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PREVALENCE OF DRUG-RESISTANT TUBERCULOSIS AND ITS ASSOCIATED FACTORS IN GALKAYO GENERAL HOSPITAL, PUNTLAND SOMALIA: A CROSS-SECTIONAL STUDY.

MSC THESIS

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DECEMBER, 2025

HARAR, ETHIOPIA

Prevalence of Drug-Resistant Tuberculosis and its Associated Factors in Galkayo TB Hospital, Puntland Somalia: A Cross-Sectional Study

A Thesis Submitted to the School of Pharmacy,

School of Graduate Studies

Haramaya University

For the partial fulfillment of a Master of Science Degree in Clinical Pharmacy

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December, 2025

Haramaya University, Harar

APPROVAL SHEET

SCHOOL OF GRADUATE STUDIES

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BIOGRAPHICAL SKETCH

The author, Hawo Mohamud Mohamed, was born in Hasbahalle, Puntland State, Somalia, on January 5, 1997. She attended Hasbahalle Primary and Secondary School in Eyl, Somalia. She graduated from Puntland State University with a BSc in Pharmacy in 2021. She was employed at Arafat Hospital, and later joined a study program leading to a Master of Science degree in Clinical Pharmacy at Haramaya University.

ACKNOWLEDGEMENT

First of all, I would like to express my gratitude to Haramaya University's College of Health and Medical Sciences and School Pharmacy for setting up a course of study for my MSc in clinical pharmacy. In addition, I would like to express my deepest thanks to my advisors: Mr. Kirubel Minsamo, Dr. Abraham Nigussie and Mr. Bisrat Hagos for their guidance and professional advice.

I would also like to thank Galkayo General Hospital for giving me necessary information to conduct this research. Finally, I would like to thank my parents and my brothers and sister.

ABBREVIATION AND ACRONYM

AOR	Adjusted Odds Ratio
BMI	Body Mass Index
CI	Confidence Intervals
COR	Crude Odds Ratio
DM	Diabetes Mellitus
DOT	Directly Observed Treatment
DR-TB	Drug-resistant Tuberculosis
DST	Drug Susceptibility Test
HIV	Human Immunodeficiency Virus
INH	Isoniazid
LMICs	Low- and Middle-Income Countries
MDR-TB	Multidrug-Resistant Tuberculosis
MTB	Mycobacterium Tuberculosis
Pre-XDT-TB	Pre-Extensively Drug-Resistant Tuberculosis
RR	Rifampicin Resistant
RR-TB	Rifampicin-Resistant Tuberculosis
SSA	Sub-Saharan Africa
TB	Tuberculosis
VIF	Variance Inflation Factor
WHO	World Health Organization
XDR-TB	Extensively Drug-Resistant Tuberculosis

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ABSTRACT

Background: Tuberculosis remains one of the most persistent and deadly infectious diseases worldwide, despite decades of global public health efforts aimed at its control and eradication. While the disease itself is both preventable and treatable, the emergence and spread of drug-resistant forms of tuberculosis have complicated these efforts and raise global concern.

Objective: To determine the prevalence of drug-resistant tuberculosis and its associated factors among tuberculosis patients in Galkayo General Hospital, Puntland Somalia, 2020-2024.

Methodology: A facility-based retrospective cross-sectional study was carried out at Galkayo General Hospital in Puntland, Somalia, from January 2020 to December 2024. Data were collected through a structured review of patient medical records using a standardized abstraction tool. A total of 422 records were randomly selected. The data were coded, entered into Epi Info, and exported to STATA version 17 for analysis. Descriptive statistics were summarized with tables, graphs, and charts. Factors associated with drug-resistant tuberculosis were examined using bivariable and multivariable logistic regression, with statistical significance determined at 95% confidence intervals and a p-value < 0.05.

Results: From a total of 410 patients included in this study, the prevalence of drug-resistant tuberculosis in the study population was 9.02% (95% CI: 6.23%–11.81%), reflecting a notable burden. Multivariable logistic regression showed that patients with prior contact with a tuberculosis case (AOR = 2.43; 95% CI: 1.13–5.21), those with a previous history of tuberculosis (AOR = 3.63; 95% CI: 1.72–7.67), and treatment failure cases (AOR = 9.03; 95% CI: 2.03–40.12) had statistically significant association with drug-resistant tuberculosis.

Conclusion: This study revealed the high burden of drug-resistant tuberculosis, identifying prior contact with tuberculosis patients, previous treatment, and treatment failure as major contributors. Reducing drug resistance requires early detection, strong treatment adherence, and integrated care. Key actions include better contact tracing, close monitoring of treatment outcomes, and linking tuberculosis and HIV services. Training healthcare workers and raising community awareness can further promote early health-seeking and strengthen efforts to control the disease.

Keywords: Drug-resistant tuberculosis; Multidrug-resistant tuberculosis; Puntland, Somalia.

1. INTRODUCTION

1.1. Background

Tuberculosis (TB) remains one of the most persistent and deadly infectious diseases worldwide, despite decades of global public health efforts aimed at its control and eradication. While the disease itself is both preventable and treatable, the emergence and spread of drug-resistant TB (DR-TB) have complicated these efforts and reignited global concern [Tobin and Tristram, 2024; Yang et al., 2024]. DR-TB, particularly multidrug- resistant TB (MDR-TB) and extensively drug-resistant TB (XDR-TB), poses a significant threat to the global health. The rise of DR-TB has created new challenges for diagnosis, treatment, and containment, highlighting an urgent need for comprehensive understanding and targeted interventions [Chowdhury et al., 2023; Koch et al., 2018; Stephanie et al., 2021].

MDR-TB and other forms of DR-TB develop when the bacteria become resistant to the medications used to treat the disease. This resistance can arise due to incomplete or inappropriate treatment, poor adherence, interrupted drug supply, or inadequate healthcare infrastructure [Liebenberg et al., 2022; Omoteso et al., 2025]. DR-TB is more difficult and expensive to treat, often requiring longer treatment durations with second-line drugs that may be less effective and cause more adverse effects. As a result, DR-TB represents both a clinical and public health threat, particularly in settings where health systems are already under strain [Tusho and Mokoboto-Zwane, 2025; Vanino et al., 2023].

The development of drug resistance in TB is influenced by a range of interrelated factors. These include socio-economic determinants such as poverty, overcrowding, and limited access to healthcare; environmental conditions that facilitate TB transmission; and health system shortcomings such as inconsistent drug supply, delayed diagnosis, and inadequate treatment monitoring [Mphothulo et al., 2025; Cannon et al., 2021].

The burden of DR-TB varies across countries and regions, with low- and middle-income countries (LMICs) disproportionately affected due to systemic healthcare limitations and socio-economic vulnerabilities. In Sub-Saharan Africa (SSA), where TB and human immunodeficiency virus (HIV) co-infections are common and healthcare access is often fragmented, DR-TB presents a growing concern. In such contexts, challenges related to early diagnosis, treatment continuity, and follow-up care further complicate control efforts [Akalu et al., 2023; Maraj et al., 2022; Liyew et al., 2025].

1.2. Statement of the problem

TB continues to pose a major threat to global health, ranking among the leading causes of death from infectious diseases. Although TB is both preventable and treatable, the increasing prevalence of DR-TB has emerged as a critical obstacle to TB elimination efforts [Suvvari, 2025; Farhat et al., 2024]. DR-TB, particularly MDR-TB, which is resistant to at least isoniazid (INH) and rifampicin, the two most effective first-line anti-TB drugs, is significantly harder and costlier to treat [Patel et al., 2024b; Shah and Shah, 2024].

According to the World Health Organization (WHO) 2024 Global TB Report, in 2023, there were an estimated 10.8 million new TB cases, slightly up from 10.7 million in 2022. The number of people developing MDR-TB or rifampicin-resistant TB (RR-TB) was estimated at 400,000, showing little change since 2020. In 2023, 3.2% of new TB cases and 16% of previously treated cases were DR-TB. TB caused about 1.25 million deaths globally that year [World Health Organization, 2024]. In 2023, only 175,650 of the estimated 400,000 MDR/RR-TB cases were enrolled in treatment [Ravikoti et al., 2025; Chen et al., 2025].

Beyond its health impact, TB imposes immense economic burdens. From 2020 to 2050, TB is projected to cause 31.8 million deaths globally, resulting in an estimated economic loss of US$17.5 trillion. In 2018 alone, 1.4 million TB-related deaths across 120 countries led to approximately US$580.1 billion in full-income losses, averaging US$407,821 per death. SSA bore the greatest share of this loss, estimated at US$200.8 billion [Idayat et al., 2025; Silva et al., 2021]. In 2023, TB-related diagnostic, treatment, and prevention services in LMICs cost approximately US$5.7 billion [World Health Organization, 2024].

DR-TB further amplifies these challenges due to its prolonged and complex treatment regimens. Patients often face substantial medical and non-medical expenses, including costs associated with adverse drug reactions, transport, accommodation, and nutritional support [Alotaibi et al., 2024; Aia et al., 2022]. According to a global systematic review and meta-analysis, MDR-TB patients incurred total treatment costs ranging from US$650 to US$8,266. The mean direct and indirect costs were estimated at US$1,936.25 and US$1,200.35, respectively, reflecting the high financial burden placed on affected individuals and households [Akalu et al., 2023].

At the regional level, in Africa, the burden of drug-resistant TB is disproportionately high due to weak health systems, limited diagnostics, frequent medicine shortages, and poor treatment monitoring. These challenges are more severe in countries affected by poverty and political

instability, where fragile infrastructures hinder early detection and treatment success. Stigma, low awareness, and delays in seeking care further contribute to the rise and spread of drug resistance [Mhazo et al., 2024; Ismail et al., 2018; Otchere et al., 2024].

Somalia is 30 countries ranks among with the highest multidrug-resistant tuberculosis (MDR-TB) burden Globally [World Health Organization, 2024]. Previous history of anti- tuberculosis medication treatment, ineffective TB control programs, illiteracy, poverty, co- infection with HIV, individuals with diabetes mellitus (DM), that have been identified as contributing to the development of MDR-TB. Additionally, the lack of well-funded and coordinated TB programs in Somalia has resulted in incomplete dosage and potential abuse of anti-TB medications for other conditions, which served as the foundation for the emergence of MDR-TB in the country. In Somalia ant TB resistance drugs is considered an emerging concern in the country [Mohamed et al., 2023]. Unfortunately, the results of the treatments have not been satisfactory, mostly because MDR-TB has developed, especially in the south-central region (Punt land), and infections have continued to spread [Karataş et al., 2024].

In Somalia, especially in areas like Galkayo, Puntland, DR-TB control is hampered by conflict, displacement, and under-resourced health services. Inadequate labs, limited trained staff, and irregular drug supplies make treatment difficult. Patients face long travel distances, high costs, and limited support. Stigma and poor health literacy also reduce treatment adherence. Despite growing concern, local data on DR-TB remains limited, constraining effective policy and intervention efforts [Karataş et al., 2024; Mohamed et al., 2023].

In light of these global, regional, and local challenges, there is an urgent need to generate context-specific evidence on the prevalence of DR-TB and its contributing factors. A better understanding of the scope and drivers of DR-TB in high-risk and under-researched settings is essential to inform targeted interventions, improve case detection and treatment outcomes, and support strategic planning in national and sub-national TB control programs.

1.3. Significance of the study

Given the growing threat and challenges posed by DR-TB, exploring its prevalence and underlying factors is highly important for several reasons. This study aims to examine the extent of DR-TB and the factors contributing to its occurrence, offering essential insights for Galkayo General Hospital to assess the quality and effectiveness of its tuberculosis management services.

The findings of this research could help pinpoint areas that require strengthening, leading to the development of improved treatment protocols, better resource distribution, and ultimately, enhanced patient care. In turn, such improvements may contribute to reducing the financial strain associated with lengthy and complex treatment regimens. Additionally, a better understanding of DR-TB patterns can equip healthcare providers with important prognostic information, helping them anticipate patient needs and complications more effectively.

Beyond the immediate clinical and operational benefits, this study has the potential to serve as a reference for future research efforts in the region. It will help fill critical knowledge gaps and provide locally relevant data that can be used to inform similar studies within Somalia and internationally, supporting the broader scientific and public health response to DR-TB.

1.4. Objectives

1.4.1. General objective

- To determine the prevalence of drug-resistant tuberculosis and its associated factors among tuberculosis patients in Galkayo TB Hospital, Puntland Somalia, 2020-2024.

1.4.2. Specific objectives

- To determine the prevalence o f drug-resistant tuberculosis among tuberculosis patients in Galkayo TB Hospital, Puntland Somalia.
- To identify factor associated with drug resistance tuberculosis among tuberculosis patients in Galkayo General Hospital, Puntland Somalia.

2. LITERATURE REVIEW

In this section, the literatures that is relevant to prevalence of drug-resistant TB and its associated factors were systematically searched using the following databases: Google scholar, Science Direct, and Pub Med. The articles were searched using the following search terms: drug-resistant tuberculosis; multidrug-resistant tuberculosis and associated factors (Somalia, Africa, or globally). There was a total of 4230 articles globally, 17 in Africa, and 1 in Somalia found using the search terms. Out of these 22 of them were directly related to the objective of this study.

2.1. Prevalence of drug-resistant tuberculosis

According to cross-sectional study done in Iran, among 1083 individuals diagnosed with TB, 27 (2.5%) were identified as having MDR-/RR-TB, while 73 cases (6.7%) were any drug resistant [Mansoori et al., 2025]. In Saudi Arabia, from the total of 901 cases, 193 had DR- TB (21.4%). Out of the 21.4% DR-TB, 91.7% were MR-TB and 8.3% were MDR-TB [Al-Shahrani et al., 2021]. In China, from a total of 10 975 patients with pulmonary TB were recorded during 2004–2019, and of these 1924 retreated pulmonary TB were finally included. Among retreated PTB, 26.2% were DR- TB [Tao et al., 2021]

As per a national survey in a high tuberculosis endemic area of Pakistan, drug susceptibility test (DST) results of 1969 isolates showed that 238 (12%) isolates were resistant to at least one drug, while 97 (4.9%) were confirmed to be MDR-TB. The remaining 1731 (88%) isolates were sensitive to all drugs [Ali et al., 2020]. Similar finding in Iraq, out of 2,296 newly diagnosed patients, 54 (2.4%) were drug-resistant TB, whereas among retreated cases, 50 (20.3%) patients represented DR-TB [Mohammed et al., 2022]. Another national report from Haiti reported that, from 2,777 patients were diagnosed with pulmonary TB by Xpert MTB/RIF screening and positive MTB cultures. A total of 74 (2.7%) patients were infected by a DR-*Mycobacterium tuberculosis* (MTB) strain [Hoffmann et al., 2021].

In Botswana, according to a retrospective review of 2568 medical records DR-TB patients reported in 139 cases (5.4%) [Tembo and Malangu, 2019]. In accordance with a cross- sectional in Uganda, from a total of 384 patients 22.9% (88) of them had DR-TB [Omona and Opiyo, 2023].

A study from north-west Ethiopia showed that, among smear-positive TB patients, the overall prevalence of MDR-TB was 19 (9.3%). The prevalence of MDR-TB among 157 new smear-

positive TB cases was 13 (8.3%) and among 48 previously treated smear-positive TB cases, it was 6 (12.5%) [Erkihun et al., 2023]. In Debre Markos Referral Hospital, of a total of 403 smear positive TB patients 248(61.2%), there was 48(11.9%) DR-TB cases. The prevalence of MDR-TB from both new and previously TB treated cases was found to be 1.5% [Tsega et al., 2017].

2.2. Factors associated with DR-TB

DR-TB remains a significant public health challenge globally, with its burden varying across different regions. Several factors have been identified to influence the development of drug resistance among TB patients. These include socio-demographic, behavioural, clinical, and treatment-related factors.

According to studies conducted in Ethiopia, Kenya, Indonesia, and Iran a history of previous TB treatment, poor adherence to treatment, HIV co-infection, and contact with known TB or MDR-TB patients were consistently associated with the development of drug-resistant TB [Hatiya et al., 2025; Okumu et al., 2024; Seid et al., 2023; Mansoori et al., 2025; Soedarsono et al., 2023].

Other clinical and behavioural factors, such as low body mass index (BMI), substance use (including smoking and khat chewing), and co-morbid conditions like diabetes mellitus (DM), were also found to increase the risk of DR-TB [Kornfeld et al., 2020; Badgeba et al., 2022; Alemu et al., 2025].

In addition, sociodemographic characteristics such as rural residence, unemployment, low educational status, and being male were also significantly associated with the likelihood of developing drug-resistant TB [Zereabruk et al., 2024; Iradukunda et al., 2025; Mansoori et al., 2025; Faye et al., 2024; Mphande-Nyasulu et al., 2022].

Furthermore, health system–related issues such as inadequate diagnostic capacity, delays in initiating appropriate treatment, and poor follow-up during the continuation phase have also been implicated as contributors to the emergence and persistence of DR-TB [World Health Organization, 2024; Tusho and Mokoboto-Zwane, 2025; Chilala et al., 2024].

2.3. Conceptual framework

This conceptual frame work is constructed by investigator based on the objectives of the study and taking earlier investigation from my literature review as a foundation.

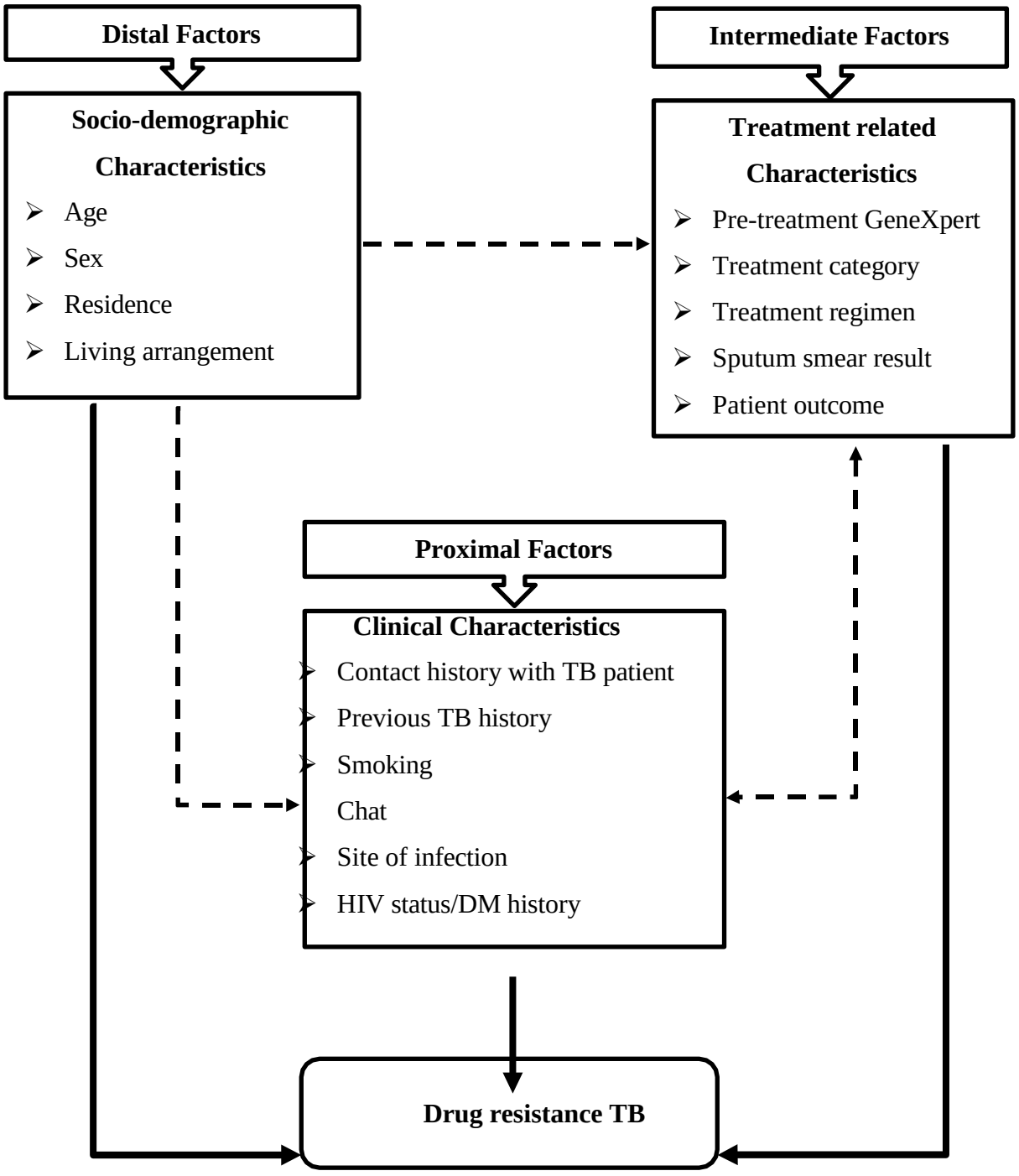

Figure 1: Conceptual framework for the study on prevalence of drug-resistant tuberculosis and its associated factors among tuberculosis patients in Galkayo General Hospital, Puntland Somalia, 2025.

3. METHODOLOGY

3.1. Study area and period

The study was conducted at Galkayo General Hospital, located in Puntland, Somalia. Galkayo General Hospital is a prominent regional healthcare facility that serves patients from across Somalia and the Somali Region of Ethiopia. The hospital has a capacity of 500 beds and employed 314 personnel, including staff nurses, paramedical staff, internship medical students, and other healthcare workers.

The hospital provided free medical care to approximately 156,000 patients annually, including internally displaced population, returnees, pastoralists, Ethiopian refugees, and marginalized minority clans residing in and around the town. Established in 1935, the hospital offered various services, such as an emergency ward, outpatient department, maternal and child health services, a maternity ward, a TB clinic, an X-ray department, surgical services, and a laboratory. Both in-patient and out-patient services were available.

Infrastructure at the hospital included two male TB wards with a total of 60 beds, one female TB ward with a capacity of 30 beds, and an MDR-TB ward, which was later used as an OPD for under-12 patients. The hospital also housed two laboratory rooms (one air-conditioned), consultation rooms, a drug distribution area, and a nurse station. Directly Observed Therapy (DOT) providers supervised all patients during drug administration.

The study was conducted from March 1 to April 30, 2025.

3.2. Study design

A facility-based retrospective cross-sectional study design was employed.

3.3. Population

3.3.1. Source population

All patients with documented TB, based on secondary data retrieved from Galkayo General Hospital.

3.3.2. Study population

All patients diagnosed with TB at Galkayo General Hospital who fulfilled the inclusion criteria during the data retrieval period between January 2020 and December 2024.

3.4. Inclusion and exclusion criteria

3.4.1. Inclusion criteria

All patients diagnosed with any type of TB (pulmonary or extrapulmonary) at Galkayo General Hospital between January 1, 2020, and December 31, 2024.

3.4.2. Exclusion criteria

TB patients with incomplete medical records (e.g., missing drug susceptibility test results, diagnosis details, or treatment data).

3.5. Sample size determination

A single population proportion formula was used to calculate the required sample size for the first objective.

n= minimum sample size for the Study

$Z_{\alpha/2}$= the standard normal deviation at 95% confidence interval ($Z_{\alpha/2}$= 1.96)

P= proportion (P=50.0%)

d= margin of error that can be tolerated, (d=5%=0.05)

$$n = \frac{(Z_{\alpha})^2 P(1-P)}{d^2} = \frac{(1.96)^2\ 0.5\ (0.5)}{(0.05)^2} = 384$$

Including 10% for contingency (38), the final calculated sample size was 422.

Table 1: Sample size determination for different factor associated with drug- resistant tuberculosis and associated factors in Galkayo General Hospital in Puntland Somalia.

Predictors	Proportion of non-exposed	Assumption	AOR	Sample size	Reference
TB relapse patients	87.1%	CI= 95% Power= 80%	3.60	344	[Kebede and Mamo, 2024]
TB treatment failure	9.00%		3.42	190	[Diriba et al., 2021]
Contact with TB patient	11.25%		3.10	194	[Baya et al., 2019]

3.6. Sampling technique and procedure

A simple random sampling technique was used to select patients' medical records from Galkayo General Hospital. The sampling frame included all TB patients registered from January 2020 to December 2024 who met the inclusion criteria. Medical record numbers were drawn using a random number generator to ensure unbiased selection.

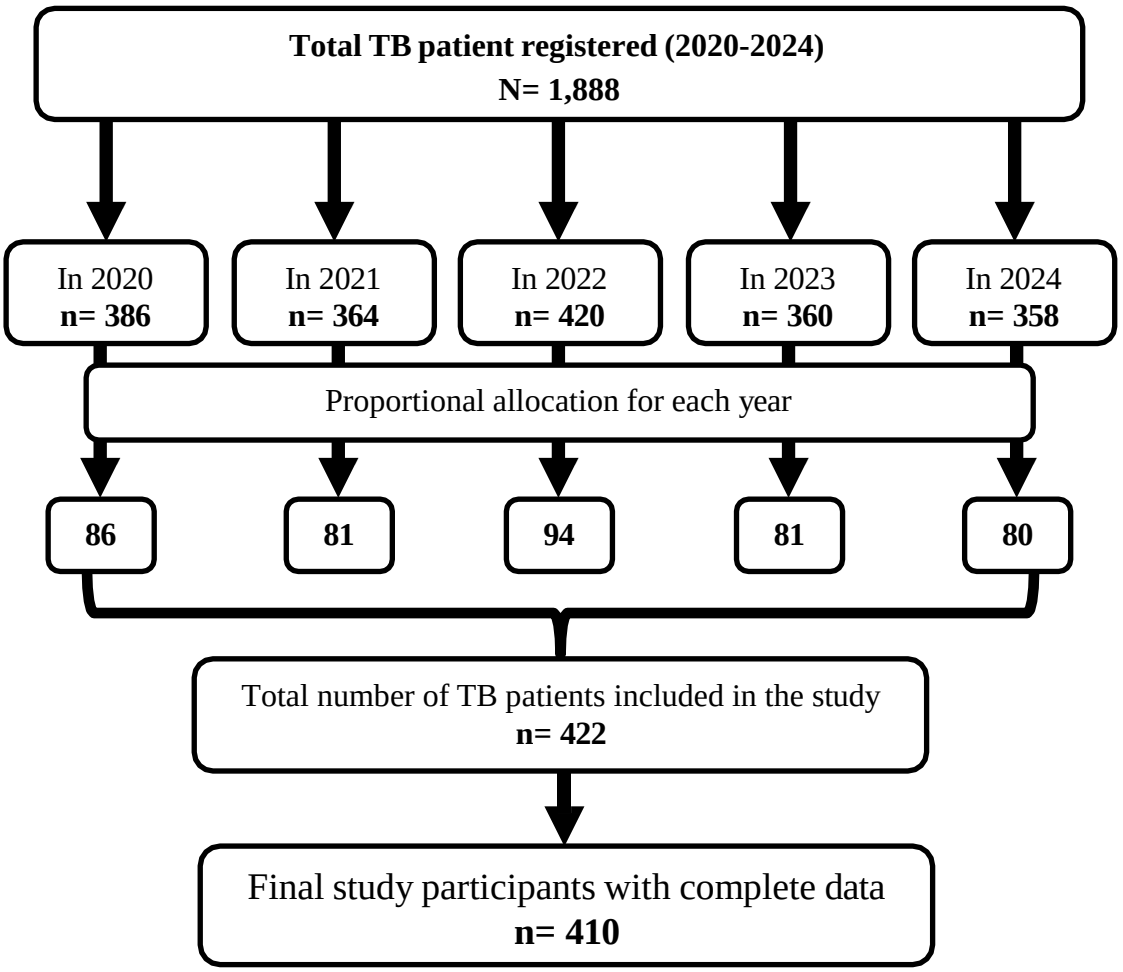

Figure 2: Flow chart for selecting study participants TB patients in Galkayo General Hospital for each year

3.7. Data collection method

3.7.1. Data collection instrument

A structured data abstraction tool was developed in the English language following an extensive review of relevant literature and similar studies. The format was carefully designed to extract comprehensive information from patients' medical records. The format aimed to collect data on key variables including sociodemographic characteristics (such as age, sex, residency, and living arrangement), clinical characteristics (including BMI, HIV status, relapse, and type of TB), and drug-related factors (such as previous TB treatment, drug resistance patterns, and use of second-line anti-TB medications). This data collection tool was used to ensure consistency, completeness, and reliability in data collection throughout the study.

3.7.2. Data collectors and supervisor

Data were collected by two pharmacy professionals and one nurse. A BSc-level pharmacist supervised the data collection process. All data collectors and the supervisor were trained for two days on data abstraction procedures, ethical considerations, record handling, and confidentiality maintenance.

3.7.3. Data collection process

The TB registration book was reviewed to identify all patients who initiated TB treatment between January 1, 2020, and December 31, 2024. Based on these records, corresponding medical record numbers were retrieved from the hospital's archive. The required data were then extracted by the trained data collectors using the prepared abstraction tool.

3.8. Study variables

3.8.1. Dependent variable

Drug-resistant tuberculosis (DR-TB)

3.8.2. Independent variables

Sociodemographic factors: age, sex, place of residence.

Clinical factors: contact history with TB patients, previous history of TB, site of infection, HIV status, presence of DM, and BMI and TB type (pulmonary or extrapulmonary).

Treatment related characteristics: pre-treatment GeneXpert, treatment category, treatment regimen, sputum smear result, patient outcome.

3.9. Operational definitions

Drug-Resistant Tuberculosis (DR-TB): Refers to any form of tuberculosis that shows resistance to one or more first-line anti-TB drugs, as documented in the patient's medical record. This includes mono-resistant TB, MDR-TB, pre-extensively drug-resistant TB (pre-XDR-TB), and XDR-TB [World Health Organization, 2024].

Prevalence of DR-TB: The proportion of TB patients diagnosed with any form of drug-resistant TB among all TB cases registered at Galkayo General Hospital from January 2020 to December 2024.

History of TB: Indicates a documented history of previous TB treatment episodes prior to the current diagnosis [World Health Organization, 2024].

Treatment Category: Classification of TB patients based on their treatment history, as documented in the medical records. Categories include: New, Relapse, Treatment Failure, and Transferred In [World Health Organization, 2024].

Body Mass Index (BMI): The BMI value recorded in the medical chart, calculated as weight in kilograms divided by the square of height in meters (kg/m^2), used to categorize patients as underweight, normal, or overweight [Zierle-Ghosh, 2025].

3.10. Data quality control

Prior to data collection, a pre-test was conducted on 5% of the sample size at Garawe General Hospital to assess the clarity and completeness of the data abstraction format. The principal investigator provided orientation to the data collectors regarding the objectives of the study and proper data abstraction procedures. During the data collection period, the principal investigator closely monitored the process to ensure data completeness, accuracy, and consistency.

3.11. Data processing and analysis

The data were entered and cleaned using KOBO Toolbox after completing the data collection and ensuring completeness and consistency. Then, the cleaned data were exported to STATA Version 17 for further processing and analysis. Descriptive statistics were used to summarize the data using frequencies, percentages, means, and standard deviations as appropriate.

A bi-variable logistic regression analysis was done to check the association between each independent variable and the outcome variable (DR-TB). Variables with a p-value less than 0.25 in the bi-variable analysis were included in the multi-variable logistic regression model. A p-value of < 0.05 was considered statistically significant, and adjusted odds ratios (AOR) with 95% confidence intervals (CI) were reported. The goodness of model fit was assessed using the Hosmer-Lemeshow test, and multicollinearity was checked using the Variance Inflation Factor (VIF). The results were presented using tables, figures, and charts, along with frequency and summary statistics to describe the study population and support interpretation with relevant literature.

3.12. Ethical considerations

Ethical approval was obtained from the Institutional Health Research Ethics Review Committee (IHRERC) of the College of Health and Medical Sciences. An official letter of permission was secured from Galkayo General Hospital. Informed, voluntary, written, and

signed consent was obtained from the hospital administration after the study's purpose and procedures were clearly explained. The confidentiality and privacy of patient data were maintained throughout the study by assigning codes to each record and avoiding the use of any personal identifiers.

3.13. Information dissemination

Once the final report is completed and approved by the advisors, both hard and soft copies will be submitted to the School of Pharmacy, College of Health and Medical Sciences, Haramaya University. The report will also be disseminated to relevant stakeholders, including the TB clinic at Galkayo General Hospital and the Puntland Ministry of Health. Furthermore, the findings of this study will be presented at conferences and submitted for publication in a reputed peer-reviewed journal, making the results accessible to the broader scientific community.

4. RESULTS

4.1. Socio-demographic characteristics

Of 422 patients, 410 had complete medical records, giving a response rate of 97.2%.

Using proportional allocation across the study years, 82 patients were selected from 2020, 70 from 2021, 91 from 2022, 80 from 2023, and 79 from 2024 (**Figure *3***).

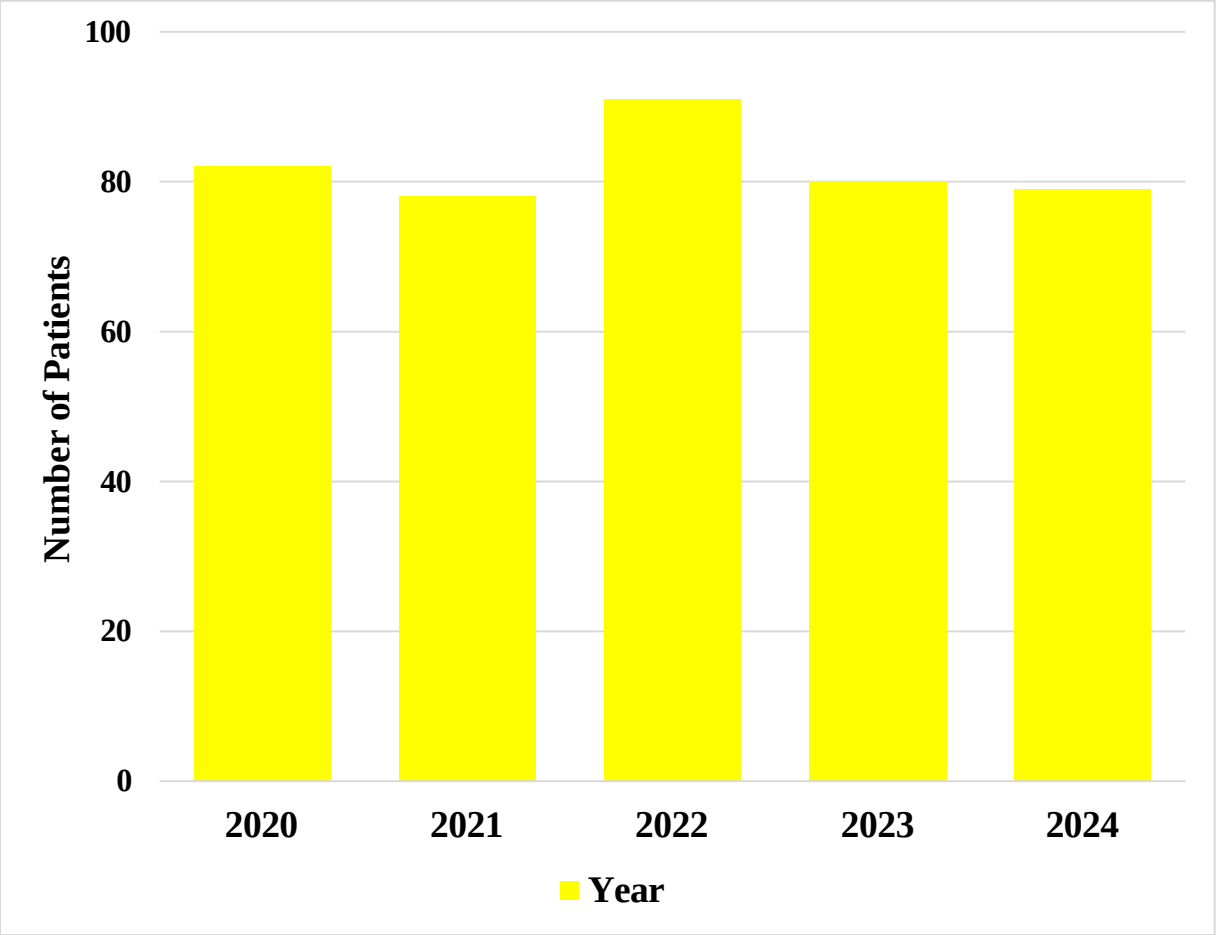

Figure 3: Distribution of sampled tuberculosis patients by year at Galkayo General Hospital, Puntland, Somalia (2020–2024).

The participants had a mean (±SD) age of 29.94±20.64 years, around a quarter of them (25.14%) falling in the age group < 15 years and more than half of them were males (64.63%). Regarding residence half (50.24%) of them resided in urban areas and approximately quarter (24.39%) of patients live alone (**Table *2***).

Table 2: Socio-demographic characteristics of TB patients attended Galkayo General Hospital between January 1st 2020 and December 31st 2024 (n=410)

Variables	Category	Frequency	Percentage (%)
Age	< 15 years	99	25.14
	15-24 years	95	23.17
	25-34 years	68	16.59
	35-49 years	57	13.90
	≥ 50 years	91	22.20
Sex	Male	265	64.63
	Female	145	35.37
Residence	Urban	206	50.24
	Rural	204	49.88
Living Arrangement	Alone	100	24.39
	With family	310	75.61

4.2. Clinical characteristics

As presented in **Table *3***, approximately one-quarter of the participants (25.85%) reported a history of contact with TB patients, while 21.22% had a previous history of TB. The majority were diagnosed with pulmonary TB (68.05%) and classified as new TB cases (79.76%). HIV co-infection was observed in a small proportion of participants (0.7%). In terms of nutritional status, based on BMI, over half of the participants (54.39%) fell within the normal BMI range, whereas nearly one-third (32.20%) were categorized as underweight.

Table 3: Clinical characteristics of TB patients attended Galkayo General Hospital from January 1st 2020 to December 31st 2024 (n=410)

Variables	Frequency	Percentage (%)
Contact History with TB Patient		
No	304	74.15
Yes	106	25.85
Previous History of TB		
No	323	78.78
Yes	87	21.22
Type of TB		
Pulmonary TB	279	68.05
Extrapulmonary TB	131	31.95
HIV Status		
Negative	402	98.05
Positive	8	1.95
DM History		
No	381	92.93
Yes	29	7.07
BMI		
Underweight	132	32.20
Normal	223	54.39
Overweight	55	13.41

BMI, Body mass index; TB, Tuberculosis

Extrapulmonary TB were diagnosed in 131 (31.95%) of the patients, TB adenitis (58; 44.27%) accounts for the majority of the cases, followed by pleural TB (23; 17.56%), bone & joint TB (13; 9.92%), spinal TB (13; 9.92%), and peritoneal TB (9; 6.87%) (**Figure *4***).

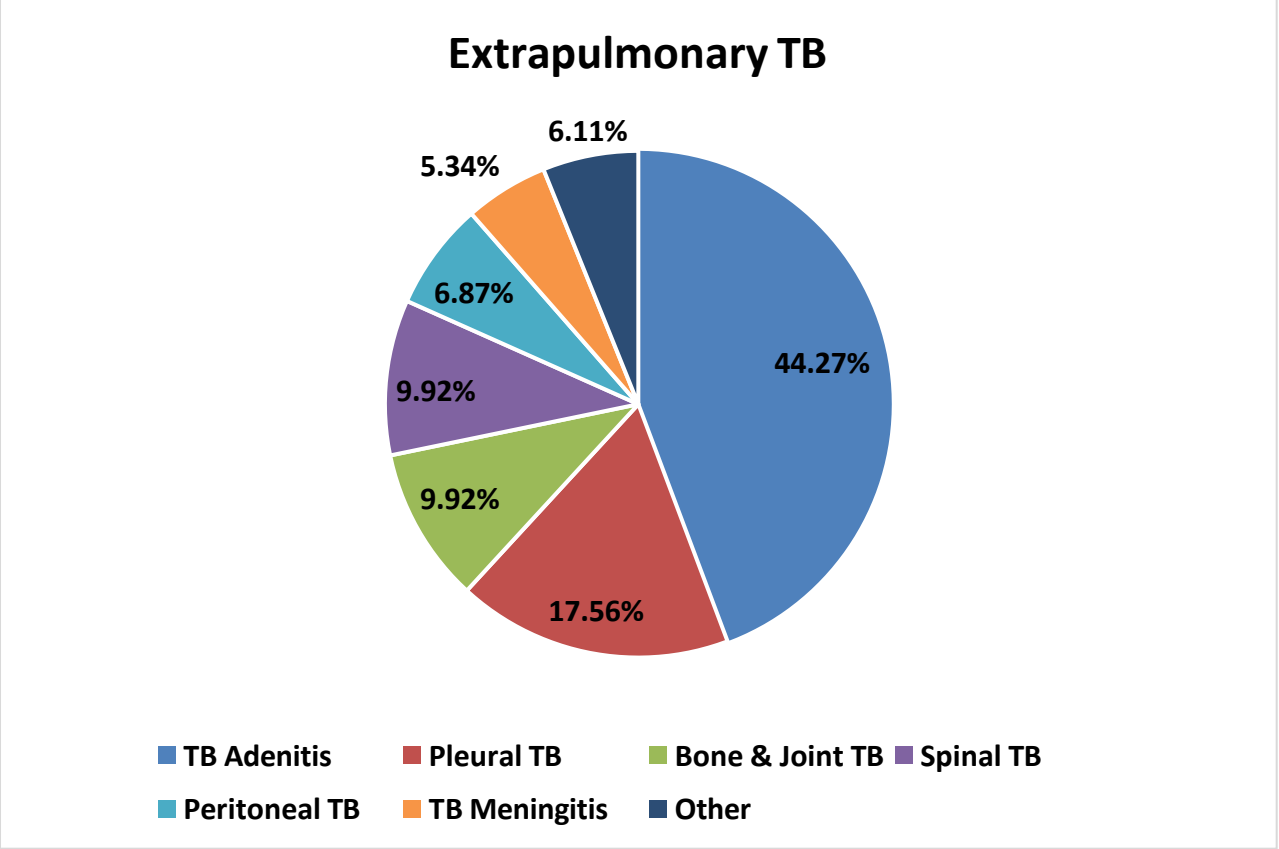

Figure 4: Types of extrapulmonary TB among TB patients attended Galkayo General Hospital from January 1st 2020 to December 31st 2024 (131).

4.3. Treatment characteristics

As shown below in **Table *4***, nearly half of the patients (44.63%) had MTB detected without rifampicin resistance (RR) on GeneXpert, while 34.39% had no test performed. The majority (79.76%) were new TB cases, and most (84.88%) were treated with the standard regimen (2RHEZ/4RH). Follow-up sputum smear results at 2–3 months, 4–5 months, and end of treatment showed high rates of negativity, although a considerable proportion of patients had no recorded results. Regarding treatment outcome, cure (44.39%) and treatment completion (38.54%) were most common, while smaller proportions experienced failure (1.71%), death (4.15%), or treatment interruption (4.39%).

Table 4: Distribution of tuberculosis patients by GeneXpert results, treatment category, regimen, sputum smear follow-up, and final treatment outcomes at Galkayo General Hospital, Puntland, Somalia, 2020–2024.

Variables	Category	Frequency	%
Pre-treatment GeneXpert Assay	MTB not detected	49	11.95
	MTB detected without RR	183	44.63
	MTB detected with RR	34	8.29
	MTB detected with INH resistance	3	0.73
	Not done	141	34.39
Treatment Category	New	327	79.76
	Relapse	39	9.51
	Failure	11	2.68
	Transferred in	33	8.05
Treatment Regimen	2RHEZ/4RH	348	84.88
	2SRHEZ/1RHEZ/5RHE	25	6.10
	Cs, Lfx, Eto, Z, Cfz, V-B6	4	0.98
	Bdq, Cfz, Z, E, Lfx, Eto, Hh, V-B6	18	4.39
	Bdq, Lfx, Lzd, Z, CFZ	1	0.24
	FDC4, Lfx, V-B6	8	1.95
	Bdq, Dlm, Lzd, Mfx, Cs, Z, V-B6	4	0.98
	Bdq, Lzd, Pto, Mfx, V-B6	2	0.49
2-3 months sputum smear	Negative	258	62.93
	Scanty 2%	1	0.24
	Scanty 4%	1	0.24
	1+	12	2.93
	2+	4	0.98
	3+	2	0.49
	POS	2	0.49
	Not done	130	31.71
4–5 months sputum smear	Negative	247	60.24
	Scanty4%	1	0.24
	1+	4	0.98
	2+	1	0.24
	Not done	157	38.92
End of treatment sputum smear	Negative	252	61.46
	1+	1	0.24
	Not done	157	38.29
Final Treatment Outcome	Cure	182	44.39
	Complete	158	38.54
	Failure	7	1.71
	Death	17	4.15
	Treatment interrupted	18	4.39
	Not evaluated	24	5.85
	Treatment adapted to DST	4	0.98

Bdq, Bedaquiline; Cfz, Clofazimine; Cs, Cycloserine; Dlm, Delamanid; E, Ethambutol; Eto, Ethionamide; H, Isoniazid; Hh, Isoniazid high does; Lfx, Levofloxacin, Lzd, Linezolid, Mfx, Moxifloxacin, Pto, Protionamide, R, Rifampicin; Z, Pyrazinamide, V-B6, Vitamin B-6

4.4. Prevalence of drug-resistant tuberculosis

The overall prevalence of DR-TB in this study was 9.02% (37 patients) with a 95% CI (6.23%-11.81%).

4.5. Factors associated with drug-resistant tuberculosis

In the bivariate logistic regression analysis, variables such as age, residency, close contact history with TB patient, previous history of TB, treatment category, BMI, and living arrangement were found to be associated with DR-TB with a *p*-value < 0.25 (**Table *5***). These variables met the minimum criteria for further multivariate logistic analysis.

In the multivariable logistic regression analysis, three variables were found to be statistically significant predictors of DR-TB, with a *p*-value of less than 0.05. These included having a history of close contact with a TB patient, previous history of TB, and TB treatment failure. The overall fit of the model was evaluated using the Hosmer-Lemeshow goodness-of-fit test, which yielded a *p*-value of 0.51, indicating that the model adequately fits the data. The mean VIF of 1.04, suggesting no evidence of significant multicollinearity (**Table *5***).

Table 5: Bivariate and multivariate logistic regression analysis of factors associated with drug-resistance among TB patients attending Galkayo General Hospital, Puntland Somalia, 2025

Variables	Category	DR-TB		COR (95% CI)	AOR (95% CI)
		No	Yes		
Sex	Male	237	28	1.79 (0.82, 3.89)	1.74 (0.76, 3.98)
	Female	136	9	1	1
Residency	Urban	182	24	1.94 (0.96, 3.92)	1.90 (0.89, 4.04)
	Rural	191	13	1	1
Contact History with TB Patient	No	282	22	1	1
	Yes	91	15	2.11 (1.05, 4.24)	**2.43 (1.13, 5.21) ***
Previous History of TB	No	303	20	1	1
	Yes	70	17	3.68 (1.83, 7.39)	**3.63 (1.72, 7.67) ***
Treatment Category	New	302	25	1	1
	Relapse	33	6	2.20 (0.84, 5.74)	1.95 (0.69, 5.46)
	Failure	7	4	6.90 (1.89, 25.19)	**9.03 (2.03, 40.12) ****
	Transferred in	31	2	0.78 (0.18, 3.45)	0.80 (0.17, 3.83)
BMI (Kg/m^2)	< 18.5	116	16	1.67 (0.81, 3.43)	2.09 (0.94, 4.67)
	18.5-24.9	206	17	1	1
	25-29.9	51	4	0.95 (0.31, 2.95)	1.17 (0.35, 3.95)

*= $p < 0.05$; **= $p < 0.001$; Hosmer-lemshow test= 0.51; Mean VIF= 1.04

5. DISCUSSION

According to this finding, the overall prevalence of DR-TB in this study was 9.02% with a 95% CI (6.23%-11.81%). This result is in-line with findings from Somalia, 11.3% [Mohamed et al., 2023], Ethiopia, 9.3% [Erkihun et al., 2023] and 8.3% [Wasihun et al., 2021], and Ecuador, 10.9% [Castro-Rodriguez et al., 2024].

However, our study showed a higher prevalence of DR-TB compared to studies conducted in China, 5.6% [Zhou et al., 2020], Haiti, 2.7% [Hoffmann et al., 2021], Sidama Regional State, Ethiopia, 5.3% [Kebede and Mamo, 2024], Northwest Ethiopia, 5.0% [Yigzaw et al., 2021], Southern Ethiopia, 5.1% [Diriba et al., 2021]. This discrepancy could be attributed to several factors. One key factor is the difference in study populations. The Chinese study focused exclusively on children, who generally have less prior exposure to TB treatment and a lower risk of developing drug resistance. Additionally, diagnosing DR-TB in children is more difficult due to lower bacterial loads, which can lead to underreporting. In contrast, our study included a broader age range, likely encompassing more high-risk individuals with greater exposure to DR-TB strains. Differences in study design may also contribute; for instance, the studies from Haiti and Northwest Ethiopia employed prospective designs, which could influence case detection and reporting compared to our cross-sectional approach. Additionally, the larger sample size in the Sidama Regional State study may have contributed to the lower prevalence reported compared to our findings.

Conversely, the prevalence of DR-TB in this study was lower compared to findings from Iraq, 20.3% [Mohammed et al., 2022], Uganda, 22.9% [Omona and Opiyo, 2023], Latin America and the Caribbean, 26.0% [Tengan et al., 2020], and Somalia, 18.6% [Sindani et al., 2013]. Several factors may explain these disparities. Notably, the studies from Iraq and Latin America and the Caribbean focused specifically on previously treated TB cases, a group that is significantly more prone to developing resistance due to incomplete, irregular, or inappropriate treatment regimens. Such patients are more likely to harbor resistant strains as a result of past treatment failures or defaulting on therapy.

In Uganda, the study population included a high proportion of HIV-positive individuals (63.0%) [Omona and Opiyo, 2023] compared to only 1.95% in our study. HIV infection increases susceptibility to TB and complicates treatment outcomes, often contributing to higher rates of drug resistance due to impaired immune response and potential drug interactions [Navasardyan et al., 2024; Patel et al., 2024a]. Additionally, the earlier Somali

study was conducted in 2013, before the scale-up of national TB control efforts, including improved diagnostic services, drug supply management, and the implementation of directly observed treatment strategies. The lower prevalence observed in our study may reflect the cumulative impact of these interventions and recent policy changes aimed at strengthening TB prevention and management in Somalia.

The current study revealed that history of contact with a TB patient, previous history of TB, being a TB treatment failure patient, and being HIV-positive as predictors for DR-TB.

Patients who had close contact with a TB patient were more than 2 times higher odds of having DR-TB case (AOR= 2.42, 95% CI: 1.13-5.21). This finding was supported by other studies carried out in India [Ladha et al., 2022], Ethiopia [Amin et al., 2021; Admassu et al., 2023], and Burundi [Iradukunda et al., 2021]. This association can be explained by the increased likelihood of direct transmission of DR-TB strains from an infected person, particularly in household or close-contact settings. When the source case has DR-TB, contacts may acquire the resistant strain through primary transmission rather than as a result of treatment failure. Additionally, contacts often share similar environmental and social conditions: such as overcrowding or limited access to healthcare—which can delay diagnosis and facilitate ongoing transmission [Zhou et al., 2024; Liebenberg et al., 2022; Oo and Borry, 2024; Saliba et al., 2023].

Patients with previous history of TB had more than three times higher chance of DR-TB (AOR= 3.63, 95% CI: 1.72-6.67) than their counterparts. Similar findings were also reported in Uganda [Omona and Opiyo, 2023], India [Ladha et al., 2022], Saudi Arabia [Saifullah et al., 2021], and Guatemala [Montes et al., 2021]. Which is consistent with findings reported in numerous studies and aligns with established biological and clinical mechanisms underlying the development of drug resistance [Ayanwale et al., 2020; Alemu et al., 2022]. In this regard, previous TB treatment is a significant risk factor for DR-TB, primarily due to the potential for inadequate or incomplete therapy, which may result from factors such as poor adherence, inappropriate drug regimens, insufficient treatment duration, or the use of substandard medications. Moreover, previous TB infection may lead to structural lung damage and immune system alterations, further increasing susceptibility to recurrent infection with resistant organisms [Xi et al., 2022; Borah et al., 2021; Mohammadnabi et al., 2024].

Another factor that demonstrated a significant association with DR-TB was a history of treatment failure, with these patients showing nearly a 9-fold higher chance of developing MDR-TB compared to those with new TB infections (AOR= 9.03, 95% CI: 2.03-40.12). which is consistent with previous studies done in Mali [Baya et al., 2019], Iran [Mansoori et al., 2025], Ethiopia [Zereabruk et al., 2024], and Ethiopia [Amin et al., 2021]. Treatment failure is frequently caused by issues such as incomplete treatment, poor patient adherence, incorrect medication combinations, or the use of substandard drugs. These factors create conditions that favor the survival and multiplication of DR MTB strains [Dookie et al., 2022; Soedarsono et al., 2023]. In such cases, resistance may develop during the course of treatment (acquired resistance) or reflect undetected primary resistance from the outset. Additionally, patients with previous treatment failure are more likely to have experienced multiple treatment episodes, further increasing the risk of harboring resistant bacilli [Oliveira et al., 2024; Omoteso et al., 2025].

6. STRENGTH AND LIMITATION OF THE STUDY

6.1. Strength of the study

The strength of this study include that; it provides the opportunity of assessing DR-TB and its associated factors among patients with TB in Galkayo TB center.

6.2. Limitation of the study

In this study, due to the nature of the cross-sectional study design, it would be impossible to determine the causal relationship between the variable and the outcome in the analysis, the study may rely on existing medical records for patient data, which could have missing or incomplete information, leading to biases or limitations in the analysis.

7. CONCLUSION AND RECOMMENDATIONS

7.1. Conclusion

In conclusion, this study highlighted the significant burden of DR-TB, emphasizing it as a major public health concern. Multivariable logistic regression analysis identified three key factors significantly associated with DR-TB: a history of contact with TB patients, previous TB history, and treatment failure.

7.2. Recommendations

To Health Professionals

- Strengthen contact tracing and early screening among individuals with known exposure to tuberculosis to ensure prompt detection of drug-resistant cases.
- Provide consistent adherence counseling and follow-up for patients with previous TB history or treatment failure.

To Hospital Officials

- Ensure availability of rapid drug susceptibility testing (DST) and strengthen laboratory capacity for early detection of resistance.
- Establish systems for rigorous treatment monitoring and provide resources to support patient adherence.
- Facilitate continuous training programs for healthcare providers on updated TB and DR-TB management guidelines.

To Regional Health Offices

- Prioritize high-risk groups through targeted public health interventions and support training programs to build capacity in TB control.
- Strengthen surveillance systems to monitor trends of drug-resistant tuberculosis and evaluate treatment outcomes.

To Researchers

- Explore the impact of socio-economic and behavioral factors on treatment adherence and drug resistance.
- Evaluate the effectiveness of novel treatment approaches and community-based interventions in similar settings.

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9. ANNEXES

9.1. Information Sheet and Informed Voluntary Consent Form for the Hospital Head

My name is Hawo Mohamud Mohamed, a Master's student in the Clinical Pharmacy Program at Haramaya University, College of Health and Medical Sciences. I kindly request your attention to provide you with information about my research study and to seek permission for your institution to serve as one of the study settings.

1. The study/project title: Magnitude of Drug-Resistant Tuberculosis and Its Associated Factors in Galkayo General Hospital, Puntland, Somalia: A Cross-Sectional Study

2. Purpose/aim of the study: The purpose of this study is to conduct research as part of the requirements for the Master of Science degree in Clinical Pharmacy for the principal investigator. The findings will also provide useful information to the hospital and relevant stakeholders in determining the magnitude of drug-resistant tuberculosis and its associated factors among tuberculosis patients in Galkayo General Hospital, Puntland, Somalia, 2025.

3. Procedure and duration: Data will be collected retrospectively from medical record cards of patients admitted to the hospital. Patient medical records will be selected based on their medical record numbers during the data collection period. All necessary information will be gathered exclusively from patient records, and no direct contact with patients will be made.

4. Risks and benefits: The study poses minimal risk since it only involves reviewing medical records. There is no direct payment for participating in the study. However, the findings may provide important information for local health planners and hospital management, which could contribute to improved prevention and management of drug-resistant tuberculosis.

5. Confidentiality: All the information provided will be kept strictly confidential. No personal identifiers will be recorded, and the data will be coded to ensure anonymity. The findings will be presented in general terms and will not reflect anything specific to individual patients. No oral or written reports will contain details that could link participants to the study.

6. Rights: You have the right to decide whether to allow or not allow this study to be conducted in your hospital. Participation is entirely voluntary, and you have the right to stop the study at any time if any misconduct or unethical practice is observed.

7. Contact address: If you have any questions or inquiries at any time about the study or the procedures, please contact:

Principal Investigator: Hawo Mohamud Mohamed

Mobile phone: +251-967589733

E-mail: _____

Haramaya University College of Health and Medical Sciences Institutional Research Ethical Review Committee (IHRERC)

Office phone: +251-254-662011

P.O. Box: 235, Harar, Ethiopia

8. Declaration of Informed Voluntary Consent: I have read the information sheet. I have clearly understood the purpose of the research, the procedure, risks and benefits, issues of confidentiality, the rights of participating and the contact address for any queries. I have been given the opportunity to ask questions for things that may have been unclear. I was informed that participants have the right to withdraw from the study at any time or not to answer any question that they do not want. I am also informed that the Hospital has the right to stop this study from being conducted if any misdeeds and unethical procedures are observed during the data collection process in the hospital's premises. Therefore, I declare my voluntary consent on behalf of the hospital management to allow to this study to be conducted in the hospital with my initials (Signature) as indicated below.

Name and Signature of Head of the Hospital: _____Date: _____

Name and Signature of Principal Investigator: _____Date: _____

9.2. Data abstraction tool

Code: _____ Date: _____

Section I: Socio-demographic Characteristics

SN	Item	Response
101	Age (in years)	_____
102	Sex	A. Male B. Female
103	Residence	A. Urban B. Rural
104	Living arrangement	A. Alone B. With family members

Section II: Clinical Characteristics

SN	Item	Response
201	Contact history with TB patients	A. Yes B. No
203	Previous TB history	A. Yes B. No
204	Site of infection	A. Pulmonary TB B. EP-TB
205	If "EP-TB" for Q. 204, specify:	_____
207	HIV status	A. Negative B. Positive
208	DM History	A. Yes B. No
209	BMI	_____kg/m^2
210	TB diagnosis	A. Drug resistant TB B. Non-drug resistant TB

Section III: Treatment related data of the patients

SN	Item		Response			
301	Pre-treatment GeneXpert assay		_____			
302	Treatment category		A. New	B. Relapse	C. Failure	D. Transferred-in
303	Treatment regimen		_____			
304	2-3 months sputum smear result		_____			
305	4-5 months sputum smear result		_____			
306	End of treatment sputum smear		_____			
307	Final treatment outcome	A. Cure B. Completed	C. Failure D. Death	E. Treatment interrupted F. Not evaluated		G. treatment adapted to DST