PREVALENCE OF RADIOGRAPHIC PATTERNS OF CHEST TUBERCULOSIS AMONG ADULT PATIENTS IN UNIVERSITY OF BENIN TEACHING HOSPITAL

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CERTIFICATION

This is to certify that this project work, **Prevalence of Radiographic Patterns of Chest Tuberculosis Among Adult Patients in University of Benin Teaching Hospital**, was carried out by **MUSA ZULFAH ABDULLAHI** with matriculation number **BMS2005198** under our guidance.

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DEDICATION

To God for His faithfulness, and to my family, mentors, and friends who inspired and supported me throughout this academic pursuit.

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I am deeply grateful to God Almighty for His grace, wisdom, and strength throughout the course of this project. My heartfelt appreciation goes to my parents and siblings for their unwavering love, prayers, and encouragement, which have been a constant source of motivation. I also wish to express my sincere gratitude to my project supervisor, Dr. E. A. Akpobasahan, for her invaluable guidance, patience, and insightful contributions that greatly aided the successful completion of this work.

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LIST OF ABBREVIATIONS

1. AFB – Acid-Fast Bacilli
2. BMC – BioMed Central
3. CDC – Centers for Disease Control and Prevention
4. CT – Computed Tomography
5. CXR – Chest X-ray
6. DNA – Deoxyribonucleic Acid
7. DOTS – Directly Observed Treatment, Short-Course
8. HAART – Highly Active Antiretroviral Therapy
9. HIV – Human Immunodeficiency Virus
10. LLFT – Liver and Lung Function Test
11. MDR – Multi-Drug Resistant
12. MRI – Magnetic Resonance Imaging
13. PPV – Positive Predictive Value
14. PTB – Pulmonary Tuberculosis
15. TB – Tuberculosis
16. WHO – World Health Organization

ABSTRACT

Pulmonary tuberculosis remains a significant health issue in Nigeria, particularly in areas with scarce resources. In these settings, delayed diagnosis often leads to wider disease spread and patients presenting with more severe symptoms. In this study, we reviewed the records of 350 adult PTB patients at the University of Benin Teaching Hospital to identify patterns in their demographics, presenting symptoms, and chest X-ray findings. We also aimed to compare doctors' clinical suspicions with radiographic evidence.

The average age of patients was 47 years, with men accounting for roughly two-thirds of the sample. Cough was the most frequent symptom, affecting just over half of the patients. Doctors suspected TB in about one-third of cases, while fever was present in around a quarter. On chest X-rays, fibro-cavitary changes were most common (31.1%), followed by cavitations (17.4%) and fibro-nodular opacities (16.9%), typically located in the upper lung lobes. Clinical suspicion by doctors detected most cases (sensitivity 79.1%), but was less effective at excluding non-TB cases (specificity 34.8%). Nevertheless, there was a significant association between clinical suspicion and X-ray findings ($p = 0.005$). These results highlight the need for improved early detection strategies. Integrating clinical assessment with radiographic and microbiological testing will enhance TB control efforts and lead to better patient outcomes.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Tuberculosis (TB) remains one of the deadliest infectious diseases globally, particularly in low- and middle-income countries (Bhalla et al., 2015). According to the World Health Organization (2021), about 10.6 million people were infected with TB, resulting in approximately 1.6 million deaths worldwide. TB primarily affects the lungs, pulmonary TB accounts for most cases and is easily transmitted through airborne droplets, making it a persistent public health threat (Abba-Sulum et al., 2021).

In Nigeria, TB remains endemic and is among the countries with the highest TB burden globally. Factors such as poverty, overcrowding, inadequate access to healthcare, and the overlap with HIV infection contribute significantly to the persistence of the epidemic (World Health Organization, 2022; Ehondor et al., 2019). Early detection and diagnosis are critical to reducing morbidity, mortality, and transmission within communities. Chest radiography continues to play a vital role in TB detection, even with the advancement of molecular diagnostic tools such as GeneXpert MTB/RIF. In resource-limited settings, radiography remains a preferred initial diagnostic method because it is quick, non-invasive, and relatively affordable (Jeong & Lee, 2008). Radiographic findings such as upper lobe infiltrates, cavitary lesions, fibrosis, and nodular opacities guide clinicians in suspecting TB, assessing severity, and anticipating complications.

At the University of Benin Teaching Hospital (UBTH), chest radiography is routinely used for adult patients suspected of pulmonary TB. However, interpreting these radiographs can be challenging due to variations in disease presentation. Factors such as disease stage, immune status, age, and comorbidities can influence radiologic appearances (Yusuph et al., 2004). For instance, while immunocompetent patients often show upper lobe cavitation, those with HIV may present atypically, sometimes with lower lobe involvement or even normal radiographs despite active disease (Awoyemi et al., 2002). The emergence of multidrug-resistant (MDR) and extensively drug-resistant (XDR) TB further complicates radiographic interpretation. These forms often exhibit bilateral cavities, bronchiectasis, or severe lung destruction, which may mimic other pulmonary diseases (Oladimeji et al., 2022). Understanding these local radiographic manifestations is crucial for timely and accurate diagnosis. This study therefore seeks to characterize the common and atypical chest radiographic patterns among adult TB patients at UBTH. By identifying these local patterns, radiologists and clinicians can improve diagnostic accuracy, enhance patient outcomes, and strengthen public health strategies for TB control.

1.2 Statement of Problem

Despite the availability of chest radiography at the University of Benin Teaching Hospital, challenges persist in the prompt and accurate diagnosis of pulmonary tuberculosis. Misinterpretation of chest radiographs or limited ability to recognize characteristic TB patterns often delays diagnosis and treatment. Such delays worsen clinical outcomes, increase complications, and prolong transmission within the community. A major gap is the lack of local data detailing the specific radiographic features of TB among adult

patients at UBTH. Although classical TB findings such as upper lobe infiltrates, cavitation, and fibrosis are well documented globally, their frequency and distribution in this local population remain unclear. Without this context-specific information, clinicians may struggle to make evidence-based decisions, leading to misdiagnoses and inappropriate treatment.

Previous Nigerian studies have shown that demographic and clinical variables influence radiographic presentation. For example, Saidu et al. (2013) reported that males accounted for 73.6% of TB cases at another teaching hospital, with cavitation being the most common radiologic finding. Similarly, in drug-resistant TB, cavitation was observed in 41.5% of cases (Oladimeji et al., 2022). However, comparable data are unavailable for UBTH, limiting clinicians' ability to tailor diagnostic and therapeutic approaches to their specific patient population. This lack of localized radiographic data hinders effective TB management and may contribute to diagnostic errors, treatment delays, and community spread. Given the increasing burden of drug-resistant TB, it is essential to establish a clear understanding of the chest radiographic patterns typical of adult TB patients in UBTH.

Therefore, this study seeks to systematically analyze thoracic radiographs of adult TB patients at UBTH to provide empirical data that will enhance diagnostic precision, support the development of contextual diagnostic protocols, and ultimately improve patient outcomes. That is why we require a focused local study, one that thoroughly examines the chest radiographs of adults with TB right here at UBTH. With this, we will finally have specific data to assist radiologists and clinicians, enabling them to make quicker and more accurate decisions. It enhances clinical reasoning, informs diagnostic

protocols suited to our environment, and most importantly, leads to better patient outcomes and stronger TB control in the community.

1.3 Research Questions

1. What are the predominant chest X-ray patterns observed among adult patients diagnosed with tuberculosis at UBTH?
2. How do these chest X-ray patterns correlate with the clinical symptoms presented by adult tuberculosis patients at UBTH?

1.4 Hypotheses

Null Hypothesis (H_0): There is no significant difference in chest radiographic patterns between adult male and female tuberculosis patients at UBTH.

Alternative Hypothesis (H_1): There is a significant difference in chest radiographic patterns between adult male and female tuberculosis patients at UBTH

1.5 Aim and Objectives of the Study

Aim:

To assess the radiographic patterns of chest tuberculosis among adult patients in UBTH.

Objectives:

1. To identify the most common chest X-ray patterns in adult TB patients in UBTH.
2. To examine the relationship between patient demographics and radiographic features.
3. To highlight the diagnostic significance of specific radiographic patterns.

1.6 Significance of the Study

This study provides locally relevant evidence on the radiographic features of pulmonary tuberculosis among adult patients at UBTH. By documenting these patterns, the research will improve the ability of radiologists and clinicians to recognize TB presentations promptly and accurately. Enhanced diagnostic capacity will reduce treatment delays, improve patient outcomes, and limit disease transmission. Beyond UBTH, the findings will be useful for other healthcare facilities in Nigeria seeking to strengthen TB diagnosis and control strategies. The results also provide valuable educational material for medical trainees, helping them recognize TB manifestations under varying clinical conditions such as HIV co-infection or drug resistance.

Furthermore, the study contributes to national TB control efforts by supplying data that can inform policy development, guide resource allocation, and refine diagnostic training programs. Ultimately, the findings enrich the body of knowledge on tuberculosis in Nigeria and support global efforts to combat the disease through improved diagnostic practices.

1.7 Scope of the Study

This study seeks to evaluate the chest radiographic patterns of tuberculosis in the adult patients that participated in patients seen at the University of Benin Teaching Hospital (UBTH) in Benin City, Nigeria. This study will be done on adults (aged 18 years and above) who have been diagnosed with pulmonary (chest) tuberculosis. Participants in this study will include both new and previously treated TB patients and will be inclusive of both drug-sensitive and drug-resistant TB patients.

The study will involve a detailed review and analysis of chest radiographs to describe and characterize the common and atypical radiographic patterns seen in this patient group. The relevant clinical information will be obtained, including demographic data (age, sex), HIV status (where available), TB treatment history, and bacteriological confirmation, to assist in the contextual understanding of the radiograph findings. As part of the study, the relationship between radiographic features and key clinical variables will be examined to better understand disease presentation in this clinical population.

To maintain clarity, consistency, and relevancy of findings, the study will specifically remove certain categories of patients. Those who are less than 18 years of age (i.e., children and adolescents) will not be considered, as the radiographic patterns of tuberculosis in these patient populations can differ from adult radiographic patterns and typically require distinct considerations. Likewise, patients with extra-pulmonary tuberculosis (the disease in locations different from the lungs, i.e., lymph nodes, pleura, bones, and/or central nervous system) will not be included, given that the research focus is pulmonary disease studied through chest radiography. Categories of cases where patient clinical records are incomplete, or chest radiographs are missing, incomplete, or inadequate will also be removed to optimally defend the validity and reliability of the analysis.

The specific and meaningful data generated by the study using its defined scope reflect adult presentations of pulmonary TB that can be used to inform the diagnostic practices at UBTH and could be used to change the way care is delivered to this patient group.

1.8 Operational Definition of Terms

- **Tuberculosis (TB):** A contagious bacterial infection resulting from Mycobacterium tuberculosis affecting mainly the lungs (pulmonary TB) but can affect other organs (extra-pulmonary TB).
- **Pulmonary Tuberculosis:** The most common and contagious is the pulmonary or respiratory strain. Pulmonary TB is commonly contracted through airborne droplets.
- **Chest Radiographic Patterns:** A diagnostic modality (chest X-ray) used to visualize and inspect the lungs and thorax, and assess for abnormalities, including TB.
- **Infiltrate:** Areas of increased density observed on chest X-rays that suggest the presence of fluid, cells, or other materials indicating infection or inflammation (as in TB).
- **Extra-pulmonary Tuberculosis:** TB that occurs outside of the lungs (such as in the lymph nodes, bones, pleura, or central nervous system).
- **Radiograph**: A photograph or image produced by X-rays passing through an object or body to reveal its inner structure.
- **Cavitation**: Lucent regions indicating an air-filled body of necrosis.
- **Nodular Opacities:** Small round shadows that can be seen on chest x-rays. These can indicate granulomatous infection, such as tuberculosis.
- **Immunocompetent:** A person whose immune system is normal and will mount an appropriate response to an infection such as TB.
- **Immunocompromised**: Exposure to someone who is immunocompromised is a person who has a weakened immune system (e.g., due to HIV) and who is more likely to be infected with TB and show atypical manifestations of TB.

- **Miliary Nodules:** Refers to miliary nodules, meaning countless little nodules, all over the lungs, appearing similar to millet seeds on a chest X-Ray and likely associated with disseminated TB.
- **Atypical Radiological Presentations:** Unusual or non-classic manifestation of TB on an imaging study/scan. Atypical presentations of TB have been related to either drug-resistant TB or immunocompromised patients.
- **Drug-Resistant TB (DR-TB):** TB caused by bacteria that do not respond to the standard first-line anti-TB drugs and require alternative treatment regimens.
- **Multidrug-Resistant TB (MDR-TB):** TB that is resistant to at least isoniazid and rifampicin, the two most effective first-line anti-TB drugs.
- **Extensively Drug-Resistant TB (XDR-TB):** A more severe type of drug-resistant TB that is resistant to isoniazid, rifampicin, and fluoroquinolones plus at least one second-line injectable drug.
- **Bilateral Lung Involvement:** A scenario where both lungs are affected in disease, versus involvement limited to a unilateral lung; common in advanced or multidrug-resistant TB.
- **Bronchiectasis:** A chronic condition in which the bronchi (airways) have become permanently dilated due to infection or inflammation, which could follow TB or develop as a complication.
- **Differential Diagnosis:** The process of differentiating TB from other diseases presenting with similar signs and symptoms or radiographical features, such as pneumonia or lung cancer.

- **Highly Active Antiretroviral Therapy (HAART)**: A treatment approach for Human Immunodeficiency Virus (HIV) infection that uses a combination of multiple antiretroviral drugs to suppress the virus and stop the progression of the disease.
- **Lower Lung Field Tuberculosis (LLFT):** A form of pulmonary tuberculosis (TB) in which the disease predominantly affects the lower lobes or basal segments of the lungs, rather than the more commonly involved upper lobes.

CHAPTER TWO

LITERATURE REVIEW

1.1 Conceptual Review

Tuberculosis and Radiographic Evaluation

Tuberculosis (TB) is a highly contagious and potentially fatal airborne disease that primarily targets the lungs but can also affect other organs such as the kidneys, spine, and brain (Olanrewaju et al., 2022) (Erinle, 2003). It is caused by the bacterium *Mycobacterium tuberculosis*, which spreads through droplets when an infected person coughs, sneezes, or speaks (Alex-Hart & Paul, 2019). Even after years of worldwide efforts, TB remains one of the leading causes of death especially in low-resource areas. The World Health Organization (2022) reports that, before the emergence of COVID-19, tuberculosis was the world's most lethal infectious disease caused by a single pathogen, claiming more lives annually than HIV/AIDS (Akhigbe et al., 2019). Health systems have responded with vaccines, better diagnostics, and antitubercular medications. Still, TB continues to spread in communities facing poverty, poor nutrition, crowded living conditions, inadequate sanitation, and fragile healthcare systems. These factors often delay diagnosis and result in incomplete or ineffective treatment, which allows the disease to spread further. The growing prevalence of drug-resistant types such as multidrug-resistant TB (MDR-TB) and extensively drug-resistant TB (XDR-TB) worsens the situation. These strains are more difficult to treat, require longer and more complex therapies, and come with higher risks of complications and death.

Chest X-rays are a primary tool for detecting and monitoring pulmonary tuberculosis (Akhigbe et al., 2019; Ezenekwe et al., 2024). When a patient presents with a persistent cough, weight loss, night sweats, or coughing up blood, physicians typically begin with a chest radiograph. The reason is that chest X-rays are fast, cost-effective, non-invasive, and widely available even in remote or underserved locations. Jeong and Lee (2008) note that this level of accessibility makes chest X-rays essential for diagnosing TB and conducting mass public health screenings. Chest X-rays are not only useful for initially identifying TB. They allow clinicians to assess the extent of the disease, identify complications, and monitor how patients are responding to therapy. With these images, doctors can determine if TB is localized or has spread, whether it remains active or is beginning to resolve, and whether further testing such as sputum culture, GeneXpert, CT scans, or bronchoscopy is needed. Active pulmonary tuberculosis typically appears on chest X-rays in several characteristic ways:

- **Upper lobe infiltrates**, especially in the apical and posterior segments of the upper lobes.
- **Cavitary lesions**, which are hallmark features of reactivation TB and signify tissue necrosis and bacterial shedding.
- **Fibrotic scarring**, often indicative of past or healing infections.
- **Nodular opacities**, including both well-defined and poorly defined lesions.
- **Pleural effusions**, seen in both primary and post-primary TB.

- In disseminated or advanced cases, miliary tuberculosis may be evident, characterized by a diffuse pattern of small nodules scattered across both lung fields, resembling millet seeds (Geng et al., 2002).

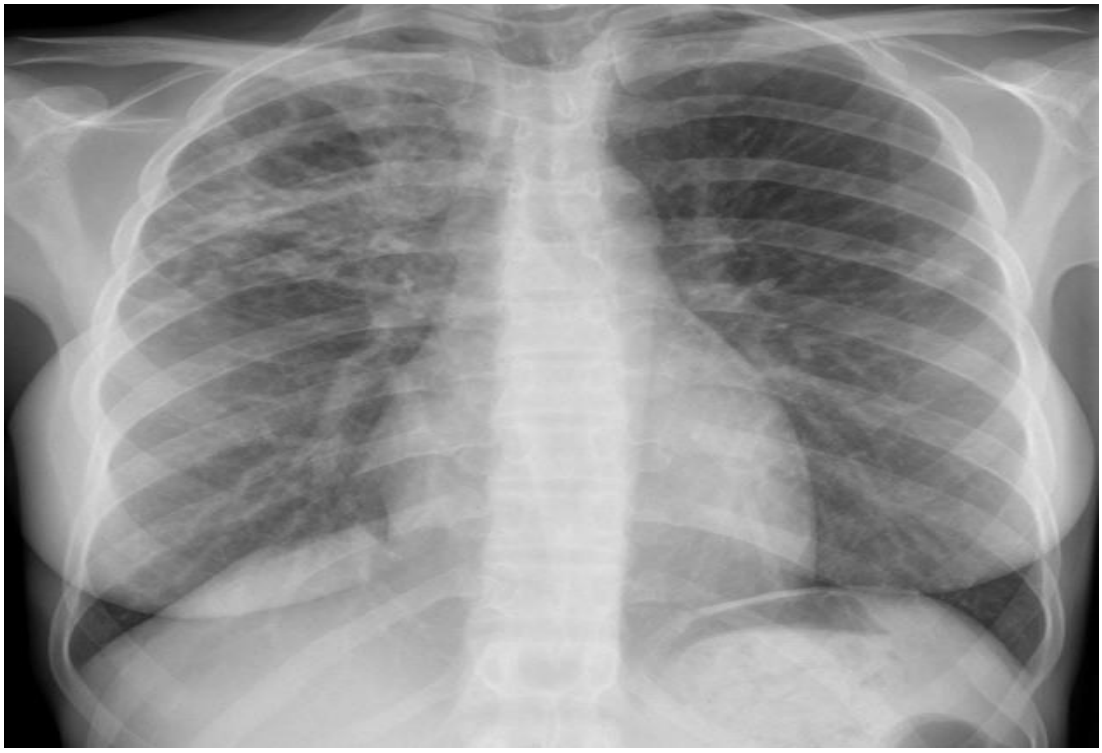


Figure 2.1 A chest radiograph showing right upper lobe cavitation in active pulmonary tuberculosis

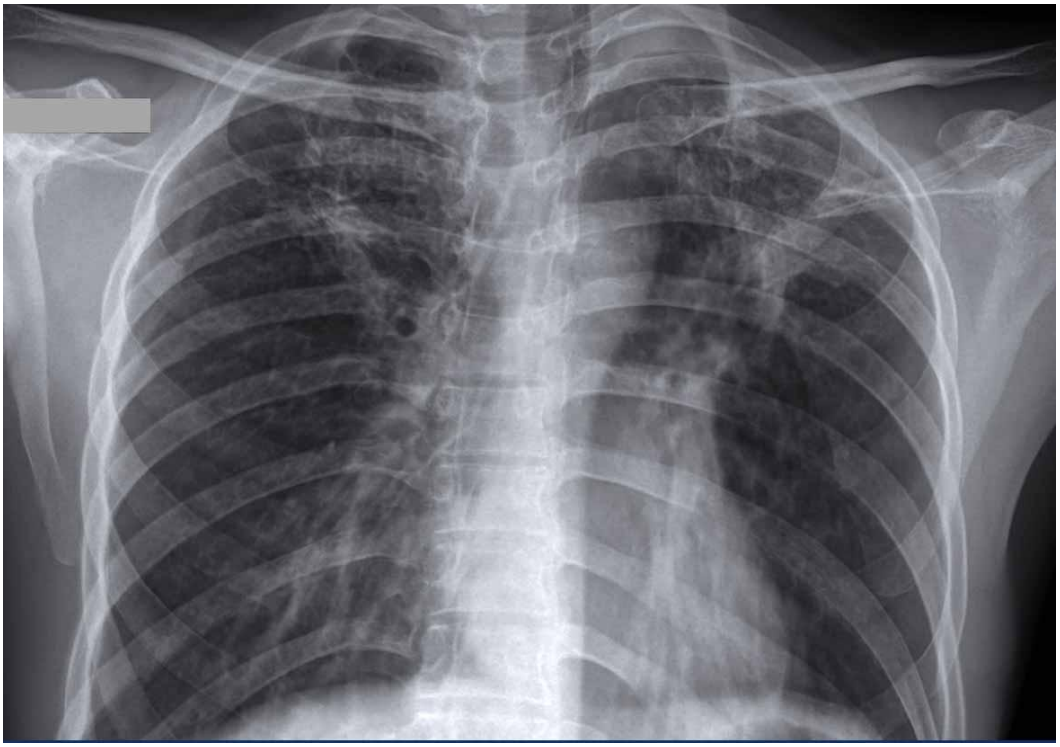


Figure 2.2 A chest radiograph showing fibrotic scarring due to pulmonary tuberculosis

These patterns, when recognized early and accurately interpreted, allow clinicians to distinguish TB from other respiratory diseases such as bacterial pneumonia, lung cancer, or fungal infections, enabling timely initiation of therapy, which is crucial to reducing transmission and preventing complications.

However, the radiological appearance of TB is not uniform and can vary significantly based on several host-related and environmental factors. These include:

- **Age**: Children and elderly patients often exhibit different radiological features compared to young adults. Pediatric TB may show more lymphadenopathy and less cavitation.

- **Immune status**: Individuals with compromised immunity, particularly those with HIV/AIDS, often present with atypical features such as lower lobe infiltrates, lack of cavitation, or diffuse interstitial patterns that are easily missed or mistaken for other conditions (Awoyemi et al., 2002).

- **Comorbidities**: Conditions such as diabetes mellitus, chronic kidney disease, or cancer can also alter the radiographic presentation, sometimes leading to more severe or unusual manifestations.

- **Drug resistance**: Patients infected with drug-resistant TB strains, such as MDR or XDR TB, often have more extensive lung damage, which may include dense consolidation, bronchiectasis, atelectasis, and chronic fibrotic changes, indicating prolonged and aggressive disease (Oladimeji et al., 2022).

How TB appears on X-rays is not just about the disease itself. Factors like late diagnosis, not completing treatment, poor follow-up, or getting infected again all make things more complicated. When these challenges build up, chest X-rays become even more essential. Doctors rely on these images to decide on treatment and to check if their approach is working. That is why chest X-rays are still crucial in fighting TB. They are not just for diagnosis, they let doctors see how advanced the disease is and how it's progressing inside the body. Being able to pick up on the different, sometimes subtle, signs of TB on an X-ray is especially important for people with other health issues or those facing drug-resistant TB. This careful approach really helps patients and reduces the spread in the community.

TB remains a major health challenge around the world, especially in countries like Nigeria. This makes it vital for doctors to understand all the ways TB can look on X-rays in different patients. It is crucial for finding the disease early, treating it effectively, and keeping it under control.

2.2 Empirical Review

Multiple studies have documented the radiographic patterns observed in pulmonary TB, detailing both classic and atypical presentations. Saidu et al. (2013) tracked 106 adults with newly diagnosed, untreated smear-positive pulmonary TB over two years. The majority were male (about 74%), with an average age of approximately 37. Over half of the participants were from lower socio-economic backgrounds, and notably, 52% were HIV-positive highlighting a significant rate of co-infection in that area. Their chest X-rays revealed familiar features: patchy or streaky opacities and cavitary lesions, most frequently in the upper lobes. Bilateral involvement was seen in nearly 69% of cases, closely resembling the classic patterns of post-primary TB. Even in a population with a high HIV prevalence, these typical radiographic signs were still commonly seen. Saidu and colleagues emphasized that chest radiography continues to play a crucial role, particularly in settings where more advanced diagnostics are lacking. Their results also underscore how factors like HIV co-infection and poverty influence TB's presentation in the community. For Nigeria, this study provides valuable local data and reinforces the ongoing importance of conventional chest imaging in TB management.

Oladimeji et al. (2022) also contributed by focusing on chest X-rays as early indicators for drug-resistant TB (DR-TB) in Nigeria. Reviewing data from 2010 to 2016, they linked CXR findings with patient histories and geographic details using robust statistical methods. Their findings were striking. Abnormal chest X-rays were present in 97% of cases, with cavitation being the most frequent feature occurring in 41.5% of patients. Cavitation was not random; it was strongly associated with patients who had previously been treated for DR-TB. This confirmed what many clinicians suspect, but Oladimeji's group went a step further. They highlighted that multiple, thick-walled, bilateral cavities are often indicative of DR-TB a clue that could improve diagnosis, especially where lab capacity is limited. Their main message: in contexts where molecular testing isn't accessible, identifying features like cavitation and extensive lung destruction on X-rays should prompt clinicians to initiate targeted DR-TB treatment promptly. Delays in diagnosis can lead to worse outcomes, making this approach both practical and urgent. Oladimeji et al. argue that chest radiography should not be relegated to a secondary role it should be central to DR-TB diagnosis, particularly for patients with prior treatment. Their research repositions the chest X-ray as more than just a confirmatory tool; it becomes a vital decision-making instrument, especially where resources are constrained.

Awoyemi et al. (2002) aimed to investigate how active pulmonary tuberculosis appears on chest X-rays and presents clinically in HIV-positive adults at University College Hospital in Ibadan, Nigeria. They studied 58 adults, all confirmed HIV-positive, who presented with respiratory symptoms. Data were gathered through patient interviews, physical examinations, blood tests such as FBC and ESR, and chest X-rays. The patients

ranged in age from 19 to 53, with an average age just under 33. Notably, more women than men had TB, with a male-to-female ratio of 1.2:2.

The chest X-ray findings were quite variable. Around 11% of the films appeared normal, while the rest showed a range of abnormalities: 37% had localized lesions, another 37% had diffuse lesions, 16% showed pulmonary cavities, and smaller percentages displayed miliary patterns, pleural effusion, or hilar adenopathy. The classic upper zone lesions typical of TB were not commonly seen in these HIV-positive patients. Instead, abnormalities tended to be more widespread, involving all three lung zones either unilaterally (17%) or bilaterally (41%), with the mid and lower zones often most affected. The study concluded that HIV changes the typical radiological pattern of pulmonary TB, making it more diffuse and often less obvious on imaging. Even when X-rays were not classic, many patients were still actively infectious, spreading Mycobacterium tuberculosis in their sputum, a significant public health issue. The authors emphasized the importance of early diagnosis and treatment for HIV-positive people with TB and recommended that anti-TB therapy should continue even if antiretroviral drugs are not available. Continued TB treatment helps curb transmission in the community and reduces early deaths among people living with HIV/AIDS.

Meghwani et al. (2013) examined Lower Lung Field Tuberculosis (LLFT) in Kanpur, India, by tracking 574 pulmonary TB patients from October 2012 to June 2013. Their approach included clinical history, examinations, chest X-rays (both PA and lateral), and sputum tests for AFB. LLFT was defined as any lesion below a horizontal line drawn across the hila on chest X-rays. Children and those with both upper and lower lung involvement were excluded. They found that 9.4% of these TB patients had LLFT. While

not the most common form, LLFT is not rare and deserves attention from clinicians in India. LLFT was seen more often in women and older adults, particularly those aged 25 to 34, who accounted for nearly 39% of LLFT cases. The disease usually affected only one lung, most often the right. On X-ray, cavitation was most frequent (42.6%), followed by nodular opacities and consolidation. Patients with HIV or diabetes had a higher risk of LLFT. Although the lesions were in an unusual part of the lung, LLFT resembled classic TB in terms of symptoms. Patients responded well to standard short-course chemotherapy, so with correct diagnosis, outcomes were good. The study highlights that LLFT is a common but under-recognized form of TB, especially among young women and older adults. Given its similar clinical presentation and good treatment response, LLFT should be considered especially in patients with risk factors such as HIV or diabetes.

In 1997, Dongola studied pulmonary TB in Khartoum and found it mainly affected young men from low-income backgrounds. Patients often presented late, already experiencing cough, chest pain, and weight loss. Sputum tests were positive in 57% of cases, and 80% reacted to the tuberculin skin test. On X-ray, most showed upper or middle zone infiltration, with more than half displaying fibrocavitary and exudative lesions. The findings underscore the urgent need for earlier diagnosis and improved radiology practices in Sudan, as TB continues to be a major public health challenge. Tahir et al (2015) examined how Highly Active Antiretroviral Therapy (HAART) affects chest X-ray appearances of pulmonary tuberculosis (PTB) in people living with HIV. They investigated 60 HIV-positive patients who were newly diagnosed with sputum smear-positive PTB. The participants were divided into two groups: one group had been on HAART for at least six months before their TB diagnosis, while the other group had

never received antiretroviral therapy. All patients underwent chest X-rays and CD4+ lymphocyte counts to assess immune status. The researchers categorized X-ray findings as “typical,” such as apical opacities or cavitation, and “atypical,” including lower or middle lung consolidation, reticulonodular patterns, miliary TB, pleural effusion, hilar lymphadenopathy, or even normal radiographs. Their results showed that the majority of HAART-experienced patients with CD4 counts of 200 cells/µl or above (78.6%) displayed the classic post-primary TB features on their chest X-rays. In contrast, atypical radiographic presentations were significantly more frequent among ARV-naïve patients with CD4 counts below 200 ($P = 0.001$). Cavitary lesions, upper zone consolidation, left-sided consolidation, and upper lung reticular changes appeared more often in the HAART group, while lobar consolidation was less frequent in untreated patients. Reticulonodular patterns, hilar adenopathy, and even normal chest films were more commonly seen in the ARV-naïve group. The main point is that immune status and HAART use influence TB’s radiographic patterns in HIV patients. Those on HAART are more likely to show typical post-primary TB findings. This is important, particularly in resource-limited settings, where chest radiography is a vital diagnostic tool. Clinicians should consider both HAART status and CD4 count when interpreting chest X-rays in HIV/TB co-infected patients. Meanwhile, Alavi et al. (2014) studied a much larger sample: 2,426 PTB patients in Khuzestan, Iran. They divided the patients into younger adults (18–64 years) and elderly adults (65 years and older) to compare clinical symptoms, radiographic findings, and treatment outcomes. Older patients more frequently presented with symptoms such as shortness of breath, hemoptysis, and weight loss. Their chest X-rays less often showed cavitation and more often showed lower lung involvement, an atypical

pattern. Elderly patients also had lower rates of sputum smear positivity, worse treatment outcomes (64% compared to 77% in younger adults), and much higher mortality (26.5% versus 4.1%). Thus, PTB in older adults tends to be more severe, presents less typically, and is associated with poorer outcomes, underscoring the need for age-specific strategies in TB management.

On a broader scale, the WHO's "Global Tuberculosis Report 2022" presents a concerning outlook. Since the COVID-19 pandemic, gains in TB diagnosis and treatment have stalled or even reversed in some regions. Global TB targets are now unattainable. In 2020, there was a sharp drop in newly diagnosed TB cases worldwide, and although there was a partial rebound in 2021, it was insufficient. More people went undiagnosed and untreated, leading to increased TB mortality. The report stresses the need for urgent action and significantly more funding to recover from the pandemic's impact. This need is heightened by the war in Ukraine, ongoing conflicts, the global energy crisis, and threats to food security, all of which worsen TB risk factors. In summary, these studies and reports highlight a key lesson: TB's radiographic features vary according to immune status, age, comorbidities, and the surrounding context. Diagnostic and management strategies must be tailored to these differences; a uniform approach is not effective.

2.2 Theoretical Framework

This study is anchored on two central theoretical models: the Diagnostic Reasoning Framework by Elstein et al. (1978) and the Epidemiological Triad Model as outlined by Porta (2014). These frameworks guide the approach to chest tuberculosis, encompassing both clinical and radiological specifics as well as the broader public health context.

2.2.1 Diagnostic Reasoning Framework

The Diagnostic Reasoning Framework outlines the process clinicians use to arrive at a diagnosis. It goes beyond simple checklists, physicians integrate patient history, physical examination, laboratory data, and imaging findings to piece together the clinical picture. For chest TB, radiographic imaging particularly plain chest X-rays takes centre stage in this evaluative process. Successfully interpreting these images hinges on pattern recognition. Physicians are trained to identify hallmark features: upper lobe infiltrates, cavitations, consolidations, fibrosis, and pleural changes. These findings are not just boxes to tick; each pattern conveys information about disease severity, treatment response, and the presence of complications. The Diagnostic Reasoning Framework emphasizes the importance of analytical thinking and clinical expertise, highlighting that interpreting a chest X-ray for TB is not merely technical, it is a skill that blends medical knowledge, hands-on experience, and sound judgment.

2.2.2 Epidemiological Triad Model

However, clinical reasoning alone does not capture the full picture. The Epidemiological Triad Model broadens the perspective by focusing on three key factors in disease dynamics: the agent, the host, and the environment. This model is crucial for understanding the variation in TB presentations, including the radiological findings seen on X-rays.

- **Agent (Pathogen):** Here, Mycobacterium tuberculosis is the primary concern. The strain's characteristics and its virulence affect radiological manifestations, some strains lead to more extensive lung damage, while others may present atypically, particularly in cases of drug resistance.

- **Host**: The patient's individual factors come into play next. Age, immune status, nutrition, genetic background, and comorbidities such as HIV or diabetes all influence how TB appears on imaging. For instance, individuals with HIV often display lower lobe infiltrates, minimal or absent cavitation, and a more diffuse pattern, making diagnosis more challenging.

- **Environment**: External conditions are also significant. Factors such as healthcare access, living situations, exposure to other TB cases, and socioeconomic status all impact disease progression. Overcrowded or substandard living environments and limited diagnostic resources often result in delayed detection, leading to more advanced disease being visible on X-rays.

By applying the Epidemiological Triad, this study examines how the interplay of pathogen, host, and environmental factors shapes the radiographic presentation of TB. This framework encourages us to relate imaging findings to the larger network of health determinants and disease transmission, rather than focusing solely on immediate symptoms.

Integration of Both Frameworks

The integration of these two frameworks forms the core of this research. The Diagnostic Reasoning Framework provides insight into how clinicians interpret both clinical and imaging information, while the Epidemiological Triad supplies context for why radiographic patterns vary across individuals and populations. This dual perspective ensures that the study remains rooted in both the specifics of diagnostic practice and the

overarching public health landscape, allowing for a comprehensive understanding that connects the patient, the disease, and their environment.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Research Setting

This study was conducted in the Radiology Department of the University of Benin Teaching Hospital (UBTH), a major tertiary healthcare institution and referral centre located in Benin City, Edo State, Nigeria. UBTH serves patients from across the country and provides a wide range of specialized medical services. Established in 1973 (then known as the Midwest Medical Centre) and later designated a federal institution in 1975, the hospital currently has a bed capacity exceeding 860 and serves as the teaching hospital for the University of Benin. The Radiology Department offers diagnostic imaging services such as X-rays, computed tomography (CT), magnetic resonance imaging (MRI), and ultrasonography. It plays a pivotal role in the diagnosis and management of tuberculosis (TB) and other chest-related diseases. The department maintains a comprehensive radiographic archive that serves as a valuable data source for research (University of Benin Teaching Hospital, 2024; Udomoh, 2019).

3.2 Study Design

A retrospective descriptive study design was employed. The research involved reviewing existing radiographic and clinical records of adult patients diagnosed with pulmonary tuberculosis (PTB) at UBTH between 2022 and 2024. This design was chosen because it enables analysis of historical data to identify patterns and correlations between radiographic findings and patient characteristics.

3.3 Target Population

The target population comprised adult patients (aged 18 years and above) who were diagnosed with pulmonary tuberculosis and underwent chest X-ray examinations at the UBTH Radiology Department during the study period (2022–2024).

3.4 Sampling Techniques/Sample Size

The selection of patient records was done through a purposive sampling method in order to fit the pre-defined inclusion criteria. The non-probability sampling technique was suitable since the research needed to use chest X-ray records that had been clinically determined to have pulmonary tuberculosis cases and had full and readable radiographic data. The sampling response strategy guaranteed that the data analysed were pertinent, dependable and applicable in answering the research queries by accessing records with desired diagnostic information.

Inclusion Criteria:

1. Adult patients having pulmonary tuberculosis and are 18 years of age and above.
2. Individuals that underwent chest X-ray examinations in UBTH 2022-2024.
3. Clear, complete, legible, and documented x-ray images and reports.

Exclusion Criteria:

1. Patients younger than 18 years.
2. Extra-pulmonary tuberculosis Cases diagnosed in such cases, which would not necessarily display pulmonary disease as the chest findings.

3. Records that lack, have incomplete, and or inconsistent clinical or radiographic information.

4. Damaged or of low quality X-ray films that could not be interpreted properly.

Using these criteria, 350 records of patients were selected as eligible and were incorporated in the final analysis. This was deemed to be sufficient in descriptive and comparative analysis of chest radiographic patterns and sufficient in meaningful analysis across demographic sub groups

3.5 Instrument for Data Collection

A structured checklist specifically designed for this study was used to collect data. The checklist was developed to make sure that the relevant variables can be extracted systematically and to have uniformity in the review of the record of a given patient. The following types of information were obtained by the instrument:

Demographic information: sex and age of the patient.

Clinical information: clinical symptoms or indications of the X-ray.

Radiographic appearances: cavitation, opacities, consolidation, fibrosis, nodules, effusion of pleura, other characteristic TB appearances.

Anatomical distribution: location, zones, lobes of the lungs, laterality (unilateral or bilateral).

Other notes: final impression, the severity indicators, and other abnormalities..

3.6 Validity of Instrument

The checklist's content validity was established through expert review by two consultant radiologists from the University of Benin. These experts examined the checklist to ensure it captured all relevant parameters for pulmonary tuberculosis and reflected current clinical and radiographic standards. Feedback obtained from this review was incorporated to refine and finalize the instrument.

3.7 Reliability of the Instrument

A pilot study was conducted using 10 randomly selected X-ray reports prior to the main data collection. The researchers assessed the consistency of data interpretation and recording. Any issues identified were addressed, and the checklist was revised accordingly to enhance reliability.

3.8 Method of Data Collection

The collection of data was done in the Radiology archives of UBTH following strict permission granted by the management of the hospital. The steps to be used to guarantee the accu racy and consistency were as follows:

Record Retrieval: Records The eligible chest X-ray images and their respective reports in the period 2022-2024 were retrieved within both the digital and hard-copy record archives.

Screening: Every record was evaluated based on the inclusion and exclusion criteria to ensure eligibility.

Review and Extraction: The X-ray report and the image were evaluated together to extract the information regarding the patient included in the study. The validated checklist was used to record the relevant findings.

Prevention of Duplication: Cross tabulation of record numbers and folder identifiers was done to eliminate chances of a patient being recorded twice.

Quality Assurance: To reduce errors in transcription and improve consistency in interpretation, a second reviewer was used to carry out periodic verification.

This was a systematic procedure that guaranteed validity of extracted information and increased the credibility of the findings of the study.

3.9 Method of Data Analysis

Data collected was analysed using the Statistical Package for the Social Sciences (SPSS) version 26. Descriptive statistics such as frequencies, percentages, means, and standard deviations were used to summarize the demographic characteristics and radiographic patterns of patients. Inferential statistics were applied using the Chi-square (χ^2) test to determine associations between radiographic features and selected demographic or clinical variables. A p-value < 0.05 was considered statistically significant. Results were presented in tables and charts for clarity and ease of interpretation.

3.10 Ethical Consideration

Ethical approval for this study was obtained from the Ethics and Research Committee of the University of Benin Teaching Hospital (UBTH). Patient confidentiality was maintained throughout the research process. No names or identifying details were recorded, and all data were used strictly for research purposes.

CHAPTER FOUR

RESULTS AND DATA ANALYSIS

4.1 Demographic Characteristics of Study Participants

A total of 350 adult patients diagnosed with pulmonary tuberculosis were included in the study. Their ages ranged from 18 to 87 years, with a mean age of 46.2 years (SD ±17.9). This indicates that PTB affected individuals across a wide age range, with a concentration in the middle-aged group. Men made up the majority of the patients (63.4%), while women accounted for 36.6%, resulting in a male-to-female ratio of approximately 1.7:1. This predominance of male patients aligns with established epidemiological trends that show higher PTB prevalence among men, likely due to behavioral and occupational risk factors such as smoking, alcohol use, and exposure to infection-prone environments.

Table 4.1 Demographic Characteristics of Study Participants

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	Mean ± SD	46.2 ± 17.9	—
	Range	18 – 87	—
Sex	Male	222	63.4
	Female	128	36.6
Total		**350**	**100.0**

4.2 Clinical Indications for Requesting Chest X-rays

Coughing was the most common cause of ordering of the chest X-rays in a patient among the adult population with 55.1% of all cases. This was proceeded by the suspected

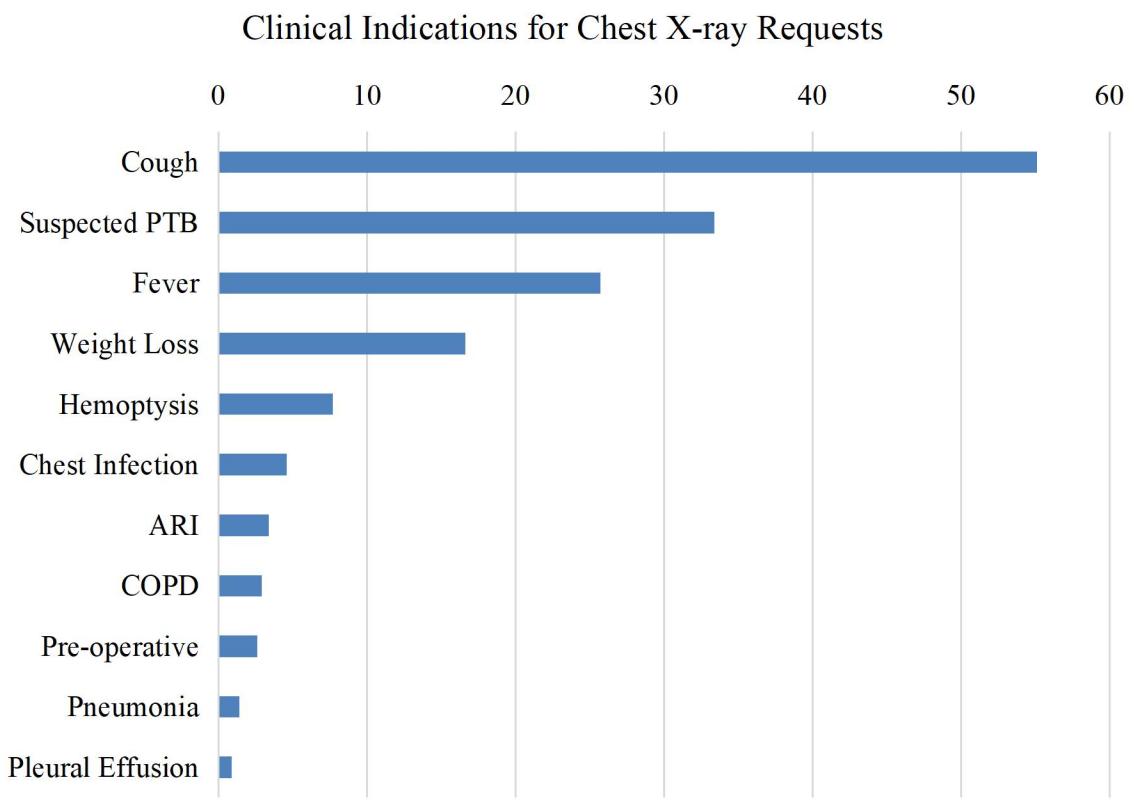
pulmonary tuberculosis (33.4%) and fever (25.7%). Other less frequent signs were weight loss (16.6%), hemoptysis (7.7%), and chest infection (4.6%), with some requests to be directed towards acute respiratory infections, COPD or to pre-operative assessment.

These results suggest that cough is the most common symptom leading to an imaging study, and more traditional TB characteristics like hemoptysis and severe weight loss were rather uncommon, which justifies the variability of TB manifestations.

Table 4.2: Frequency of Clinical Indications for Chest X-ray Requests

Clinical Indication	Frequency (%)
Cough	193 (55.1)
Suspected PTB	117 (33.4)
Fever	90 (25.7)
Weight Loss	58 (16.6)
Hemoptysis	27 (7.7)
Chest Infection	16 (4.6)
ARI	12 (3.4)
COPD	10 (2.9)
Pre-operative	9 (2.6)
Pneumonia	5 (1.4)
Pleural Effusion	3 (0.9)

Figure 4.2 Clinical Indications for Chest X-ray Requests



4.3 Radiographic Findings

4.3.1 Frequency Specific Radiographic Patterns

The chest X-rays had a large number of abnormalities reported.

The commonest results were:

1. Fibro-cavitary changes - 31.1%
2. Cavitations - 17.4%
3. Fibro-nodular opacities - 16.9%

These combined formed a greater part of one out of every five abnormalities indicating the prevalence of chronic, destructive patterns which are characteristic of advanced or post-primary TB. Other results were inhomogeneous opacities (15.1%), and

homogeneous consolidation (7.1%), patchy consolidation (5.1%) and pleural effusion were rare.

In general, this trend represents an indication of a patient group with a disease as opposed to early-stage TB.

Table 4.3.1 Frequency Specific Radiographic Patterns

Radiographic Finding	Frequency (%)
Fibro-cavitary changes	109 (31.1)
Cavitations	61 (17.4)
Fibro-nodular opacities	59 (16.9)
Inhomogeneous opacities	53 (15.1)
Homogeneous consolidation	25 (7.1)
Patchy consolidation	18 (5.1)
Reticulo-nodular opacities	11 (3.1)
Pleural effusion	8 (2.3)
Other findings	6 (1.7)

4.3.2 Categorized Radiographic Findings

Fibro-cavitary and cavitary lesions combined to constitute 48.5% of overall radiographic results when classified into larger diagnostic categories, demonstrating a great rate of advanced TB.

The others (32 percent) were fibro-nodular and inhomogeneous opacities, with the rest being consolidation and pleural-related abnormalities.

This distribution supports the clinical picture of late presentation and widespread lung involvement in the group of participants of the study.

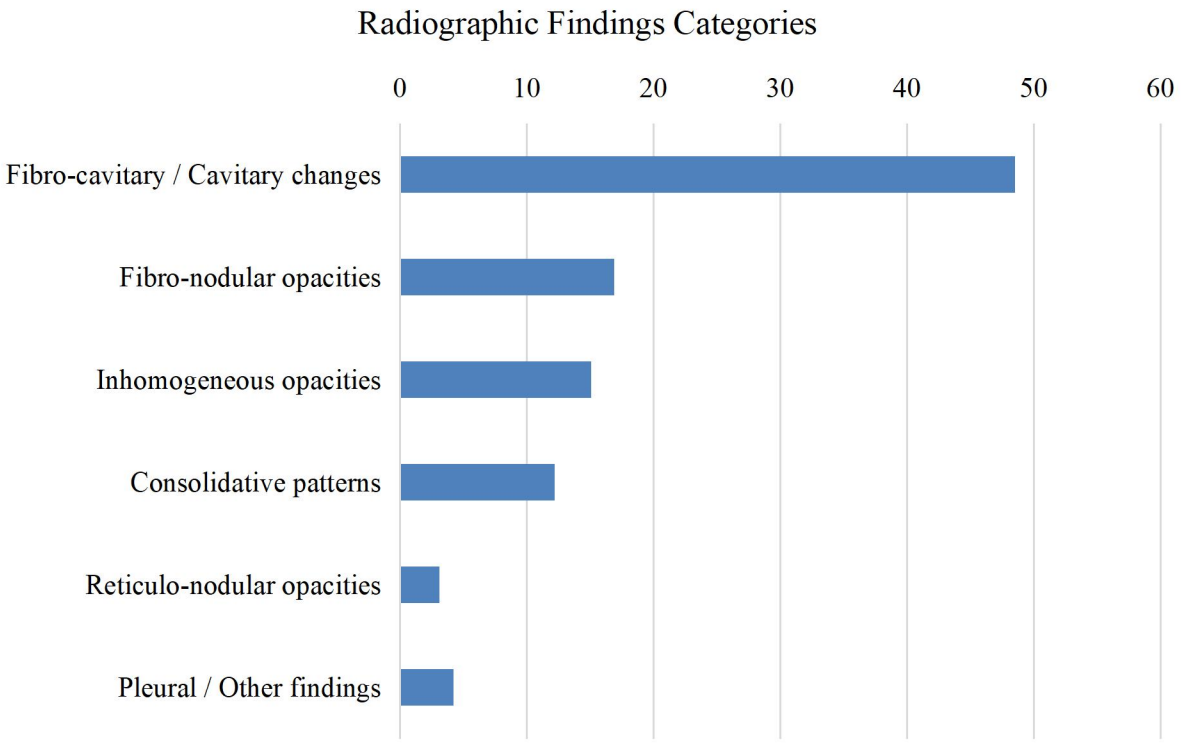


Figure 4.3.2: Distribution of Radiographic Finding Categories

4.4 Anatomical Distribution of Pulmonary Lesions

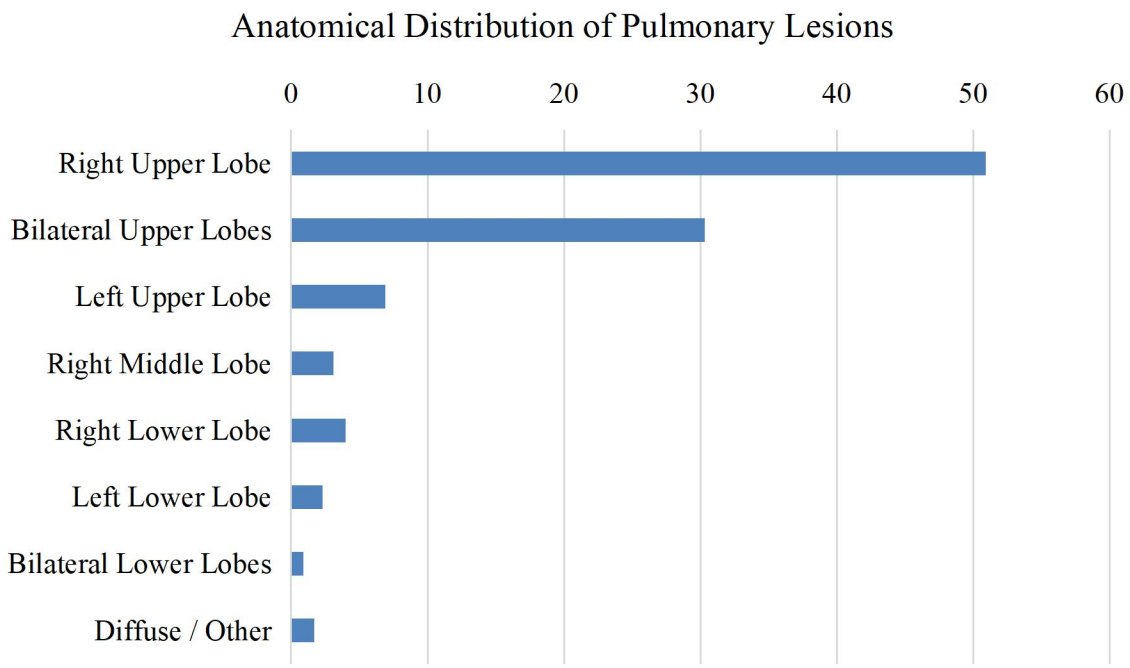
The lesions were found mostly in the upper lobes of the lungs, as it is typical in classical TB. There was 50.9% in right upper lobe and 30.3% bilateral upper lobe involvement. It was 6.9% in the left upper lobe, and rarely the lower lobes (less than 10%).

This apical preference is in line with the fact that Mycobacterium tuberculosis is oxygen-dependent, and the tendency is similar to TB imaging in the world.

Table 4.4 Anatomical Distribution of Pulmonary Lesions

Affected Lung Lobe	Frequency (%)
Right Upper Lobe	178 (50.9)
Bilateral Upper Lobes	106 (30.3)
Left Upper Lobe	24 (6.9)
Right Middle Lobe	11 (3.1)
Right Lower Lobe	14 (4.0)
Left Lower Lobe	8 (2.3)
Bilateral Lower Lobes	3 (0.9)
Diffuse / Other	6 (1.7)

Figure 4.4 Anatomical Distribution of Pulmonary Lesions



4.5 Radiographic Findings in Clinically Suspected PTB Cases

In patients that were clinically suspected to be having PTB, the radiographic distribution was more or less the same as that of the overall sample. The general findings were most frequently:

Fibro-cavitary lesions - 31.1%

Cavitations - 17.4%

Fibro-nodular opacities - 16.9%

Almost two out of three suspected clinically instances presented evidence of chronic or advanced disease on imaging. Nevertheless, a percentage of suspected cases showed atypical patterns, or non-specific ones, which also indicates the difficulty in diagnosis of case evaluation based on clinical evaluation only.

Table 4.5 Radiographic Findings in Clinically Suspected PTB Cases

Radiographic Finding	Frequency (%)
Fibro-cavitary changes	109 (31.1)
Cavitations	61 (17.4)
Fibro-nodular opacities	59 (16.9)
Inhomogeneous opacities	53 (15.1)
Homogeneous consolidation	25 (7.1)
Patchy consolidation	18 (5.1)
Reticulo-nodular opacities	11 (3.1)
Pleural effusion	8 (2.3)
Other findings	6 (1.7)

4.6 Diagnostic Performance

4.6.1 Diagnostic Performance of Clinical Indicators

Diagnostic Performance of Clinical Indicators The performance of the clinical indicators in a diagnostic task are investigated and compared to the results of other diagnostic tools of the same task.

Clinical suspicion revealed using the results of chest X-ray as the reference standard:

Sensitivity: 79.1% (clinicians made the correct diagnosis of the majority of PTB cases)

Specificity: 34.8% (the PTB is overestimated in most patients)

Positive predictive value: 43.6%

Negative predictive value: 74.1%

The general diagnostic accuracy: 52%

These findings denote that, though clinical testing is useful in detecting the possibility of an infected person, it is not precise and therefore should never be used without additional diagnostic tools such as radiographic and laboratory testing to prevent a false diagnosis.

Table 4.6.1 Diagnostic Performance of Clinical Indicators for PTB

Metric	Value
Sensitivity	79.1
Specificity	34.8
Positive Predictive Value (PPV)	43.6
Negative Predictive Value (NPV)	74.1
Accuracy	52.0
Positive Likelihood Ratio (LR^+)	1.21
Negative Likelihood Ratio (LR^-)	0.60

4.6.2 Diagnostic Value of Individual Clinical Symptoms

Among individual symptoms:

The sensitivity of weight loss was the highest (80%) and NPV (92.2%), so it could be applied to the elimination of PTB in the absence of this phenomenon, but it was not specific.

The sensitivity of hemoptysis was moderate (71.4%) and had low predictive value.

Cough and fever which were common were non-specific and could thus not be used as diagnostic indicators.

The results of these studies confirm that a single symptom cannot be used as a good predictor of pulmonary tuberculosis, thus validating the necessity of combined clinical-radiological examination.

Table 4.6.2 Diagnostic Value of Individual Clinical Symptoms

Symptom	Sensitivity	Specificity	PPV	NPV
Cough	60.5	22.0	45.6	34.0
Fever	61.9	28.7	22.8	68.9
Weight Loss	80.0	32.6	14.0	92.2
Hemoptysis	71.4	31.4	8.8	92.2

4.7 Hypothesis testing

Association Between Clinical Suspicion and Radiographic Findings

Table 4.7 demonstrates a clear statistical association between clinicians suspecting PTB and finding PTB features on chest X-ray ($p = 0.005$, Pearson's Chi-squared test). There was no correlation between clinical suspicion and radiographic findings.

Clinical suspicion of PTB had a significant association with radiographic evidence ($p = 0.005$). Out of 102 cases of suspected clinically, 76 percent displayed normal pattern of PTB on X-ray. Moreover, there were many patients who were assessed as the cause of other reasons and had radiographic signs of PTB, which shows that the burden of unrewarded disease is high.

In spite of the close relationship, the results indicate that clinical suspicion is not enough because many confirmed PTB patients did carry atypical or non-specific imaging characteristics. This highlights the importance of integrating clinical, radiographic and laboratory methods with a view on enhancing diagnostic accuracy.

Table 4.7. Cross-tabulation of Clinical Suspicion with Radiographic Findings (Pearson's Chi-squared test)

Clinical Status	Radiographic PTB Present	No Radiographic PTB	Row Total
Suspected PTB	73 (75.5 %)	29 (24.5 %)	102 (100 %)
Other Indications	162 (65.3 %)	86 (34.7 %)	248 (100 %)
Column Total	235 (67.1 %)	115 (32.9 %)	350 (100 %)

Test Statistic	Value	df	p-value (2-sided)
Pearson Chi-Square (χ^2)	7.87	1	0.005

Significant at $\alpha < 0.05$

4.8 Discussion Of Findings

This study examined the clinical and radiographic characteristics of adult patients with pulmonary tuberculosis (PTB) at the University of Benin Teaching Hospital. 350 patients records were accessed, focusing on demographic information, presenting symptoms, chest X-ray findings, and how well clinical suspicion matched radiographic evidence. 63% of the patients were male and 37% female, resulting in a male-to-female ratio of

roughly 1.7 to 1. The average age was around 47, placing most patients within the productive adult years. This is consistent with findings from other studies in Nigeria and globally. PTB disproportionately affects adult men. The reasons likely include factors such as higher rates of smoking and alcohol use among men, greater exposure to crowded environments, and other risk factors. Cough was the most common reason patients sought a chest X-ray about 55% listed it as their main complaint. In about a third of cases, clinical suspicion of PTB was the driving factor, while fever was noted in a quarter of patients. Fewer individuals reported weight loss (17%) or hemoptysis (8%). These findings are in line with Khalid et al. (2023), who emphasized that cough is the hallmark symptom of TB. However, this also highlights a challenge, cough is a symptom shared by many other lung diseases, making it difficult to rely on symptoms alone. Conditions like pneumonia, bronchitis, and other chronic infections can mimic TB, so imaging and laboratory tests are essential for accurate diagnosis. The chest X-ray findings were clear. Fibro-cavitary changes were most common, appearing in about 31% of cases, followed by cavitations, fibro-nodular opacities, and inhomogeneous opacities. Consolidation and pleural effusion were less frequently observed. This aligns with the results of Kolade Yunusa and Egenti (2016), who also found that fibro-cavitary lesions are predominant in PTB. The presence of these advanced patterns indicates that many patients presented late, either due to delayed healthcare-seeking or missed early diagnosis. In total, fibro-cavitary and cavitational changes were seen in more than half of the patients, signifying extensive lung damage and advanced disease. This supports the established understanding that fibro-cavitary lesions are characteristic of post-primary TB. The location of lesions was significant as well. The right upper lobe was affected in over half of the cases, and

bilateral upper lobe involvement was also common. The middle and lower lobes were rarely involved. This pattern matches established knowledge: the upper lobes, with their higher oxygen content, provide a favourable environment for Mycobacterium tuberculosis. When it came to diagnosis, clinical suspicion corresponded with X-ray findings in about 79% of cases, meaning that physicians identified most true cases. However, specificity was low, just under 35%, indicating that many patients initially suspected of having PTB did not show radiographic signs of the disease. The positive predictive value was moderate (44%), while the negative predictive value was somewhat higher (74%), suggesting that when clinicians did not suspect PTB, imaging usually confirmed the absence. Overall diagnostic accuracy was 52%. Thus, while clinical suspicion is helpful, it is insufficient on its own, an observation also made by Akhigbe et al. (2019). Symptoms are important, but without imaging and laboratory confirmation, misdiagnosis is a real possibility. Examining individual symptoms, weight loss had the highest sensitivity (80%), though its specificity was low, meaning it was common in PTB but also in non-PTB patients. Hemoptysis and fever had moderate sensitivity, but their positive predictive values were limited. Cough was present in both PTB and non-PTB cases, reinforcing that no single symptom is definitive for tuberculosis. All of these findings highlight the same message that clinicians must go beyond symptoms and clinical impressions to diagnose PTB accurately. Imaging and laboratory confirmation remain crucial.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

This study investigated the clinical and radiographic patterns of pulmonary tuberculosis (PTB) among adult patients at the University of Benin Teaching Hospital (UBTH). Data from 350 patients were analyzed to determine the relationship between clinical suspicion and radiographic confirmation of PTB. The findings revealed that most patients were male (63%) and within the productive age group, with a mean age of 47 years. Cough (55%) was the most common presenting symptom, followed by fever (26%) and clinical suspicion of PTB (33%). Classical symptoms such as weight loss and haemoptysis were less frequently reported (17% and 8% respectively). Radiographically, fibro-cavitary changes (31.1%), cavitations (17.4%), and fibro-nodular opacities (16.9%) were the most frequent findings, predominantly affecting the upper lobes particularly the right upper lobe. These patterns indicate that many patients presented with advanced disease. Clinical suspicion showed a sensitivity of 79.1% and specificity of 34.8%, yielding an overall diagnostic accuracy of 52%. A statistically significant relationship was observed between clinical suspicion and radiographic confirmation ($p = 0.005$). However, over 65% of patients with non-specific symptoms still demonstrated radiographic evidence of PTB, emphasizing that symptom-based diagnosis alone is insufficient.

5.2 Conclusion

The conducted research shows that pulmonary tuberculosis (PTB) remains a significant diagnostics issue especially in resource-constrained settings like Nigeria. The results

indicate that PTB is more common among adults in their working age, and those who are more represented are men- an epidemiological pattern that is similar to the national and international levels. The classical hallmark symptoms of TB were not exhibited in most patients clinically. Rather, they had obscure or indistinct respiratory symptoms like cough and fever, which can readily be confused with other respiratory diseases. Consequently, clinical symptoms were found to be highly sensitive but lowly specific giving rise to a risk of over-diagnosis when used without supplemental diagnostic instruments.

Chest radiography was also found to be critical in reducing uncertainty of diagnosis. Patterns recurrently, including fibro-cavitary lesions, nodular opacities and upper-lobe disease, particularly on the right, were well related to active PTB. The statistically significant correlation of clinical suspicion and radiographic results ($p = 0.005$) makes the combination of both strategies useful. Nevertheless, the radiologic manifestation of TB in a few individuals without the typical clinical features underscores the threat of undiagnosed conditions in cases where radiology is not regularly used.

In general, the research points to the fact that there is no single diagnostic method that can be used independently. In order to achieve good PTB detection, a layered approach is needed involving integration of clinical assessment, regular radiographic examination and confirmatory microbiological tests including GeneXpert or sputum microscopy. The ongoing enhancement of such synergy in the diagnosis is essential to achieve earlier diagnosis, start treatment in a timely manner, and prevent the spread of diseases. Sealing the loopholes in the diagnostic practice is a significant milestone towards the continued effort to control and eventually eradicate PTB in Nigeria.

5.3 Recommendations

The findings of this study reveal key gaps in the early diagnosis and management of pulmonary tuberculosis (PTB), particularly within resource-limited settings. Addressing these challenges requires coordinated efforts between clinicians, health institutions, and policymakers. The following recommendations are therefore proposed:

1. Enhance Diagnostic Capacity and Of Access to Imaging.

Health facilities ought to enhance radiographic services by ensuring the equipment is well maintained, buying reliable X-ray machines and extending imaging facilities to underserved regions. Mobile chest X-ray schemes may be implemented to remote communities. Simultaneously, radiographers and radiologists are to be provided with ongoing professional education on the early and atypical trends in PTB to enhance the accuracy of diagnosis.

2. Normalize Clinical Evaluation and Reporting Practices.

Clinicians must have high index of suspicion towards PTB among patients with persistent cough or some unexplained respiratory symptoms, however minor or unusual they may be. A regular chest radiography should be part of patient examination. To have a clear, consistent and accurate communication of TB-related findings by radiologists to clinicians, standard radiographic reporting templates should be implemented in hospitals.

3. Combine Clinical, Radiologic, and Microbiologic Testing into one Protocol.

TB diagnosis must be conducted in accordance with an organized algorithm, which is a complex of clinical assessment and chest X-ray results and laboratory verification

(GeneXpert, sputum smear, or culture). This combined solution helps to reduce cases which are missed, false positives and make sure that the decisions of treatment are informed by evidence. There should be clear guidelines on what to do in the case of conflicting clinical and diagnostic results.

4. Provide Triage Risk Scoring Tools based on Symptom.

Health facilities ought to implement or come up with structured risk score system which categorizes patients with regard to severity, duration, demographic risk factors and history of exposure to risks. Then the high-risk patients can be given the priority on imaging and lab tests which enhances efficiency on high volume settings and timely diagnosis.

5. Enhance Knowledge of the Community and Promotion of Early Presentation.

Early symptom recognition (among middle aged and disproportionately among men) needs to be the focus of public health campaigns. Community education, education at workplace, and media messages should focus on the need to consult medical care in case of persistent cough and respiratory symptoms. Better social enlightenment can decrease the time of diagnosis and limit the spread.

6. Encourage Clinical Research and Inter-Hospital Data Exchange.

Radiographic patterns, the regional variations, and the effectiveness of the emerging diagnostic technologies should be confirmed by multicentre studies in various regions of the country. The creation of a national data-sharing platform will improve the process of

policymaking based on evidence and will provide a greater benefit to TB surveillance and the creation of best-practice guidelines

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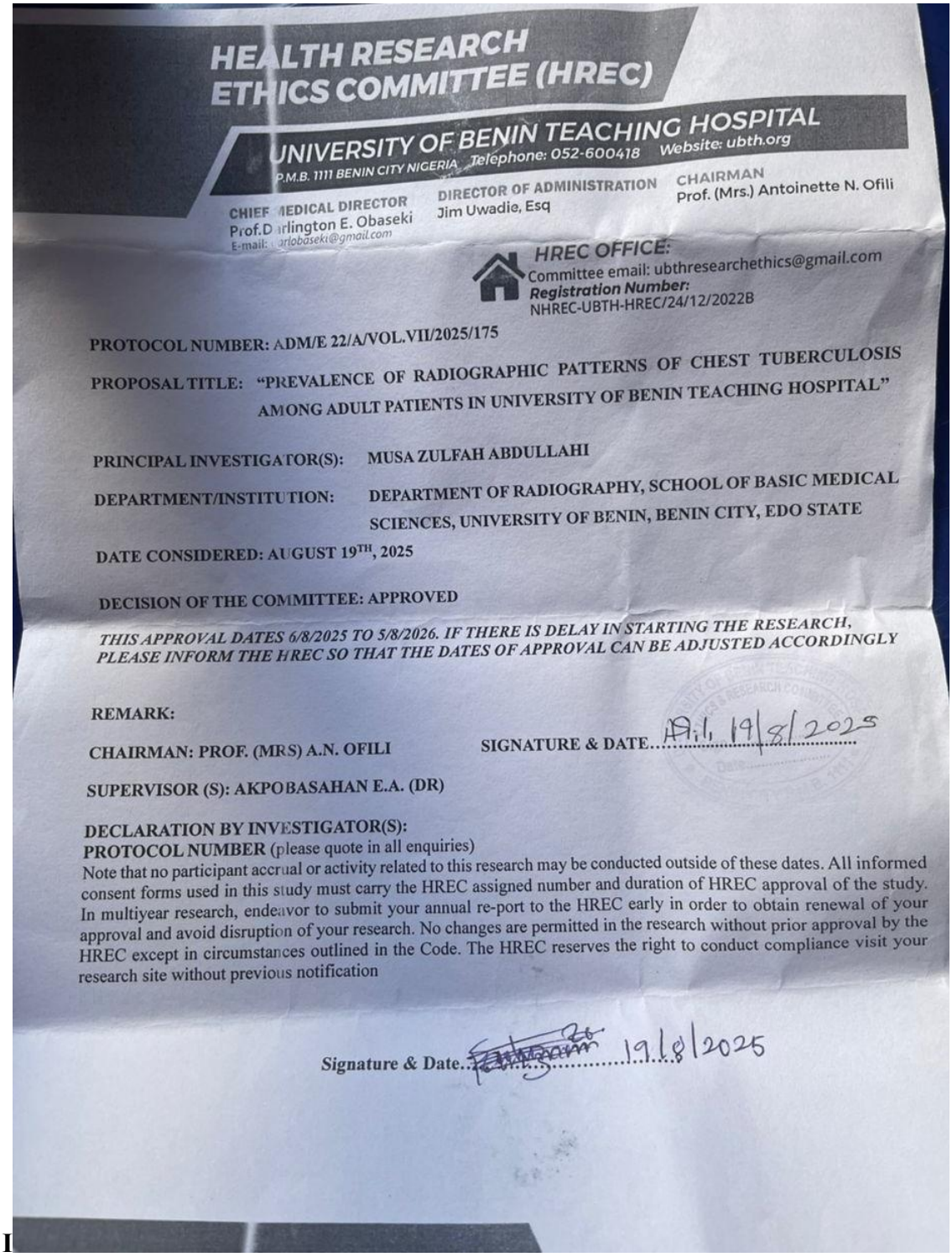
APPENDIX



HEALTH RESEARCH ETHICS COMMITTEE (HREC)

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Registration Number:
NHREC-UBTH-HREC/24/12/2022B

PROTOCOL NUMBER: ADM/E 22/A/VOL.VII/2025/175

PROPOSAL TITLE: "PREVALENCE OF RADIOGRAPHIC PATTERNS OF CHEST TUBERCULOSIS AMONG ADULT PATIENTS IN UNIVERSITY OF BENIN TEACHING HOSPITAL"

PRINCIPAL INVESTIGATOR(S): MUSA ZULFAH ABDULLAHI

DEPARTMENT/INSTITUTION: DEPARTMENT OF RADIOGRAPHY, SCHOOL OF BASIC MEDICAL SCIENCES, UNIVERSITY OF BENIN, BENIN CITY, EDO STATE

DATE CONSIDERED: AUGUST 19TH, 2025

DECISION OF THE COMMITTEE: APPROVED

THIS APPROVAL DATES 6/8/2025 TO 5/8/2026. IF THERE IS DELAY IN STARTING THE RESEARCH, PLEASE INFORM THE HREC SO THAT THE DATES OF APPROVAL CAN BE ADJUSTED ACCORDINGLY

REMARK:

CHAIRMAN: PROF. (MRS) A.N. OFILI SIGNATURE & DATE..... 19/8/2025

SUPERVISOR (S): AKPOBASAHAN E.A. (DR)

DECLARATION BY INVESTIGATOR(S):
PROTOCOL NUMBER (please quote in all enquiries)
Note that no participant accrual or activity related to this research may be conducted outside of these dates. All informed consent forms used in this study must carry the HREC assigned number and duration of HREC approval of the study. In multiyear research, endeavor to submit your annual re-port to the HREC early in order to obtain renewal of your approval and avoid disruption of your research. No changes are permitted in the research without prior approval by the HREC except in circumstances outlined in the Code. The HREC reserves the right to conduct compliance visit your research site without previous notification

Signature & Date..... 19/8/2025

I

APPENDIX II

Radiographic Data Collection Checklist

Title: Prevalence of Radiographic Patterns of Chest Tuberculosis Among Adult Patients in University of Benin Teaching Hospital (UBTH)

Objective: To identify and record the presence and frequency of various radiographic patterns of chest tuberculosis among adult patients.

S/N	Patient ID	Age	Sex	Date of Exam	Cavity present	Consolidation	Fibrosis	Pleural Effusion	Nodules	Miliary Pattern	Lobe affected	Other findings	Remark