.*, 2018) and shows a significant population infected with active pulmonary tuberculosis. The disease is prevalent in densely populated areas such as slums because of increased population growth (Oppong *et al*., 2015). This results in an increase in *Mycobacterium tuberculosis* in the air (Pardeshi *et al.,* 2020) and thus many people could be infected especially those living in the slums. Survey conducted in 2016 established that tuberculosis prevalence in Kenya is higher than had been estimated and about half of those who fall ill each year are missed. The infection is complicated by the fact that individuals with latent tuberculosis are asymptomatic (Fox *et al.*, 2017). This is because asymptomatic individuals are less likely to seek diagnosis and subsequent medication (Galatas *et al.,* 2016). Currently, direct diagnosis by gene expert and immediate treatment is done whereas hematological and biochemical biomarkers are currently not being taken into account. These biomarkers aids in the diagnosis, treatment, and prognosis of tuberculosis infection (Khan *et al.*, 2019). In Kenya, the antibiotics used for the treatment of tuberculosis are recommended by World Health Organization (Mirzayev *et al.,* 2020). Anti- tuberculosis medication includes isoniazid, ethambutol, pyrazinamide, streptomycin and, rifampicin. However, their efficacy has not been accessed in densely populated areas of Nairobi County. Therefore, this study will determine the prevalence of active pulmonary tuberculosis infection in densely populated areas of Mukuru Kwa Njenga and pipeline. In addition, hematological and biochemical changes in tuberculosis

patients will be determined. More so, the efficacy of the WHO-recommended antibiotics will be accessed.

1.3 Justification

Generating data on the prevalence of tuberculosis in densely populated areas of Mukuru Kwa Njenga and pipeline in Nairobi County will be useful to the Ministry of Health as they will be in a position to access primary data concerning the infection. This will present a chance to create tuberculosis control techniques and implement necessary preventive measures to stop the spread of tuberculosis. In addition, the study will determine the hematological and biochemical changes that occur with tuberculosis infection. This will add to already existing tuberculosis tools and techniques. Data on the efficacy of the recommended antibiotics against tuberculosis infection will be generated. This will inform the World Health Organization and Ministry of Health on the status of the efficacy of the medications This will empower them to choose wise judgments on the continuous use of the medications or if alternatives are needed.

1.4 Study objectives

1.4.1 Main objective

To determine biochemical and hematological changes among people with active pulmonary tuberculosis infection living in densely populated areas in Nairobi County

1.4.2 Specific objectives

i. To determine the prevalence of *Mycobacterium tuberculosis* for study subjects visiting Pipeline and Mukuru Kwa Njenga slums health facilities?
ii. To determine hematological and biochemical changes in a patient with tuberculosis infection.
iii. In-Vitro assessment of the efficacy of anti-tuberculotic drugs against *Mycobacterium tuberculosis* by culture and sensitivity.

1.5 Research questions

i. What is the prevalence of *Mycobacterium tuberculosis* for study subjects visiting Pipeline and Mukuru Kwa Njenga slums health facilities?

ii. What are the hematological and biochemical changes in a patient with tuberculosis infection?

iv. What is the In-vitro efficacy of anti-tuberculotic drugs against *Mycobacterium tuberculosis* by culture and sensitivity?

1.6 Assumptions

The first assumption is that the participants in the study would be honest and objective to facilitate this, the survey respondents were assured in writing of confidentiality and anonymity of their feedback to reduce any potential for hesitation or dishonesty in responses to survey questions. Methodological assumptions pertain to the methods and techniques used to collect, analyze, and interpret data. Assumptions about the reliability and validity of measurement instruments, the appropriateness of statistical procedures, or the generalizability of findings to the broader population was made. The assumption is the sense that the sample represented the whole population of the two slums. The survey respondents were guaranteed in writing the confidentiality and anonymity of their input to eliminate any possibility of reluctance or dishonesty in responding to survey questions. This was done upon the first presumption that the research participants would be honest and objective. Assumption that the sample is sufficiently large, diverse, and representative of the population of interest to generalize findings beyond the sample.

1.7 Study significance

Findings from this study can be of importance to the national and county government and any other interested party who are involved in developing policies and regulations. This study provides data necessary for tracking the incidence and prevalence of TB, which

informs public health policies and resource allocation. Contributes to global efforts aimed at TB eradication by identifying effective prevention and control measures. It also helps the health sector personnel's in understanding pathophysiology. Changes in biochemical markers such as liver enzymes, kidney function tests and electrolyte levels indicate organ involment and the systematic impact of TB and hematological changes reflects the body immune response to active pulmonary tuberculosis infection. While microbiological confirmation remains the gold standard, biochemical and hematological alterations can support the diagnosis, especially in resource-limited settings. Certain patterns of biochemical and hematological changes may help differentiate TB from other respiratory or systemic diseases with similar clinical presentations

1.8 Limitations and Delimitation of the Study

The results of this study may not apply to other areas because it only looks at two slums. The study is restricted to information gathered within a two-month period; historical information gathered earlier is not taken into account. This study has a sample size of 162 participants due to time and budget constraints, which may restrict the generalizability of the findings to a larger population.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

Tuberculosis is an airborne disease caused by *Mycobacterium tuberculosis* (Fogel *et al., 2015*).

The disease affects a quarter of the world's population *(*Glaziou *et al., 2018).* World health organization and other stakeholders have made eradicating tuberculosis a priority (WHO *et al., 2016*). The tuberculosis complex is made up of the additional seven tuberculosis-causing organisms *M. bovis, M. africanum, M. microti, M. caprae, M. pinnipedii, M. Canetti, and M. mungi* (Malone *et al., 2017*). All these species cause tuberculosis infection. However, the main factor causing the illness globally is *Mycobacterium tuberculosis* (Khan *et al., 2019*). *Mycobacterium tuberculosis* is also called tubercle bacilli (Supply *et al., 2014*). *M. tuberculosis* is an Acid-fast, strictly aerobic, tiny, rod-shaped bacteria. Once stained, acid-fast bacteria don't fade under the influence of acid or alcohol (Riddell *et al*.,2019). Mycobacterium species compared to other bacterial infections, it grows slowly, causing sickness to manifest more gradually (Pereira *et al*., 2020).

Mycobacterium tuberculosis is a cellular pathogen within cells that tends to be tissue rich in oxygen (Sershen *et al*., 2016). It is further spread from the site of primary lung injury through lymphatic vessels or blood to other portions of the body (Al-janabi *et al*., 2019). When an infected individual coughs or sneezes close to a healthy person, the respiratory system is the most likely route of infection (Patterson *et al.,* 2019). According to predictions from the World Health Organization, in 2020, 9.9 million people worldwide contracted tuberculosis, and 1.5 million people died from it (Sundaram *et al.*, 2023). 95% of instances of *Mycobacterium tuberculosis*, which affects 22% of the global population,

occur in settings with minimal resources (Kelsey *et al*., 2019). Case findings and treating symptomatic individuals with infectious tuberculosis (TB) are the cornerstones of the World Health Organization's global TB control strategy (WHO). Finding cases involves actively looking for individuals displaying symptoms of active pulmonary tuberculosis, such as fever, sweats at night, coughing of blood and weight loss. (Field *et al*., 2018). Patients with symptoms should be identified and then subjected to diagnostic procedures such as sputum smear microscopy, chest X-rays, and molecular studies such as GeneXpert (Kabir *et al.*, 2021). Antibiotics are usually used in combination for a minimum of six months for treating symptomatic individuals with active pulmonary tuberculosis infections (Tiberi *et al.*, 2018). Four medications make up the typical treatment regimen: isoniazid, rifampicin, streptomycin, and ethambutol in the first phase, and isoniazid and rifampicin in the second phase (WHO *et al.*, 2018). Treatment adherence is essential to preventing the emergence of drug-resistant tuberculosis and ensuring positive results. (Kendal *et al*., 2019). Patients should have routine monitoring for adverse effects and responsiveness to treatment so that medication can be modified as necessary. Contact tracing and infection control measures are also essential to prevent the spread of TB within communities and healthcare settings (Kompala *et al.*, 2013). For effective control of the disease, it is important to understand its prevalence, hematological and biochemical changes, and efficacy of anti-tuberculotic drugs to effectively eradicate tuberculosis (Chae *et al*., 2018).

2.1 Prevalence of active pulmonary tuberculosis infection among people living in densely populated areas in Nairobi county.

In Kenya today, *Mycobacterium tuberculosis* is one of the biggest causes of death and a severe public health concern. (Mung'atu *et al*., 2015). People who live in highly crowded places are important reservoirs of tuberculosis (Pelissari *et al.*, 2017). Kenya is one of the

22 nations with a high burden of tuberculosis (Enos *et al*., 2016). The prevalence of tuberculosis infection is approximated using data from World Health Organization (Kibuchi *et al.,* 2015). Despite the advancements made in the previous ten years, improving tuberculosis (TB) case detection continues to be one of the top priorities for national programs all over the world (Floyd *et al.,* 2018). The directly observed treatment short course (DOTS) approach is supported by the WHO's global tuberculosis control plan (Behzadifar *et al.,* 2015). As the standard procedure for case findings, this technique depends on symptomatic individuals voluntarily seeking medical treatment at hospitals (Lorent *et al.,* 2014).

Many studies have shown a robust correlation between urbanization, population density, and the prevalence of tuberculosis (Mohidem *et al*., 2021). Urban areas, especially in low- and middle-income countries tend to have higher tuberculosis (TB) prevalence rates compared to rural areas due to factors such as overcrowding, poverty, inadequate healthcare access and migration (Woldesemayat *et al*., 2021). Epidemiological studies conducted in densely populated urban settings have consistently reported higher rates of tuberculosis (TB) transmission and incidence (Dhanaraj *et al.,* 2015). For example, research in megacities like Mumbai, Delhi, and Sao Paulo has shown high numbers of tuberculosis (TB) prevalence rates, particularly in slum areas characterized by overcrowded living conditions and poor sanitation. Studies employing molecular epidemiology techniques, such as genotyping and whole genome sequencing, have provided insights into the transmission dynamics of tuberculosis (TB) in densely populated areas (Auld *et al*., 2018). These investigations often reveal clustered cases, indicating local transmission chains within communities, households, or social networks. Studies examining the social determinants of active tuberculosis transmission in densely populated areas underscore factors like poverty, homelessness, malnutrition,

unemployment, and crowded housing as primary contributors to the elevated rates of tuberculosis infections (Tadokera *et al*.,2018). These conditions facilitate the spread of *Mycobacterium tuberculosis* and hinder efforts to control tuberculosis (TB) effectively. Limited access to healthcare services and poor-quality healthcare infrastructure in densely populated areas contribute to delayed diagnosis, inadequate treatment, and ongoing transmission of active pulmonary tuberculosis infections (Cattamanchi *et al.,* 2015). Studies highlight the importance of improving the healthcare systems especially in this densely populated areas an implementing community based tuberculosis (TB) control programs and interventions (Yassin *et al*., 2013).

The literature also demonstrates a range of strategies designed to address tuberculosis infection in places with high population density (Shaweno *et al*., 2018). This include case finding, contact tracing, community engagement, and improved housing conditions (Zaildo *et al.,* 2023). However, there are obstacles to putting these interventions into practice, including a lack of resources, societal stigma, the dynamics of migration, and conflicting health objectives. In order to prevent the spread of active pulmonary tuberculosis infection in densely populated areas, some studies examine the relationship between urban planning and tuberculosis control. These studies advocate for policies that support appropriate urban development, equitable access to housing, sanitation, and healthcare services, as well as the creation of healthy living environments.

The rate of tuberculosis case detection has remained unchanged in recent years (Lonroth *et al.,* 2013). The population of urban slums in developing countries is expanding at the quickest rate of any type of habitation worldwide. (Oppong *et al*., 2015). An important effect of this densely populated slum growth is on the epidemiology of infectious diseases that spread through multiple channels. In particular, a lack of both appropriate sewage systems and water supply, inadequate sanitation, shabby housing, and excessive density

encourages the development of tuberculosis infection. This is due to the proximity of housing hence transmission from one house to another (Kristin *et al.,* 2018). Close household proximity results in to increase in *Mycobacterium tuberculosis* burden load in the air (Miglioro *et al.,* 2019). However, data on tuberculosis infection in Kenya slums is scarce (Nyang'au *et al*., 2016). In this study, the prevalence of active pulmonary tuberculosis in the slums of pipeline ne and Mukuru Kwa Njenga Nairobi County will be determined.

2.2 Hematological and biochemical alterations that occurs with active pulmonary tuberculosis infection.

Tuberculosis causes severe bone marrow and peripheral blood problems and also affects the lungs (Hungund *et al*., 2012). Reversible hematological blood abnormalities are often associated with active pulmonary tuberculosis and are used as markers for diagnosis, prognosis, and response to treatment. (Minardi *et al.,* 2021). In active pulmonary tuberculosis, a variety of hematological and biochemical abnormalities are useful diagnostic markers. (Shah *et al.,* 2022. These indicators include hemoglobin, packed cell volume (PCV), red blood cells (RBC), blood indices, platelet count, white blood cells (WBC) count, erythrocyte sedimentation rate, and C-Reactive Protein (Minardi *et al.,* 2021). Treatment plans and treatment monitoring heavily depend on hematological markers (Shah *et al*., 2022). To enhance treatment results, patient survival, and quality of life, it is crucial to evaluate and manage infectious illnesses like tuberculosis concerning hematological indicators (Amar *et al.,* 2022). Such hematological results are affordable and can aid in prompting medical professionals and primary care providers to detect early alterations in active pulmonary tuberculosis patients in a very affordable manner.

Studies have shown that tuberculosis is associated with biochemical changes, namely low serum albumin, low or high serum calcium levels, and low or high serum potassium among others (Uchenna *et al.,* 2021). This study will analyze early changes in biochemistry parameters in sputum smear-positive tuberculosis and evaluate its diagnostic and prognostic techniques during the course of the disease. More so, the influence of tuberculosis infection on albumin, calcium, potassium, and sodium will be evaluated.

Active pulmonary tuberculosis can result in anemia, either as a consequence of chronic inflammation or, in certain instances, due to direct bone marrow suppression caused by the infection (Minardi *et al*., 2021). Active pulmonary tuberculosis infection can also cause alteration in white blood cells count. Initially there might be leukocytosis but as the disease progress, leukopenia may occur due to bone marrow suppression (Minardi *et al.,* 2021). Thrombocytosis or thrombocytopenia similarly to white blood cells may initially rise due to inflammation but may decrease as the disease progresses (Kirwan *et al*., 2021). Erythrocyte sedimentation rate is a non-specific marker of inflammation. In tuberculosis cases, Erythrocyte sedimentation rate is often elevated due to the chronic inflammatory response (Sumampouw *et al*., 2021). Abnormal liver function tests can be noted with tuberculosis infection as well. Elevated liver enzymes such as alanine transaminases and aspartate transaminase (Lingaraja *et al.,* 2014). This can occur due to hepatic granuloma formation or drug induced liver injury from tuberculosis infection and its medication. Hypoalbuminemia, decreased levels of serum albumin can occur in active pulmonary tuberculosis infection (Ganesan *et al.,* 2019). This is due to chronic inflammation and malnutrition commonly associated with the disease. Electrolyte abnormalities is associated with gastrointestinal involvement and can lead to electrolyte imbalances such as hyponatremia and hypokalemia (Shrimanker *et al.,* 2019). Active

pulmonary tuberculosis infection can cause hypercalcemia which is the increased level of calcium in the blood (Rajendra *et al.,* 2016). This can occur due to granulomatous inflammation leading to increased production of 1,25-dihydroxyvitamin D, which enhances calcium absorption in the gut (Teben *et al.,* 2016).

2.3 In-vitro efficacy of anti-tuberculotic drugs by culture and sensitivity.

First-line medications for tuberculosis treatment have historically included pyrazinamide, ethambutol, isoniazid, and rifampicin (Dookie et al., 2022). In our present regimen, streptomycin is utilized as a second line antibiotic to treat tuberculosis infection, replacing pyrazinamide. The World Health Organization recommends isoniazid with rifampicin (Getahun *et al.* 2015) as a treatment for tuberculosis infection. Nonetheless, there is evidence to question the overall effectiveness of these regimens (Surendra *et al.,* 2012). In 2017, it was estimated that 558,000 new cases of tuberculosis worldwide were resistant to rifampicin (Alharazi *et al*., 2023). Eighty-two percent of these new cases of tuberculosis developed into multidrug-resistant TB (MDR-TB). Consequently, it's critical to keep up with the latest research on the mechanism underlying the rise in drug resistance in *Mycobacterium tuberculosis* (Singh *et al.,* 2016). Regardless of resistance to other anti-TB medications, multidrug-resistant tuberculosis (MDR-TB) is defined as an organism's high level of resistance to both isoniazid and rifampicin. (Dheda *et al.,* 2024). Drug sensitivity testing (DST) on the isolates is how multi-drug resistant tuberculosis infection (MDR-TB) is diagnosed. DST data can also be used to identify the drug regimen (Aurin *et al.,* 2014). Compared to first-line medications, second-line anti-tuberculosis medications are less effective and more likely to induce side effects. (Ramachandran *et al*., 2015).

The first-line antibiotic for treating tuberculosis infection is rifampicin (Grobbelaar *et al.,* 2019). It is one of the most powerful and successful anti-TB medications, it forms the

basis of therapy regimens for tuberculosis. (Patil *et al*., 2020). Rifampicin resistance is a significant concern, and is often associated with multidrug- resistant tuberculosis. (MDR-TB) (Guled *et al.*,2016) and extensively drug-resistant tuberculosis infection (XDR-TB). Rifampicin sensitivity testing is carried out by molecular approaches such as the Xpert MTB/RIF assay or culture-based drug susceptibility testing (DST) (Yadav *et al*., 2021). By generating a drug enzyme complex, rifampicin inhibits the bacterial enzyme RNA polymerase, which is in charge of DNA transcription (Alifano *et al*., 2015. Bacterial mutations that modify the structure of the RNA polymerase beta subunit are the cause of rifampicin resistance in bacteria (Ning *et al*., 2021).

Isoniazid is a key first-line antibiotic and is highly effective against susceptible strains of *Mycobacterium tuberculosis* (Amaral *et al.,* 2017). It is critical component of standard TB treatment regimens and is often combined with rifampicin, ethambutol and streptomycin. Isoniazid resistance is often associated with the development of MDR-TB and XDR-TB (Stag *et al*., 2017). Isoniazid is used to treat tuberculosis that is only effective against actively replicating *Mycobacterium tuberculosis* (Johansen *et al*., 2022). This is due to its capacity to prevent the production of mycolic acid, which interferes with the formation of cell walls. Isoniazid is not effective against asymptomatic tuberculosis infection if replication of *M. tuberculosis* is not taking place (Houben *et al.*, 2014). This is because isoniazid is only bactericidal against replicating *M. tuberculosis* (Laura *et al*., 2018).

Ethambutol is another first line antibiotic used in combination with rifampicin, isoniazid and streptomycin for treatment of active pulmonary tuberculosis infection (Linger *et al.*, 2014). It is particularly effective against actively replicating *Mycobacterium tuberculosis* and is often included in standard tuberculosis infection treatment regimens. Ethambutol resistance is less common than rifampicin resistance but can still occur, especially in

combination with other drug resistance (Heyckendorf *et al.,* 2018). Sensitivity testing for ethambutol is typically performed alongside other anti-TB drugs using culture based DST or molecular methods (Cheng *et al.,* 2014). The combination of these drugs helps to maximize treatment efficacy, shorten the duration of therapy, and reduce the risk of treatment failure and relapse (Dartois *et al.,* 2022). Ethambutol's mechanism of action complements that of other anti-TB drugs, providing a synergistic effect against M. tuberculosis (Zhu *et al*., 2018).

The first antibiotic to be effectively used to treat tuberculosis infection was streptomycin (Kerantzas *et al.,* 2017). The discovery of streptomycin in the 1940s transformed treatment for tuberculosis (TB), greatly enhancing patient outcomes (Murray *et al.,* 2015). Streptomycin was first prescribed as monotherapy before being added to combination regimens with other anti-TB medications (Sotgiu *et al.,* 2015). By preventing the synthesis of bacterial proteins, it demonstrates bactericidal efficacy against *Mycobacterium tuberculosis* (Kumar *et al.,* 2021). By attaching itself to the bacterial ribosome, streptomycin prevents the production of proteins and causes cell death (Lin *et al.,* 2018). Streptomycin is an effective treatment for drug-susceptible tuberculosis when used in combination therapy (Caminero *et al.,* 2018). Streptomycin is used with other first-line medications such as isoniazid, rifampicin, pyrazinamide, and ethambutol in order to maximize efficacy and minimize drug resistance (Jang *et al.,* 2020). However, its use as a first-line treatment has been restricted due to the advent of streptomycin-resistant strains of *Mycobacterium tuberculosis*. Resistance may arise due to inactivating enzyme synthesis or bacterial ribosome alterations (Wilson *et al*., 2014). Cross-resistance to other aminoglycoside antibiotics and streptomycin resistance are frequently correlated.

Overall, a patient's susceptibility to rifampicin, ethambutol, streptomycin, and isoniazid depends on a number of factors, including the patient's commitment to therapy, the susceptibility of the infecting strain, and the existence of mutations causing medication resistance. Sensitivity testing is crucial to managing tuberculosis infections and halting the development of drug-resistant types of the illness. It is important to consider the high resistance of isoniazid and rifampicin therapy while treating tuberculosis infection (Huang *et al.*, 2019). Although most trials have focused on adherence, efforts to reduce the length of tuberculosis infection treatment are encouraging. (Sharma *et al.,* 2012). Nevertheless, there hasn't been any discussion of the effectiveness of isoniazid, ethambutol, streptomycin, and rifampicin medication trials in high-burden areas. The effectiveness of the anti-tuberculosis medications isoniazid, ethambutol, rifampicin and streptomycin will be accessed in this study.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

The approach used in this study acts as a road map for the inquiry, gathering, and processing of data. In order to provide a thorough understanding of the phenomenon under inquiry, a mixed-method approach was used. In order to triangulate data and improve the validity of conclusions, this required integrating quantitative surveys with qualitative interviews. Descriptive statistics were used to evaluate the quantitative data in order to spot patterns and trends, and thematic analysis was used to study the qualitative data in order to find recurrent themes and subtle insights.

3.1 Location of the study

The slums of Mukuru Kwa Njenga and the pipeline are located in Nairobi County, which is the capital city of Kenya. They are neighboring slums which shares its borders with the industrial area commercial zone to the south, the Jomo Kenyatta international airport to the north, and other expanding suburban communities in the Embakasi region, such as Denholm estate. Although they stretch into Makadara and Starehe consistencies, they are part of the Embakasi south constituency. Mukuru Kwa Njenga is one of Nairobi's biggest slums. They are located in the unused land along the Nairobi/Ngong River the city's industrial district, between the outering road, North Airport Road, and Mombasa Road. More than 100,000 people live there. Including many slums in the world, these two have struggled with issues like poverty, illiteracy, and bad sanitation. Whole families live in these slums which makes a good study site due to close proximity of housing hence enhances spread of tuberculosis.

3.2 Research design

This was a cross sectional experimental study with laboratory experiments conducted at Mama Lucy Kibaki hospital. Blood and sputum samples were collected for laboratory analysis. Blood sample was used to measure hematological and biochemical alterations while sputum for identification of *Mycobacterium tuberculosis* as well as to determine sensitivity of first-line antibiotics of tuberculosis infection. Case-control studies were used to compare individuals with tuberculosis infection to those without infections who acts as a control to identify variabilities of different parameters in biochemistry and hematology.

3.3 Target population

Target population are the patients who visit the hospital presenting with signs and symptoms of active pulmonary tuberculosis infection.

3.4 Inclusion and Exclusion Criteria

3.4.1 Inclusion criteria

Patients displaying symptoms of active pulmonary tuberculosis.

3.4.2 Exclusion criteria

Those who have alternative diagnoses such as lung cancer, pneumonia etc.

Patients unable to provide enough sputum specimen.

Inability to provide consent including children whose parents do not consent.

3.5 Variables

3.5.1 Independent variables

Anti-tuberculosis medication which includes isoniazid, ethambutol, streptomycin, and rifampicin

3.5.2 Dependent variables

Active pulmonary tuberculosis infection

3.6 Sampling procedures

Systematic random sampling in every third person was used to ensure enough samples from patients. Sample. This method was straightforward and easy to implement it ensured that the sample is spread evenly across the population. This study executed this procedure as the population was large hence less time-consuming.

3.7 Sample size determination

The sample size for this study will be determined using a formula that takes into account the size of population (NN), the desired margin of error (ee), the significance level, and the confidence level. The formula used is:

$$n=N1+(e)2n=1+N(e)2N$$

Where:

- n is the sample size.
- N is the size of population.
- E is the margin of error.

In this study, the margin of error (e) will be derived from calculation based on a predetermined significance level of 5% and confidence level of 95%. These levels are accepted standards in statistical analysis for establishing the reliability and accuracy of results.

Therefore;

n =162/1+(0.05) *2

n =sample in the study will be 162

3.8 Data collection tools.

Once consent is given to the study participants filled out questionnaires containing details of age, gender, residence, medical conditions, use of alcohol and smoking, etc. Participants who met the inclusion research then had venous blood drawn from their arms. 4ml of blood was needed for this research. Blood was put directly into EDTA-containing tubes. These samples were labeled and processed for hematological and red tops for biochemical investigations. Sputum was collected in special containers which were labeled. It was then stored in a refrigerator and transported for laboratory diagnosis of *Mycobacterium tuberculosis*. Culture and sensitivity was performed to determine the efficacy of rifampicin, isoniazid, ethambutol, and streptomycin.

Logs for recording instrument maintenance, calibration, quality control procedures, and troubleshooting activities are among the data collecting tools for gene experts. Over time, these records guarantee the performance, dependability, and correctness of GeneXpert devices and test findings. Automated hematology analyzers are sophisticated devices that assess several blood parameters and conduct complete blood counts. These analyzers evaluate parameters like hemoglobin concentration, hematocrit, platelet count, differential leukocyte count, and white and red blood cell counts using modern technologies like flow cytometry, impedance, and laser-based approaches. Automated hematology analyzers usually retain their data electronically, which can then be transmitted to laboratory information systems (LIS) for additional reporting and analysis.

3.9 Data Collection Methods

Sputum samples from the patients with met the inclusion criteria with prolonged coughing, fevers, and chest for more than two weeks was collected in a sterile container. It was then placed into a cooler box and then transported to the laboratory for diagnosis of *Mycobacterium tuberculosis.* GeneXpert was performed for diagnosis of active

pulmonary tuberculosis. GeneXpert is a disposable cartridge-based equipment system for nucleic acid amplification. The reagent that comes with the test was combined with the collected sputum, and the cartridge holding this combination was inserted into the GeneXpert machine. At this stage, the procedure was automated. The prevalence of tuberculosis was calculated by counting and recording both positive and negative slides. With the use of a sterile syringe, 3–4 ml of peripheral venous blood was aseptically extracted and then placed into a tube containing 0.2 ml of an EDTA solution (4%) solution. The test was conducted using a hematology analyzer to assess various hematological alterations. The remaining 2 ml of blood was utilized to determine the erythrocyte sedimentation rate. Before the readings were obtained, the blood was poured into a Westergren tube till the zero mark and let to stand vertically for an hour. Hemoglobin, leukocyte count, red blood cell count, mean cell volume, mean cell hemoglobin, hematocrit, mean corpuscular hemoglobin concentration, and ESR is among the hematological parameters that was examined.

To investigate biochemical changes routine laboratory testing was performed including liver function tests, Aspartate transaminases (AST), Alkaline transaminases (ALT), Alkaline phosphatase (ALP), and kidney function tests including potassium, sodium, creatinine, and urea levels. The place where venipuncture was done was sterilized using cotton swabs. Blood was withdrawn from the vein by use of a needle and a syringe. It was then stored in a red top vacutainer which makes blood to clot because it does not contain an anticoagulant. It was then centrifuged at 1500rev/sec for 3 minutes and then the serum was separated and placed in crystal vial tubes. The serum was placed in a biochemistry auto analyzer to analyze biochemical analytes according to the manufacturer's instructions.

The samples which turned positive for gene expert were taken to National reference laboratory for culture and sensitivity. The fully automated BACTEC MGIT 960 was used by the manufacturer's instructions to perform a culture and sensitivity test for *Mycobacterium tuberculosis*. The Centers for Disease Control and Prevention (CDC) recommends a turnaround time of 2-4 weeks after receiving the samples for culture and sensitivity testing. BACTEC MGIT 960 is superior to other culture systems in terms of turnaround speed and sensitivity. The MGIT (Mycobacteria Growth Indicator Tube) system is a method used to detect the presence of *Mycobacterium tuberculosis* by; collecting sputum sample, decontaminating the sample to remove other bacteria that might be present. This helps to isolate the *Mycobacterium tuberculosis* and reduce the chance of false positives. A specimen is then inoculated into MGIT tube containing liquid growth medium. The medium typically contains nutrients that support growth of mycobacteria. The MGIT tube also contains a fluorescent sensor embedded in the bottom. This sensor measures the concentration of oxygen and detects changes in carbon dioxide levels within the tube. Incubation is done by placing inoculated MGIT tube in a specialized instrument called an MGIT instrument which provides optimal conditions for bacterial growth, including controlled temperature and agitation. The instrument continuously monitors the MGIT tubes to fluorescence. As *Mycobacterium tuberculosis* grow and metabolize nutrients in the medium, they consume oxygen and produce carbon dioxide, which correlates with bacterial growth. When Mycobacterial growth occurs, the oxygen level decreases and the carbon dioxide level increases, leading to an increase in fluorescence. When the fluorescence reaches a predetermined threshold, it indicates that mycobacterial growth has occurred in the tube. This triggers an alert in the MGIT instrument, signaling that the tube is positive for Mycobacterial growth. Once a positive

signal is detected, further testing, in this case drug susceptibility testing is performed to determine appropriate antibiotic treatment.

Mycobacterium tuberculosis isolates were found in eighteen (18) patients for their susceptibilities to isoniazid (INH), Ethambutol (ETH), streptomycin (STR) and rifampin (RIF). The selection of the most appropriate antibiotic therapy for patients with mycobacterial infections is aided by the measures that AST by MGIT takes to provide vital information regarding the susceptibility of mycobacterial isolates. For the MGIT procedure, 0.5 milliliters of test organism suspension were added to an MGIT containing 0.1 microgram of isoniazid per milliliter, streptomycin (STR) 4.0 micrograms/milliliter, Ethambutol (EMB) 5.0 micrograms/milliliter, and 1.0 microgram of rifampicin per milliliter, along with a growth control MGIT. The tubes were checked every day while being incubated at 37 degrees. According to the interpretation of the MGIT AST data, the tubes containing the drugs were classified as resistant if they did not glow within two days after the positive growth control did, and susceptible if they did occur within that time frame. Rifampicin, isoniazid, streptomycin, and ethambutol effectiveness and resistance for *Mycobacterium tuberculosis* will be evaluated in this way.

3.10 Validity and reliability of the data

Validity and reliability of the data was dependent of different instruments used during the study. The gene expert assay is a significant advancement in modern medicine (MDR-TB) since it detects tuberculosis that is medication resistant to many drugs. It has great specificity and good sensitivity. GeneXpert assays exhibit high sensitivity and specificity, allowing for accurate detection and identification of target nucleic acids. The system's proprietary cartridge-based design and closed amplification/detection system minimize the risk of contamination and false-positive results, enhancing the reliability of diagnostic testing. Compared to other diagnostic methods for *Mycobacterium tuberculosis*, gene

expert is quicker. However, a hematology analyzer has additional validation studies such as carryover and proper mixing, as well as important components like accuracy, precision, a clinically reportable range for analytical measurements, a reference range, and instrument flags that help with sensitivity and specificity. Built-in validation algorithms ensure the accuracy and reproducibility of measurements, minimizing the risk of errors and false results. Hematological analyzers can be smoothly integrated with Laboratory Information Systems (LIS) to facilitate electronic record-keeping, automatic data transfer, and result reporting. Workflow is streamlined, transcription errors are decreased, and overall laboratory efficiency is increased by LIS integration.

The mycobacterial growth indicator tube uses a liquid culture detection method as its foundation. It has higher sensitivity (91%) and specificity (95%) as well as accuracy (92%) than other traditional methods for detecting anti-tuberculin medicines. The MGIT system is fully automated, streamlining the process of mycobacterial culture and detection. It eliminates the need for labor-intensive procedures associated with traditional culture methods, such as agar-based cultures or Lowenstein-Jensen slants, reducing hands-on time and minimizing the risk of human error. The MGIT system offers faster detection of mycobacterial growth compared to conventional methods. The continuous monitoring of growth in liquid media allows for earlier detection of positive cultures, typically within 1-2 weeks, compared to several weeks required by solid culture methods. Rapid detection enables timely initiation of treatment and infection control measures, improving patient outcomes and reducing transmission of tuberculosis infection and other mycobacterial infections. Even at low bacterial numbers, the MGIT method exhibits excellent sensitivity for the detection of mycobacterial growth. The ideal circumstances for mycobacterial development are provided by the liquid culture media employed in MGIT tubes, which also reduces the possibility of false-negative results and improves the

recovery of clinically important strains. The MGIT system demonstrates high sensitivity for the detection of mycobacterial growth, even at low bacterial concentrations. The liquid culture media used in MGIT tubes provide optimal conditions for mycobacterial growth, enhancing the recovery of clinically relevant strains and minimizing the risk of false-negative results.

3.11 Data management

Appropriate tools for data recording, such as spreadsheets, databases used. Data was securely stored to prevent loss, corruption, or unauthorized access. Make use of dependable storage options, like institutional servers, external hard drives, and cloud-based platforms. Implement data backup procedures to create redundant copies of data and protect against data loss. The data was cleaned and preprocessed to identify and correct errors, inconsistencies, or missing values. Verification of the accuracy and completeness of data entries through validation checks and data quality assurance procedures. Documentation of any data cleaning procedures performed to maintain transparency and reproducibility. Data generated was stored in a computer with a password only known to the researcher. Content analysis was used for data generated by objective one. Objective two and three MANOVA was used to determine variation in hematological, and biochemical changes and drug efficacy. Post hoc test least significance difference (LSD) help in comparing prevalence data on IBM SPSS 29 version. After the complete analysis of data, it is presented in graphics. Statistical data was represented by curves and lines across coordinates. This help in investigating the relationship between variables in my study that's prevalence by age or gender. It helps analyze the frequency distribution. Data generated on gene expert results positives and negatives aid to determine the prevalence of the infection. Data generated from culture and sensitivity, identify the efficacy of anti-tuberculotic drugs and finally data on

hematological and biochemical tests generate data on alteration caused by tuberculosis for easier diagnosis, prognosis and treatment.

3.12 Data analysis and presentation

SPSS was an appropriate software to clean and preprocess the data. Descriptive statistics was used to summarize the main characteristics of data, such as mode, median and mean frequency distribution and standard deviation. Descriptive statistics was done to provide initial insights into the dataset and help identify patterns and trends. Inferential statistics was then conducted to test hypotheses and make inferences about population parameters on sample data. ANOVA was chosen based on the research design and results interpreted in relation to the research objectives. Data visualization techniques was used to present the findings visually and enhance comprehension. Charts, graphs, tables were used to illustrate comparison in the data and relations and trends. Text that presents the main findings in an easy-to-read manner and interprets them in light of the research goals, theoretical framework, and body of current literature

3.13 Ethical consideration

In this research, ethical consideration was a crucial practice to protect the validity of the investigation. The Nairobi County Health Department and NACOSTI gave accreditation for approval before the study being carried out. The Mount Kenya University ethical review committee approved the research proposal and ensure highest standards and principles of ethics to conduct the research. Informed consent was obtained voluntarily from participants before involving them in the study. Participants were provided with clear and understandable information about the purpose, risk, benefits, and their rights in participation. Informed consent was obtained in writing and participants were given freedom to withdraw from the study at any time without penalty. Therefore, before the collection of samples for laboratory diagnosis, potential candidates were given consent

by signing a consent form. The tools used to acquire the raw data was maintained in a secure location that is only accessible to the researcher. Respect for potential clients was ensured by; Keeping the study's findings confidential to protect the participants' privacy, respecting the right to change mind or withdraw without penalty and monitoring their welfare. Participant were allocated identification numbers for confidentiality purposes.

Privacy and confidentiality of participant's personal information was ensured. It was collected, stored and handles securely to prevent unauthorized access or disclosure. Confidentiality measures were implemented to ensure that individual participants cannot be identified from research data without their explicit consent. Risk were minimized through careful study design, risk assessment and mitigation strategies. Unnecessary discomfort, distress and harm was avoided as much as possible in this research. Conflicts of interest were avoided where personal, financial or professional interest could compromise the integrity and objectivity of the research.

CHAPTER FOUR

RESEARCH RESULTS AND DISCUSSIONS

4.1 Demographics

One hundred and sixty-two (162) study subjects were recruited in the current study. The composition distribution of the study subjects was one hundred and eleven males (111) and fifty-one females (51). The age distribution of the study subjects was five- months (0.5 years) up to seventy-eight (78 years) with an average age of thirty -six years (36 years).

4.2 The prevalence of *Mycobacterium tuberculosis* for study subjects visiting Pipeline and Mukuru Kwa Njenga slums health facilities.

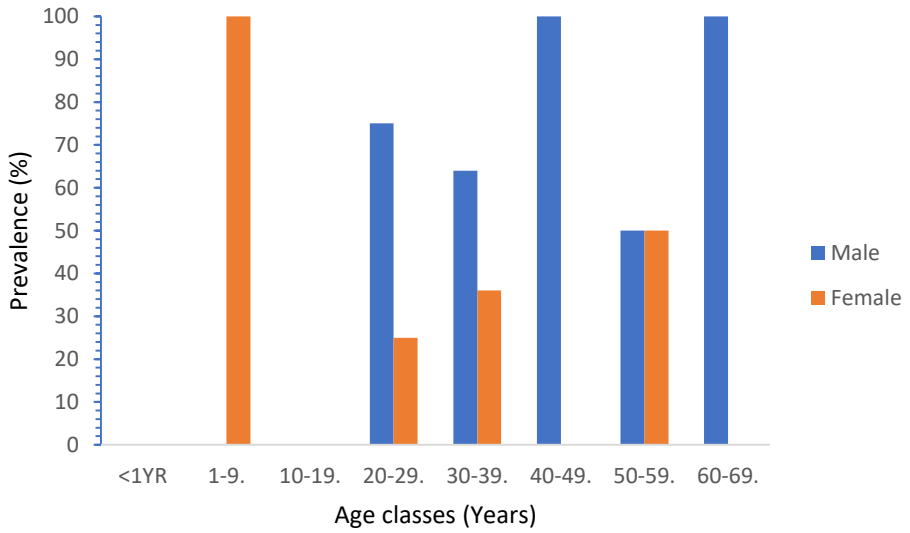
Table 1: Prevalence of *Mycobacterium tuberculosis* for study subjects visiting Pipeline and Mukuru Kwa Njenga slums health facilities

Gender	Number of study subjects	Positive	Negative
Male	111 (100%)	18 (11.1%)	93 (57.4%)
Female	51 (100%)	11(6.8 %)	40 (24.6%)
Total	**162 (100%)**	**29(17.9%)**	**133 (82.1%)**

Sputum specimens were collected from the study subjects and qualitatively analyzed. Twenty-nine (29) sputum specimens generated positive results for *mycobacterium tuberculosis* while one hundred and thirty-three (133) generated negative results for *mycobacterium tuberculosis.* This study had a total of 111 males and 51 males enrolled for this study. The percentage distribution of *Mycobacterium tuberculosis* infection was 17.9% positive and 82.1% negative. Out of the twenty-nine study subjects, whose results for *Mycobacterium tuberculosis* were positive, eighteen (18) were males translating to 62% while eleven were females translating to 38%. Therefore, the overall prevalence of *mycobacterium tuberculosis* for study subjects visiting Pipeline and Mukuru Kwa Njenga

slums health facilities was 17.9 % with a male and female distribution of 18 (11.1 %) and 11 (6.8 %) respectively as shown in table 1 below. On the other hand, one hundred and thirty-three (133 (82.1%) study subjects turned to be *Mycobacterium tuberculosis* negative. The gender distribution was 93 (57.4 %) males and 40 (24.6 %) females

Figure 2: Prevalence in different age and gender.



The prevalence of *Mycobacterium tuberculosis* infection in different age classes and sex in Mukuru Kwa Njenga was determined as shown in figure shown below. The prevalence of *Mycobacterium tuberculosis* infection was highest in both male and female aged between 30-39 years old. Children below 1-year old had no infection of *Mycobacterium tuberculosis.* Only female patients aged between 1-9 years old had the bacterial infection. In addition, only male patients aged between 60-69 years old had the infection. However, the prevalence of *Mycobacterium tuberculosis* infection was not significantly different in male and female patients across all age classes, t_7=1.3, CI=95%, p=0.2.

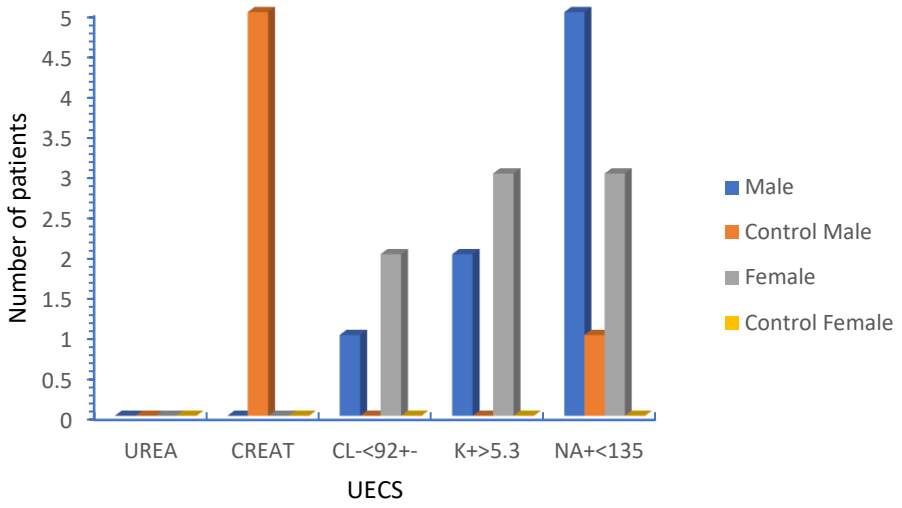
The prevalence of *Mycobacterium tuberculosis* infection in different age classes and sex in Mukuru Kwa Njenga was determined as shown in figure 1.4. The prevalence of *Mycobacterium tuberculosis* infection was highest in both male and female aged between 30-39 years old. Children below 1-year old had no infection of *Mycobacterium*

tuberculosis. Only female patients aged between 1-9 years old had the bacterial infection. In addition, only male patients aged between 60-69 years old had the infection. However, the prevalence of *Mycobacterium tuberculosis* infection was not significantly different in male and female patients across all age classes, t_7=1.3, CI=95%, p=0.2.

4.3 The hematological and biochemical changes in patients diagnosed with tuberculosis infection

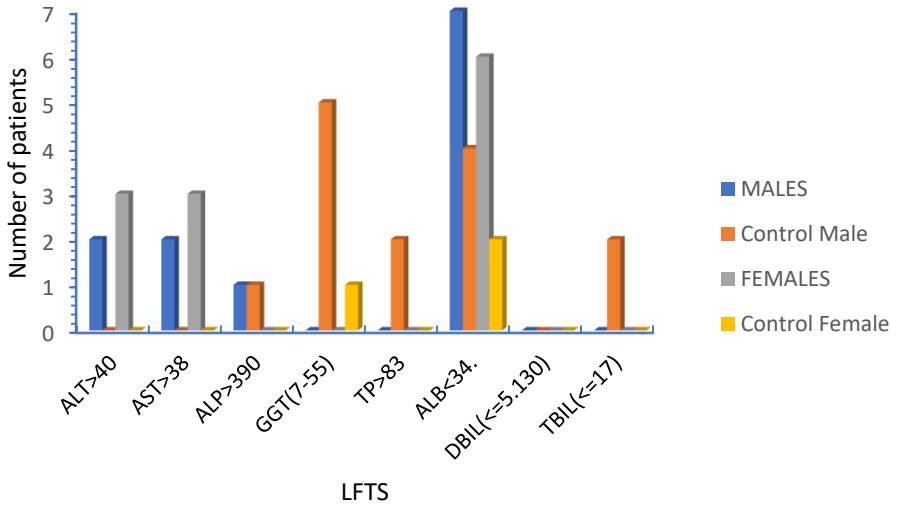
4.3.1 Biochemical changes

Figure 3: Different kidney function tests parameters in regards to gender.



The Kidney Function Tests were determined in twenty-eight (28) patients. The Urea, Electrolytes, Creatinine parameter levels did not differ significantly with sex, p>0.05.

Figure 4: Different parameters of Liver Function Tests in Males and Females



The Liver Functions Tests were determined in twenty-eight (28) number of patients alongside controls. Similarly, the determined Liver Function Tests parameter levels did not differ significantly with sex, $p>0.05$.

Table 2: Clinical Chemistry Biochemical Changes

Paired Samples Statistics					
		Mean	**N**	**Std. Deviation**	**Std. Error Mean**
Pair 1	pk	4.611	28	.8867	.1676
	ck	4.321	28	.5116	.0967
Pair 2	pna	132.14	28	21.102	3.988
	cna	141.57	28	5.487	1.037
Pair 3	pcl	100.93	28	6.655	1.258
	ccl	100.43	28	2.456	.464
Pair 4	pbun	3.786	28	.9497	.1795
	cbun	4.082	28	1.2031	.2274
Pair 5	pcreat	94.32	28	17.508	3.309
	ccreat	90.00	28	14.340	2.710
Pair 6	ptp	73.00	28	5.907	1.116
	ctp	72.36	28	5.684	1.074
Pair 7	palb	29.86	28	8.835	1.670
	calb	45.89	28	5.940	1.123
Pair 8	past	28.18	28	10.684	2.019
	cast	13.36	28	8.225	1.554
Pair 9	palt	28.46	28	16.847	3.184
	calt	9.75	28	6.461	1.221

Pair 10	palp	152.46	28	94.970	17.948
	calp	135.29	28	63.780	12.053
Pair 11	pggt	30.21	28	12.876	2.433
	cggt	11.50	28	7.141	1.350
Pair 12	ptbili	11.36	28	3.664	.692
	ctbili	9.243	28	4.6025	.8698
Pair 13	pdbili	2.911	28	1.5081	.2850
	cdbili	1.825	28	1.1686	.2208

Key: p=patient, c=control subject,

Table 3: Clinical Chemistry Biochemical Changes

Paired Samples Test									
		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	Df	Sig. (2-tailed)
Pair 1	pk - ck	.2893	.9476	.1791	-.0782	.6567	1.615	27	.118
Pair 2	**pna - cna**	**-9.429**	**22.152**	**4.186**	**-18.018**	**-.839**	**-2.252**	**27**	**.033**
Pair 3	pcl - ccl	.500	7.162	1.354	-2.277	3.277	.369	27	.715
Pair 4	pbun - cbun	-.2964	1.6165	.3055	-.9232	.3304	-.970	27	.340
Pair 5	pcreat - ccreat	4.321	23.203	4.385	-4.676	13.319	.986	27	.333
Pair 6	ptp - ctp	.643	8.125	1.535	-2.508	3.793	.419	27	.679
Pair 7	**palb - calb**	**-16.036**	**10.543**	**1.992**	**-20.124**	**-11.948**	**-8.049**	**27**	**.000**
Pair 8	**past - cast**	**14.821**	**14.765**	**2.790**	**9.096**	**20.547**	**5.312**	**27**	**.000**
Pair 9	**palt - calt**	**18.714**	**16.456**	**3.110**	**12.333**	**25.095**	**6.018**	**27**	**.000**
Pair 10	palp - calp	17.179	113.435	21.437	-26.807	61.164	.801	27	.430
Pair 11	**pggt - cggt**	**18.714**	**15.085**	**2.851**	**12.865**	**24.563**	**6.565**	**27**	**.000**
Pair 12	ptbili - ctbili	2.1143	6.7100	1.2681	-.4876	4.7161	1.667	27	.107
Pair 13	**pdbili - cdbili**	**1.0857**	**1.8777**	**.3548**	**.3576**	**1.8138**	**3.060**	**27**	**.005**

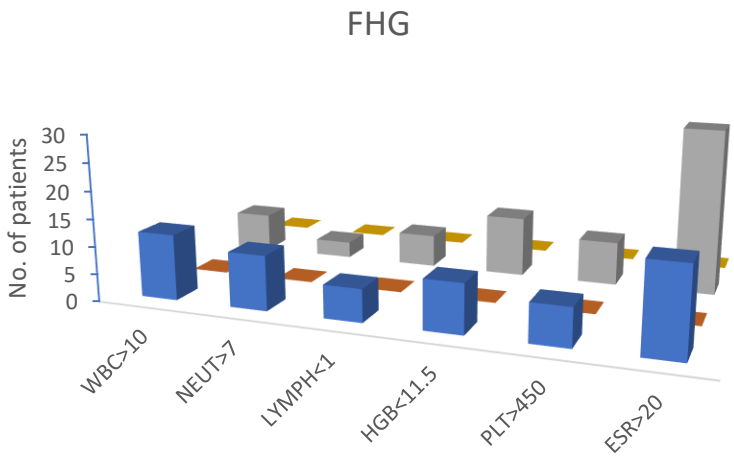
Key: p=patient, c=control subject,

The following biochemical parameters were analyzed for the study subjects whose sputum analysis for *Mycobacterium tuberculosis* turned positive and also for healthy individuals who formed the control group of the study. The biochemical parameters and the mean concentration of the study subjects(patients) and the healthy individuals (control subjects) were as follows: potassium (k+): patient (4.6 mmol/l) and control subjects (4.3 mmol/l), the mean difference was not statistically significant(**p=0.118**). Sodium (Na+):

patients (132 mmol/l) and control subjects (142 mmol/l), there was a statistically significant mean difference. (**p=0.033**). Chloride (cl-): patient (101 mmol/l) and control subjects (100 mmol/l), there was no statistically significant mean difference (**p=0.715).** Blood urea nitrogen (bun): patient (3.8 mmol/l) and control subjects (4.1mmol/l), the mean difference was not statistically significant (**p=0.34**). Creatinine (Creat: patient (94 µmol/l) and control subjects (90 µmol/l), the mean difference was not statistically significant (**p=0.333).** Total protein (Tp): patient (73g/l) and control subjects (72 g/l), the mean difference was not statistically significant (**p=0.679).** Albumin (Alb): patient (30g/l) and control subjects (46 g/l), the mean difference was statistically significant (**p=0.000).** Aspartate aminotransferase (AST): patients (28iu/l) and control subjects (13/l), the mean difference was statistically significant (**p=0.000).** Alanine aminotransferase (ALT): patients (28iu/l) and control subjects (10 iu/l), the mean difference was statistically significant (**p=0.000).** Alkaline phosphatase (ALP): patients (152iu/l) and control subjects (135iu/l), the mean difference was not statistically significant (**p=0.430).** Gamma glutamate transferase (ggt): patients (30iu/l) and control subjects (12iu/l), the mean difference was statistically significant (**p=0.000).** Total bilirubin (tb): patients (11 µmol/l) and control subjects (9 µmol/l), the mean difference was not statistically significant (**p=0.107).** Direct bilirubin (db): patients (2.9 µmol/l) and control subjects (1.8 µmol/l), the mean difference was statistically significant (**p=0.005).**

4.3.2 Hematological changes

Figure 5: Significant Full Haemogram parameters affected in regards to gender.



	WBC>10	NEUT>7	LYMPH<1	HGB<11.5	PLT>450	ESR>20
Male	12	10	6	9	7	16
Control Male	0	0	0	0	0	0
Female	7	3	6	11	8	30
Control Female	0	0	0	0	0	0

Hematological changes in patients with *Mycobacterium tuberculosis* infection were analyzed as shown in the figure 5 above. Higher number of females had ESR more than 30mm/hr. The FHG parameters were significantly higher in males compared to their controls, t_5=6.7, p=0.001. Similar observation was in females t_5=2.7, p=0.04. However, the FHG levels were not significantly different between male and female patients, p>0.05.

Table 4: Hematological Changes A

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Prbc	3.760	30	.9231	.1685
	cRBC(10^6/UL	4.353	30	.5680	.1037
Pair 2	Phb	10.973	30	2.0529	.3748
	cHB(g/dl))	14.00	30	1.365	.249
Pair 3	Phct	34.03	30	5.846	1.067
	cHCT(%)	42.50	30	4.015	.733
Pair 4	Pmcv	82.67	30	7.102	1.297
	cMCV(fl)	98.07	30	8.346	1.524

Pair 5	Pmch	26.10	30	4.397	.803
	cMCH(pg)	31.57	30	2.285	.417
Pair 6	Pmchc	29.30	30	4.786	.874
	cMCHC((g/dl)	32.17	30	2.036	.372
Pair 7	Pplt	410.97	30	160.762	29.351
	cPLT(10^3/UL	272.13	30	51.827	9.462
Pair 8	Pwbc	11.827	30	3.3717	.6156
	cwbc(10^3/UL)	6.337	30	1.8539	.3385
Pair 9	pneu(%)	69.37	30	8.732	1.594
	cN(%)	52.57	30	5.386	.983
Pair 10	plymp(%	31.10	30	8.953	1.635
	cL (%)	39.53	30	4.953	.904
Pair 11	peos(%	2.97	30	1.650	.301
	cE (%)	2.787	30	.8003	.1461
Pair 12	pmon(%	6.67	30	3.594	.656
	cM(%)	4.660	30	1.8926	.3455
Pair 13	pbas(%	.457	30	.2487	.0454
	cB(%)	.3053	30	.30832	.05629
Pair 14	pesr(mm/hr	50.40	30	17.708	3.233
	Cesr	2.70	30	1.343	.245

Key: Key: p=patient, c=control subject,

Table 5: Hematological Changes B

Paired Samples Test									
		Paired Differences							
					95% Confidence Interval of the Difference				**Sig. (2-tailed)**
		Mean	**Std. Deviation**	**Std. Error Mean**	**Lower**	**Upper**	**T**	**df**	
Pair 1	pRBC - cRBC(10^6/UL	-.5933	.9677	.1767	-.9547	-.2320	-3.358	29	.002
Pair 2	phb - cHB(g/dl))	-3.0267	2.3180	.4232	-3.8922	-2.1611	-7.152	29	**.000**
Pair 3	phct - cHCT(%)	-8.467	6.917	1.263	-11.049	-5.884	-6.704	29	**.000**
Pair 4	pmcv - cMCV(fl)	-15.400	11.961	2.184	-19.866	-10.934	-7.052	29	**.000**
Pair 5	pmch - cMCH(pg)	-5.467	5.050	.922	-7.352	-3.581	-5.930	29	**.000**

Pair 6	pmchc - cMCHC((g/dl)	-2.867	5.322	.972	-4.854	-.879	-2.950	29	**.006**
Pair 7	pplt - cPLT(10^3/UL	138.833	158.199	28.883	79.761	197.906	4.807	29	**.000**
Pair 8	pwbc - cwbc(10^3/UL)	5.4900	3.3429	.6103	4.2418	6.7382	8.995	29	**.000**
Pair 9	pneu(%) - cN(%)	16.800	11.287	2.061	12.585	21.015	8.152	29	**.000**
Pair 10	plymp(% - cL (%)	-8.433	9.769	1.784	-12.081	-4.786	-4.729	29	**.000**
Pair 11	peos(% - cE (%)	.1800	1.8585	.3393	-.5140	.8740	.530	29	.600
Pair 12	**pmon(% - cM(%)**	**2.0067**	**4.3037**	**.7857**	**.3996**	**3.6137**	**2.554**	**29**	**.016**
Pair 13	**pbas(% - cB(%)**	**.15133**	**.38883**	**.07099**	**.00614**	**.29653**	**2.132**	**29**	**.042**
Pair 14	**pesr(mm/hr – cesr**	**47.700**	**17.603**	**3.214**	**41.127**	**54.273**	**14.842**	**29**	**.000**

Key: p=patient, c=control subject,

The hematological parameters and the mean concentration of the study subjects(patients) and the healthy individuals (control subjects) were as follows: erythrocyte sedimentation rate (ESR): patient (50 mm/hr) and control subjects (3 mm/hr), the mean difference was statistically significant(**p=0.000**). Red blood cell count (rbc): patient (3.7 X10^6/UL) and control subjects (4.3X10^6/UL), the mean difference was statistically significant(**p=0.002**). Hemoglobin concentration (hb): patient (11 g/dl) and control subjects (14 g/dl), the mean difference was statistically significant(**p=0.000**). Hematocrit (hct): patient (34%) and control subjects (42%), the mean difference was statistically significant(**p=0.000**). Mean cell volume (mcv): patient (83 fl) and control subjects (98 fl), the mean difference was statistically significant(**p=0.000**). Mean cell hemoglobin (mch): patient (26 pg) and control subjects (32pg), the mean difference was statistically significant(**p=0.000**). Mean cell hemoglobin concentration (mchc): patient (29 g/dl) and control subjects (32 g/dl), the mean difference was statistically significant(**p=0.006**).

Platelets (plt): patient (410 X 10^6/UL) and control subjects (272 X 10^6/UL), the mean difference was statistically significant(**p=0.000**), total white blood cell count (wbc): patient (11.8 X 10^3/UL) and control subjects (6.3 X 10^3/UL), the mean difference was statistically significant(**p=0.000**). Neutrophils (neu): patient (69%) and control subjects (52 %), the mean difference was statistically significant(**p=0.000).** Lymphocytes (lym): patient (31%) and control subjects (39%), the mean difference was statistically significant(**p=0.000)**. Eosinophils (eos): patient (2.9%) and control subjects (2.7 %), the mean difference was not statistically significant(**p=0.6)**. Monocytes (mon): patient (6.6%) and control subjects (4.7 %), the mean difference was not statistically significant(**p=0.016)**. Basophils (bas): patient (0.4%) and control subjects (0.3%), the mean difference was statistically significant(**p=0.042)**.

4.4 In-Vitro assessment of the efficacy of first-line anti-tuberculosis drugs against *Mycobacterium tuberculosis* by culture and sensitivity

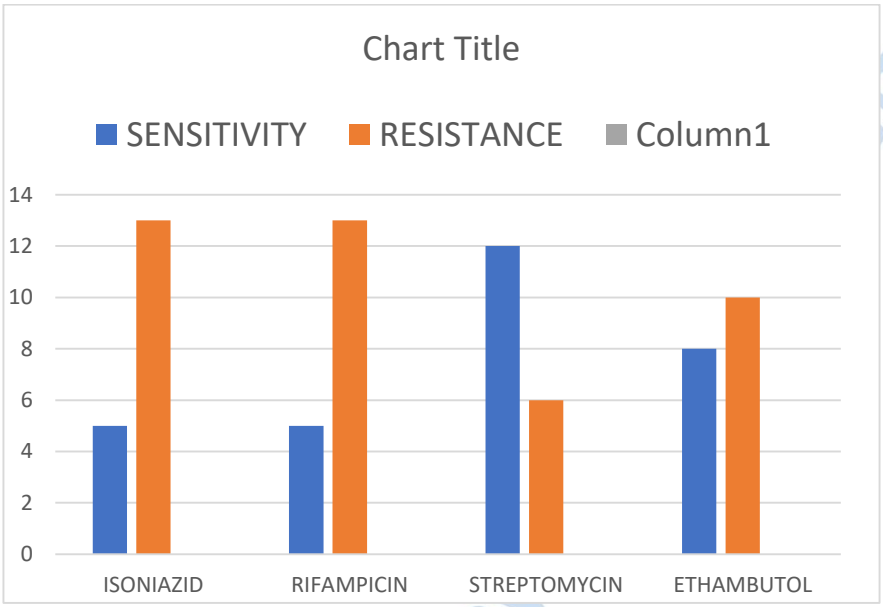
Table 6: culture and sensitivity pattern of *Mycobacterium tuberculosis*

Anti-biotic	***Sensitive(number(%)***	***Resistant (number(%)***
Streptomycin	***12(67%)***	***6(33%)***
Isoniazid	***5(28%)***	***13(73%)***
Rifampicin	***5(28%)***	***13(73%)***
Ethambutol	***8(44%)***	***10(56%)***

Among the sputum specimens which were cultured, 18 had growth of mycobacterium tuberculosis. The culture growth was subjected to drug sensitivity testing using the following anti-biotic i.e. streptomycin, isoniazid, rifampicin and ethambutol. Twelve (67%) culture growths were sensitive to streptomycin and six (33%) were resistant to streptomycin. Five (28%) culture growths were sensitive to isoniazid and thirteen (73%)

were resistant to isoniazid. Five (28%) culture growths were sensitive to rifampicin and thirteen (73%) were resistant to rifampicin. Eight (44%) culture growths were sensitive to ethambutol while ten (56%) culture growths were resistant to ethambutol. Among the four types of anti-biotic, streptomycin produced the highest sensitivity of 67 % whilst isoniazid and rifampicin produced the highest resistance of 73%.

Figure 6: culture and sensitivity pattern of *Mycobacterium tuberculosis*



4.5 Discussions

4.5.1 Prevalence of active tuberculosis infection among people living in densely populated areas in Nairobi County.

Mycobacterium tuberculosis was present in 17.9% of research participants who visited the health facilities in the Pipeline and Mukuru Kwa Njenga slums. This study's finding is similar to that in Nigeria, 18.3% of 16,743 people who had tuberculosis screenings were found to have *Mycobacterium tuberculosis* (Ogbudebe et al., 2015). The age group of 30-39 was found to have the greatest reported *Mycobacterium tuberculosis* which is also to this study's findings. The national estimate from previous years is comparable to the study's estimate of the prevalence of positive tuberculosis cases. Although less than

Nairobi County's 2016 forecasts, nevertheless. This may be the result of tactics created by the Sustainable Development Goals, which aim to implement policies that will end tuberculosis infection by 2030. The distribution of males and females was 18 (11.1%) and 11 (6.8%), respectively. Despite the fact that fewer women than men were chosen for this study, the results indicate that men are twice as likely as women to be infected. This stands in contrast to a 2016 study carried out in Kenya by Videlis Nduba, where women participated at a greater rate of 87% as opposed to 77% of men.

A nationwide tuberculosis survey conducted in Rwanda in 2014 found that men were five times more likely than women to have the illness. The differences in gender prevalence are assumed to be caused by either extrinsic (external) or intrinsic (biological) factors. Progesterone and testosterone may have an immune-suppressive effect, but estrogen may have an immune-enhancing effect. Men are more likely than women to experience risk factors such as indoor air pollution, smoking, hazardous alcohol use, HIV, malnourishment, and recurrent cases of tuberculosis.

According to other research, men are twice as likely as women to drink alcohol and smoke. The incidence of active pulmonary tuberculosis gradually increased with age, evidently impacting older individuals more than younger ones. The sustainable development goals (SDGs), which were created to aid in the eradication of tuberculosis infection, may be the reason why a far smaller number of cases than expected were found during tuberculosis surveys. The rate of *Mycobacterium tuberculosis* in the research population is within the predicted range when compared to previous literature, as evidenced by studies that showed comparable findings in the study. In Nigeria, 18.3% of 16,743 people who had tuberculosis screenings were found to have *Mycobacterium tuberculosis* (chidubem *et al.,* 2015). The age group of 30-39 was found to have the greatest reported *Mycobacterium tuberculosis* load. For individuals under the age of 15,

the frequency of bacteriologically proven pulmonary TB illness ranged from 119 (95 percent CI 79–160) per 100,000 people in Rwanda to 638 (95 percent CI 502–774) per 100,000 people in Zambia. Overall, the male to female ratio ranged from 2.0 (Ethiopia) to 4.1. (Uganda). The absolute number of cases was often highest among those in the 35–44 age group, although the prevalence per 100,000 people generally increased with age.

The national estimate from previous years is comparable to the study's estimate of the prevalence of positive tuberculosis cases. Although less than Nairobi County's 2016 forecasts, nevertheless. This may be the result of tactics created by the Sustainable Development Goals, which aim to implement policies that will end tuberculosis infection by 2030. Data analysis has resulted in the calculation of descriptive statistics and trends for every year. The findings indicated that for the previous eight years, there had been an average reduction of 5%, with the greatest decline recorded in 2012–2013. Males continue to be disproportionately affected by tuberculosis (58% against 42% of the population being female).

Age and sex distribution.

It is clear from the data that age and sex are significant predictors of tuberculosis (TB) infection. Males are more susceptible to tuberculosis (TB) than females, and young people are more susceptible than the elderly and small children. In terms of the male to female sex ratio, the frequency of bacteriologically confirmed active pulmonary tuberculosis ranged from 1:2 in Ethiopia to 4:1 in Uganda. Surveys carried out in a number of African nations revealed a broad difference in the frequency of tuberculosis among people over the age of 15, with the disease's burden differing among them. In all African surveys, men were more likely than women to have tuberculosis, and men 35 years of age and older made up a sizable share of all prevalent cases.

All things considered, the findings highlight the importance of considering age and gender when combating the tuberculosis epidemic in Africa and the need for specific treatments to address the region's distinct demographic patterns of tuberculosis prevalence. All African surveys found that the prevalence of tuberculosis was higher in men than in women, which is consistent with regular notification statistics and prevalence surveys in Asia. The age group of 35 years and older constituted a noteworthy segment of the tuberculosis cases that were widespread in Africa, indicating the necessity of targeting interventions towards this demographic. In Ghana, Malawi, Rwanda, Tanzania, and older age groups showed the largest numbers of tuberculosis infection cases and prevalence rates per 100,000 inhabitants, suggesting an aging epidemic in these countries, comparable to studies in Asia.

Because more instances in older people signal reactivation of a prior tuberculosis infection rather than current transmission, the age distribution of tuberculosis cases suggests decreased transmission in these four countries. On the other hand, despite years of implementing Stop tuberculosis and Direct Observation Therapy (DOTS) strategies, tuberculosis prevalence in most other African countries peaked among those aged 25–54 years and stabilized across middle to older age groups, indicating widespread community transmission. The noteworthy rise in tuberculosis prevalence among younger age groups in Malawi, Zambia, and Zimbabwe—where over 50% of notified tuberculosis patients are co-infected with HIV—likely reflects the impact of the HIV epidemic in these areas.

4.5.2 The hematological and biochemical changes in patients diagnosed with tuberculosis infection

Tuberculosis remains a serious infectious disease and public health issue in Kenya. It causes a variety of hematological and metabolic alterations. This study demonstrates that individuals with active pulmonary tuberculosis display a wide spectrum of abnormalities

in hematological and biochemical changes in comparison to a control group of healthy individuals. Many of the variations agree with the results of previous studies. Apart from the lungs, TB also affects the bone marrow. Hematological disorders of note are linked to tuberculosis. These hematological traits can therefore be utilized as markers for the prognosis, diagnosis, and course of treatment. Since tuberculosis is a bacterial infection, leukocytosis has been seen in numerous investigations, including one conducted in Babylon by Ali Mohamad *et al.* in 2011.

According to this study, compared to healthy study participants, male and female tuberculosis patients had noticeably higher amounts of white blood cells, neutrophils, and lymphocytes. When compared to healthy controls, the white blood cell count in research participants with pulmonary tuberculosis was elevated ($p<0.000$), which is comparable to a study conducted in India by Rohini et al (2015). Patients with tuberculosis exhibiting elevated absolute white blood cell counts (7.7+-3.71*10^3 cells/Ul). White blood cell >10.6*10^3/Ul and white blood cells <3.6*10^3/Ul were characterized as leukocytosis and leukopenia respectively. This aligns with previous research from south eastern Nigeria, Ethiopia, Pakistan. The immune system reaction to White blood cells, including neutrophils, lymphocytes, monocytes, eosinophils, and basophils, play crucial roles in the immune response against bacterial infections. An increase in their numbers, particularly neutrophils and monocytes, is typical during bacterial infections like tuberculosis. Therefore, observing leukocytosis in individuals with tuberculosis is consistent with the body's immune response to combat the bacterial infection.

However, in the clinical assessment and management of tuberculosis, other aspects like the infection's stage and individual differences in immunological response should also be taken into account. When compared to a healthy control group, patients with active pulmonary tuberculosis exhibited noticeably higher mean absolute counts of white blood

cells, neutrophils, lymphocytes, and platelets. Shat et al 2022 's study and this one are comparable. Notable results include the considerable increase in mean absolute white blood cell count, neutrophil count, lymphocyte count, and platelet count in tuberculosis patients relative to healthy controls. These variations in blood cell counts could point to a number of underlying medical or physiological processes. Increased neutrophil, lymphocyte, monocyte, eosinophil, and basophil counts in the white blood cell count indicate an active immune system.

Neutrophils (neu): the mean difference between the patient (69 percent) and control participants (52 percent) was statistically significant (p=0.000).). Poly-morphonuclear neutrophils are the most abundant type of white blood cells and play a central role in the immune response to bacterial pathogens Moefong et al.,2020 study correspond to this study in term of significance level

When an inflammatory reaction becomes chronic, neutrophilia, a symptom of a reported persistent inflammatory response, frequently turns into lymphocytosis. The most prevalent kind of white blood cells, neutrophils usually arrive at the scene of bacterial illnesses first. In reaction to bacterial infections, inflammation, or tissue damage, an increase in neutrophil count, or neutrophilia, is frequently observed.

Lymphocytes (lym): patient (31%) and control subjects (39%), the mean difference was statistically significant (p=0.000). This study was conquering with (shah *et al*.,2022) whose study showed significance increase and decrease in lymphocytes. One subset of white blood cells involved in the adaptive immune response are lymphocytes. Certain malignancies, long-term inflammatory diseases, and viral infections can all result in elevated lymphocyte counts, or lymphocytosis. It is consistent with predictions to observe leukocytosis, or an increase in white blood cells, in tuberculosis patients. Mycobacterium tuberculosis, the bacterial infection that causes tuberculosis, sets off the body's immune

system. When the body mobilizes white blood cells to fight bacterial infections, leukocytosis is a typical reaction. Sixty-three (63%) percent of patients with pulmonary tuberculosis had documented incidences of leukocytosis, forty (40%) percent had lymphocytopenia, and forty-three (43%) percent had neutrophilia.

The difference between monocytes and eosinophils and controls was not statistically significant. This shows that the levels of these blood cells in the study group and the control group were not significantly different from one another. This lack of significance suggests that any differences in monocyte and eosinophil counts between the two groups may not be a significant result of the tuberculosis infection, but rather could be the result of random chance or variability. Although there have been numerous findings on eosinophilia and tuberculosis infection, it is unknown how they help regulate *Mycobacterium tuberculosis*. Nonetheless, a number of studies back up the idea that the cationic proteins found in eosinophils are myco-bactericidal, encouraging lysis. In an in vitro study, it was observed that human erythropoietin (EPO) induced surface alteration followed by lysis of M. tuberculosis bacilli, and EPO-containing macrophages exhibited strong anti-mycobacterial activity.

The statistical significance of basophils was ($p<0.042$). Basophils with a statistical significance of $p<0.042$ indicate a difference between the study participants and the control group. This suggests that it is unlikely that the fluctuation in basophil count that has been seen is the result of random chance. This result is consistent with data from Umuhaia that shown a large increase in eosinophils following tuberculosis infection.

MPV is a measure of the average size of platelets in the blood. Changes in MPV can indicate alterations in platelet production and function. A decrease in (mean platelet volume) MPV may suggest decreased platelet production or increased platelet destruction. Platelets play a part in blood clotting and wound healing. Many conditions,

such as infections, inflammation, and illnesses, can cause thrombocytosis, or an increase in platelet count. The patient group had a significant increase in MPV when compared to the healthy controls, which may be a sign of a continuous immune response or inflammatory process. This result could suggest an underlying medical issue, such as active lung tuberculosis. According to research done in Iraq, Sudan, South Eastern Nigeria, Guyana, and Jimma University, the average number of platelets among tuberculosis patients—both male and female—was much higher than in control groups (Gebreweld *et al.*, 2024).

The observed outcomes could be explained by reactive thrombocytosis, a condition that can develop in various clinical settings such as pulmonary tuberculosis infections. Because pro-inflammatory cytokines like IL-6 and INF are released by platelets, they are crucial for inflammation and immune responses because they encourage the creation of acute-phase proteins and thrombocytosis. Platelet counts greater than 450*10^3/Ul and less than 150*10^3Ul were used to categorize thrombocytopenia and thrombocytosis, respectively. With a higher significance of ($p<0.001$), the platelet counts of both genders were higher than those of the control groups. The higher platelet counts in both genders relative to the control group indicate a potentially important finding. It implies that there might be a significant difference in platelet counts between the study group and the control group, and it is unlikely that this difference was accidental. This has to do with reactive thrombocytosis, which can be found in many clinical conditions, such as pulmonary tuberculosis. In contrast to Awodu et al. and a study by Kirwan et al., 2022, which found that there was a significantly lower platelet count in pulmonary tuberculosis patients, this observation is similar to the increase in platelet count that was noticed in Saudi Arabia with patients diagnosed with the disease. Thirty-three percent of the cases had normal HB values. Both genders of pulmonary tuberculosis patients showed a

significant decrease ($p < 0.00$ and $p < 0.002$) in their hemoglobin (HB) and red blood cell (RBC) concentrations when compared to healthy controls. Mean red blood cells count, hemoglobin, HCT, MPV were significantly lower than that of male $p<0.001$. The significant decrease in mean red blood cell (RBC) count, hemoglobin, hematocrit (HCT), among patients compared to healthy controls is an important finding that warrants attention and further investigation. A decrease in RBC count suggests a potential decrease in the oxygen-carrying capacity of the blood. This could be indicative of anemia, a condition characterized by a deficiency in the number of RBCs or hemoglobin.

The protein found in red blood cells called hemoglobin transports oxygen from the lungs to the body's other tissues. Hemoglobin levels falling is another sign of anemia and can cause symptoms including weakness, exhaustion, and dyspnea. The amount of blood that is made up of red blood cells is known as the hematocrit. Further evidence of anemia is provided by a decline in hemoglobin levels and red blood cell count that is associated with a drop in hematocrit (HCT).

Further investigation, including clinical assessment and additional diagnostic tests, would be necessary to determine the specific cause of these elevated blood cell counts and their clinical significance in the male patient population. Additionally, considering factors such as age, comorbidities, and medication use among the study participants would help in interpreting these findings accurately. The significant decrease in these blood parameters among patients compared to healthy controls, with a significance level of $p<0.001p<0.001$, indicates a potential disturbance in hematopoiesis (the process of blood cell formation) or an increased rate of blood cell destruction. Anemia and other blood disorders should be considered as potential underlying causes. Further clinical evaluation, including additional laboratory tests and medical history assessment, would be necessary

to determine the specific cause of these blood parameter changes and to guide appropriate management strategies for male patients exhibiting these abnormalities.

This study reports significant elevated figures in Erythrocyte sedimentation rate. The significant elevation in Erythrocyte sedimentation rate reported in the study is noteworthy. ESR is a non-specific marker of inflammation and is often elevated in various conditions, including infections, autoimmune diseases, and malignancies. In the context of tuberculosis, an elevated ESR can indicate the presence of inflammation associated with the infection. Tuberculosis is characterized by a chronic inflammatory response in the lungs and other affected organs. The presence of *Mycobacterium tuberculosis* triggers an immune response and causes inflammatory cells to be drawn in and cytokines to be produced, both of which can raise the ESR. Therefore, the significant elevation in ESR observed in the study suggests a pronounced inflammatory response associated with tuberculosis. Monitoring ESR levels can be helpful in diagnosing and monitoring the progression of the disease, as well as assessing the response to treatment. However, it's important to interpret ESR results in conjunction with other clinical findings and diagnostic tests for a comprehensive assessment of the patient's condition.
Several publications and research that detail elevated ESR levels in patients with recently diagnosed tuberculosis fully corroborate these findings. Red blood cells adhere to one another during an inflammatory process due to the increased concentration of immunoglobulins, fibrinogen, and other acute-phase proteins (haptoglobin, CRP and ceruloplasmin) in the blood. The red cells that are crammed together create rouleaux, which settle and sediment more quickly. Normal levels will be noted in patients upon completion of treatment for pulmonary tuberculosis based on findings from other research. AlOmar *et al.* stated that: the erythrocyte sedimentation rate was higher in

pulmonary tuberculosis, a condition that can be effectively controlled and treated with several anti-tuberculosis medication combinations.

Serum sodium levels that are abnormal can be a sign of electrolyte imbalances, which can be caused by a number of things, such as dehydration, hormone imbalances, or underlying illnesses that affect the adrenal glands or kidneys. Serum albumin is a gauge of nutritional status and liver health. Malnourishment, inflammation, or liver disease may be indicated by a drop in serum albumin levels.

The two main types of enzymes in liver cells are AST and ALT. Increased blood levels of AST and ALT can be a sign of injury or damage to the liver. Liver damage can be brought on by a number of illnesses, such as infections like hepatitis or non-infectious disorders like medication toxicity or fatty liver disease. GGT is another enzyme that is present in the liver, bile ducts, and other organs. Increased GGT levels are frequently linked to liver conditions, especially alcoholic liver disease and bile duct obstruction.

The breakdown of hemoglobin in the liver results in the waste product bilirubin. Increased blood levels of direct bilirubin may be a sign of bile duct blockage or liver diseaseSignificant biochemical changes were found in the study's serum albumin, sodium, AST, ALT, gamma-glutamyl transferase (GGT), and direct bilirubin. These findings may provide light on a number of aspects of the condition under investigation, which seems to involve liver function and possibly other systemic effects.

The results of this investigation demonstrated biochemical alterations in serum albumin, sodium, AST, ALT, gamma glutamate transferases, and direct bilirubin. There was no statistically significant difference in potassium mean between the research participants and the control group. ($p=0.118$). This is in contrast to previous research, the results of which may have also been impacted by the electrolyte imbalance caused by variations in the study population size. The mean difference for sodium (Na^+) was lower and hence

statistically significant (p=0.033). This alteration may be brought on by local invasion of the pituitary, hypothalamus, and adrenal glands. This is comparable to the discovery made by Nematollah Jonaidi Jafari et al. in 200 TB cases, which showed decreased serum sodium levels.

There was no discernible difference in the values of the research participants and controls for chloride (cl-), blood urea nitrogen (bun), total protein (tp), or creatinine (creat). This indicates that infections with tuberculosis have no effect on these bodily enzymes and electrolytes. An essential finding is that there was no discernible variation in blood urea nitrogen (BUN), creatinine (Creat), or chloride (Cl-) levels between the research participants and controls. These parameters are frequently assessed through blood testing and offer important insights into several facets of renal function and electrolyte equilibrium.

Chloride is essential to the body's ability to maintain both acid-base and fluid balance. For healthy neuron and muscle function, chloride levels must be normal. The fact that there was no discernible change in chloride levels between the study participants and the controls points to similar electrolyte balance, especially in terms of chloride levels, between the two groups.

BUN is a waste product that the liver produces when proteins break down. Since the kidneys eliminate it, BUN levels may be an indicator of renal health. Dehydration or renal impairment may be indicated by elevated BUN values. Given that there was no statistically significant difference in BUN values between the research participants and controls, it is likely that kidney function as measured by BUN levels was comparable in the two groups.

Another waste product eliminated by the kidneys from muscle metabolism is creatinine. Creatinine levels are another measure of renal function, similar to BUN. Increased

creatinine levels could indicate problems with the kidneys. As measured by creatinine levels, renal function was equivalent in the study participants and controls, as evidenced by the lack of a significant difference in creatinine values between the two groups.

Overall, it appears that renal function and electrolyte balance were comparable between the study participants and controls because there were no appreciable variations in the levels of creatinine, BUN, or chloride between the two groups. This finding could be useful in determining the general health state of the study participants as well as in eliminating the possibility that substantial renal dysfunction is the cause of the observed variations in other biochemical indicators.

Alanine aminotransferase (ALT),Aspartate aminotransferase (AST), Albumin (ALB)and Gamma glutamate transferase (ggt): the mean difference was statistically higher in patients diagnosed with *Mycobacterium tuberculosis* than in healthy individuals with a significance of (**p=0.000).** Direct bilirubin (db), the mean difference was statistically elevated in the study subjects than in healthy individuals with p value of **(p=0.005).** Alkaline phosphatase (ALP), Total bilirubin (tb): the mean difference was not statistically significant **(p=0.430, p=0.107)** respectively. The mean ALT was significantly higher in tuberculosis patients than in healthy individuals which is consistent to research done in Gunaya. However, the finding contradicted with the finding of Manner et al, on biochemical parameters in relation to tuberculosis infection in Sudanese patients which showed significant decrease in ALT in tuberculosis patients.Changes in these biochemical indicators indicate that the condition under investigation may entail injury or dysfunction of the liver, whether as a side effect or expression of the underlying illness process. Understanding the importance of these biochemical alterations and their implications for diagnosis, prognosis, and care will require additional research and linkage with clinical results.

4.5.3 In-Vitro assessment of the efficacy of first-line anti-tuberculosis drugs against *Mycobacterium tuberculosis* by culture and sensitivity

Effective treatment of the disease, patient care, and infection control depend on the timely and correct detection of an active pulmonary tuberculosis infection and the evaluation of the infection's responsiveness to anti-TB medications. In addition, treating drug-resistant forms of tuberculosis is far more challenging than treating drug-susceptible strains. Drug-resistant tuberculosis (TB) is becoming more commonplace worldwide, which has brought attention to the need for prompt and reliable drug resistance identification in order to start patients on the right course of treatment as soon as possible.

Isolates from eighteen patients were tested for their susceptibility to isoniazid, rifampicin, ethambutol, and streptomycin which are the first line antibiotics for treatment of tuberculosis infection. Drug susceptibility testing was done via mycobacterium indicator tube. Among 25 sputum specimens which were cultured, 18 had growth of *Mycobacterium tuberculosis*. The culture growth was subjected to drug sensitivity testing using the following anti-biotic i.e. streptomycin, isoniazid, rifampicin and ethambutol. Twelve (67%) culture growths were sensitive to streptomycin and six (33%) were resistant to streptomycin. Five (28%) culture growths were sensitive to isoniazid and thirteen (73%) were resistant to isoniazid. Five (28%) culture growths were sensitive to rifampicin and thirteen (73%) were resistant to rifampicin. Eight (44%) culture growths were sensitive to ethambutol while ten (56%) culture growths were resistant to ethambutol. This resistance patterns of isoniazid are similar to springers *et al.,* 2023, isoniazid resistance was observed in 18 among 29 isolates found to be resistant to rifampicin, equivalent of 62.1%, while isoniazid was able to predict rifampicin resistance by 80.2% and in contrast with Al hajoj *et al.*, 2015 whose study had Isoniazid and rifampin resistance of 17.8% and 2.6%, respectively.

Streptomycin exhibited the highest sensitivity of 67 percent among the four antibiotic classes, while isoniazid and rifampicin produced the highest resistance of 73 percent. The most prevalent mutation *in M. tuberculosis* strains that results in drug resistance is mono-resistance to isoniazid. Furthermore, compared to rifampicin, the development of INH resistance is more complicated. The katG gene-encoded enzyme catalase peroxidase activates INH in vivo. According to studies, this gene has mutations in about 50% of strains that are resistant to INH.

Rifampicin resistance develops only after an initial resistance to another medicine, like isoniazid. As a result, it might be applied to MDR TB diagnosis. Isolates that show resistance to rifampicin contain a mutation that alters the sequence of a 27-amino-acid region of the beta subunit of the RNA polymerase enzyme. Over 95% of the rifampicin-resistant variations are caused by a particular mutation found in the 81bp region of the rpoβ gene, according to research. Mutations at codons 526 or 531 are the most frequent causes of high level resistance (between 65 and 86 percent).

4.6 Drug resistance according to sex

Of the patients in the study population, 7/18 (38.8%) were female and 11/18 (61.2%) were male. There was any resistance in 2/7 (28.5%) of the females and 5/11 (45%) of the males with TB diagnoses. Compared to females, men are more susceptible to tuberculosis (TB) sickness. Male patients with tuberculosis may also have a higher relative risk of developing multidrug-resistant (MDR) or rifampicin-resistant (RR) tuberculosis than female patients due to the prevalence of many risk variables in males. Our findings indicate that male MDR-TB patients are more likely to be over 65 years old compared to female patients. This finding aligns with a gender assessment report on drug-resistant tuberculosis (DR-TB) in Nigeria, which also found that men over 65 had a much greater prevalence of DR-TB than women of the same age. Consistent with our findings, previous

research has demonstrated that the incidence of tuberculosis (TB) in men increases with age and is consistently greater than in women in the same age groups. This pattern may be explained by variables such the higher rates of noncompliance and increased risk of retreatment in male MDR-TB patients. This finding is significant since male tuberculosis death peaks far later in life than that of female tuberculosis mortality, which peaks in the 20–30 age range. Hence, there is a need to intensify active case finding for MDR-TB in older men and ensure prompt initiation of MDR-TB treatment.

Male patients have a higher likelihood of treatment failure as a result of having a higher incidence of DR-TB than female patients, which makes men more prone to develop DR-TB. Males experienced more conversion failures than females following two and five months of tuberculosis therapy, according to a prior study from southern Nigeria. Men were also twice as likely in this study to not respond well to tuberculosis therapy.

4.7 Drug resistance mechanism

Due to the lengthy treatment schedule of at least six months, drug resistance in tuberculosis (TB) is a special challenge. This can result in problems with patient adherence and the frequent formation of drug-resistant strains of *Mycobacterium tuberculosis*. An update on drug resistance genes and current knowledge of drug resistance mechanisms and drug interactions in *Mycobacterium tuberculosis* are provided in this chapter. Darwin's theory of evolution, which holds that resistance results from genetic changes that give rise to a bacterium's drug-resistant features that can be inherited by later generations, is clearly shown by the development of drug resistance in bacteria. This is in contrast to tolerance, also known as phenotypic resistance, which is frequently observed in M. tuberculosis and other bacterial species. In this case, drug resistance is temporarily induced due to modifications in cellular metabolism or physiology, especially in stationary-phase, starved, or dormant bacteria. Knowing the genetic changes

causing drug resistance improves our understanding of the mechanisms and effects of drugs, and it also makes it possible to quickly identify drug resistance using molecular tools.

Mycobacterium tuberculosis has developed several mechanisms to resist the effects of antibiotics. Understanding these mechanisms is crucial for developing new treatments and managing drug-resistant TB. Here's an overview of the primary drug-resistant mechanisms of M. tuberculosis:

Genetic Mutations

Genetic alterations in certain genes are the primary source of drug resistance in *Mycobacterium tuberculosis*. Target protein structure can be changed by these changes, which may reduce the effectiveness of antibiotics in binding molecules. Several notable examples include: Rifampicin resistance which results from the drug's inability to attach to the RNA polymerase and prevent RNA production. This is caused by mutations in the rpoB gene, which codes for the RNA polymerase β subunit. Isoniazid Resistance: The katG gene encodes the catalase-peroxidase enzyme, which is necessary for isoniazid activation. This medication is not effective due to mutations in this gene. Mutations in the inhA gene, which codes for the target enzyme enoyl-ACP reductase, can also give resistance. Ethambutol Resistance: Mutations in the embB gene affect the arabinosyl transferase enzyme, which is involved in the construction of cell walls, reducing the efficacy of the medicinePyrazinamide Resistance: The pncA gene, which codes for the pyrazinamidase enzyme required to convert pyrazinamide into its active form, is mutated to produce resistance.

Efflux Pumps

Antibiotics are actively removed from bacterial cells by membrane proteins known as efflux pumps. This causes lowering of the concentration and efficacy of the medication

inside the cell. Multidrug resistance in *Mycobacterium tuberculosis* can result from overexpression of efflux pump genes.

Cell Wall Permeability

Many antibiotics can't penetrate the mycobacterial cell wall because of its distinct and complicated structure, which is rich in mycolic acids and other lipids. Changes in the components of the cell wall might worsen drug permeability and increase resistance.

Enzymatic Inactivation

Certain strains of *Mycobacterium tuberculosis* have the ability to manufacture enzymes that render antibiotics ineffective. As an example, consider β-lactamases: These enzymes have the ability to hydrolyze β-lactam antibiotics, rendering them inert. Although β-lactams are not often the first-line treatment for tuberculosis, resistance can make them more challenging to administer in the future.

Biofilm Formation

Mycobacterium tuberculosis bacteria can create biofilms, which are arranged colonies of bacteria encased in a matrix. Antibiotic resistance and the host immune system can be thwarted by biofilms, which can result in recurring infections and resistance. Understanding the processes driving medication resistance in *Mycobacterium. tuberculosis* is essential to developing effective therapies and strategies to combat tuberculosis (TB). This is especially important in light of the increasing prevalence of extensively drug-resistant (XDR) and multi-drug resistant (MDR) TB.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

This research aimed to investigate prevalence of *Mycobacterium tuberculosis* among people living in densely populated areas in Nairobi County, its hematological and biochemical changes and efficacy of the current regime anti-tuberculotic drugs used in Kenya today. The findings include; there were 17.9% positive cases and 82.1 negative cases of *Mycobacterium tuberculosis* infection in the percentage distribution. Of the twenty-nine research participants whose *Mycobacterium tuberculosis* test results were positive, eighteen (18) were males, or 62 percent, and eleven were females, or 38 percent. Thus, the overall prevalence of *Mycobacterium tuberculosis* among research participants who visited the health facilities in the Pipeline and Mukuru Kwa Njenga slums was 17.9%, with a distribution of 18 (11.1%) and 11 (6.8%) percent for men and women, respectively. These findings highlight the importance of continuous and intense diagnosis of active pulmonary tuberculosis infection and development of control strategies in densely populated areas to ensure zero TB transmission.

There were numerous hematological changes such as hemoglobin, platelets, red blood cell count, neutrophils, lymphocytes and erythrocyte sedimentation observed in this study compared to healthy controls. A number of liver function tests and kidney function tests were also observed and therefore these parameters aid in diagnosis and prognosis of active pulmonary tuberculosis infection. Isoniazid and rifampicin resistance was a concern in this study as both had a high percentage compared to ethambutol and streptomycin. This signifies high development of drug resistant tuberculosis infection and continuous directly observed treatment should be highly considered to ensure adherence to medication by infected people.

5.2 Conclusion

In conclusion, the WHO's estimated tuberculosis prevalence in Nairobi's slums Mukuru Kwa Njenga and pipeline was lower than the first direct measure. It is more difficult to identify and treat the remaining cases when the burden is minimal. Kenya must continue to adopt routine case detection measures for the broader public while also implementing new and more active strategies that target high-risk populations, such as those living in the Nairobi slums. It is necessary to implement policies and procedures that increase access to healthcare and lessen the underreporting of instances of diagnosed active pulmonary tuberculosis. A useful baseline for evaluating future trends in the burden of tuberculosis disease is provided by all surveys.

Hematological and biochemical changes are important markers in diagnosis of TB due to their observed significance between patients and controls.

Improved TB treatment regimens and quick antibiotic sensitivity testing are necessary in light of the rise of multi-drug resistant and extreme drug resistant tuberculosis infection. Patients have been forced to depend on a single, protracted treatment option for decades, so the potential of new TB regimens is thrilling. There are numerous ways to reduce the likelihood that these new regimens may cause resistance. It is possible to create novel drug sensitivity testing assays to identify resistance both early in the introduction of new pharmaceuticals and before repurposed medications reach the market.

5.3 Recommendations

Several areas for further investigation are suggested in light of the study's limitations and conclusions. To improve the results' generalizability, future research should strive to incorporate a bigger and more varied sample size. Participants may come from a variety of age groups, socioeconomic backgrounds, and geographic locations. Utilizing this information, policymakers can create programs and policies that are more successful such

as DOTs.. For instance, the gaps and needs that have been discovered might be used to define ways to improve digital literacy in the context of schooling. In order to investigate the complex nature of the research subject and to publish and distribute findings broadly to inform and influence both academic and practical domains, researchers should also work in interdisciplinary teams. Attention should be given to prevent the transmission and emergence of drug resistance.

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APPENDICES

Appendix I: Informed Consent Explanation

Title of the study:

Prevalence of Active pulmonary tuberculosis infection among people living in densely populated areas in Mukuru Kwa Njenga and pipeline Nairobi County

Principal investigator: Milca cherono

Introduction

This project is interested in investigating the prevalence of active pulmonary tuberculosis in Mukuru Kwa Njenga and Pipeline slums of Nairobi County, the efficacy of anti-tb drugs, and hematological and biochemical changes in tuberculosis patients.

Procedure to be followed

Upon accepting to participate in the study, participants signed an informed consent form which they were able to answer questions from the questionnaire. Sputum samples was collected in properly sealed tubes and stored in a refrigerator for transportation to Mama Lucy Kibaki microbiology laboratory for analyzing *Mycobacterium tuberculosis.* Results was given appropriately and control measures to those who tested positive.

Risk

There is a risk of contracting tuberculosis infection if personal protective equipment is not used appropriately.

Benefits.

This procedure was done free of charge as well as free medication for those who will test positive

Appendix II: Consent form

I ----------

Do hereby give consent to Milca Cherono to include me in this study on biochemical and hematological changes among people with active pulmonary tuberculosis infection living in densely populated areas in Nairobi county

I have read and understood the consent of this form. I am aware that I can withdraw from the study without losing any benefits.

SERIAL NUMBER…….

SIGN…….

WITNESS…….

DATE……

Appendix III: Questionnaire

PART 1: DEMOGRAPHICS

ID CODE----------

AGE----------

SEX----------

PHONE CONTACTS----------

EMAIL ADDRESS----------

PART 2: TUBERCULOSIS SCREENING

Please answer the following questions by circling the appropriate answer

1. Have you ever had contact with persons with tuberculosis or suspected tuberculosis?

   A.YES

   B.NO

2. Have you ever been a volunteer or health care worker who served people diagnosed with active pulmonary tuberculosis infection?

   A.YES

   B.NO

PART 3: CLINICAL ASSESSMENT.

Please answer the following questions

1. **Do you have any of the following symptoms?**

   A. Cough

   B. Night sweats

   C. Loss of weight

   D. Fever

   E. Chest pain

F. Coughing blood (hemoptysis)

G. Anorexia

2. Have you been recently on TB drugs (past 2 years)

A.YES

B. NO

3. Do you have any of the following conditions?

A. Infected with HIV.

B. Using any immunosuppressive drugs such as tumor necrosis factor-alpha, steroids, or system corticosteroids equivalent to or greater than 15mg of prednisolone.

C. Diagnosed with diabetes mellitus, kidney failure, cancer, or leukemia.

D. Smoking cigarettes or using alcohol.

4. GENE EXPERT RESULTS. (TO BE FILLED BY LABTECH)

DATE OBTAINED..... / ..../……..

RESULTS: NEGATIVES……. POSITIVES…….

PART 5: MANAGEMENT OF POSITIVE TESTS

All persons who will be diagnosed with active pulmonary tuberculosis will be given appropriate medication.

Appendix IV: Introduction Letter

Mount Kenya University

DIRECTORATE OF GRADUATE STUDIES

MMLS/2022/49032

19th May, 2023

National Commission for Science Technology & Innovation (NACOSTI)
Off Waiyaki, Upper Kabete
P.O Box 30623- 00100
NAIROBI, KENYA

Dear Sir/Madam,

RE: MILCA CHERONO – REGISTRATION NO. MMLS/2022/49032

The purpose of this letter is to introduce the above named student who is pursuing **Master of Science in Medical Laboratory Science Degree** in the Department of **Medical Laboratory Science** in Medical School.

The title of the research is "***Active Pulmonary Tuberculosis Infection and Its Biochemical and Hematological Changes Among People Living in Densely Populated Areas in Nairobi County.***"

It has been cleared by the University's Ethics Review Committee (Certificate attached) and now has to proceed to the field to collect data between **May, 2023 and July, 2023.**

Any assistance accorded to the student will be highly appreciated.

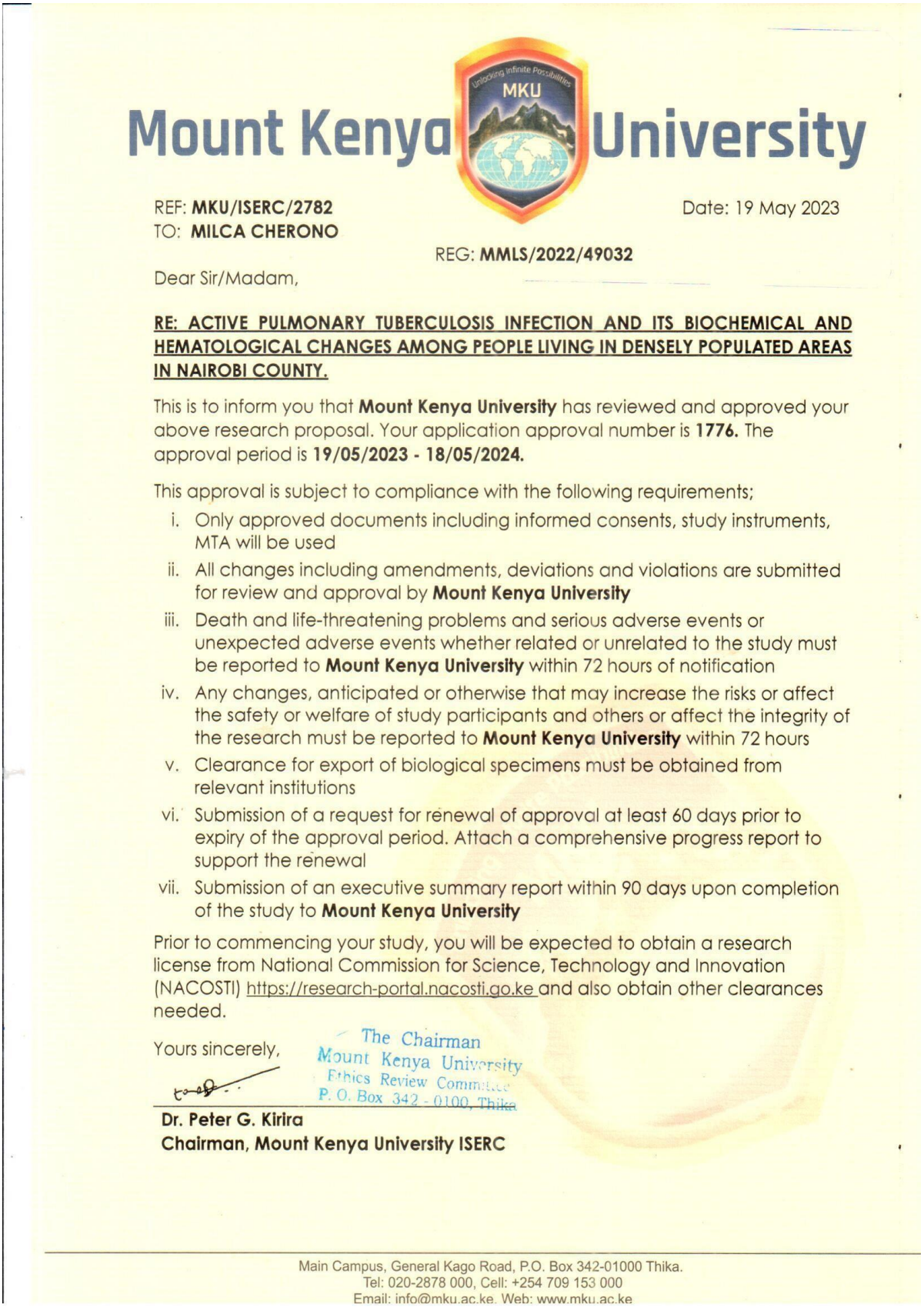
Thank you.

Mount Kenya University
P.O. Box 342-01000, THIKA
Office of the Director
Graduate Studies

Dr. Samuel M. Karanja, Ph.D
Director, Graduate Studies
Enc.

Main Campus, General Kago Road, P.O. Box 342-01000 Thika.
Tel: 020-2878 000, Cell: +254 709 153 000
Email: info@mku.ac.ke, Web: www.mku.ac.ke
Chartered and ISO 9001 : 2015 Certified Institution.
Unlocking Infinite Possibilities

Appendix V: Ethical review certificate



Mount Kenya University

REF: **MKU/ISERC/2782**
TO: **MILCA CHERONO**

Date: 19 May 2023

REG: **MMLS/2022/49032**

Dear Sir/Madam,

RE: ACTIVE PULMONARY TUBERCULOSIS INFECTION AND ITS BIOCHEMICAL AND HEMATOLOGICAL CHANGES AMONG PEOPLE LIVING IN DENSELY POPULATED AREAS IN NAIROBI COUNTY.

This is to inform you that **Mount Kenya University** has reviewed and approved your above research proposal. Your application approval number is **1776.** The approval period is **19/05/2023 - 18/05/2024.**

This approval is subject to compliance with the following requirements;

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

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://research-portal.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely,

The Chairman
Mount Kenya University
Ethics Review Committee
P. O. Box 342 - 0100, Thika

Dr. Peter G. Kirira
Chairman, Mount Kenya University ISERC

Main Campus, General Kago Road, P.O. Box 342-01000 Thika.
Tel: 020-2878 000, Cell: +254 709 153 000
Email: info@mku.ac.ke, Web: www.mku.ac.ke

Appendix VI: Research Permit (NACOSTI)

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **106093**

Date of Issue: **30/June/2023**

RESEARCH LICENSE

This is to Certify that Ms.. Milca Cherono of Mount Kenya University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Nairobi on the topic: ACTIVE PULMONARY TUBERCULOSIS INFECTION AND ITS BIOCHEMICAL AND HEMATOLOGICAL CHANGES AMONG PEOPLE LIVING IN DENSELY POPULATED AREAS IN NAIROBI COUNTY for the period ending : 30/June/2024.

License No: **NACOSTI/P/23/26875**

106093

Applicant Identification Number

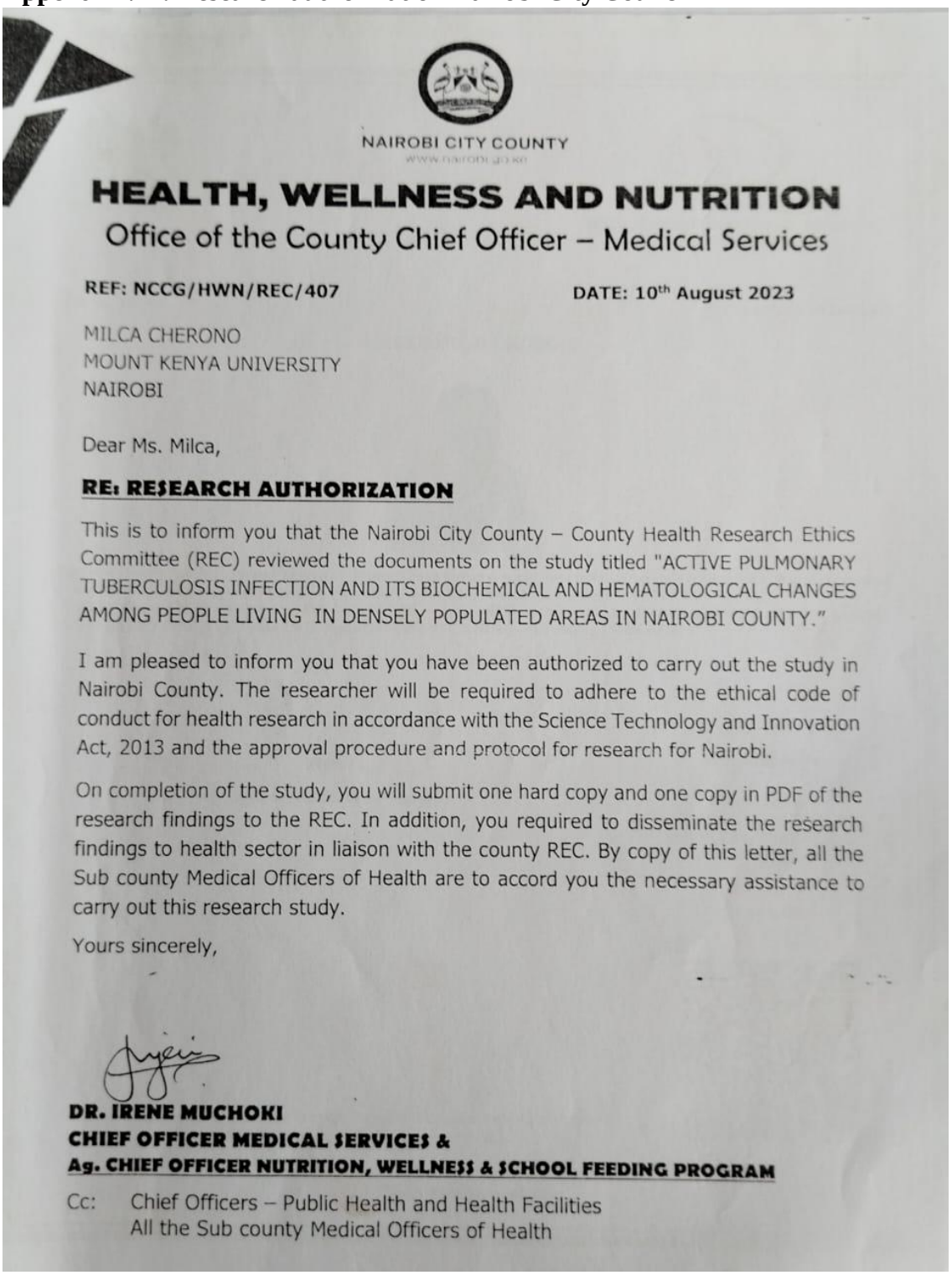
Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

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

See overleaf for conditions

Appendix VII: Research authorization Nairobi City Council



NAIROBI CITY COUNTY

HEALTH, WELLNESS AND NUTRITION

Office of the County Chief Officer – Medical Services

REF: NCCG/HWN/REC/407 **DATE: 10th August 2023**

MILCA CHERONO
MOUNT KENYA UNIVERSITY
NAIROBI

Dear Ms. Milca,

RE: RESEARCH AUTHORIZATION

This is to inform you that the Nairobi City County – County Health Research Ethics Committee (REC) reviewed the documents on the study titled "ACTIVE PULMONARY TUBERCULOSIS INFECTION AND ITS BIOCHEMICAL AND HEMATOLOGICAL CHANGES AMONG PEOPLE LIVING IN DENSELY POPULATED AREAS IN NAIROBI COUNTY."

I am pleased to inform you that you have been authorized to carry out the study in Nairobi County. The researcher will be required to adhere to the ethical code of conduct for health research in accordance with the Science Technology and Innovation Act, 2013 and the approval procedure and protocol for research for Nairobi.

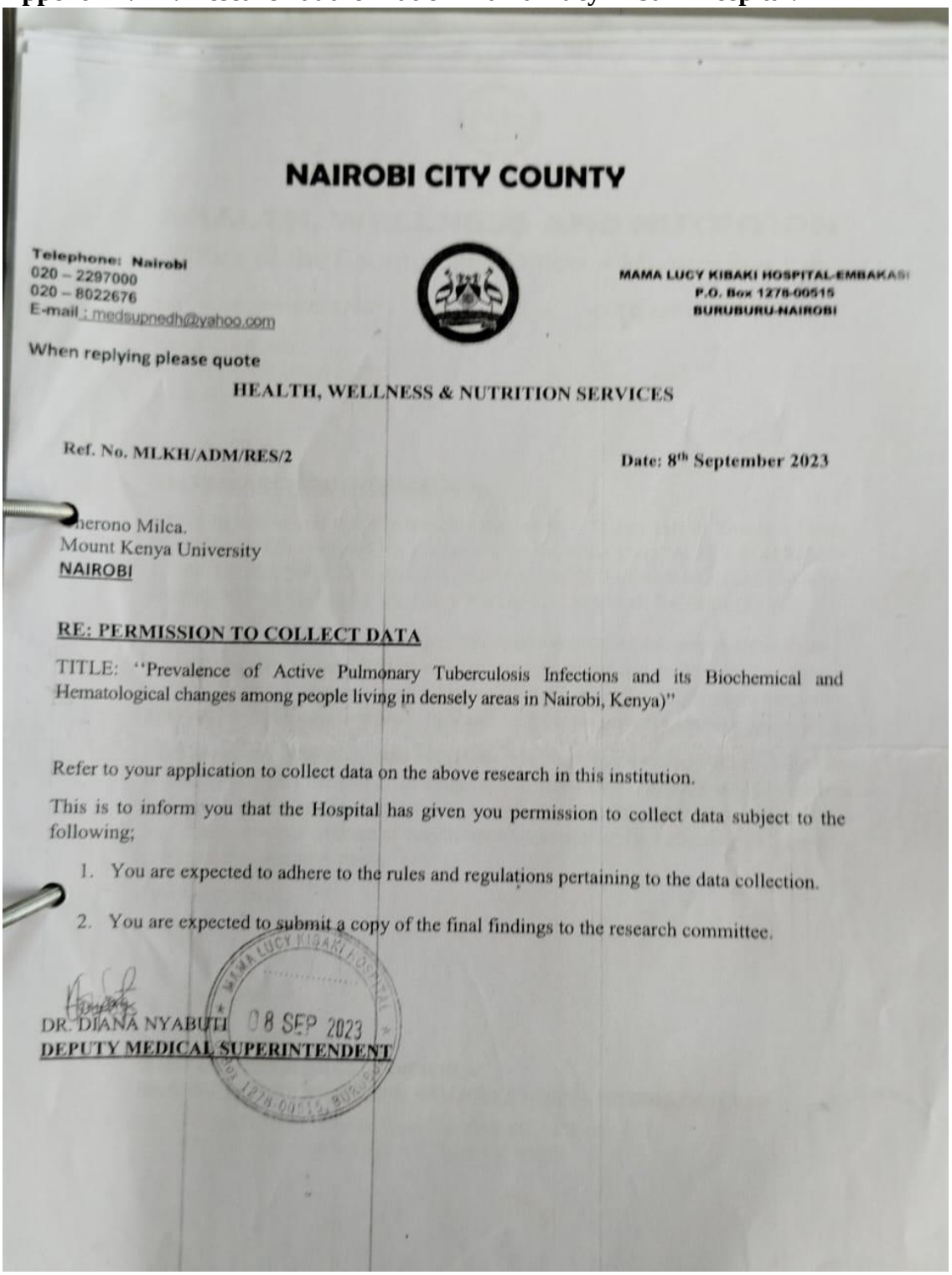
On completion of the study, you will submit one hard copy and one copy in PDF of the research findings to the REC. In addition, you required to disseminate the research findings to health sector in liaison with the county REC. By copy of this letter, all the Sub county Medical Officers of Health are to accord you the necessary assistance to carry out this research study.

Yours sincerely,

DR. IRENE MUCHOKI
CHIEF OFFICER MEDICAL SERVICES &
Ag. CHIEF OFFICER NUTRITION, WELLNESS & SCHOOL FEEDING PROGRAM

Cc: Chief Officers – Public Health and Health Facilities
All the Sub county Medical Officers of Health

Appendix VIII: Research authorization Mama Lucy Kibaki Hospital.



NAIROBI CITY COUNTY

Telephone: Nairobi
020 – 2297000
020 – 8022676
E-mail : medsupnedh@yahoo.com

When replying please quote

MAMA LUCY KIBAKI HOSPITAL-EMBAKASI
P.O. Box 1278-00515
BURUBURU-NAIROBI

HEALTH, WELLNESS & NUTRITION SERVICES

Ref. No. MLKH/ADM/RES/2

Date: 8th September 2023

herono Milca.
Mount Kenya University
NAIROBI

RE: PERMISSION TO COLLECT DATA

TITLE: ''Prevalence of Active Pulmonary Tuberculosis Infections and its Biochemical and Hematological changes among people living in densely areas in Nairobi, Kenya)''

Refer to your application to collect data on the above research in this institution.

This is to inform you that the Hospital has given you permission to collect data subject to the following;

1. You are expected to adhere to the rules and regulations pertaining to the data collection.
2. You are expected to submit a copy of the final findings to the research committee.

MAMA LUCY KIBAKI HOSPITAL P.O. BOX 1278-00515 BURUBURU

08 SEP 2023

DR. DIANA NYABUTI
DEPUTY MEDICAL SUPERINTENDENT

Appendix VII: A map showing Mukuru Kwa Njenga slums and Pipeline.