MAGNITUDE OF POST-TUBERCULOSIS LUNG DISEASES AND ASSOCIATED FACTORS AMONG ADULT PATIENTS ADMITTED TO ASELLA REFERRAL AND TEACHING HOSPITAL, ETHIOPIA

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A RESEARCH THESIS

SUBMITTED TO THE DEPARTMENT OF INTERNAL MEDICINE

COLLEGE OF HEALTH SCIENCE, ARSI UNIVERSITY

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE SPECIALTY CERTIFICATE IN INTERNAL MEDICINE

JANUARY, 2026

ASELLA, ETHIOPIA

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Acronyms/Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
AOR	Adjusted Odds Ratio
ARTH	Asela Referal and Teaching Hospital
AU	Arsi University
CoHS	College Of Health Sciences
COPD	Chronic Obstructive Lung Disease
DM	Diabetes Mellitus
HDU	High Dependency Unit
HIV	Human Immunodeficiency Virus
MDR-TB	Multidrug Resistant Tuberculosis
OR	Odds Ratio
PTLD	Post-Tuberculosis Lung Disease
PTB	Pulmonary Tuberculosis
SD	Standard Deviation
TASH	Tikur Anbessa Specialized Hospital
TB	Tuberculosis
WHO	World Health Organization

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Abstract

Introduction: Globally an estimated 155 million tuberculosis (TB) survivors were alive in 2020, of whom approximately 27 million people could be identified and evaluated for 'post-tuberculosis lung disease' (PTLD). The post-TB lung disease is a chronic respiratory disease that persists even after successful completion of treatment for primary tuberculosis. Its global prevalence may reaches up to 59% among patients with history of TB treatment. However, data on its prevalence and associated factors is lacking in Ethiopia.

Methodology: An institution based cross-sectional study was conducted on patients who had a history of pulmonary tuberculosis treatment and were admitted to the medical ward over six years, from January 1, 2019, to December 31, 2024, to assess the magnitude and associated factors of post-tuberculosis lung disease. A total of 181 participants were selected by simple random sampling. Data were collected from logbooks and patient charts using checklists on koboToolbox and analyzed using SPSS version 31. Descriptive statistics were carried out, and categorical variables were reported as frequencies and percentages, whereas mean and median reporting was used for numerical variables. Crude odds ratios with their 95% confidence intervals (CI) were estimated in the bivariate logistic regression and those variables with a P value < 0.25 in the bivariate logistic regression were fitted into the multivariable logistic regression analysis. The strength of association was reported using adjusted odds ratios with 95% CI, and P value < 0.05 was declared as statistically significant.

Results: Among the 181 studied individuals, one-third (33.7%) had bacteriologically confirmed pulmonary tuberculosis. The overall prevalence of PTLD was 65.19% (95% CI: 58.25-72.13%). Age older than 60 years (AOR = 20.22, 95% CI: 3.64-112.21, p = <0.001), rural residence (AOR = 7.05, 95% CI: 1.8-27.1, p = 0.005), cigarette smoking (AOR = 182.98, 95% CI: 4.11-813.08, p = 0.007), history of PTB recurrence (AOR = 8.27; 95% CI: 1.40-48.68, p = 0.020), and poor compliance with previous PTB treatment (AOR = 8.62; 95% CI: 1.66-44.80, p = 0.010) were independently associated with developing PTLD. However, HIV seropositivity was associated with reduced risk of PTLD (AOR = 0.073, 95% CI: 0.017-0.310, p < 0.001).

Conclusion: This study revealed that PTLD is 65.19% among admitted patients and significantly associated with age 60 years or older, recurrent tuberculosis, poor adherence to prior tuberculosis treatment, cigarette smoking, and rural residence.

Keywords: Post-tuberculosis lung disease, PTLD prevalence, Asela Referral and Teaching Hospital, Ethiopia.

1. Introduction

1.1. Background

Tuberculosis (TB), caused by the bacillus Mycobacterium *tuberculosis*, commonly infects the lung, but any organ of the body can be affected (1). Even though it is a preventable and usually curable disease, TB remains a global and Africa's leading cause of death from a single infectious agent (1, 2). Globally more than 10 million people continue to fall ill with TB every year (1, 2). According to a World Health Organization (WHO) report of 2019, Ethiopia is among the 30 countries with a high TB, Human Immunodeficiency Virus (HIV) and Multi-Drug Resistant TB (MDR-TB) with an annual estimated TB incidence of 151 per 100,000 population (2).

An estimated 155 million people who survived TB were alive in 2020, of which approximately 27 million could be identified and evaluated for post-tuberculosis morbidity (3). Post-tuberculosis lung disease (PTLD) is a residual lung pathology, which persists even after successful completion of treatment for primary tuberculosis (4). The first international post-tuberculosis symposium defined PTLD as evidence of chronic respiratory abnormality, with or without symptoms, which is attributable at least in part to previous tuberculosis (5). These PTLDs include; chronic respiratory symptoms, acute respiratory exacerbations, chronic obstructive pulmonary disease (COPD), bronchiectasis, respiratory function impairment, fungal lung disease, tuberculosis recurrence or reinfection, limited exercise tolerance, chronic persistent pleural effusion, bronchopleural fistula, pleural malignancy, fibrothorax, and pleural thickening, among others (4–8).

The exact pathophysiology of PTLD is not clear (4). Damage of lung tissues during the time of active pulmonary TB, chronic inflammation due to persistent Mycobacterium *tuberculosis* infection, and the healing response of the tissues with resultant damage to the respiratory tract structures were described as the possible pathophysiologic mechanisms of PTLD (9, 10).

Post-tuberculosis lung disease is a heterogeneous condition, and there are no standardized tools for its diagnosis (4). However, chronic respiratory symptoms, spirometer changes, and imaging findings have been used in patients with a self-reported history of TB treatment to diagnose it (4, 5, 11).

1.2. Statement of the problem

Tuberculosis remains one of the major public health problems globally, particularly in low- and middle-income countries (1). While the world has achieved significant strides in TB prevention and treatment, the long-term PTB sequelae following its treatment have gained limited attention (4)(12). Post-tuberculosis lung disease is one such sequelae (5).

Even though the global prevalence of PTLD is not clearly known, abnormal lung function occurs in 33%-59% (13–15), persistent respiratory symptoms occur in 60.7% (16), and radiologic abnormality occurs in up to 64.6% of patients with a history of PTB treatment (17).

Despite its growing recognition globally, data on PTLD are scarce in Ethiopia (18). Only two published studies are found, and both were conducted on outpatient populations in tertiary hospitals: Tikur Anbessa Specialized Hospital (TASH) and Saint Paul Hospital (18,19). A study conducted at TASH found that among all patients having follow-up at the chest clinic, 18.5% were presented with chronic pulmonary complications related to TB (18).

Clinical observations at ARTH have also revealed a number of patients with a history of TB treatment who now suffer from chronic lung diseases. Some of these patients are dependent on home oxygen therapy, further highlighting the long-term sequelae of TB.

Although post-TB treatment is associated with such significant chronic sequelae and high prevalence all over the world and in Africa, data is limited about its prevalence and associated factors in Ethiopia in general and in this study area in particular. These lacks of evidence may pose challenges for timely diagnosis, management, and follow up of affected patients. Therefore, identifying the magnitude of PTLD and its associated factors is crucial for improving patient care and implementing appropriate interventions. This study assessed the magnitude of PTLD and its associated factors among patients with a history of pulmonary PTB admitted to ARTH.

1.3. Significance of the study

This study will help to understand the burden of PTLD within the population of the study setting. It will provide useful information for academicians, clinicians, public health professionals, researchers, and policymakers.

Academically it will contribute to the existing body of knowledge by providing data on the local burden of PTLD and its key risk factors, which is currently limited in Ethiopia. Clinicians and health care providers may use the finding from this study to improve post-TB management strategies and timely diagnosis. This may enhance patient care, improve quality of life for PTB survivors, and reduce long-term respiratory complications of PTB.

Understanding the burden of PTLD and its associated factors may also help policymakers and public health officials by improving their insight into the need for post-TB follow-up programs and rehabilitation services for PTB survivors. It may also help them to design the method to mitigate the risk factors for PTLD and develop national guidelines for PTLD screening and management.

Although most of the studies reported a high prevalence of PTLD, the results were inconsistent, and great variability had been observed. Moreover, the limited number of studies in Ethiopia and the nonexistence of data on its exact burden of PTLD and associated factors in this study area was a significant research gap. This study may also serves as basis for further research and guideline development.

2. Literature Review

2.1 Burden of the disease

The global prevalence of PTLD is not clearly known (4). However, a meta-analysis of 61 studies conducted from 1960 to 2022 found that 59.1% of patients with a history of TB treatment had abnormal spirometer results, with 17.8% showing obstructive pattern, 21.3% restrictive pattern, and 12.7% a mixed pattern (13).

According to another meta-analysis conducted on 32 studies from low- and middle-income countries, the pooled prevalence was 46.7% for abnormal lung function, 41.0% for persistent respiratory symptoms, and 64.6% for radiologic abnormalities (17).

A population-based cohort study conducted on immigrants to Canada showed that the incidence of airway disease was 42.5% among pulmonary TB patients compared with 11.6% among non-TB controls (20). This study showed a twofold higher risk of airway disease among immigrants diagnosed with respiratory TB compared with non-TB controls (20).

A prospective cohort study conducted at one of the TB Research Clinics in Mozambique from June 2014 to June 2016 enrolled 69 patients diagnosed with TB and followed them with spirometry for lung impairment (15). The proportion of patients with restrictive type of pulmonary function impairment was 78%, 68.9%, and 64.5% at weeks 8, 26, and 52, respectively (15). At the end of treatment for PTB, 35.5% had moderate or severe lung impairment (15).

A study done in Malawi on survivors of the first episode of PTB found out that 60.7% reported respiratory symptoms, 34.2% had abnormal spirometry, and 44.2% had bronchiectasis of more than one lobe, and 9.4% had more than one destroyed lobe on HRCT imaging (16). At 1 year, 30.7% reported respiratory symptoms, 19.3% and 14.1% had experienced declines in FEV1 or FVC of ≥100 ml, respectively, 16.3% had reported ≥1 acute respiratory event, and 12.2% had symptoms affecting their ability to work (16).

Despite Ethiopia being one of the high-burden TB countries, there is very limited study on PTLD. A study done at TASH more than ten years ago found that about 18.5% of all patients having follow-up at the chest clinic presented with chronic pulmonary complications of TB:

61.9% had clinically significant parenchymal scarring and fibrosis, 29.9% had bronchiectasis, 3.7% had aspergilloma, 3% had granuloma/calcification, 0.7% had pleural thickening, and 0.7% underwent pneumonectomy (18).

2.2. Factors associated with PTLD

2.2.1 Socio-demographic factors

Three studies found that PTLD diagnosed by abnormal spirometer, persistent symptoms, or abnormal radiology, was slightly higher in older adults (14, 17, 21). Another study revealed increased age as a strong risk of lung function impairment (22). The study done in TASH shows that most of the patients with PTLD were 25-44 years old (18). Sex of the patients was also associated with PTLD, as two studies showed males more affected than females (14, 15).

Results were inconsistent regarding the association between socioeconomic status and magnitude of PTLD. The meta-analysis study found that patients from low-income countries faced a greater risk of developing long-term lung complications following PTB treatment (13, 17). Persistent respiratory symptoms were more prevalent in rural settings compared to urban or mixed settings (68.8% vs. 39.1% vs. 27.2%, respectively, p=0.0035) (17). Respiratory symptoms prevalence were higher in Southeast Asia than in Africa (17). Post-tuberculosis lung disease varied significantly across WHO regions, being highest in the Western Pacific and Southeast Asian regions (57.7% and 57.5%, respectively), followed by the Americas (50.8%), then the African and Eastern Mediterranean regions (38.2% and 18.2%, respectively) (17).

Other socio-demographic factors such as occupation, marital status, and educational status are not well evaluated.

2.2.2 Behavioral risk factors

Inevitably, the high prevalence of other harmful respiratory exposures, including tobacco smoking, biomass exposure, and illicit drug use in many TB populations, increased the risk of post-tuberculosis complications (4, 17). However, the exact risk of biomass fuel exposure or household air pollution was not clear (17).

2.2.3 Clinical and Other Factors

MDR TB participants appeared to have a higher prevalence of PTLD, up to 90% (17, 23). The duration of symptoms before diagnosis of PTB and the fibrotic pattern were found to be independent risk factors for lung function impairment (24). Lower baseline spirometer at TB treatment completion and presence of respiratory symptoms at time of TB treatment completion were associated with impaired lung function and persistence at 1 year, respectively (16).

The prevalence of cough and shortness of breath among post-TB treatment participants, was higher among HIV- negative people compared with people living with HIV (45.9% vs. 29.5%, p=0.002 and 50.0% vs. 39.5%, p=0.038, respectively) (4,16). Assessment with chest CT scan also revealed higher airway and parenchymal lung damage in HIV-negative patients compared to HIV-positive (4,16). There is limited study that assessed the effect of diabetes mellitus (DM) on PTLD. However, one study reported DM as one of the comorbidities that lead to poor lung function after TB treatment (24).

Delay in diagnosis, extensive lung damage during initial disease, and untreated TB are usually associated with chronic impairment of lung function (23). Another systematic review also confirmed that a history of recurrent TB was one of the strongest predictors of PTLD (16).

One prospective study from Uganda found out that residual cavitation leads to chronic pulmonary aspergillosis, occurring in 26% in those with cavitation vs. 0.8% in those without cavitation (25).

2.2.4 Conceptual frame work

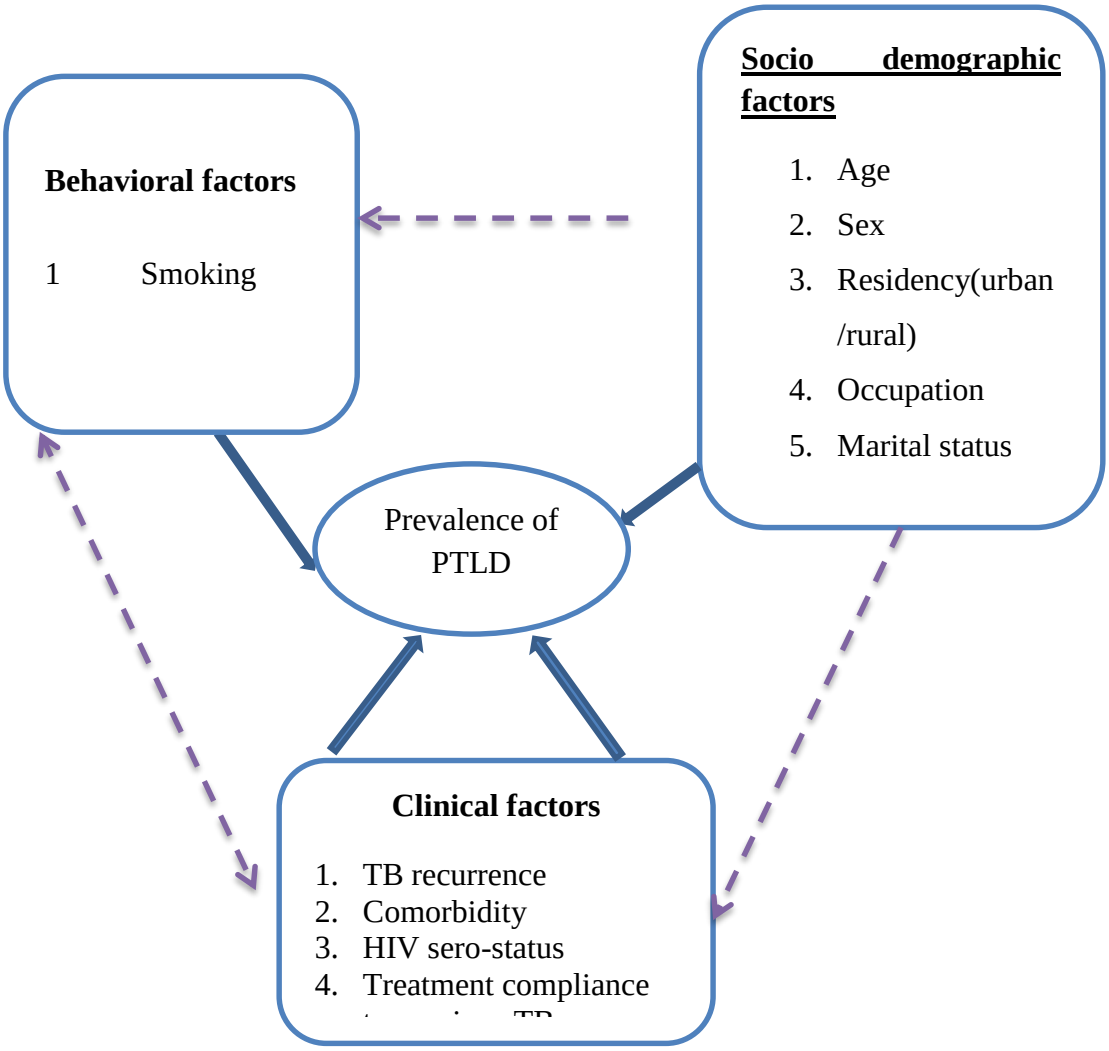

Figure 1: Conceptual frame work of PTLD, Asella, Ethiopia, April 2025 (14–17,22–24)

3. Objective

3.1. General objective

- To determine the magnitude of post-tuberculosis lung disease and identify associated factors among adult patients admitted to ARTH from January 1, 2019, to December 31, 2024.

3.2. Specific objectives

- To determine the magnitude of PTLD among adult patients admitted to ARTH from January 1, 2019, to December 31, 2024.
- To identify the factors associated with PTLD among adult patients admitted to ARTH from January 1, 2019, to December 31, 2024.

4. Method and Materials

4.1 Study area

This study was conducted at Asella Teaching Referral Hospital. Asella is a town in central Ethiopia, which is located in the Arsi Zone of the Oromia Region, about 175 kilometers Southeast of Addis Ababa. Since 1964, Asella Referral and Teaching Hospital was serving 3.5-4 million. The hospital has 321 beds with more than 6 departments (Internal Medicine, Surgery, Pediatrics, Gynecology and Obstetrics, Orthopedics, and Oncology). It also gives services such as Directly Observed Treatment, Short Course (DOTS) clinic for tuberculosis. The hospital is involved in training specialties in four major departments (Internal Medicine, Surgery, Pediatrics and Child Health, and Gynecology and Obstetrics). The hospital has modern investigation modalities like digital X-rays, portable X-ray, different types of ultrasound, echocardiography, computerized tomography scan, endoscopy, culture, and GeneXpert in addition to other laboratory services. The Department of Internal Medicine has a medical ward with 56 beds and one high dependence unit (HDU) with four beds.

4.2. Study design and period

A hospital based cross-sectional study was conducted on patients admitted to the medical ward over six years, from January 1,2019, to December 31, 2024, to determine the magnitude of PTLD and associated factors among patients admitted to ARTH. Data was collected from logbooks and patient charts from November 1 to December 5, 2025.

4.3. Source and Study Population

4.3.1 Source population

- All adult patients with a history of PTB treatment who were admitted to the medical ward of ARTH during the study period.

4.3.2 Study population

- All adult patients with a history of PTB treatment completion fulfilling eligibility criteria and admitted to the medical ward of ATRH during the study period.

4.4. Eligibility Criteria

4.4.1 Inclusion criteria

- Adults (>/= 18 years)
- Patients with a history of TB treatment completion.

4.4.2 Exclusion Criteria

- Patients diagnosed with bronchiectasis, COPD or ILD before first treatment for PTB
- Patients with active TB or on ant-TB treatment

4.5 Sample size and sampling procedures

4.5.1 Sample size determination

The sample size for the study was determined using a single population formula considering the following assumption. According to the study done in TASH, Ethiopia, the prevalence of PTLD was 18.5 %, taking 95% confidence interval with, margin of error of 5%. As this study hasn't assessed associated factors, it was difficult to calculate the sample size for individual associated factors (18).

$$n = \frac{Z_{\frac{\alpha}{2}}^{2} P (1 - P)}{d^{2}}$$

Where n represent sample size, $Z_{a/2}$ = Z-statistics, p = estimate of proportion, and d = margin of error. = $(1.96)^2$*0.185(1-0.1.85)/ $(0.05)^2$ =232

$$n = \frac{n_0}{\left(1 + \frac{n_0}{N}\right)}$$ Since study population (N) was <10,000, n =232/1+232/824, n = 181 for PTLD. Therefore, the final sample size was 181.

4.5.2 Sampling procedure

A simple random sampling technique was used to select charts from medical ward logbooks. Frist, a sampling frame was developed by listing the medical record numbers of all admitted patients with a history of PTB treatment and fulfilling the inclusion criteria during the study period. Each chart numbers was assigned a unique identification number. Using an online random number generator, 181 charts were selected from the list. For missing or incomplete charts, replacement was made by randomly selecting from the remaining pool of eligible charts.

4.6 Study variables

4.6.1 Dependent variable

- Post-tuberculosis lung diseases

4.6.2 Independent variables

- Socio-demographic and economic characteristics (age, sex, place of residence, marital status, occupation, educational level)
- Clinical factors (duration since treatment for TB was completed, treatment compliance, and history of TB recurrence)
- Comorbidities **(**HIV serostatus, bronchial asthma, DM, cardiac disease, hypertension).

4.7. Operational definitions

Post-tuberculosis lung disease (PTLD) is residual lung dysfunction and/or symptoms that persist or arise after successful completion of PTB treatment (5). It was assessed with a data extraction form that collects data from patients' chart involving symptoms, pulmonary function test, and/or chest imaging (chest X-ray, or chest computed tomography) (4, 5).

History of pulmonary TB treatment is a documented past PTB diagnosis either bacteriologically (sputum AFB, GeneXpert, or culture), radiologically (CXR, chest CT) or clinically with anti-TB treatment completion (1, 5).

Comorbid conditions are disorders occurring alongside PTLD, including HIV infection, DM, COPD, hypertension, cardiac disease, etc. (5, 26).

Pulmonary function test is a way of assessing lung capacity and function using measurements such as Forced Vital Capacity (FVC), Forced Expiratory Volume 1 (FEV1), and FVC to FEV1 ratio (FVC/FEV1) (4, 5).

4.8. Data collection procedures

Data extraction tools were developed in the English version, and then the data was collected by two trained medical interns from patient charts and supervised by the principal investigator. A format that contains study variables of interest was prepared and used on koboToolbox.

4.9. Data quality control

The data was collected by trained medical interns from patients' charts documented by the clinician. The principal investigator trained and coordinated the process of data collection. The collected data was checked for its completeness every day and any identified gap was corrected immediately.

4.10. Data processing and analysis

Data was entered and analyzed by SPSS version 31. Descriptive statistics were carried out, and categorical variables were reported as frequencies and percentages, whereas median and mean were used for continuous variables. Results were presented using tables, frequencies, and percentages. Binary logistic regression analysis was applied to identify factors associated with PTLD. Those variables with a P value < 0.25 in the bivariate logistic regression were fitted into the multivariable logistic regression analysis. For all variables, before putting them into multivariable logistic regression analysis, multicollinearity was assessed. All variance inflation factor (VIF) values were below 5 and there was no condition index that exceeded 30, indicating the absence of multicollinearity among independent variables. The strength of association was presented using adjusted odds ratio (AOR) with 95% CI, and a P value < 0.05 was declared as statistically significant.

4.11. Ethical considerations

Ethical clearance was obtained from Arsi University, College of Health Sciences, and the Ethical Research Committee (ERC). Then, an official letter was delivered to the data manager, and after getting permission, the selected patient's charts were used for the study. Confidentiality of data

collected was kept, and names of the patients were not included during data collection and information gained was not exposed to third parties.

4.12. Results Dissemination Plan

The final result of this study will be presented for a research defense at Arsi University, Asella Referral and Teaching Hospital, and disseminated to the internal medicine department, hospital administration, policy makers, the regional and federal health bureau for service improvements, and the research coordinating office for publication of the research work.

5. Results

5.1 Socio-demographic Characteristics of Study Population

The medical record numbers of a total of 854 patients who had a history of PTB treatment and were admitted to the medical ward of ARTH from January 1, 2019, to December 31, 2024, were checked. Among those, 181 charts were selected. Twenty patients had missing charts, for which other charts were reselected by a similar method.

Among 181 individuals, 102 (56.35%) were female, giving a female-to-male ratio of 1.29:1. The overall age of participants ranged from 18 to 85 years, with a median age of 46 years. Nearly half (49.72%) of the population were younger than the median age of 46 years, and those above 60 years constituted only 36 (19.89%) of the studied population. Regarding occupation, 71 (39.22%) were farmers, and 67 (37.01%) were housewives. In terms of place of residency, 148 (81.77%) were from rural parts of the country (Table 1).

Table 2: Socio demographic characteristics of study population, selected adult patients who had history of pulmonary tuberculosis treatment and admitted to ARTH medical ward from January 1, 2019 to December 31, 2024

Characteristics	Categories	Numbers N = 181	Percentage (%)
Age	</=60	145	80.11
	>60	36	19.89
Sex	Female	102	56.35
	Male	79	43.65
Occupation	Farmer	71	39.22
	House wife	67	37.01
	Gov't/private employee	10	5.52
	Others*	33	18.23
Residency	Urban	33	18.23
	Rural	148	81.77

*Others – student, daily laborers, unemployed, retired

5.2 Clinical Characteristics of the Study Population

Among the study population, the diagnosis of PTB was made bacteriologically (either with GeneXpert or AFB) in one-third (33.70%), by imaging and clinically in 39.22%, and unknown for 27.07% of the patients. In regard to the treatment compliance to prior TB treatment, 143 (79.01%) were adherent to their treatment, while the treatment compliance was poor for 7.71%,

and unknown for 13.28%. Nineteen (10.5%) of the patients had a recurrence of PTB at least once. Nineteen (10.50%) of the patients had a recurrence of PTB at least once. The duration since the patient completed their last PTB treatment to admission to the hospital ranged from 1 year to 35 years, with a mean of 9 years and a median of 7 years.

Among 49 (27.07%) patients who had at least one comorbidity, HIV was seen in 25 (13.81%) of the study population. Other comorbidities were hypertension 7 (3.87%), diabetes mellitus 8 (4.42%), bronchial asthma 6 (3.31%), and heart failure 6 (3.31%). Only 9 (4.97%) of patients were found to be cigarette smokers with a mean of 12 pack-years of cigarette smoking.

The diagnoses of admission were corpulomonale 59 (32.60%), pneumonia 20 (11.0%), bronchiectasis 27 (14.92%), left-sided heart failure 17 (9.39%), sepsis 8 (4.42%), and others (Table 3).

Table 4: Clinical characteristics of study population, selected adult patients who had history of pulmonary tuberculosis treatment and admitted to ARTH medical ward from January 1, 2019 to December 31, 2024

Variables	Categories	Number	(%)
Mode of PTB diagnosis	Clinical	42	23.20
	Bacteriologically confirmed	61	33.70
	Imaging	29	16.02
	Unknown	49	27.07
History of PTB recurrence		19	10.5
Number of recurrence	None	162	89.50
	Once	1	0.55
	Twice	11	6.08
	Thrice	7	3.87
Duration since last TB treatment	</=5 years	75	41.44
	> 5 years	106	58.56
Any Comorbidities during the previous PTB		49	27.07
Comorbidities	HIV	25	13.81
	DM	8	4.42
	Hypertension	7	3.87
	Heart failure	6	3.31
	Bronchial asthma	6	3.31

Table 2 continued …			
Admission diagnosis	Corpumonale	59	32.60
	Pneumonia	20	11.05
	Bronchiectasis	27	14.92
	Left side HF	17	9.39
	Sepsis	8	4.42
	Other*	50	27.62

**Others – pyelonephritis, upper gastrointestinal bleeding, diabetic ketoacidosis, acute exacerbation of bronchial asthma*

Note: DM diabetes mellitus, HF heart failure, HIV human immunodeficiency virus, PTB pulmonary tuberculosis

5.3 Magnitude of Post-TB Lung Disease among Study Population

In this study the magnitude of PTLD among admitted patients with a history of PTB treatment was assessed using persistent respiratory symptoms, chest imaging, and/or pulmonary function test. Chest imaging with either chest X-ray and/or chest CT scan was available for 149 (82.32%) patients, but only 3 patients had PFT documented.

This study found persistence of at least one respiratory symptom after completion of PTB treatment in 107 (59.12%) patients. The common symptoms were cough 90 (49.72%), easy fatigability 76 (41.99%), and shortness of breath 72 (39.78%). Among 149 patients who had chest imaging, 106 (71.14%) had evidence of PTLD. The chest imaging findings were secondary evidence of pulmonary hypertension 68 (45.64%), pulmonary scarring/fibrosis 60 (40.27%), and bronchiectasis 34 (22.82%). The composite prevalence of PTLD as assessed using persistent pulmonary symptoms, abnormal PFT, and/or chest imaging was 65.19% (Figure 2).

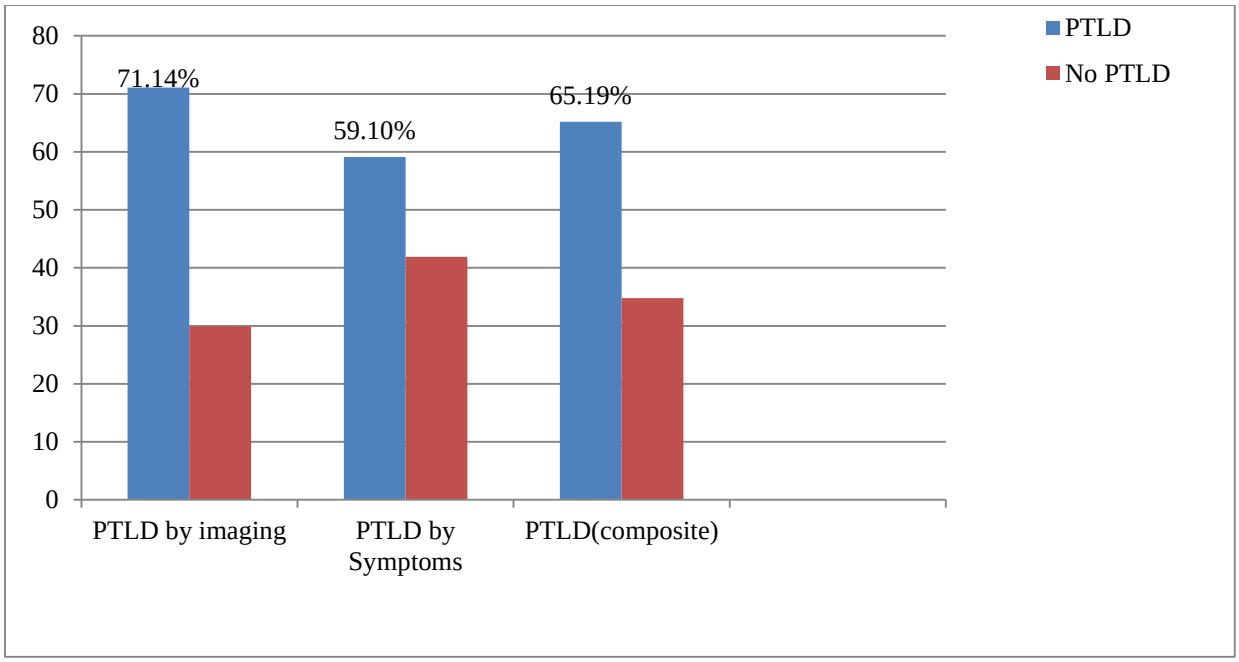

Figure 2: Proportion of PTLD among selected adult patients who had a history of pulmonary tuberculosis treatment and were admitted to the medical ward of ARTH from January 1, 2019, to December 31, 2024**.**

5.4 Factors Associated with Post-TB Lung Disease among the Study Population

In this study, older age (>60 years), rural residency, cigarette smoking, history of recurrent PTB, poor adherence to prior PTB treatment, and HIV serostatus were found to be independently associated with PTLD.

Adults who were 60 years or older were approximately 20 times more likely to develop PTLD than adults who were younger than 60 years (AOR = 20.22, 95% CI: 3.64-112.21, p = <0.001). Post-tuberculosis lung disease was more prevalent in rural residents compared to urban residents; patients from rural settings were seven times more likely to develop PTLD than those from urban (AOR = 7.05, 95% CI: 1.66-44.80, p = 0.005).

A current or past history of cigarette smoking was also found to markedly increase the development of PTLD (AOR = 182.98, 95% CI: 4.11-813.08, p = 0.007). In contrast, patients with HIV infection were found to have significantly reduced odds of PTLD (AOR = 0.073, 95% CI: 0.017-0.310, p < 0.001).

A history of PTB recurrences was another factor that showed a significant positive association with PTLD. It revealed increased odds of developing PTLD by approximately eightfold (AOR = 8.27; 95% CI: 1.40-48.68, p = 0.020). Treatment compliance during previous TB treatment was also significantly associated with PTLD, as patients who had poor adherence showed 8.62 times higher odds of developing PTLD compared with those who had good treatment compliance (AOR = 8.62; 95% CI: 1.66-44.80, p = 0.010) (Table 5).

Table 6: Factors associated with PTLD among selected adult patients who had a history of pulmonary tuberculosis treatment and were admitted to the medical ward of ARTH from January 1, 2019, to December 31, 2024.

Variables	Had PTLD		COR (95% CI)	p-value	AOR (95% CI)	p-value
	Yes	No				
Age in years						
<60	84	61	1		1	
=/>60	34	2	12.35(2.86-53.36)	<0.001	20.2(3.6-112.2)	<.001
Sex						
Female	74	28	1		1	
Male	35	44	0.476(0.256-.886)	0.019	.276 (.062-1.232)	0.092
Duration since last TB treatment						
</=5 years	44	31	0.614(.331-1.140)	0.122	0.823(.336-2.016)	0.671
> 5 years	74	32	1		1	
Cigarette smoking history						
No	110	62	1		1	
Yes	8	1	4.51(.55-36.90)	0.160	182.3(4.1-813.1)	.007
Residence						
Urban	12	21	1		1	
Rural	106	42	4.417(1.99-9.77)	<0.001	7.0(1.8-27.1)	.005
HIV sero-status						
Positive	6	19	0.124(0.046-0.33)	<0.001	0.07(0.017-0.31)	<.001
Negative	112	44	1		1	
History of PTB recurrence						
No	102	60	1		1	
Yes	16	3	3.137(0.88-11.21)	0.079	8.27(1.40-48.68)	.020
Treatment compliance to previous TB treatment						
Yes	94	60	1		1	
No	24	3	5.106(1.47-17.70)	0.010	8.62(1.66-44.8)	.010
Heart failure						
Yes	2	4	.254(.045-1.429)	0.120	0.532(.064-4.422)	.559
No	116	59	1		1	

Note: COR crude odds ratio, AOR adjusted odds ratio, CI confidence interval

6. Discussion

In this cross-sectional study assessing magnitude and associated factors of PTLD among adults with a history of PTB treatment and admitted to medical wards over six years, 65.19% (95% CI: 58.25-72.13%) of patients had PTLD. This observed prevalence of PTLD is closely comparable to the result from a meta-analysis of 32 studies from low- and middle-income countries that reported 64.6% radiologic abnormalities following TB treatment (17). Similarly, the study from Malawi found 60.7% of PTB survivors had persistent respiratory symptoms, which is comparable to the symptomatic burden observed in our study (16). This consistently high burden of PTLD in middle- and low-income countries may reflect the additive impact of delayed presentation and delayed diagnosis of PTB, poor health-seeking behavior, incomplete healing of lung parenchyma after initial infection, and limited access to structured follow-up.

However, several studies reported a lower prevalence compared to our findings. For instance, a population-based cohort study conducted on immigrants to British Columbia, Canada showed that the incidence of air way disease was 42.5% among post pulmonary TB patients (20). Another prospective study from Mozambique also showed lower prevalence of 35.5% of lung impairment (15). The study from Tikur Anbessa Specialized Hospital reported 18.5% chronic pulmonary complications among follow-up patients also much lower than our estimate(18). These lower prevalences compared to our finding may have occurred because our study involved only hospitalized patients, and variations in diagnostic assessments may have contributed as well.

Consistent with a study from Taiwan, our study found statistically significant increased odds of PTLD in older adults (22). The reason behind this association could be due to reduced pulmonary physiologic reserve and a higher likelihood of comorbidities in older individuals. Our finding of a positive association between rural residence and higher PTLD aligns with results from meta-analysis(17). This expected higher prevalence may have happened as a result of limited health access in rural settings, exposure to biomass smoke, and lower socioeconomic status, which could be a barrier to healing from PTB disease.

In line with other studies, we found a higher prevalence of PTLD among smokers compared to never-smokers (4,17). This effects of tobacco smoking on lung tissue occurred may be due to potentiating airway inflammation and accelerating parenchymal destruction, which may augment TB related lung injury.

The statistically significant association between a history of PTB recurrences and poor treatment compliance is also consistent with other studies (14–16, 24). Recurrence of PTB significantly increases the likelihood of subsequent PTLD, as it leads to repeated inflammatory episodes, recurrent cavitation, and parenchymal destruction. Similarly, poor adherence increases the risk of persistent infection and may lead to greater lung damage.

Interestingly, we found a lower risk of PTLD among people living with HIV (PLHIV) compared to HIV sero-negative patients, which is consistent with meta-analyses and studies (4, 6). Probably this occurred as PLHIV usually have less cavitation due to weakened immunity, which leads to less parenchymal destruction during initial PTB infection.

7. Limitation and Strength of the Study

This study is not without limitations. First, it is a cross-sectional study and subject to missing and incomplete charts. However, we tried and replaced missing charts by reselection. Second, almost all of our patients have no PFT measured. This could affect the true prevalence of PTLD, as some patients may have lung function impairment even before developing pulmonary symptoms or imaging abnormalities. As this is the reality in many hospitals in our setting, we used imaging and persistent respiratory symptoms to measure PTLD. Thirdly, this is a single-centered, hospital based study and may not represent the true prevalence of PTLD in the general population.

Besides these challenges, the strength of this study is that it addresses a rarely studied topic in general and in Ethiopia in particular. It also assessed the inpatient population using data over a longer duration, six years, of hospital admission.

8. Conclusion

This cross-sectional hospital based study revealed a higher prevalence of PTLD (65.19%) among admitted patients with a history of PTB. Higher risks of PTLD were significantly associated with older age, rural residency, cigarette smoking, recurrent PTB, and poor adherence to prior TB treatment. However, HIV seropositivity was associated with reduced incidence of PTLD.

9. Recommendation

The higher prevalence of PTLD in this study highlights that, patients with a history of PTB shall have long-term surveillance to detect and treat PTLD. Therefore, the Ministry of Health and the regional TB program should establish a long-term clinical surveillance system for individuals previously treated for PTB.

Based on our finding of significantly associated factors to developing PTLD, we recommend that health facilities should institutionalize screening hospitalized patients with a history of TB treatment for post-tuberculosis complication with special attention to older adults, rural dwellers, cigarette smokers, and those with recurrent PTB. Clinicians and TB clinic staff should strengthen adherence counseling during active PTB treatment to minimize poor compliance, which we found significantly associated with PTLD.

Researchers should do more studies that explore causal pathways between the associated factors and PTLD.

10. References

1. World Health Organization, World Health Organization Staff. Global tuberculosis report 2013. World health organization; 2013.

2. Ministry of Health-Ethiopia. Guidelines for Clinical and Programmatic Management of TB , TB / HIV , DR-TB and Leprosy in Ethiopia. Vol. 7, Addis Ababa, Ethiopia. 2020. 9–15 p.

3. Dodd PJ, Yuen CM, Jayasooriya SM, van der Zalm MM, Seddon JA. Quantifying the global number of tuberculosis survivors: a modelling study. The Lancet Infectious Diseases. 2021 Jul 1;21(7):984-92.

4. Meghji J., Brown J. and ML. Post-Tuberculosis Infections and Chronic Lung Disease. In: Essential Tuberculosis. 1st ed. Switzerland; 2021. p. 283–91.

5. Allwood BW, Van Der Zalm MM, Amaral AF, Byrne A, Datta S, Egere U, Evans CA, Evans D, Gray DM, Hoddinott G, Ivanova O. Post-tuberculosis lung health: perspectives from the First International Symposium. The International Journal of Tuberculosis and Lung Disease. 2020 Aug 1;24(8):820-8.

6. Choi JA, Hong KT, Oh YW, Chung MH, Seol HY, Kang EY. CT manifestations of late sequelae in patients with tuberculous pleuritis. American Journal of Roentgenology. 2001 Feb;176(2):441-5.

7. Alami B, Addou O, Jaffal M, Lamrani MA, Boubbou M, Kamaoui I, Maaroufi M, Sqalli NH, Tizniti S. Radiological spectrum of Thoracic Sequelae and Complications of Tuberculosis. European Congress of Radiology-ESTI 2014.

8. Kim HY, Song KS, Goo JM, Lee JS, Lee KS, Lim TH. Thoracic sequelae and complications of tuberculosis. Radiographics. 2001 Jul;21(4):839-58.

9. Ravimohan S, Kornfeld H, Weissman D, Bisson GP. Tuberculosis and lung damage: from epidemiology to pathophysiology. European respiratory review. 2018 Feb 28;27(147).

10. Stek C, Allwood B, Walker NF, Wilkinson RJ, Lynen L, Meintjes G. The immune mechanisms of lung parenchymal damage in tuberculosis and the role of host-directed

therapy. Frontiers in Microbiology. 2018 Oct 30;9:2603.

11. Amaral AF, Coton S, Kato B, Tan WC, Studnicka M, Janson C, Gislason T, Mannino D, Bateman ED, Buist S, Burney PG. Tuberculosis associates with both airflow obstruction and low lung function: BOLD results. European Respiratory Journal. 2015 Sep 30;46(4):1104-12.

12. Menzies NA, Quaife M, Allwood BW, Byrne AL, Coussens AK, Harries AD, Marx FM, Meghji J, Pedrazzoli D, Salomon JA, Sweeney S. Lifetime burden of disease due to incident tuberculosis: a global reappraisal including post-tuberculosis sequelae. The Lancet Global Health. 2021 Dec 1;9(12):e1679-87.

13. Taylor J, Bastos ML, Lachapelle-Chisholm S, Mayo NE, Johnston J, Menzies D. Residual respiratory disability after successful treatment of pulmonary tuberculosis: a systematic review and meta-analysis. EClinicalMedicine. 2023 May 1;59.

14. Jing C, Zheng H, Wang X, Wang Y, Zhao Y, Liu S, Zhao J, Du Q. Disease burden of tuberculosis and post-tuberculosis in Inner Mongolia, China, 2016–2018—based on the disease burden of post-TB caused by COPD. BMC Infectious Diseases. 2023 Jun 14;23(1):406.

15. Khosa C, Bhatt N, Massango I, Azam K, Saathoff E, Bakuli A, Riess F, Ivanova O, Hoelscher M, Rachow A. Development of chronic lung impairment in Mozambican TB patients and associated risks. BMC Pulmonary Medicine. 2020 May 7;20(1):127.

16. Meghji J, Lesosky M, Joekes E, Banda P, Rylance J, Gordon S, Jacob J, Zonderland H, MacPherson P, Corbett EL, Mortimer K. Patient outcomes associated with post-tuberculosis lung damage in Malawi: a prospective cohort study. Thorax. 2020 Mar 1;75(3):269-78.

17. Maleche-Obimbo E, Odhiambo MA, Njeri L, Mburu M, Jaoko W, Were F, Graham SM. Magnitude and factors associated with post-tuberculosis lung disease in low-and middle-income countries: a systematic review and meta-analysis. PLOS Global Public Health. 2022 Dec 20;2(12):e0000805.

18. Binegdie AB, Parekh M, Tolessa TB, Ahmed FO, Sherman CB, Ethel JC, Schluger NW. Sequelae of patients treated for pulmonary tuberculosis in chest clinic, Tikur Anbessa Specialized Hospital (TASH), Addis Ababa, Ethiopia. Ethiop Med J. 2015 Dec 21;53(4):167-71.

19. Ashamo AY, Tsehay H. Characteristics and Pattern of Post-tuberculosis Lung Disease at Saint Paul Hospital Chest Clinic, Addis Ababa, Ethiopia. InB106. TUBERCULOSIS BREAKTHROUGHS 2024 May (pp. A4875-A4875). American Thoracic Society.

20. Basham CA, Karim ME, Cook VJ, Patrick DM, Johnston JC. Post-tuberculosis airway disease: a population-based cohort study of people immigrating to British Columbia, Canada, 1985–2015. EClinicalMedicine. 2021 Mar 1;33.

21. Muñoz-Sellart M, Cuevas LE, Tumato M, Merid Y, Yassin MA. Factors associated with poor tuberculosis treatment outcome in the Southern Region of Ethiopia. The International Journal of Tuberculosis and Lung Disease. 2010 Aug 1;14(8):973-9.

22. Chung KP, Chen JY, Lee CH, Wu HD, Wang JY, Lee LN, Yu CJ, Yang PC, TAMI Group. Trends and predictors of changes in pulmonary function after treatment for pulmonary tuberculosis. Clinics. 2011 Jan 1;66(4):549-56.

23. Silva DR, Freitas AA, Guimarães AR, D'Ambrosio L, Centis R, Muñoz-Torrico M, Visca D, Migliori GB. Post-tuberculosis lung disease: a comparison of Brazilian, Italian, and Mexican cohorts. Jornal Brasileiro de Pneumologia. 2022 May 13;48(02):e20210515.

24. Ngahane BH, Nouyep J, Motto MN, Njankouo YM, Wandji A, Endale M, Ze EA. Post-tuberculous lung function impairment in a tuberculosis reference clinic in Cameroon. Respiratory medicine. 2016 May 1;114:67-71.

25. Page ID, Byanyima R, Hosmane S, Onyachi N, Opira C, Richardson M, Sawyer R, Sharman A, Denning DW. Chronic pulmonary aspergillosis commonly complicates treated pulmonary tuberculosis with residual cavitation. European Respiratory Journal. 2019 Mar 18;53(3).

26. Allwood BW, Nightingale R, Agbota G, Auld S, Bisson GP, Byrne A, Dunn R, Evans D,

Hoddinott G, Günther G, Islam Z. Perspectives from the 2nd International Post-Tuberculosis Symposium: mobilising advocacy and research for improved outcomes. IJTLD open. 2024 Mar 1;1(3):111-23.

11.Annexes

Annex I: Data extraction form

Data Extraction tool: Magnitude of Post-tuberculosis Lung Disease, Clinical Pattern and Associated Factors among admitted patients at AU, ARTH

Questionnaire ID: _____

Date of Admission: _____

Part 1: Socio demographic and economic factors

No	Question	Response	Skip to
1.	Age	…… years	
2.	Sex	1. Female 2. Male	
3.	Occupation	1. Farmer 2. House wife 3. Unemployed 4. Daily laborer 5. Merchant 6. Government employee 7. Private/NGO 8. Other, specify…….	
4.	Educational status	1. No formal education 2. Primary education	

		3. Secondary education 4. College and above	
5.	Marital status	1. unmarried 2. Married 3. Divorced 4. Widowed	
6.	Residence	1. Urban 2. Rural	

Part 2: Medical History

No	Question	Response	Skip to
7.	How was the diagnosis of PTB made?	1. AFB 2. Genexpert 3. Imaging(CXR, CT) 4. Clinical 5. Not documented	
8.	Treatment compliance to previous PTB	1. Yes 2. No 3. Not recorded	
9.	History of TB recurrence	1. Yes 2. No 3. Not recorded	
10	If yes how many times	--------	

11	Duration since PTB treatment completion.	_____	
12.	Comorbid conditions (select all that apply)	1. HIV 2. DM 3. Hypertension 4. COPD 5. B. Asthma 6. None 7. Other, specify _____	
13.	Smoking history	1. Yes 2. No	If no skip to question number 14.
14.	If yes, how much pack year	_____	

Part 3: Current Clinical Symptoms and Patterns

No	**Question**	**Response**	**Skip to**
15.	Diagnosis at admission	_____	
16.	Post TB treatment symptoms (select all that apply)	1. Chronic cough 2. Hemoptysis 3. Shortness of breath 4. Chest pain 5. Fatigue 6. Weight loss 7. None 8. Others _____	

17.	Pulmonary function test done?	1. Yes 2. No 3. Not documented	If no skip to question No. 19
18.	If yes	1. Normal 2. Obstructive 3. Restrictive 4. Mixed	
19.	Current chest imaging available?	1. Yes 2. No	If no skip to question No. 22
20.	If yes to Q 19, what chest imaging was done?	1. Chest X-ray 2. Chest ultrasound 3. Chest CT	
21.	If yes to Q 19, What was chest the imaging result?	1. Lung parenchymal scaring/fibrosis 2. Bronchiectasis 3. Pulmonary nodules 4. Chronic pulmonary Aspergillossis 5. Bullae 6. Emphysematous change 7. Normal 8. Others _____	

22. Any additional notes relevant to Post TB lung disease_____

_____

_____

Date of data collection: _____

Data collector's name: _____ sign_____

Annex II: Investigator Assurance Form

I, the undersigned resident, agree to accept all responsibilities for the scientific, ethical, and technical conduct of the research project and for the provision of required progress reports as per the terms and conditions of the Research and Publication Committee and/or Department of Internal Medicine, of Arsi University.

I also assert that this research thesis is my original work, has not been presented for a degree at any other university, and that all sources of materials used for this research have been accordingly acknowledged.

Name of Resident _____

Signature_____

Date_____

Approval of Advisors

1. Name _____

   Signature_____

   Date _____

2. Name _____

   Signature_____

   Date _____

Department Head

Name _____

Signature _____

Date _____