

MAKERERE UNIVERSITY

SCHOOL OF PUBLIC HEALTH

MORTALITY AND ITS PREDICTORS AMONG TB PATIENTS WITHIN TWO YEARS AFTER TB TREATMENT DISCHARGE AT KAWAALA AND KISWA HEALTH CENTRE IVS, KAMPALA CITY, UGANDA

BY

NALUBEGA MADINAH

2022/HD07/465U

A DISSERTATION SUBMITTED TO THE SCHOOL OF PUBLIC HEALTH, MAKERERE UNIVERSITY IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF PUBLIC HEALTH OF MAKERERE UNIVERSITY

OCTOBER 2026

DECLARATION

I, NALUBEGA MADINAH hereby declare that this dissertation is my original work and to the best of my knowledge has never been presented to any higher learning institution as a requirement for the award of any academic merit. I henceforth present it for the partial fulfillment of the award of the Master of Public Health degree from Makerere University, Kampala, Uganda

Signature: _____ Date: 16/OCTOBER/2026

SUPERVISORS' APPROVAL

This dissertation was prepared and submitted under our supervision:

_____ Date: 27/10/2026

Dr. Esther Buregyeya (MBChB, MPhil, PhD)

Associate Professor

Department of Disease Control and Environmental Health

Makerere University School of Public Health

_____ Date: 27/oct/2026

Dr. Phyllis Awor (MD, PhD)

Lecturer and Researcher,

Department of Community Health and Behavioural Sciences

Makerere University School of Public Health

ACKNOWLEDGEMENT

First, heartfelt gratitude goes to God Almighty for the strength, protection, and grace that sustained this work from start to finish.

I sincerely thank my supervisors, Professor Esther Buregyeya and Dr. Phyllis Awor, as well as my overseers Dr. Edward Buzigi and Dr. Aggrey Mukose, for their guidance, careful feedback, and steady mentorship. Their insistence on clarity and rigor helped shape this dissertation into a stronger piece of work.

Special appreciation goes to the Principal Investigators Professor Mari Armstrong-Hough and Dr. Achilles Katamba, the coordinator, Dr. Ssuna Bashir and the entire TB–DM study team. This dissertation was made possible because of the foundation laid by the primary TB–DM cohort, and the team's support and coordination greatly eased the research process.

I also acknowledge the doctors, nurses, and administrators at Kawaala and Kiswa Health Centre IVs for their cooperation and support during record review and follow-up. Their assistance, despite busy clinical schedules, is deeply appreciated.

To the TB–DM cohort participants and the families who provided information during follow-up—thank you for your time and openness, especially in sensitive discussions around illness and death. This study is ultimately about people, and your contribution mattered greatly.

I am grateful to my class colleagues for encouragement and shared learning throughout the programme, and to my family members for their prayers, understanding, and support.

Finally, special appreciation goes to my husband. His patience, encouragement, and practical support made a real difference. He carried the emotional side of this journey with me, and he believed in the value of finishing even when it was tiring. This dissertation reflects that support as much as it reflects academic work.

To everyone mentioned—and anyone unintentionally left out—thank you sincerely.

TABLE OF CONTENTS

DECLARATION i
ACKNOWLEDGEMENT iii
LIST OF TABLES viii
LIST OF FIGURES viii
ACRONYMS AND ABBREVIATIONS ix
OPERATIONAL DEFINITIONS x
ABSTRACT xi
CHAPTER ONE: INTRODUCTION AND BACKGROUND 1
1.0 Introduction 1
1.1 Background 2
CHAPTER TWO: LITERATURE REVIEW 4
2.1 Tuberculosis overview 4
2.1.1 Pathophysiology and clinical presentation of TB 4
2.1.2 Treatment regimens and guidelines: global and Ugandan perspectives 5
2.1.3 Multidrug-resistant and extensively drug-resistant TB 6
2.2 Global and regional TB burden 6
2.2.1 Epidemiology of tuberculosis 6
2.2.1.1 Global incidence and mortality 6
2.2.1.2 SubSaharan African and Ugandan context 7
2.3 Treatment success and continuing challenges 9
2.3.1 WHO-recommended treatment and programme delivery 9
2.3.2 Limitations of treatment-outcome indicators 9
2.4 Post-treatment outcomes in TB 10
2.4.1 Definition and classification of treatment outcomes 10
2.4.2 Post-TB mortality evidence 10
2.5 Long-term health and quality of life after TB 11
2.6 Mortality after TB treatment 12
2.6.1 Post-treatment mortality rates 12
2.6.1.1 Global evidence 12
2.6.1.2 Sub-Saharan African and Ugandan evidence 13

2.6.2 Timing and factors associated with mortality 13
2.6.2.1 Importance of the first two post-treatment years 13
2.6.2.2 Later post-treatment mortality 14
2.7 Predictors of post-treatment mortality 15
2.7.1 Demographic and socio-economic factors 15
2.7.2 Clinical factors 16
2.7.3 Social and behavioural factors 17
2.7.4 Health-facility factors 18
2.7.5 Synthesis of recent evidence informing this study 19
2.8 Research gaps addressed 20
2.8.1 Limited Ugandan post-treatment outcome evidence 21
2.8.2 Limited multi-domain analysis of potential predictors 21
2.8.3 Limited evidence on timing after treatment discharge 21
CHAPTER THREE: STATEMENT OF THE PROBLEM, JUSTIFICATION AND CONCEPTUAL FRAMEWORK 22
3.1 Problem statement 22
3.2 Justification 23
3.3 Conceptual framework 24
CHAPTER FOUR: RESEARCH QUESTIONS AND STUDY OBJECTIVES 26
4.1 Research questions 26
4.2 General objective 26
4.3 Specific objectives 26
CHAPTER FIVE: METHODOLOGY 27
5.1 Study design 27
5.2 Study setting 27
5.3 Study population 27
5.4 Eligibility criteria 28
5.4.1 Inclusion criteria 28
5.4.2 Exclusion criteria 28
5.5 Sample-size justification 28
5.6 Sampling procedure 28

5.7 Study variables and operational measurement 29
5.8 Data-collection procedures 32
5.9 Quality assurance and quality control 33
5.10 Data management and analysis 34
5.11 Ethical considerations 35
CHAPTER SIX: RESULTS 36
6.1 Mortality rate and baseline characteristics of participants 36
6.2 Predictors of mortality within 24 months after discharge 37
6.2.1 Bivariate analysis 40
6.2.2 Multivariable analysis (Firth penalised logistic regression) 45
6.3 Time to mortality and its predictors 47
6.3.1 Overview and analytical approach 47
6.3.2 Kaplan–Meier survival estimates 47
6.3.2.1 Overall survival of the study cohort 47
6.3.2.2 Survival by HIV status 49
6.3.2.3 Survival by diabetes/pre-diabetes status 50
6.3.2.4 Survival by Monthly Income Level 52
6.3.3 Time-to-event analysis (Cox proportional hazards) 54
6.3.3.1 Modelling approach 54
6.3.3.2 Cox regression results 55
CHAPTER SEVEN: DISCUSSION 57
7.1 Mortality rate within 24 months after TB treatment discharge 57
7.2 Predictors of post-TB mortality 58
7.2.1 HIV co-infection 58
7.2.2 Diabetes and pre-diabetes 59
7.2.3 Demographic and socio-economic factors 60
7.2.4 Health-facility and follow-up factors 61
7.2.5 Nutritional and behavioural factors 62
7.3 Time-to-event findings 62
7.3.1 Concentration of mortality within the first year 62
7.3.2 Survival according to HIV and dysglycaemia 63

7.3.3 Cox proportional-hazards analysis 63
7.4 Implications of the findings 64
7.5 Strengths and limitations 65
7.5.1 Strengths 65
7.5.2 Limitations 65
CHAPTER EIGHT: CONCLUSIONS AND RECOMMENDATIONS 67
8.0 Conclusions 67
8.1 Conclusions by study objective 67
8.2 Recommendations 67
8.2.1 First-year post-TB follow-up 67
8.2.2 Continuity of HIV care 67
8.2.3 Post-TB mortality surveillance 68
8.2.4 Future research 68
REFERENCES 69
APPENDICES 74
Appendix I: Clearance letter from Overseer 74
Appendix II: IRB Approval Letter 75
Appendix III: Waiver of Informed consent 77
Appendix IV: Secondary data extraction tool 78
Appendix V: Verbal consent script- English version 81
Appendix VI: Verbal Autopsy Script- Luganda version 82
Appendix VII: Verbal Autopsy Questionnaire- English version 84
Appendix VIII: Verbal Autopsy questionnaire- Luganda Version 87

LIST OF TABLES

Table 5.1 Study variables, operational measurements, analysis categories and data sources 29
Table 5.2 Variables obtained from each data source 32
Table 6.1- Key Mortality Indicators 36
Table 6.2: Baseline characteristics of tuberculosis patients discharged after treatment at Kawaala and Kiswa Health Centre IVs (N = 259) 38
Table 6.3: Bivariate analysis of potential predictors of mortality within 24 months after discharge 41
Table 6.4: Adjusted analysis of potential predictors of mortality within 24 months (Firth penalised logistic regression) 46
Table 6.5: Overall survival within 24 months post-discharge (N = 259) 48
Table 6.6: Survival probabilities (S (t)) by HIV status 49
Table 6.7: Survival probabilities (S(t)) by diabetes/pre-diabetes status within 24 months after TB treatment discharge 51
Table 6.8: Survival probabilities S(t) by Monthly Income 53
Table 6.9: Cox proportional-hazards regression for time to death within 24 months 55

LIST OF FIGURES

Figure 3.1 Researcher-developed conceptual framework for post-treatment mortality and time to mortality 25
Figure 6.1: Distribution of deaths by time interval within 24 months after TB treatment discharge 37
Figure 6.2 Overall Kaplan–Meier survival curve for tuberculosis patients within 24 months after treatment discharge. 48
Figure 6.3: Kaplan–Meier survival curves by HIV status within 24 months after TB treatment discharge 50
Figure 6.4: Kaplan–Meier survival curves by diabetes/pre-diabetes status within 24 months after TB treatment discharge. 52
Figure 6.5: Kaplan–Meier survival curves stratified by monthly income within 24 months after TB treatment discharge 54

ACRONYMS AND ABBREVIATIONS

TB	Tuberculosis
HCIV	Health Centre IV
HIV	Human immunodeficiency virus
MDR-TB	Multidrug-resistant tuberculosis
XDR-TB	Extensively drug-resistant tuberculosis
WHO	World Health Organization
NTLP	National Tuberculosis and Leprosy Programme
DOTS	Directly observed treatment, short-course
ART	Antiretroviral therapy
NCD	Non-communicable disease
COPD	Chronic obstructive pulmonary disease
IRIS	Immune reconstitution inflammatory syndrome
FBG	Fasting blood glucose
HbA1c	Glycated haemoglobin
BMI	Body mass index
KCCA	Kampala Capital City Authority
TB–DM	Tuberculosis–diabetes mellitus
CI	Confidence interval
COR	Crude odds ratio
AOR	Adjusted odds ratio
HR	Hazard ratio
AHR	Adjusted hazard ratio
KM	Kaplan–Meier

OPERATIONAL DEFINITIONS

TB treatment discharge: The recorded end-of-treatment date used as time zero for post-treatment follow-up; source records may also describe this as treatment completion.

Post-treatment mortality: All-cause death occurring within 24 months after TB treatment discharge.

Predictor: A measured characteristic examined for its prognostic relationship with subsequent mortality or time to death. The term is used in an epidemiological prognostic sense; this study did not develop or validate an individual-level clinical prediction model.

Alive/censored: A participant without a confirmed death during observed follow-up, censored at 24 months or earlier last-known-alive time where applicable.

Dysglycaemia: A combined analysis category indicating diabetes or pre-diabetes as recorded in the parent TB–DM cohort.

Perceived long waiting time: A participant-reported follow-up challenge recorded as yes/no; the study instrument contained no numeric time threshold.

Verbal autopsy: A structured interview with a next of kin about the symptoms and circumstances preceding a confirmed death; it was not equivalent to medical certification of cause of death.

ABSTRACT

Background: Tuberculosis (TB) treatment completion is an important indicator of programme success; however, this does not always indicate full recovery, and some patients die after treatment has ended. Evidence on the magnitude, timing and determinants of post-treatment mortality remains limited in routine Ugandan settings. This study assessed mortality among TB patients within two years after treatment discharge at Kawaala and Kiswa Health Centre IVs, Kampala City.

Objective: To determine two-year mortality, potential predictors of mortality and time to mortality among TB patients after treatment discharge

Methods: An ambispective cohort study included 259 eligible participants from a parent TB-diabetes cohort. Vital status was established from cohort and facility records, telephone follow-up and verbal-autopsy interviews with next of kin. Mortality was summarized as a cumulative proportion and person-time rate. Firth penalised logistic regression assessed potential predictors, while Kaplan–Meier and exploratory Cox proportional-hazards methods assessed survival and time to death

Results: Participants contributed 6,036 person-months (503 person-years). Ten deaths occurred, giving a two-year cumulative mortality of 3.9% and a crude mortality rate of 19.9 deaths per 1,000 person-years. Five deaths occurred within 0–6 months and five during 6–12 months; none occurred during 12–24 months. Overall survival was 0.981 at six months and 0.961 at 12 months, remaining unchanged through 24 months. HIV-positive status was the strongest potential predictor of mortality across the Firth models (Model A: AOR 3.34, 95% CI 0.96–11.64; Model B: AOR 3.37, 95% CI 0.97–11.71) and the exploratory Cox model (AHR 3.41, 95% CI 0.98–11.84). Dysglycaemia did not show a clear prognostic relationship with mortality (AHR 1.12, 95% CI 0.23–5.54). All adjusted estimates were imprecise because only 10 deaths occurred

Conclusion: Post-treatment mortality was relatively low but was concentrated entirely within the first year. HIV-positive status showed the strongest potential predictor signal, although the estimates remained imprecise. The findings support evaluating structured first-year post-TB follow-up and mortality surveillance, with particular attention to continuity of HIV care among HIV-positive survivors. Larger multicentre prospective studies are needed to confirm predictors of mortality and improve precision and generalizability.

CHAPTER ONE: INTRODUCTION AND BACKGROUND

1.0 Introduction

Tuberculosis (TB) remains one of the leading infectious causes of illness and death worldwide despite major advances in its diagnosis, treatment and prevention. In 2024, an estimated 10.7 million people developed TB and approximately 1.23 million died from the disease (World Health Organization, 2025a). Global and national TB programmes have traditionally assessed treatment success using outcomes such as cure and treatment completion. These indicators are essential for monitoring programme performance; however, they mainly reflect what happens during the treatment period.

Increasing attention is now being given to the health of patients after TB treatment has ended. Some individuals who successfully complete treatment continue to experience recurrent disease, chronic respiratory impairment, functional limitations and premature mortality (Allwood et al., 2021; Nightingale et al., 2023; Romanowski et al., 2019). Consequently, successful treatment does not necessarily indicate complete clinical recovery, and understanding health outcomes after treatment is becoming an important component of TB care.

Post-treatment mortality is particularly relevant in high-TB-burden settings such as Uganda, where HIV infection and other comorbid conditions may influence recovery after treatment. Understanding the magnitude of mortality, when deaths occur, and the factors associated with mortality can provide useful evidence for planning appropriate follow-up and continuity of care.

This dissertation therefore examined mortality among TB patients during the 24 months following treatment discharge at Kawaala and Kiswa Health Centre IVs in Kampala City. Specifically, it determined the magnitude of post-treatment mortality, examined demographic, socio-economic, clinical and health-facility factors associated with mortality, and assessed the timing of death during the two-year follow-up period. The study provides locally relevant evidence to improve understanding of patient outcomes beyond successful TB treatment.

1.1 Background

Evidence from different settings show that people who have been treated for TB, may continue to experience an increased risk of death even after successful treatment. A systematic review and meta-analysis by Romanowski et al. (2019) found an almost threefold pooled standardized mortality ratio among people previously treated for TB compared with the general population. The excess risk was particularly evident during the period following treatment completion. Long-term complications such as residual lung damage, recurrent infection, persistent inflammation and co-existing illnesses have been proposed as possible contributors to this continued vulnerability (Allwood et al., 2021; Nightingale et al., 2023).

The burden of post-treatment illness may be especially important in settings where TB commonly occurs together with other health conditions. HIV, for example, may influence survival after TB treatment through persistent immunosuppression and susceptibility to opportunistic infections. Diabetes and pre-diabetes may affect metabolic and immune recovery, while under-nutrition and chronic lung disease may reduce physiological reserve. Recovery may also be influenced by socio-economic and health-facility factors, including income, transport costs, stigma, social support, access to follow-up services and the quality of care available after treatment.

Uganda remains a high-TB-burden setting. Through the National Tuberculosis and Leprosy Programme, the country has strengthened TB case detection, provision of free treatment, TB/HIV integration and monitoring of treatment outcomes (Ministry of Health, 2023). However, routine programme indicators remain largely focused on diagnosis, treatment and the outcome recorded at the end of treatment, with comparatively less information routinely available on survival after treatment completion.

Existing Ugandan evidence indicates that mortality after TB treatment is clinically important. Lumu et al. (2023), in a cohort of people living with HIV, reported a post-treatment mortality rate of 15.42 deaths per 1,000 person-years, with deaths occurring more frequently during the earlier period of follow-up. Evidence from eastern Uganda has also demonstrated substantial mortality among adults treated for TB (Izudi et al., 2020). Nevertheless, the magnitude and timing of mortality after successful treatment may vary according to population characteristics, HIV status, comorbidities, healthcare access and the setting in which patients receive care.

Kawaala and Kiswa Health Centre IVs are public health facilities operating under the Kampala Capital City Authority. Both facilities participated in the parent TB–diabetes cohort from which participants for the present study were drawn. They provide routine TB diagnosis and treatment, TB/HIV-related services, and referral and follow-up functions. Their participation in the parent cohort provided an opportunity to link existing demographic and clinical information with post-treatment follow-up data and determine mortality outcomes within an urban public-health setting.

Despite this opportunity, facility-specific information on mortality during the two years after TB treatment discharge, the timing of such deaths and the factors associated with mortality at Kawaala and Kiswa Health Centre IVs had not been established within the available study records. Examining these outcomes was therefore important for understanding what happens to patients after they have achieved a favourable TB treatment outcome and for generating evidence that may inform post-treatment care in similar urban Ugandan settings.

CHAPTER TWO: LITERATURE REVIEW

2.1 Tuberculosis overview

2.1.1 Pathophysiology and clinical presentation of TB

Tuberculosis (TB) is caused by Mycobacterium tuberculosis and most commonly affects the lungs, although extra-pulmonary disease can involve almost any organ. Transmission occurs through airborne droplet nuclei released by people with infectious pulmonary TB. After inhalation, the bacilli may be contained by host immunity or progress to active disease. Progression is more likely when immune function is impaired, including in people living with HIV, those with diabetes or under-nutrition, and other clinically vulnerable groups (World Health Organization, 2025a). Pulmonary TB commonly presents with persistent cough, hemoptysis, chest pain, fever, night sweats, fatigue and weight loss, while extra-pulmonary manifestations depend on the site involved.

The biological effects of pulmonary TB can extend beyond the period of active infection. Tissue destruction, fibrosis and airway distortion may persist even after bacteriological cure. This is important to the present study because mortality after treatment may reflect not only recurrent TB but also residual organ damage and interacting comorbidities. In a national Ugandan survey involving 41,154 adults, van Kampen et al. (2019) identified 798 participants with a previous history of TB. Among these survivors, 16% reported chronic respiratory symptoms and 41% had chest radiograph abnormalities. After adjustment for age, sex, smoking, education, setting and region, previous TB was associated with fourfold higher odds of chronic respiratory symptoms (adjusted OR 4.02, 95% CI 3.25–4.96) and markedly higher odds of radiographic abnormalities (adjusted OR 17.52, 95% CI 14.76–20.79). These findings show that apparent treatment success can coexist with substantial residual pulmonary disease.

Comorbidity further complicates recovery. Diabetes, for example, is associated with poorer TB outcomes, while hyperglycaemia detected during active disease may not always represent established diabetes. Menon et al. (2020) in a systematic review of 11 prospective studies, found newly detected hyperglycaemia in 27.3% of participants at baseline. About half of these newly detected cases remained unresolved at follow-up, although the pooled prevalence of hyperglycaemia at three to six months was lower at 11% (95% CI 7–16%). This distinction is

relevant when interpreting diabetes and pre-diabetes in post-TB cohorts because metabolic abnormalities recorded during active disease may persist in some patients but resolve in others.

The wider post-TB literature supports this clinical picture. Allwood et al. (2021) describe persistent airflow obstruction, bronchiectasis, fibrosis and reduced exercise capacity as important consequences of previous pulmonary TB. Nightingale et al. (2023) place these respiratory effects within a broader view of post-TB health that also includes cardiovascular, neurological, psychological, social and economic outcomes. Evidence on intervention is more limited. In a systematic review and meta-analysis of 25 studies involving 10,592 participants, Alene et al. (2024) found that rehabilitation produced a small but significant improvement in lung function (Hedges's g = 0.21, 95% CI 0.03–0.39), while evidence for several other preventive approaches remained insufficient. Thus, persistent morbidity after TB is well described, but the best way to prevent or manage every post-treatment complication is not yet established.

2.1.2 Treatment regimens and guidelines: global and Ugandan perspectives

Treatment depends on drug susceptibility, disease site and patient characteristics. Drug-susceptible pulmonary TB is generally treated with a multidrug regimen containing an intensive phase followed by a continuation phase, while drug-resistant disease requires regimens selected according to resistance patterns and current national and international guidance (World Health Organization, 2025b). In Uganda, the National Tuberculosis and Leprosy Programme coordinates free TB diagnosis and treatment, adherence support, HIV testing and linkage, contact investigation and routine reporting (Ministry of Health, 2023). These programme functions are essential, but their principal indicators remain centered on diagnosis, treatment and the outcome recorded when treatment ends.

Clinical trial evidence has substantially changed the treatment of highly drug-resistant TB and illustrates why treatment success should be considered separately from longer-term health. In the Nix-TB trial conducted at three South African sites, Conradie et al. (2020) treated 109 patients with extensively drug-resistant or treatment-intolerant/non-responsive multidrug-resistant TB using a six-month all-oral regimen of bedaquiline, pretomanid and linezolid. Ninety per cent achieved a favourable outcome six months after treatment. However, peripheral neuropathy occurred in 81% and myelosuppression in 48%, demonstrating that effective microbiological treatment can still carry an important burden of treatment-related morbidity.

The subsequent ZeNix trial tested whether linezolid exposure could be reduced without losing much efficacy. Among 181 participants, favorable outcomes ranged from 84% to 93% across four bedaquiline-pretomanid-linezolid regimens, while lower linezolid doses and shorter exposure reduced neuropathy and myelosuppression (Conradie et al., 2022). The broader implication is that modern TB treatment increasingly achieves high cure rates even in difficult drug-resistant disease, but the end of treatment does not automatically resolve lung damage, adverse drug effects, comorbid disease or social consequences. This distinction underpins the growing interest in post-TB health.

2.1.3 Multidrug-resistant and extensively drug-resistant TB

Multidrug-resistant TB is resistant to at least isoniazid and rifampicin, while definitions for more extensive resistance have evolved alongside new drug classes and molecular testing. Drug resistance remains important because it can prolong illness, delay effective therapy, increase toxicity and leave patients with greater residual disease burden (World Health Organization, 2025b). Although shorter all-oral regimens have improved outcomes, drug-resistant TB survivors are not necessarily comparable with survivors of uncomplicated drug-susceptible disease.

This difference matters when comparing post-treatment mortality studies. Salindri et al. (2024) followed 1,032 adults who had initiated treatment for rifampicin-resistant or multidrug/extensively drug-resistant TB in Georgia. Eighty-seven post-treatment deaths occurred, and HIV co-infection was associated with substantially higher post-TB mortality (aHR 3.74, 95% CI 1.77–7.91). By contrast, the present dissertation concerns participants who completed treatment in routine urban Ugandan Health Centre IVs. Findings from drug-resistant cohorts are therefore informative about mechanisms and high-risk groups but should not be transferred directly to the current population without considering differences in disease severity and treatment history.

2.2 Global and regional TB burden

2.2.1 Epidemiology of tuberculosis

2.2.1.1 Global incidence and mortality

TB remains a major global public-health problem. The World Health Organization estimated that 10.7 million people developed TB and 1.23 million died from the disease in 2024, with low- and

middle-income countries carrying most of the burden (World Health Organization, 2025a). These figures describe the burden during active disease and treatment, but they do not fully capture health loss occurring after treatment completion.

Modeling work suggests that this omitted burden is substantial. Menzies et al. (2021) modeled lifetime health outcomes for people developing TB in 2019 and estimated approximately 122 million disability-adjusted life-years attributable to incident TB. Of these, 58 million DALYs, or about 47% of the estimated lifetime burden, were attributed to post-TB sequelae. The model necessarily relied on assumptions about lung-function loss and subsequent mortality, but it illustrates why an exclusive focus on treatment-period outcomes can underestimate the total health burden of TB.

Empirical studies also show that excess mortality persists after treatment. Romanowski et al. (2019) synthesized ten studies involving 40,781 individuals and 6,922 deaths. Compared with control populations, people previously treated for TB had a pooled standardized mortality ratio of 2.91 (95% CI 2.21–3.84); among those with confirmed cure or treatment completion, the pooled ratio was even higher at 3.76 (95% CI 3.04–4.66). Considerable heterogeneity was present, meaning that the absolute level of risk varies between settings, but the direction of the evidence is consistent: successful treatment does not return all survivors to the mortality profile of people without previous TB.

Wang et al. (2025) similarly describe post-TB morbidity as a combination of chronic respiratory disease, cardiovascular disease, malignancy and other long-term complications that may contribute to excess mortality. Read alongside the burden estimates of Menzies et al. (2021), this evidence cautions against viewing later mortality as recurrent TB alone; some deaths may arise from sequelae or comorbid conditions that persist or develop after microbiological cure.

2.2.1.2 SubSaharan African and Ugandan context

The African region carries a disproportionate TB burden because high transmission intersects with HIV, under-nutrition, poverty and health-system constraints (World Health Organization, 2025a). Within this context, the post-treatment period deserves attention because the same vulnerabilities that complicate active TB may continue after treatment. Evidence from Uganda is now emerging from several different populations rather than from programme reports alone.

Lumu et al. (2023) followed 1,111 antiretroviral-therapy-experienced people living with HIV who had completed TB treatment at a specialist HIV clinic in Uganda. Over 4,410.6 person-years, 67 deaths occurred, giving an all-cause mortality rate of 15.42 per 1,000 person-years (95% CI 12.14–19.59). Mortality was highest in the first year after treatment at 25.89 per 1,000 person-years and fell to 10.65 and 5.37 per 1,000 person-years at years three and five, respectively. Low CD4 count (<200 cells/mL) remained associated with mortality (aHR 1.81, 95% CI 1.06–3.11), as did a history of TB retreatment (aHR 2.12, 95% CI 1.16–3.85). This study is directly relevant to the current dissertation because it demonstrates post-treatment mortality in Uganda, although its specialist HIV-clinic population differs from the mixed HIV-status population at Kawaala and Kiswa.

A similar pattern has been reported outside Uganda. Acharya et al. (2024) analyzed 1,804 HIV-TB co-infected patients from 16 antiretroviral therapy centres in Mumbai, India. Mortality was 18.0% during TB treatment and remained 10.6% in the post-treatment period. A CD4 count of 0-200 cells/mm3 was associated with substantially higher mortality (HR 3.04, 95% CI 2.13-4.15), and a fall in CD4 count between the start and end of TB treatment was associated with higher post-treatment mortality. Although the Mumbai cohort differs from routine Health Centre IV populations in Kampala, the findings strengthen the argument that immune recovery, rather than HIV status alone, is important when interpreting survival after TB treatment.

More recent Ugandan work has broadened this evidence. Baluku et al. (2024) studied 334 pulmonary TB survivors in rural Uganda and documented 38 deaths (11.4%) over 1,333.8 person-years, equivalent to 28.5 deaths per 1,000 person-years. Median time from cure to death was 8.8 months, and mortality was associated with previous hospitalization (aHR 4.3, 95% CI 1.1–16.6) and unemployment (aHR 7.04, 95% CI 1.5–31.6). In a separate Ugandan cohort of 125 pulmonary TB survivors, Bongomin et al. (2025) reported 8.8% mortality and a rate of 24.3 per 1,000 person-years; HIV infection was associated with a threefold higher mortality hazard (aHR 3.04, 95% CI 1.46–6.34). Together these studies show that post-TB mortality is not confined to one Ugandan setting, but estimates differ according to population, disease severity, follow-up duration and clinical context.

2.3 Treatment success and continuing challenges

2.3.1 WHO-recommended treatment and programme delivery

For drug-susceptible pulmonary TB, treatment success remains a central programme objective and is supported by appropriate regimens, adherence counseling, bacteriological monitoring and patient-centred care (World Health Organization, 2025b). Uganda implements these services through the National Tuberculosis and Leprosy Programme, including HIV testing and linkage, contact investigation and outcome reporting (Ministry of Health, 2023). These interventions have improved the management of active TB, but programme success is still largely judged at or before the point of treatment completion.

The difficulty is that the end-of-treatment outcome and the patient's subsequent health are related but not identical. Fox et al. (2019), in a prospective cohort across 70 clinics in Vietnam, enrolled 10,964 adults with smear-positive pulmonary TB and 25,707 household controls. During a median follow-up of 2.9 years, 342 patients died during treatment and a further 637 (5.8%) died after discharge. The standardized mortality ratio among TB patients was 4.0 (95% CI 3.7–4.2) compared with the control population. Nearly half of post-treatment deaths were judged likely to be TB-related using available cause-of-death information. This large cohort demonstrates why treatment success alone is an incomplete indicator of the longer-term burden.

2.3.2 Limitations of treatment-outcome indicators

Standard treatment outcomes are indispensable for programme monitoring, but they do not measure recurrent TB, post-TB lung disease, functional limitation, progression of comorbidities or death occurring after treatment has ended. Evidence from Korea illustrates the difference clearly. Choi et al. (2023) compared 82,098 TB survivors with the same number of matched controls. Mortality was 18.2 per 1,000 person-years among survivors compared with 8.8 per 1,000 person-years among controls, and the fully adjusted mortality hazard remained 62% higher in TB survivors (HR 1.62, 95% CI 1.54–1.70). Such findings argue for viewing cure and treatment completion as important milestones rather than final measures of recovery.

Post-treatment evaluation should therefore complement, not replace, conventional TB programme indicators. The need is not necessarily for every survivor to attend a new specialist clinic. Rather, available evidence supports identifying people with persistent symptoms, poorly controlled comorbidities or other markers of vulnerability and ensuring an appropriate route back

into care. This is consistent with post-TB clinical standards and with qualitative work from African settings showing that survivors and health workers often face uncertainty about where post-treatment problems should be managed (Karanja et al., 2022; Meghji et al., 2024; Migliori et al., 2021).

2.4 Post-treatment outcomes in TB

2.4.1 Definition and classification of treatment outcomes

Standardized TB treatment outcomes allow programmes to compare treatment performance across settings. The principal categories are cure, treatment completion, treatment failure, death, loss to follow-up and not evaluated (World Health Organization, 2025b). A patient is classified as cured when treatment is completed with the required bacteriological evidence of response, while treatment completion refers to completing the prescribed course without evidence of failure but without the bacteriological documentation required for classification as cured. Death refers to death from any cause during treatment; failure, loss to follow-up and not evaluated captures other unfavorable or incomplete treatment outcomes.

These definitions are deliberately treatment-centered. They are not intended to describe the subsequent development of chronic respiratory disease, recurrent TB, disability or death. For the present dissertation, post-treatment mortality therefore represents a distinct outcome period beginning after the recorded favourable treatment outcome. Keeping this distinction clear avoids treating a later death as though it were a failure of the original treatment outcome classification.

2.4.2 Post-TB mortality evidence

The most consistent finding across the literature is that mortality remains elevated after TB treatment, although its absolute magnitude varies widely. Romanowski et al. (2019) found an almost threefold pooled excess mortality compared with control populations. Fox et al. (2019) reported 637 post-discharge deaths among 10,964 Vietnamese patients, while Choi et al. (2023) observed more than twice the crude mortality rate among 82,098 Korean TB survivors compared with matched controls. These studies differ in setting, age structure and methods of outcome ascertainment, but they converge on the conclusion that post-treatment survival deserves separate consideration.

A particularly relevant comparison comes from Uganda. Lumu et al. (2023) reported 15.42 deaths per 1,000 person-years among people living with HIV, Baluku et al. (2024) reported 28.5 per 1,000 person-years among pulmonary TB survivors in rural Uganda, and Bongomin et al. (2025) reported 24.3 per 1,000 person-years in a tertiary-hospital pulmonary TB cohort. These values should not be interpreted as competing estimates of one national rate. Lumu's cohort was restricted to ART-experienced people living with HIV, Baluku's participants came from rural settings, and Bongomin's cohort had a high burden of advanced pulmonary disease and fibrosis. The variation itself is informative because it suggests that post-treatment mortality is shaped by who is studied and how severely affected they were before treatment ended.

2.5 Long-term health and quality of life after TB

Survival is only one aspect of post-TB health. Pulmonary TB can leave fibrosis, bronchiectasis, airflow obstruction, reduced exercise capacity and chronic respiratory symptoms. The Ugandan national survey by van Kampen et al. (2

019) provides local empirical evidence: 16% of 798 people with previous TB reported chronic respiratory symptoms and 41% had radiological abnormalities. These findings show that residual disease is common enough to matter at population level and may provide one pathway linking previous TB with later mortality.

Health-related quality of life may also identify survivors with greater vulnerability. Bongomin et al. (2025) found that 32% of their Ugandan cohort had a St. George's Respiratory Questionnaire score above 60, indicating poor respiratory health-related quality of life. A score above 60 was associated with higher subsequent mortality (aHR 2.01, 95% CI 1.49–2.72). The same cohort had pulmonary fibrosis in 51.2% and far-advanced pulmonary TB in 36.8% at baseline. These findings support the view that residual functional burden can remain clinically important long after treatment completion.

The post-treatment experience also includes uncertainty about symptoms and care seeking. Meghji et al. (2024) interviewed 23 symptomatic pulmonary TB survivors in Blantyre, Malawi, together with 18 health workers and 12 TB officers. Survivors described anxiety about persistent or recurrent symptoms, uncertainty about whether they had truly recovered and uncertainty about where to seek care. Providers similarly reported heterogeneous approaches to investigation and

retreatment. This qualitative evidence helps explain why simply advising patients to return when unwell may not be sufficient if the pathway back to care is unclear.

At a health-facility and service-delivery level, Karanja et al. (2022) interviewed 38 stakeholders from Kenya, Malawi and international organizations and then held workshops involving 59 participants. Stakeholders broadly recognized the need for holistic post-TB care, but identified uncertainty about programme ownership, funding, staff, equipment and integration with non-communicable-disease services. Their findings are useful for the Ugandan context because they show that post-TB follow-up is not only a clinical question; implementation depends on how responsibilities are organized within already constrained health services.

The same need for a broader, survivor-centered approach is evident in review literature. Nightingale et al. (2023) concluded that routine TB outcomes rarely capture health-related quality of life, social recovery, comorbidity and long-term wellbeing, and recommended that these outcomes receive greater attention in post-TB care. Leung et al. (2025) systematically synthesized 16 qualitative studies and identified recurring physical, psychological, social and economic consequences, including stigma and threats to survivors' social roles. Thu et al. (2025), focusing specifically on post-TB lung disease, described continuing respiratory symptoms and reduced lung function after microbiological cure and highlighted the unresolved questions of which patients are at greatest risk and how services should monitor them. These sources complement the cohort studies by showing what mortality statistics alone cannot capture: survival may coexist with substantial continuing illness and reduced wellbeing.

2.6 Mortality after TB treatment

2.6.1 Post-treatment mortality rates

2.6.1.1 Global evidence

Post-treatment mortality has been documented in low-, middle- and high-income settings. The systematic review by Romanowski et al. (2019) reported a pooled standardized mortality ratio of 2.91, while Fox et al. (2019) found 637 post-treatment deaths among 10,964 Vietnamese patients. In Korea, Choi et al. (2023) reported 5,549 deaths among 82,098 TB survivors during 304,971 person-years, giving a mortality rate of 18.2 per 1,000 person-years compared with 8.8 per 1,000 among matched controls. The consistency across these very different settings strengthens the argument that post-treatment mortality is not an isolated programme problem.

At the same time, not every setting shows the same degree of excess mortality. Gorvetzian et al. (2024) linked 3,182 adult TB treatment survivors in Georgia, USA, to the National Death Index and identified 233 deaths (7.3%). The overall age- and sex-adjusted standardized mortality ratio was 0.89 (95% CI 0.73–1.05), although mortality was elevated in important subgroups, including US-born survivors. This contrasts with the high pooled excess mortality reported by Romanowski et al. (2019) and illustrates why local demographic composition, migration, comorbidity and access to health care can modify observed post-TB mortality.

2.6.1.2 Sub-Saharan African and Ugandan evidence

Ugandan studies indicate clinically important mortality after treatment but also demonstrate substantial heterogeneity. Lumu et al. (2023) reported a rate of 15.42 per 1,000 person-years among ART-experienced people living with HIV. Baluku et al. (2024) found a higher rate of 28.5 per 1,000 person-years among 334 rural pulmonary TB survivors, while Bongomin et al. (2025) reported 24.3 per 1,000 person-years in 125 pulmonary TB survivors followed from a tertiary-hospital cohort. The differences probably reflect variation in HIV prevalence, previous disease severity, health-service level, follow-up duration and ascertainment rather than simple geographical differences.

Evidence from eastern and north-eastern Uganda also demonstrates that treatment outcomes are embedded in social and service conditions. Izudi et al. (2020) documented mortality among adults treated for TB in rural eastern Uganda, while Nidoi et al. (2021) found that socio-economic circumstances strongly influenced treatment outcomes in Karamoja. Although these studies were not designed specifically around post-treatment mortality, they provide important context: the patients who enter the post-treatment period do so with different levels of material resources, access to care and physiological reserve.

2.6.2 Timing and factors associated with mortality

2.6.2.1 Importance of the first two post-treatment years

The timing of death is important because an identical two-year mortality proportion can have different programme implications depending on whether deaths occur immediately after treatment or are spread evenly over time. Ugandan evidence suggests that risk is often concentrated early. In Lumu et al. (2023) mortality was 25.89 per 1,000 person-years in the first year, compared with 10.65 in year three and 5.37 in year five. Baluku et al. (2024) similarly

reported a median interval from cure to death of only 8.8 months. These patterns support close attention to the transition from treatment completion into the first post-treatment year.

International data show a similar, although not identical, pattern. Salindri et al. (2024) observed 87 post-treatment deaths among people treated for drug-resistant TB in Georgia, with a median time to death of 21 months. The longer interval than in the Ugandan rural cohort may reflect different disease, treatment and health-service contexts. The consistent point is not that all post-TB deaths occur within a fixed period, but that the early years after treatment carry appreciable risk and merit explicit study.

Several pathways may contribute to this early vulnerability. Residual lung damage can limit respiratory reserve; recurrent disease can emerge; nutritional recovery may be incomplete; and HIV or metabolic disease may remain poorly controlled. The concentration of risk should therefore not be interpreted as proof that lack of post-treatment follow-up causes mortality. Rather, it identifies a period when unresolved disease and comorbidity may become clinically apparent and when timely access to care could be particularly important.

2.6.2.2 Later post-treatment mortality

Excess risk does not necessarily disappear after the first year. Choi et al. (2023) followed a large population-based cohort for several years and still found an adjusted mortality hazard 1.62 times that of matched controls. Romanowski et al. (2019) likewise included studies with at least 12 months of follow-up and found sustained excess mortality. Later deaths are likely to be heterogeneous, including respiratory, cardiovascular, malignant, infectious and other causes rather than recurrent TB alone.

This broader cause-of-death profile is supported by international data. In the Romanowski et al. (2019) meta-analysis, cardiovascular disease accounted for approximately 20% of reported post-treatment deaths. Gorvetzian et al. (2024) similarly found cardiovascular disease and malignancy to be common causes of death among US TB survivors, while HIV-related mortality was markedly over-represented relative to the general population. These findings caution against interpreting all-cause post-TB mortality as a direct measure of recurrent TB

2.7 Predictors of post-treatment mortality

2.7.1 Demographic and socio-economic factors

Age and sex frequently predict long-term mortality, but their effects depend on the composition of the cohort. In the Korean population study, male TB survivors had more than twice the mortality hazard of females (adjusted HR 2.31, 95% CI 2.16–2.47), and mortality increased with age (Choi et al., 2023). Large population-based studies have sufficient events to estimate these gradients precisely. Smaller cohorts, including the present study, may not reproduce them because relatively few deaths produce wide confidence intervals even when the direction of effect is similar.

Socio-economic position is also relevant, although it is measured differently across studies. Choi et al. (2023) reported a higher mortality hazard among survivors in the lowest income category (HR 1.27, 95% CI 1.18–1.37). In rural Uganda, Baluku et al. (2024) found a much stronger association with unemployment (aHR 7.04, 95% CI 1.5–31.6), but the wide interval indicates considerable uncertainty around the magnitude. Income and employment should not be treated as interchangeable: income measures current resources, while employment may also reflect functional capacity, social position and illness severity.

Nidoi et al. (2021) provide additional Ugandan evidence, although their outcome was treatment success rather than post-treatment mortality. In 264 former TB patients from ten diagnostic and treatment units in Karamoja, the wealthiest quintile had lower odds of an unsuccessful treatment outcome (adjusted OR 0.42, 95% CI 0.18–0.99), while informal-sector employment was associated with higher odds of an unsuccessful outcome (adjusted OR 4.71, 95% CI 1.18–18.89). Qualitative findings identified inadequate food, migration, stigma, lack of social protection, drug stock-outs and transport difficulties. This study supports the plausibility of socio-economic pathways but should not be cited as direct evidence of post-treatment mortality.

Socio-economic consequences may also extend beyond the individual patient. Atkins et al. (2022) reviewed 36 studies on the socio-economic effects of TB on children and adolescents, including 29 qualitative, five quantitative and two mixed-methods studies. The studies described impoverishment, stigma, family separation, nutritional effects and missed education. Although the review focused on younger populations and was not designed to estimate post-treatment mortality, it demonstrates how TB can continue to affect household resources and social

functioning. This supports treating income in the present study as one indicator of socio-economic position rather than as a complete measure of vulnerability.

2.7.2 Clinical factors

HIV is among the most consistently reported clinical determinants of mortality after TB treatment. In Lumu et al. (2023), all participants were living with HIV, but poorer immune status distinguished higher-risk survivors: CD4 count below 200 cells/mL was associated with an 81% higher adjusted mortality hazard. Bongomin et al. (2025) compared HIV-positive and HIV-negative pulmonary TB survivors in Uganda and found an aHR of 3.04 (95% CI 1.46–6.34). Salindri et al. (2024) reported a similar pattern in drug-resistant TB survivors in Georgia, where HIV was associated with an aHR of 3.74 (95% CI 1.77–7.91). The consistency across different settings strengthens biological plausibility, but the size of the association still depends on ART access, immune recovery, viral suppression and competing illnesses.

Diabetes has a well-established association with adverse outcomes during TB treatment, but evidence specifically after treatment is more mixed. Huangfu et al. (2019) reviewed 104 publications; 64 studies reporting mortality included 56,122 people with TB and diabetes and 243,035 with TB alone. Diabetes was associated with higher odds of death (OR 1.88, 95% CI 1.59–2.21) and relapse (OR 1.64, 95% CI 1.29–2.08). However, these estimates mainly concern treatment-period and overall TB outcomes rather than mortality beginning strictly after treatment completion.

Post-treatment analyses are less consistent. Houck et al. (2023) studying 927 people with TB in the state of Georgia, found a strong association between diabetes and death before or during treatment, but the post-treatment estimate was less precise. In adjusted cause-specific analysis, diabetes had an HR of 2.69 (95% CI 0.71–10.16), while pre-diabetes had an HR of 1.38 (95% CI 0.14–13.91). These wide intervals crossed one. Gorvetzian et al. (2024) using a much larger post-treatment survivor cohort, found diabetes associated with post-treatment mortality (adjusted HR 2.05, 95% CI 1.44–2.91). The difference between studies suggests that diabetes is clinically important but that its post-treatment effect is sensitive to sample size, case definition and population characteristics.

Nutritional status may act both as a marker of disease severity and as a determinant of recovery. In Korea, higher BMI was associated with lower long-term mortality among TB survivors (HR 0.91 per unit increase, 95% CI 0.90–0.92) (Choi et al., 2023). Among adults treated for drug-resistant TB in Georgia, Chakhaia et al. (2025) found that failure to gain weight was associated with substantially higher mortality during and after treatment; among those with low baseline BMI, lack of weight gain was associated with approximately fivefold higher post-treatment mortality (aHR 4.99, 95% CI 1.25–19.94). This suggests that change in nutritional status may be more informative than a single BMI measurement.

Residual pulmonary disease is another plausible determinant. van Kampen et al. (2019) documented high levels of respiratory symptoms and radiographic abnormality among Ugandan TB survivors, while Bongomin et al. (2025) found that poor respiratory health-related quality of life predicted mortality. These findings do not prove that lung damage caused individual deaths, but they support including chronic respiratory disease and functional status in post-TB risk assessment where feasible.

Treatment-related toxicity may also contribute to long-term health, especially among people treated for drug-resistant TB. The Nix-TB and ZeNix trials achieved high favorable-outcome proportions but documented substantial linezolid-related neuropathy and myelosuppression, particularly with higher and longer dosing (Conradie et al., 2020, 2022). This is a reminder that a favorable microbiological outcome does not necessarily imply that treatment-related morbidity has fully resolved.

2.7.3 Social and behavioural factors

Behavioural exposures can interact with pre-existing lung injury and other chronic disease. Choi et al. (2023) found that cumulative smoking exposure and heavy alcohol consumption were independently associated with mortality among TB survivors; heavy alcohol use carried an adjusted HR of 1.12 (95% CI 1.01–1.23). In the US Georgia cohort, excess alcohol use was associated with post-treatment mortality even after adjustment (HR 1.64, 95% CI 1.17–2.30) (Gorvetzian et al., 2024). These findings support measuring smoking and alcohol use in post-TB research, while also showing why missing comparator data can prevent meaningful estimation.

The association between alcohol and TB is also supported by broader epidemiological evidence. Imtiaz et al. (2017) included 36 studies in meta-analyses of alcohol exposure and TB risk. Any alcohol use was associated with a 35% higher risk of TB (RR 1.35, 95% CI 1.09-1.68), while alcohol-related problems were associated with more than threefold higher risk (RR 3.33, 95% CI 2.14-5.19). These estimates concern TB incidence rather than post-treatment mortality and should not be interpreted as direct evidence for death after cure. They nevertheless support the biological and behavioural relevance of harmful alcohol use when studying long-term outcomes in TB survivors.

Stigma, social support and transport constraints may affect outcomes less directly, mainly by shaping care seeking, nutrition and continuity of treatment for comorbid conditions. Nidoi et al. (2021) identified stigma, food insecurity, migration and transport barriers as important influences on TB treatment outcomes in Karamoja. Although these findings relate to the treatment period, similar mechanisms can plausibly operate after treatment, when formal TB support may be reduced. For this reason, social and behavioural variables should be interpreted as potential pathways rather than assumed direct causes of mortality.

2.7.4 Health-facility factors

Post-treatment care depends on whether survivors know where to seek help and whether services can respond to persistent symptoms and comorbidities. Meghji et al. (2024) found that symptomatic survivors in Blantyre often experienced uncertainty about returning to care, while providers described inconsistent investigation and referral practices. Karanja et al. (2022) similarly found that stakeholders in Kenya and Malawi identified unclear leadership, limited funding, staff shortages, equipment constraints and weak integration between TB and NCD programmes as barriers to implementing post-TB services.

These findings suggest that health-facility variables should go beyond counting clinic visits. Frequent visits may reflect deteriorating health rather than good or poor care, creating the possibility of reverse causation. More informative measures would include why the patient attended, whether symptoms were assessed, actual waiting time, whether referral was completed and whether appropriate investigations were available. The current dissertation includes participant-reported access, quality, waiting time and follow-up attendance; these are useful indicators, but they capture only part of the post-treatment care pathway.

Romanowski et al. (2023) used a theory-informed process to develop a post-TB care package in British Columbia and emphasized the need to link assessment to practical referral and management pathways rather than simply adding surveillance. Although that work arose from a high-income setting, the principle is relevant to Uganda: post-treatment follow-up is most useful when findings can trigger an achievable clinical action within existing health services.

2.7.5 Synthesis of recent evidence informing this study

Across the reviewed evidence, bacteriological treatment success and complete recovery are clearly not the same outcome. Large cohorts from Vietnam and Korea, meta-analytic evidence and Ugandan cohort studies all demonstrate continuing mortality after treatment (Choi et al., 2023; Fox et al., 2019; Lumu et al., 2023; Romanowski et al., 2019). Ugandan data also show that many survivors continue to have respiratory symptoms or structural lung abnormalities (van Kampen et al., 2019). Clinical and qualitative reviews reach the same broader conclusion: post-TB health includes respiratory impairment, other comorbidities, psychological wellbeing, social functioning and economic recovery, not survival alone (Allwood et al., 2021; Leung et al., 2025; Nightingale et al., 2023; Thu et al., 2025). Rehabilitation may improve selected outcomes, but evidence for many specific post-TB interventions is still developing (Alene et al., 2024; Wang et al., 2025).

The literature is less uniform on who is most likely to die after treatment. HIV shows one of the more consistent positive associations, particularly where immune recovery is poor. This pattern appears in Ugandan cohorts and in studies from other settings, including the Mumbai HIV-TB cohort reported by Acharya et al. (2024) and the drug-resistant TB cohort analyzed by Salindri et al. (2024) Diabetes is also associated with worse TB outcomes overall, but post-treatment estimates vary from clear associations in larger cohorts to wide, inconclusive estimates in smaller studies (Gorvetzian et al., 2024; Houck et al., 2023; Huangfu et al., 2019). Nutritional recovery, residual lung disease and socio-economic disadvantage are also plausible contributors, although they are measured differently across studies.

Timing adds another layer to this variation. Lumu et al. (2023) and Baluku et al. (2024) found mortality concentrated relatively early after treatment, whereas population-based studies and meta-analyses show that excess risk can persist for several years (Choi et al., 2023; Romanowski et al., 2019). This makes time to death important in its own right rather than simply an extension

of a cumulative mortality proportion. It also means that an early concentration of deaths in one cohort should not be interpreted as evidence that risk disappears after the first year.

Differences in study design further complicate direct comparison. Follow-up may begin at cure, treatment completion or another recorded discharge point; deaths may be identified through registries, active tracing or verbal autopsy; and losses to follow-up may be censored, excluded or handled in sensitivity analyses. Lumu et al. (2023) for example, showed that treating all participants lost to follow-up as deaths increased the estimated mortality rate from 15.42 to 44.65 per 1,000 person-years. Transparent outcome ascertainment, explicit censoring rules and emphasis on confidence intervals are therefore essential when interpreting post-TB mortality studies.

For the present study, the evidence supports a multi-domain approach rather than a search for one universal predictor. Clinical factors such as HIV, dysglycaemia, nutritional status and chronic lung disease may interact with material circumstances, behaviour and access to continuing care. Socio-economic and service factors are also not interchangeable: income, employment, transport constraints, waiting experience and follow-up attendance represent different parts of the recovery pathway(Atkins et al., 2022; Imtiaz et al., 2017; Nidoi et al., 2021; Romanowski et al., 2023). These relationships are best interpreted as plausible and interacting pathways, particularly in a small observational cohort where adjusted associations cannot establish causation.

2.8 Research gaps addressed

Important evidence now exists on TB treatment outcomes and on the longer-term health of TB survivors. The remaining gap is therefore broader than the absence of a mortality estimate for Kawaala and Kiswa. First, routine programme indicators largely end at treatment outcome, creating a discontinuity between documented treatment success and what happens to patients afterwards. Second, Ugandan post-treatment evidence comes from selected populations and settings, including specialist HIV care, rural cohorts and tertiary-hospital survivors, which may not represent patients discharged from urban Health Centre IVs. Third, available studies do not consistently examine clinical, socio-economic and health-facility factors together. Finally, the timing of post-treatment deaths is not routinely captured, yet this information is important for determining when follow-up may be most useful.

2.8.1 Limited Ugandan post-treatment outcome evidence

Ugandan studies have demonstrated that post-treatment mortality is real, but each answers a somewhat different question. Lumu et al. (2023) focused exclusively on people living with HIV in specialist care; Baluku et al. (2024) studied pulmonary TB survivors in rural Uganda; and Bongomin et al. (2025) followed survivors from a tertiary-hospital pulmonary TB cohort with substantial residual lung disease. These studies provide important benchmarks, but there remains limited evidence from routine urban lower-level facilities serving a mixed population. The present study contributes to this gap by following eligible participants discharged from Kawaala and Kiswa Health Centre IVs.

2.8.2 Limited multi-domain analysis of potential predictors

Much of the literature examines one domain at a time. HIV studies often have detailed immunological data but limited socio-economic information; studies of diabetes focus on metabolic status; and qualitative health-facility studies describe access and service organization without estimating mortality hazards. Yet post-treatment recovery is likely to reflect interaction between biological reserve, comorbidity, material resources and care access. By examining available demographic, socio-economic, clinical and follow-up variables in the same cohort, this dissertation attempts a broader assessment while recognizing that only routinely available or collected variables can be analyzed.

2.8.3 Limited evidence on timing after treatment discharge

Existing evidence suggests that mortality is often concentrated soon after treatment, but the pattern is not uniform. Lumu et al. (2023) reported the highest mortality rate in the first year, and Baluku et al. (2024) found a median time to death of 8.8 months, whereas other cohorts observed substantial mortality for several years. Before the present analysis, the distribution of deaths across the first 24 months had not been described for eligible participants from the two study facilities. Estimating both cumulative mortality and time to death therefore addresses a practical gap that a single end-point proportion would miss.

CHAPTER THREE: STATEMENT OF THE PROBLEM, JUSTIFICATION AND CONCEPTUAL FRAMEWORK

3.1 Problem statement

Although successful completion of tuberculosis treatment is an important programme achievement, evidence from Uganda shows that mortality continues after treatment has ended. At the Infectious Diseases Institute in Kampala, Lumu et al. (2023) followed 1,111 ART-experienced people living with HIV after TB treatment completion and reported an overall mortality rate of 15.42 deaths per 1,000 person-years; mortality was highest in the first year at 25.89 per 1,000 person-years. More recently, a cohort of 125 pulmonary TB survivors followed from Mulago National Referral Hospital in Kampala recorded 8.8% mortality and a rate of 24.3 deaths per 1,000 person-years (Bongomin et al., 2025). In rural Uganda, Baluku et al. (2024) reported 11.4% cumulative mortality and 28.5 deaths per 1,000 person-years among 334 pulmonary TB survivors. These findings indicate that post-treatment mortality is clinically important in Uganda, although the magnitude varies across populations and settings.

Several responses have been implemented to improve TB outcomes and address important comorbidities. Uganda has strengthened directly observed treatment, routine HIV testing and linkage to antiretroviral therapy, contact investigation and treatment-outcome monitoring (Ministry of Health, 2023). In Kampala, diabetes screening has also been integrated into routine TB services. In a 2016–2017 implementation study across ten Kampala health facilities, including Kawaala and Kiswa Health Centre IVs, 4,590 TB patients were registered and 88.0% were screened using random blood glucose; 92 patients were identified with diabetes. Kawaala and Kiswa registered 593 and 299 TB patients, respectively, during the reporting periods, showing that both facilities were active TB treatment sites and had already participated in TB–diabetes integration (Nsonga et al., 2019). International post-TB standards have also increasingly recommended assessment for persistent symptoms, functional impairment and comorbidity after treatment completion (Nightingale et al., 2023; World Health Organization, 2025b)

Despite these efforts, most routine TB interventions and indicators remain concentrated on diagnosis, the treatment period and the treatment outcome recorded at completion. The Kampala diabetes-screening initiative addressed an important comorbidity during TB care, but it did not establish longer-term survival after treatment. Similarly, the post-treatment studies from the Infectious Diseases Institute and Mulago National Referral Hospital provide important Kampala

evidence, but they involved selected populations—a specialist HIV cohort and a tertiary-hospital pulmonary TB cohort—and therefore do not directly describe outcomes among the broader mixed-HIV-status population treated at urban Health Centre IVs.

For Kawaala and Kiswa Health Centre IVs specifically, the magnitude of mortality during the first two years after TB treatment discharge, the period in which deaths are concentrated, and the patient or health-facility characteristics that may predict mortality had not been established in the available cohort information. This gap has practical implications. If clinically vulnerable patients die soon after discharge, routine services that largely conclude active TB follow-up at treatment completion may have limited opportunity to identify persistent respiratory disease, HIV-related illness, metabolic problems, nutritional vulnerability or other complications requiring continued care. The issue is therefore not simply the absence of facility-specific statistics, but the limited evidence available to guide who may need closer post-treatment attention and when that attention may be most useful.

This study therefore quantified mortality within 24 months after TB treatment discharge, examined potential predictors of mortality and described time to death among eligible members of the parent TB–diabetes cohort at Kawaala and Kiswa Health Centre IVs. By using a cohort with existing clinical and demographic information and supplementing it with post-treatment outcome ascertainment, the study sought to provide locally relevant evidence on the transition from a favourable TB treatment outcome to subsequent survival.

3.2 Justification

Locally generated evidence on the magnitude and timing of post-TB mortality can help clinicians and programme managers determine whether post-treatment follow-up warrants greater attention and when it may be most useful. Identifying potential predictors can also help define groups that may merit closer clinical assessment, while evaluation of HIV, glycaemic and nutritional status alongside health-facility experiences supports more integrated TB–HIV–non-communicable-disease planning. The study makes efficient use of a well-characterized parent cohort, supplemented by post-treatment outcome follow-up, and provides evidence from urban Health Centre IVs that complements existing Ugandan studies from specialist HIV, tertiary-hospital and rural settings.

3.3 Conceptual framework

The conceptual framework for this dissertation was developed by the researcher from the reviewed post-TB literature rather than being adopted from a single named model. It groups potential predictors into demographic and socio-economic, clinical, behavioural and social, and health-facility and follow-up domains. All four domains are linked to post-treatment mortality and time to mortality, while dashed arrows in Figure 3.1 show selected relationships among the domains and double-headed arrows show plausible reciprocal pathways.

The measured variables are presented as stand-alone constructs: age, sex, highest level of education attained, occupation, monthly income, HIV status, glycaemic status, nutritional status, recorded comorbidities, post-treatment social support, reported stigma challenge, transport-cost challenge, number of post-treatment follow-up visits, access to post-treatment follow-up care, perceived quality of follow-up care and perceived long waiting time. Smoking and alcohol history were available only for deceased participants and are therefore shown with other incompletely measured or unmeasured factors.

The inter-domain arrows are supported by empirical evidence. In north-eastern Uganda, Nidoi et al. (2021) found that the wealthiest quintile had lower odds of an unsuccessful TB treatment outcome (adjusted OR 0.42, 95% CI 0.18–0.99), while qualitative findings linked financial hardship with food and transport barriers, stigma, social support and difficulties reaching TB services; this supports pathways from socio-economic conditions to behavioural/social and health-facility factors. Meghji et al. (2024) found that persistent post-TB respiratory symptoms shaped anxiety, care seeking and routes of return to health facilities, supporting links from clinical status and the evolving post-treatment health trajectory to facility use. Leung et al. (2025), synthesizing 16 qualitative studies, identified physical, psychological, economic and social effects of post-TB sequelae, including threats to social roles, stigma and limited access to care. Together with Nightingale et al. (2023) and Karanja et al. (2022), these findings support clinical and socio-economic influences on social and health-facility domains, a reciprocal relationship between behavioural/social and health-facility factors, and feedback arrows from the outcome domain to those two domains. These reverse arrows represent changes during the post-treatment health trajectory before death or censoring; they do not imply that death itself causes the preceding exposures. Plausible but incompletely measured factors such as objective

pulmonary function, recurrent TB, treatment adherence, mental health and housing conditions are shown separately.

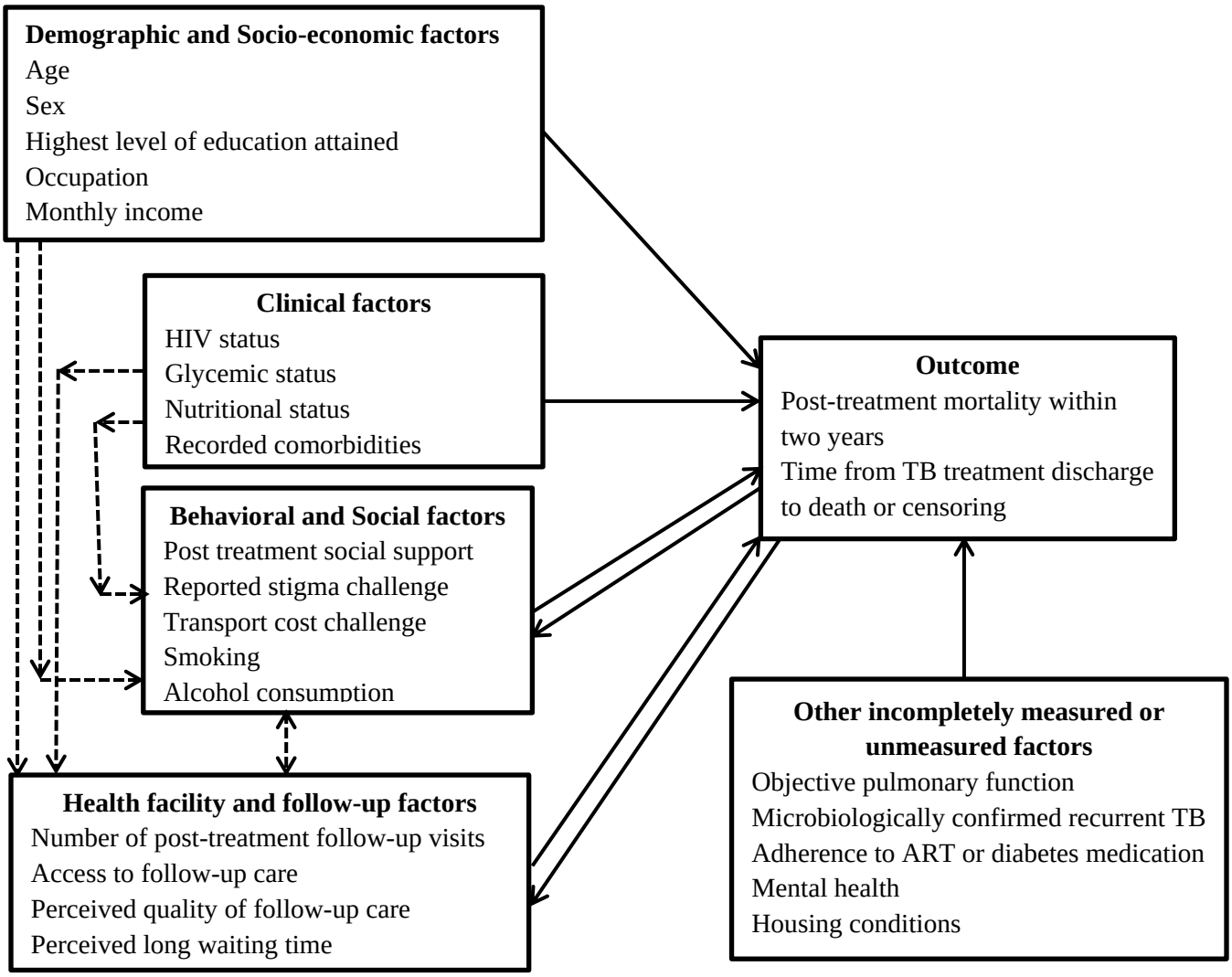


Figure 3.1 Researcher-developed conceptual framework for post-treatment mortality and time to mortality

Note: Solid arrows: Hypothesized pathways to the outcome, Dashed arrows: Relationships among factor domains, Double headed arrows: Reciprocal pathways.
Inter-domain pathways informed by Nadoi et al, (2021), Nightingale et al, (2023), Meghji et al, (2024), Karanga et al, (2022) and Leung et al, (2025).
Smoking and alcohol consumption history were incompletely measured and were not estimable for survivor comparisons.

CHAPTER FOUR: RESEARCH QUESTIONS AND STUDY OBJECTIVES

4.1 Research questions

1. What was the cumulative mortality and crude mortality rate among TB patients within two years after treatment discharge at Kawaala and Kiswa Health Centre IVs?

2. Which measured demographic, socio-economic, clinical and health-facility characteristics were potential predictors of mortality within two years after TB treatment discharge?
3. What was the time-to-death pattern, and which selected patient characteristics were potential predictors of time to death within two years after TB treatment discharge?

4.2 General objective

To determine mortality and its predictors among TB patients within two years after TB treatment discharge at Kawaala and Kiswa Health Centre IVs, Kampala City, Uganda.

4.3 Specific objectives

1. To determine the cumulative mortality and crude mortality rate among TB patients within two years after treatment discharge at Kawaala and Kiswa Health Centre IVs.

2. To determine demographic, socio-economic, clinical and health-facility predictors of mortality within two years after TB treatment discharge among patients at Kawaala and Kiswa Health Centre IVs.
3. To determine time to mortality and its predictors within two years after TB treatment discharge at Kawaala and Kiswa Health Centre IVs.

CHAPTER FIVE: METHODOLOGY

5.1 Study design

An ambispective cohort design was used. The retrospective component extracted demographic, clinical and treatment information from the parent TB–diabetes cohort and facility records. The prospective component used telephone follow-up to establish post-treatment vital status and selected follow-up experiences; verbal-autopsy interviews with next of kin were conducted for confirmed deaths. Participants contributed follow-up for up to 24 months after TB treatment discharge.

5.2 Study setting

The study was conducted at Kawaala and Kiswa Health Centre IVs in Kampala, Uganda. Both facilities were included in the parent TB–diabetes cohort and operated within the Kampala Capital City Authority public-health system. Study documentation indicates that the sites provided routine TB assessment and treatment, treatment-outcome recording, HIV-related services and referral or follow-up functions. Their participation enabled linkage of parent-cohort measurements with facility records and post-treatment telephone outcome ascertainment.

The sites were selected because they hosted the parent cohort and had identifiable TB treatment and contact records required for post-treatment follow-up. The supplied documents did not contain reliable current comparative notification or mortality statistics for surrounding Health Centre IVs; the site justification is therefore based on cohort linkage, service relevance and feasibility rather than an unsupported claim that these facilities had the highest burden.

5.3 Study population

The source population comprised 284 participants enrolled in the parent TB–diabetes cohort with microbiologically confirmed pulmonary TB. The analytic population for this dissertation comprised 259 participants who met the eligibility criteria and had sufficient information for post-treatment vital-status ascertainment. The analytic outcome classified 10 confirmed deaths and 249 participants who survived or were censored.

5.4 Eligibility criteria

5.4.1 Inclusion criteria

Participants were eligible if they were members of the parent TB–diabetes cohort, had a recorded favourable TB treatment outcome and end-of-treatment date within the study period, and had sufficient identifying and follow-up information to ascertain post-treatment vital status for inclusion in the mortality or survival analysis.

5.4.2 Exclusion criteria

Participants were excluded if their records could not be linked reliably to the parent cohort, a valid TB treatment-discharge time origin could not be established, died or lost to follow up before completion of treatment or post-treatment vital status could not be ascertained sufficiently for analysis. The supplied records established that 25 of the parent cohort's 284 participants were excluded and were not in the analytic cohort because they were either dead or loss to follow up before end of treatment (Therefore had no established outcome of Cured or completed treatment).

5.5 Sample-size justification

No separate a priori sample-size formula was applied. The study sought to include the full eligible and ascertainable cohort nested within the parent study. Of 284 parent-cohort participants, 259 (91.2%) were included in the analytic cohort. This census-type inclusion maximized the available information but did not guarantee adequate precision for predictor modelling. With only 10 deaths, adjusted estimates were expected to have wide confidence intervals and were treated as exploratory.

5.6 Sampling procedure

Parent-cohort identifiers were used to enumerate potentially eligible participants. Records were linked to TB registers, clinical charts and laboratory or cohort files. Participants with an eligible treatment-discharge record were followed through the available record and telephone sources. All participants meeting the eligibility and outcome-ascertainment requirements were included; no random or systematic subsampling was performed.

5.7 Study variables and operational measurement

The primary outcomes were all-cause mortality within 24 months and time from TB treatment discharge to death or censoring. Candidate explanatory variables were selected from the researcher-developed conceptual framework and the variables available in the study records. Table 5.1 defines the measurements and analysis categories. Where the source documentation did not support a numeric threshold, none was introduced.

Table 5.1 Study variables, operational measurements, analysis categories and data sources

Variable	Operational definition/ measurement	Analysis category	Source
Mortality status	Confirmed all-cause death within 24 months after TB treatment discharge; otherwise alive/censored.	Alive/Dead	Facility/parent-cohort records telephone follow-up; next-of-kin confirmation
Time to death/censoring	Months from the recorded treatment-discharge date to death or censoring.	Continuous months; interval midpoint used when exact date unavailable	Treatment records; follow-up report; verbal autopsy
Age	Age in completed years in the parent record.	Continuous; per 10 years for crude analysis; standardized per SD in Firth Model A	Parent TB–DM cohort record
Sex	Sex recorded in the cohort record; spelling/case harmonized.	Female; male	Parent TB–DM cohort record
Highest level of education attained	Highest recorded education level.	None; primary; secondary; tertiary	Parent cohort/facility record

Occupation	Recorded principal occupation.	Farmer; trader; professional; unemployed; other	Parent cohort/facility record
Monthly income	Self-reported monthly income category in Uganda shillings.	<100,000; 100,000–500,000; >500,000	Parent cohort/follow-up record
HIV status	Most recent recorded HIV result/status.	Negative; positive; unknown. Unknown excluded from HIV contrasts/models	Clinical chart; laboratory/parent-cohort record
Diabetes/pre-diabetes	Diabetes or pre-diabetes classification recorded by the parent cohort; thresholds were not re-derived in this dissertation.	Dysglycaemia (diabetes or pre-diabetes); neither recorded	Parent TB–DM cohort laboratory/clinical record
Nutritional status	Nutritional/BMI category recorded in the parent dataset; original numeric thresholds were not available in the supplied materials.	Underweight; normal; overweight; obese. Underweight vs not underweight in Model B	Parent cohort/clinical chart
Other comorbidity	Condition named in the record, including chronic lung disease, hypertension or malnutrition.	Recorded; not recorded for each condition	Clinical chart/parent-cohort record
Number of post-treatment follow-up visits	Number of documented/reported post-treatment visits.	None, once, twice, more than twice, or missing as recorded	Telephone follow-up /facility record
Access to post-treatment follow-up care	Participant-reported ease of obtaining follow-up care.	Easy; difficult	Telephone follow-up

Perceived quality of post-treatment follow-up care	Participant-reported rating of follow-up services.	Excellent; good; fair; poor	Telephone follow-up
Perceived long waiting time	Whether ‘long waiting times’ was selected/reported as a follow-up challenge. The instrument specified no duration threshold.	Reported; not reported	Telephone follow-up structured item
Transport-cost challenge	Whether transport costs were reported as a follow-up challenge.	Reported; not reported	Telephone follow-up structured item
Reported stigma challenge	Whether stigma was reported as a follow-up challenge.	Reported; not reported	Telephone follow-up structured item
Post-treatment social support	Recorded perceived support after treatment.	Weak/none; moderate; strong	Telephone follow-up
Nutritional support	Whether nutritional support during treatment was recorded.	Yes; no	Parent cohort/clinical record
Smoking and alcohol	Behavioural history recorded in Verbal autopsy for deceased participants.	Not used for survivor-versus-deceased association estimation because comparator data were structurally absent	Verbal autopsy

Note. Categories reproduce the supplied study records. No threshold was added when the source instrument or data dictionary did not provide one.

Table 5.2 Variables obtained from each data source

Data source	Variables/information obtained
Parent TB–DM cohort records	Identifier, age, sex, education, occupation, income, HIV, glycaemic classification, nutritional status, comorbidities and treatment dates/outcomes.
TB register	TB diagnosis, treatment course, recorded outcome and treatment-discharge date.
Clinical charts	HIV and comorbidity information, clinical history and treatment documentation where available.
Laboratory records	HIV and glycaemic-related results/classifications available to the parent cohort.
Telephone post-treatment follow-up	Vital status, last-known-alive information, follow-up visits, access, service quality, perceived waiting time, transport cost, stigma and support.
Verbal-autopsy interview	Next-of-kin confirmation and contextual information for the 10 deaths, including symptoms, health seeking and reported circumstances; not a comparable exposure source for survivors.

5.8 Data-collection procedures

5.8.1 Records review and linkage

Structured extraction was used to link parent-cohort information with TB registers, clinical charts and laboratory records. The linked file was reviewed for identifier consistency, treatment-discharge dates, outcome status, range errors, inconsistent category spelling and missingness before analysis.

5.8.2 Telephone follow-up

Contact information from the parent cohort was used to establish whether participants were alive, had died or had incomplete follow-up within 24 months after discharge. For surviving

participants, structured items recorded selected experiences of follow-up care. For reported deaths, the respondent's identity and relationship to the participant were verified before the verbal-autopsy interview.

5.8.3 Verbal autopsy

The verbal-autopsy dataset contained 10 records, one for each confirmed death. A structured telephone interview with a next of kin collected symptoms before death, health-seeking behavior, known diagnoses, perceived and health-worker-reported causes, and contextual information. The information supported confirmation and description of deaths; it was not treated as medically certified cause-of-death adjudication. Because smoking, alcohol and other variables were collected only for deceased participants, they were not used to calculate comparative crude odds ratios.

5.8.4 Ascertainment of death timing

Exact dates were used where a reliable date was available from records or family report (verbal autopsy with next of kin). When an exact date was unavailable but the interval was known, a prespecified interval approximation was used for survival analysis: a death reported within <6 months was assigned approximately 3 months, and a death reported during 6–12 months was assigned approximately 9 months. Participants without a death were right-censored at 24 months unless earlier last-known-alive information applied. This convention was used transparently and sensitivity to timing imprecision considered in the limitations.

5.9 Quality assurance and quality control

Quality procedures supported by the supplied records included use of structured extraction and follow-up tools; review of identifiers and linkages across sources; completeness, range and internal-consistency checks; harmonization of category spelling and case; review of ambiguous outcome information; confirmation of death reports with next of kin; de-identification of the analysis file; and restricted data access. The available documentation did not verify independent duplicate extraction or double data entry for this dissertation, and these procedures are therefore not claimed.

5.10 Data management and analysis

5.10.1 Data management

Linked data were cleaned and stored in de-identified form. Variable distributions and missingness were reviewed before analysis. Variables with no variation were not used to estimate associations. Complete-case analysis was used within each model; very small 'unknown' categories were excluded from contrasts where a reliable estimate was not possible.

5.10.2 Analysis for Objective 1

Participant characteristics were summarized using means and standard deviations for age and frequencies and percentages for categorical variables. Two-year cumulative mortality was the number of confirmed deaths divided by 259. The crude mortality rate used the 10 deaths and 503 person-years of follow-up and was expressed per 1,000 person-years. Deaths were also counted in 0–6, 6–12, 12–18 and 18–24-month intervals.

5.10.3 Analysis for Objective 2

Each potential predictor was first examined in a crude or univariable model. Because outcome cells were sparse and some contained zero deaths, crude odds ratios (CORs) were estimated using Firth penalized logistic regression with reference categories stated explicitly. Firth regression reduces first-order small-sample bias and yields finite estimates under separation (Firth, 1993; Heinze & Schemper, 2002). Effect estimates and 95% confidence intervals were prioritized; p-values were secondary.

Two prespecified parsimonious adjusted Firth models were retained. Model A included age (per cohort standard deviation), sex, HIV status and diabetes/pre-diabetes. Model B included HIV status, underweight and participant-perceived long waiting time. Adjusted results are reported as adjusted odds ratios (AORs) and 95% confidence intervals. The models estimate adjusted prognostic relationships rather than causal effects; predictive performance was not evaluated.

5.10.4 Analysis for Objective 3

Kaplan–Meier methods estimated overall survival from the treatment-discharge time origin, with estimates reported at 0, 6, 12, 18 and 24 months (Kaplan & Meier, 1958). Cox proportional-hazards regression estimated hazard ratios using the Efron method for tied event times (Cox, 1972). A univariable Cox model contained one explanatory variable at a time. The full exploratory adjusted model included HIV status, diabetes/pre-diabetes, age, sex and income and

used N = 256 because three participants had unknown HIV status. A reduced sensitivity model included HIV status and diabetes/pre-diabetes only. Income estimates were finite but imprecise. Proportional-hazards checks were interpreted descriptively because only 10 deaths occurred.

5.11 Ethical considerations

Ethical approval was obtained from the Makerere University School of Public Health Research and Ethics Committee. A waiver of written consent applied to anonymized secondary-record review. Verbal informed consent was obtained for telephone follow-up and verbal-autopsy interviews. The identity and relationship of next of kin were confirmed; emotional readiness was considered and interviews could be deferred. No audio recordings were taken. Analysis data were de-identified and access was restricted to authorized personnel.

CHAPTER SIX: RESULTS

This chapter reports findings according to the three study objectives: mortality within 24 months, predictors of mortality, and time to mortality. The analytic cohort comprised 259 participants, including 10 confirmed deaths and 249 survivors or censored participants.

6.1 Mortality rate and baseline characteristics of participants

A total of 259 TB patients who were recorded as cured/completed treatment at discharge from Kawaala and Kiswa Health Centre IVs were included and followed for up to 24 months. Over 6,036 person-months of observation (about 503 person-years), 10 deaths were confirmed. This gives a crude mortality rate of 19.9 deaths per 1,000 person-years and a cumulative mortality proportion of 3.9% within two years (Table 6.1).

Five deaths occurred during the first six months and five additional deaths occurred between six and 12 months. No deaths were observed between 12 and 24 months (Figure 6.1).

Table 6.1- Key Mortality Indicators

Metric	**Value**
Cohort size (N)	259
Deaths (n)	10
Alive/Censored (n)	249
Person-months	6,036
Person-years	503
Crude mortality rate (per 1,000 PY)	19.9
Cumulative mortality proportion (%)	3.9

Note. Mortality proportion = 10/259. The crude mortality rate used 6,036 person-months (approximately 503 person-years) of observed follow-up.

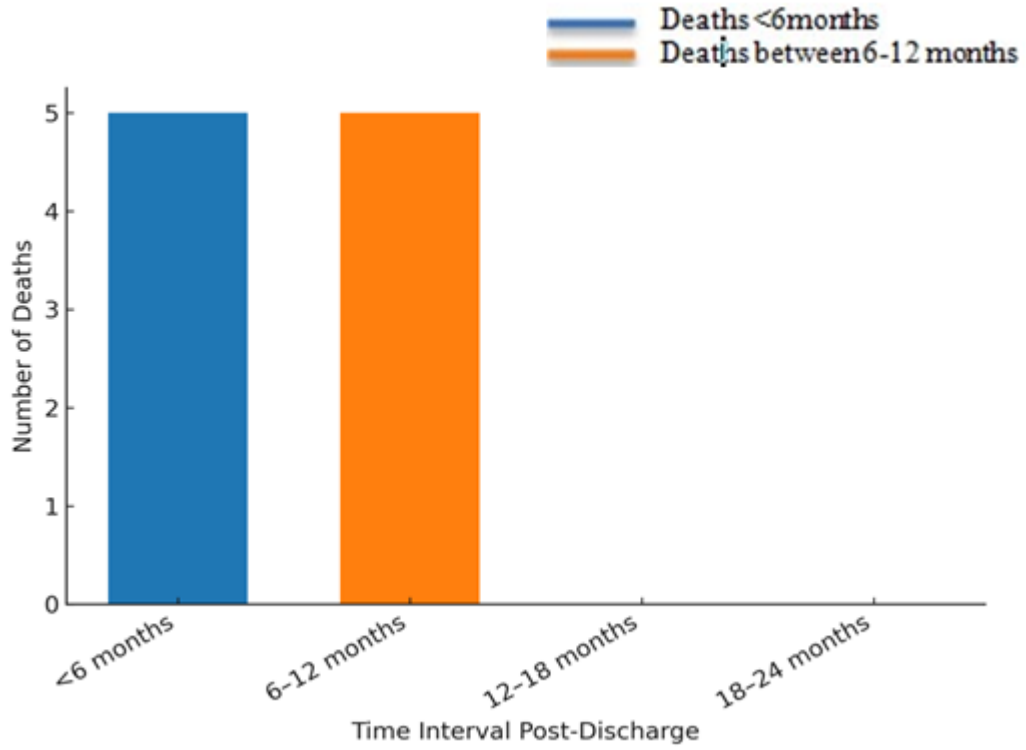


Figure 6.1: Distribution of deaths by time interval within 24 months after TB treatment discharge

Note. The bars show five deaths during 0–6 months, five during 6–12 months and none during 12–24 months.

6.2 Predictors of mortality within 24 months after discharge

Table 6.2 presents baseline characteristics by vital status. The mean age was 35.9 years (SD 9.0) among survivors or censored participants and 35.3 years (SD 6.0) among those who died.

The cohort was largely male in both groups (alive: 78.7%; deceased: 90.0%). More than half reported a monthly income of UGX 100,000–500,000 (alive: 58.6%; deceased: 70.0%). About a quarter of survivors reported < UGX 100,000 (24.1%) compared with 10.0% among those who died. A fifth of deaths (20.0%) reported > UGX 500,000 (alive: 17.3%).

Some variables had no variation by design or setting. All participants were urban residents, all had pulmonary TB, and all were discharged as cured/completed treatment. These variables therefore could not be assessed as predictors in association models.

Among survivors or censored participants, 55 (22.1%) were HIV-positive, 191 (76.7%) were HIV-negative and three (1.2%) had unknown status. Among the 10 deaths, five were HIV-positive and five were HIV-negative. Nutritional-status distributions were broadly similar between the two outcome groups (Table 6.2).

Regarding glycaemic status, pre-diabetes was recorded among 38 survivors and two deaths, while diabetes alone was recorded among four survivors and no deaths. The combined dysglycaemia category therefore comprised 42 survivors and two deaths. Hypertension, malnutrition and chronic lung disease occurred in relatively small numbers (Table 6.2).

Descriptively, HIV-positive status was recorded for 50.0% of deaths and 22.1% of survivors or censored participants. Other baseline distributions are shown without adjusted interpretation in Table 6.2.

Table 6.2: Baseline characteristics of tuberculosis patients discharged after treatment at Kawaala and Kiswa Health Centre IVs (N = 259)

Characteristic	**Alive**		**Deceased**	
	N	% / Mean±SD	N	% / Mean±SD
Age (years)	249	35.9 ± 9.0	10	35.3 ± 6.0
Sex: Female	53	21.3%	1	10.0%
Sex: Male	196	78.7%	9	90.0%
Income: UGX 100,000–500,000	146	58.6%	7	70.0%
Income: < UGX 100,000	60	24.1%	1	10.0%
Income: > UGX 500,000	43	17.3%	2	20.0%
Residence: Urban	249	100.0%	10	100.0%
HIV Status: Negative	191	76.7%	5	50.0%

HIV Status: Positive	55	22.1%	5	50.0%
HIV Status: Unknown	3	1.2%	0	0.0%
Nutritional Status: Obese	12	4.8%	1	10.0%
Nutritional Status: Underweight	48	19.3%	2	20.0%
Nutritional Status: Normal	137	55.0%	5	50.0%
Nutritional Status: Overweight	52	20.9%	2	20.0%
TB Type: Pulmonary TB	249	100.0%	10	100.0%
Treatment Outcome: Cured	249	100.0%	10	100.0%
Comorbidity: Pre-diabetes	38	15.3%	2	20.0%
Comorbidity: Diabetes	4	1.6%	0	0.0%
Diabetes/pre-diabetes (combined dysglycaemia)	42	16.9%	2	20.0%
Comorbidity: Hypertension	13	5.2%	0	0.0%

Comorbidity: Malnutrition	49	19.7%	1	10.0%
Comorbidity: Chronic lung disease	19	7.6%	1	10.0%

Note. Percentages are calculated within each vital-status column. HIV status reflects the final verified classification. Diabetes/pre-diabetes (combined dysglycaemia) includes participants recorded with either diabetes or pre-diabetes.

6.2.1 Bivariate analysis

Table 6.3 presents crude Firth penalised odds ratios (CORs), 95% confidence intervals and p-values. Firth estimation was used because sparse and zero cells made ordinary logistic estimates unreliable.

The crude odds ratio for HIV-positive versus HIV-negative status was 3.45 (95% CI 1.01–11.76; p = 0.048). For diabetes/pre-diabetes versus neither condition, the crude odds ratio was 1.44 (95% CI 0.33–6.19; p = 0.628).

Participant-reported long waiting time had a COR of 1.66 (95% CI 0.48–5.74; p = 0.421). Transport-cost and stigma challenges had CORs of 0.29 (95% CI 0.05–1.69) and 0.33 (95% CI 0.06–1.92), respectively.

Counts, percentages and estimable crude odds ratios for follow-up visits are retained in Table 6.3. Crude odds ratios were not forced for categories with inadequate support or structurally incomplete data.

Nutritional support during treatment had a COR of 1.96 (95% CI 0.58–6.61; p = 0.279). Age, sex and the remaining estimable factors are reported with their confidence intervals in Table 6.3.

1. Table 6.3: Bivariate analysis of potential predictors of mortality within 24 months after discharge

Variable	Level/contrast	Alive/censored n (%)	Deaths n (%)	COR	95% CI	p-value
Access to post-treatment follow-up care	Difficult	83 (33.3%)	4 (40.0%)	1.38	0.40–4.75	0.609
Access to post-treatment follow-up care	Easy	166 (66.7%)	6 (60.0%)	1.00	—	—
Age	Per 10-year increase	35.9 ± 9.0	35.3 ± 6.0	0.97	0.49–1.93	0.934
Alcohol use	No	0 (—)	7 (70.0%)	Not estimable	—	—
Alcohol use	Yes	0 (—)	3 (30.0%)	Not estimable	—	—
Challenge: Long waiting times	Not reported	176 (70.7%)	6 (60.0%)	1.00	—	—
Challenge: Long waiting times	Reported	73 (29.3%)	4 (40.0%)	1.66	0.48–5.74	0.421
Challenge: Stigma	Not reported	169 (67.9%)	9 (90.0%)	1.00	—	—
Challenge: Stigma	Reported	80 (32.1%)	1 (10.0%)	0.33	0.06–1.92	0.218
Challenge: Transport costs	Not reported	162 (65.1%)	9 (90.0%)	1.00	—	—
Challenge: Transport costs	Reported	87 (34.9%)	1 (10.0%)	0.29	0.05–1.69	0.170

Comorbidity: Chronic lung disease	Not recorded	230 (92.4%)	9 (90.0%)	1.00	—	—
Comorbidity: Chronic lung disease	Recorded	19 (7.6%)	1 (10.0%)	1.87	0.30–11.54	0.502
Comorbidity: Diabetes	Not recorded	245 (98.4%)	10 (100.0%)	—	—	—
Comorbidity: Diabetes	Recorded	4 (1.6%)	0 (0.0%)	—	—	—
Comorbidity: Hypertension	Not recorded	236 (94.8%)	10 (100.0%)	1.00	—	—
Comorbidity: Hypertension	Recorded	13 (5.2%)	0 (0.0%)	0.83	0.04–16.66	0.906
Comorbidity: Malnutrition	Not recorded	200 (80.3%)	9 (90.0%)	1.00	—	—
Comorbidity: Malnutrition	Recorded	49 (19.7%)	1 (10.0%)	0.64	0.11–3.74	0.620
Comorbidity: Pre-diabetes	Not recorded	211 (84.7%)	8 (80.0%)	—	—	—
Comorbidity: Pre-diabetes	Recorded	38 (15.3%)	2 (20.0%)	—	—	—
Dysglycaemia (combined)	Neither recorded	207 (83.1%)	8 (80.0%)	1.00	—	—
Dysglycaemia (combined)	Diabetes/pre-diabetes	42 (16.9%)	2 (20.0%)	1.44	0.33–6.19	0.628
Education level	None	19 (7.6%)	0 (0.0%)	1.00	—	—
Education level	Primary	86 (34.5%)	4 (40.0%)	2.03	0.10–42.15	0.648

Education level	Secondary	88 (35.3%)	3 (30.0%)	1.54	0.07–33.35	0.782
Education level	Tertiary	56 (22.5%)	3 (30.0%)	2.42	0.11–52.51	0.574
Employment status	Farmer	41 (16.5%)	1 (10.0%)	1.00	—	—
Employment status	Other	17 (6.8%)	1 (10.0%)	2.37	0.22–25.56	0.477
Employment status	Professional	30 (12.0%)	2 (20.0%)	2.27	0.28–18.61	0.446
Employment status	Trader	101 (40.6%)	4 (40.0%)	1.23	0.18–8.22	0.833
Employment status	Unemployed	60 (24.1%)	2 (20.0%)	1.14	0.14–9.19	0.900
Follow-up visits after discharge	More than twice	49 (19.7%)	4 (40.0%)	10.45	0.54–204.26	0.122
Follow-up visits after discharge	None	57 (22.9%)	0 (0.0%)	1.00	—	—
Follow-up visits after discharge	Once	86 (34.5%)	3 (30.0%)	4.65	0.23–94.10	0.316
Follow-up visits after discharge	Twice	57 (22.9%)	3 (30.0%)	7.00	0.34–142.24	0.205
HIV status	Negative	191 (76.7%)	5 (50.0%)	1.00	—	—
HIV status	Positive	55 (22.1%)	5 (50.0%)	3.45	1.01–11.76	0.048

HIV status	Unknown	3 (1.2%)	0 (0.0%)	Not modelled	—	—
Income level	< UGX 100,000	60 (24.1%)	1 (10.0%)	1.00	—	—
Income level	> UGX 500,000	43 (17.3%)	2 (20.0%)	2.32	0.29–18.56	0.428
Income level	UGX 100,000–500,000	146 (58.6%)	7 (70.0%)	2.06	0.34–12.39	0.428
Nutritional status	Normal	137 (55.0%)	5 (50.0%)	—	—	—
Nutritional status	Obese	12 (4.8%)	1 (10.0%)	—	—	—
Nutritional status	Overweight	52 (20.9%)	2 (20.0%)	—	—	—
Nutritional status	Underweight vs all other categories	48 (19.3%)	2 (20.0%)	1.22	0.28–5.24	0.787
Nutritional support during treatment	No	165 (66.3%)	5 (50.0%)	1.00	—	—
Nutritional support during treatment	Yes	84 (33.7%)	5 (50.0%)	1.96	0.58–6.61	0.279
Quality of follow-up services	Excellent	37 (14.9%)	2 (20.0%)	1.00	—	—
Quality of follow-up services	Fair	69 (27.7%)	2 (20.0%)	0.54	0.09–3.31	0.505

Quality of follow-up services	Good	116 (46.6%)	6 (60.0%)	0.84	0.18–3.83	0.818
Quality of follow-up services	Poor	27 (10.8%)	0 (0.0%)	0.27	0.01–6.24	0.416
Sex	Female	53 (21.3%)	1 (10.0%)	1.00	—	—
Sex	Male	196 (78.7%)	9 (90.0%)	1.72	0.30–10.05	0.545
Smoking status	No	0 (—)	7 (70.0%)	Not estimable	—	—
Smoking status	Yes	0 (—)	3 (30.0%)	Not estimable	—	—
Support system after treatment	Moderate	104 (41.8%)	6 (60.0%)	1.22	0.19–7.76	0.831
Support system after treatment	Strong	116 (46.6%)	3 (30.0%)	0.59	0.08–4.28	0.602
Support system after treatment	Weak/None	29 (11.6%)	1 (10.0%)	1.00	—	—

Note. COR = crude odds ratio from a separate univariable Firth model. Reference categories are shown explicitly. Smoking and alcohol were not estimable because comparable survivor data were not available; no odds ratios were assigned.

6.2.2 Multivariable analysis (Firth penalised logistic regression)

Firth penalised logistic regression was used for adjusted associations because only 10 deaths occurred. Two prespecified parsimonious models are presented in Table 6.4.

Model A (core clinical and demographic factors) included age (standardized), sex, HIV status and diabetes/pre-diabetes. Adjusted odds ratios (AORs) were 3.34 for HIV-positive status (95% CI 0.96–11.64; p = 0.057), 1.38 for diabetes/pre-diabetes (95% CI 0.25–5.43; p = 0.676), 1.73 for male sex (95% CI 0.39–16.32; p = 0.514), and 0.91 per SD increase in age (95% CI 0.43–1.68; p = 0.776).

Model B included HIV status, underweight status and participant-perceived long waiting time. Adjusted estimates were 3.37 for HIV-positive status (95% CI 0.97–11.71; p = 0.055), 1.59 for perceived long waiting time (95% CI 0.42–5.44; p = 0.474), and 1.20 for underweight (95% CI 0.22–4.59; p = 0.810).

All adjusted confidence intervals were wide and included the null value, reflecting the limited precision available from 10 deaths.

Table 6.4: Adjusted analysis of potential predictors of mortality within 24 months (Firth penalised logistic regression)

Model A: Age, Sex, HIV status and Diabetes/Prediabetes

Variable	**Adjusted OR**	**95% CI**	**p-value**
Age, per SD increase	0.91	0.43–1.68	0.776
Male sex	1.73	0.39–16.32	0.514
HIV-positive	3.34	0.96–11.64	0.057
Diabetes/pre-diabetes	1.38	0.25–5.43	0.676

Model B: HIV status, underweight status and participant-reported long waiting time.

Variable	**Adjusted OR**	**95% CI**	**p-value**
HIV-positive	3.37	0.97–11.71	0.055
Underweight	1.20	0.22–4.59	0.810
Perceived long waiting time	1.59	0.42–5.44	0.474

Note. AOR = adjusted odds ratio; CI = confidence interval. Estimates describe adjusted associations and are exploratory; they are not interpreted as causal effects.

Objective 3 was examined using Kaplan–Meier survival estimates and exploratory Cox proportional hazards regression.

6.3 Time to mortality and its predictors

6.3.1 Overview and analytical approach

Time zero was the recorded TB treatment discharge/completion date. The event was all-cause death confirmed through records and/or next-of-kin follow-up. The verbal-autopsy subset contained information only for confirmed deaths and was not a separate comparison cohort. Participants without a confirmed death were right-censored at 24 months or earlier last-known-alive time where applicable.

Kaplan–Meier survival functions were estimated overall and for the prespecified strata shown below. A univariable Cox model evaluated one predictor at a time. The full adjusted Cox model included HIV status, diabetes/pre-diabetes, age, sex and income; ties were handled using the Efron method. The model used N = 256 after exclusion of three participants with unknown HIV status. A reduced sensitivity model included HIV status and diabetes/pre-diabetes only. Because only 10 deaths occurred, all Cox estimates are exploratory.

6.3.2 Kaplan–Meier survival estimates

6.3.2.1 Overall survival of the study cohort

The overall KM curve (Figure 6.2) shows survival among all 259 participants over 24 months after discharge. The curve drops during the first 12 months, corresponding to the 10 observed deaths, and then remains flat through 24 months, reflecting the absence of later deaths.

Survival was 1.000 at discharge. By six months, survival was 0.981 (95% CI 0.954–0.992) after five deaths. By 12 months, survival was 0.961 (95% CI 0.929–0.979) after a total of 10 deaths. Survival remained at 0.961 (95% CI 0.929–0.979) at 18 and 24 months. Median survival was not reached because more than 96% of participants were alive at the end of follow-up.

Table 6.5 presents numbers at risk at 0, 6, 12, 18 and 24 months.

Table 6.5: Overall survival within 24 months post-discharge (N = 259)

Time (months)	Number at Risk	Deaths (cumulative)	Survival S(t)	95 % CI
0	259	0	1.000	—
6	254	5	0.981	0.954–0.992
12	249	10	0.961	0.929–0.979
18	249	10	0.961	0.929–0.979
24	249	10	0.961	0.929–0.979

Survivors were right-censored at 24 months; no additional deaths occurred after 12 months.

The estimated survival probability was unchanged between 12 and 24 months because no additional deaths were observed after month 12.

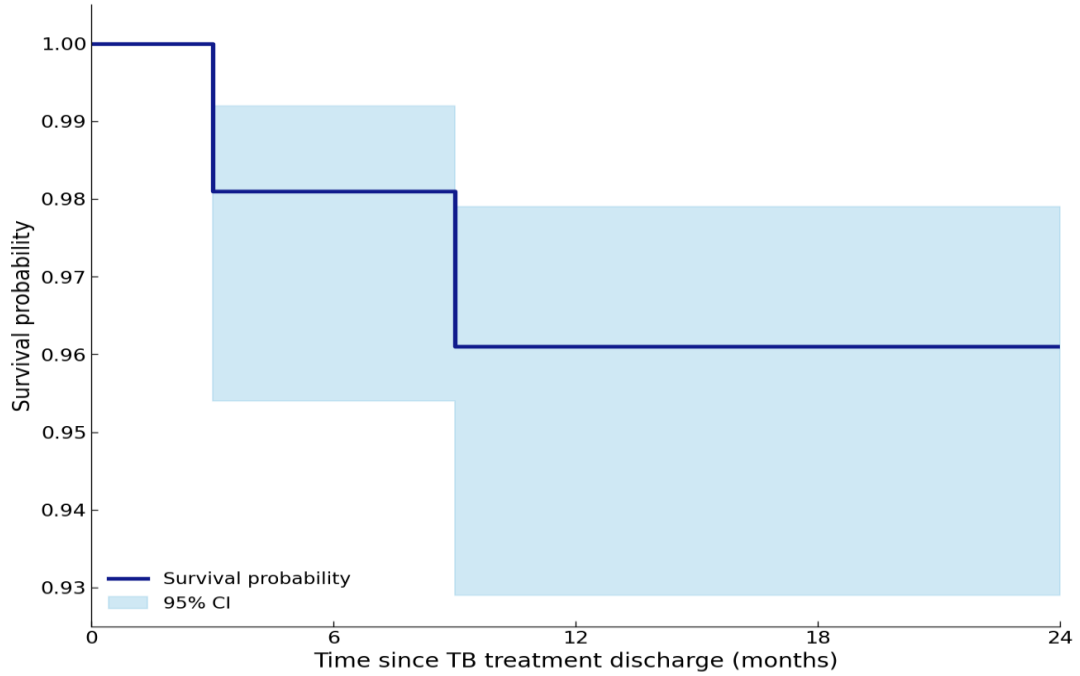


Figure 6.2 Overall Kaplan–Meier survival curve for tuberculosis patients within 24 months after treatment discharge.

Note. Shaded bands represent 95% confidence intervals; survivors were right-censored at 24 months.

6.3.2.2 Survival by HIV status

Figure 6.3 and Table 6.6 summarize survival by HIV status. Among 60 HIV-positive participants, two deaths occurred within the first six months and three during 6–12 months (five deaths; 8.3% by one year). Among 196 HIV-negative participants, three deaths occurred within six months and two during 6–12 months (five deaths; 2.6%). Three participants with unknown HIV status were excluded from this subgroup comparison.

At six months, survival was 0.967 (95% CI 0.873–0.992) among HIV-positive participants and 0.985 (95% CI 0.953–0.995) among HIV-negative participants. At 12 months, survival was 0.917 (95% CI 0.811–0.964) and 0.974 (95% CI 0.940–0.989), respectively; both curves then remained unchanged through 24 months.

The descriptive log-rank comparison gave chi-square = 4.07 (p = 0.044). This nominal result is based on only 10 deaths and should be interpreted together with the wide confidence intervals and exploratory Cox estimates.

Table 6.6: Survival probabilities (S (t)) by HIV status

Note. Three participants with unknown HIV status were excluded. Survivors were right-censored at 24 months; no deaths occurred after month 12

Time (months)	No. at Risk (HIV+)	Deaths (cum.)	S(t) HIV+	95 % CI	No. at Risk (HIV–)	Deaths (cum.)	S(t) HIV–	95 % CI
0	60	0	1.000	—	196	0	1.000	—
6	58	2	0.967	0.873–0.992	193	3	0.985	0.953–0.995
12	55	5	0.917	0.811–0.964	191	5	0.974	0.940–0.989
18	55	5	0.917	0.811–0.964	191	5	0.974	0.940–0.989
24	55	5	0.917	0.811–0.964	191	5	0.974	0.940–0.989

Notes: *No deaths occurred beyond 12 months; median survival not reached.*

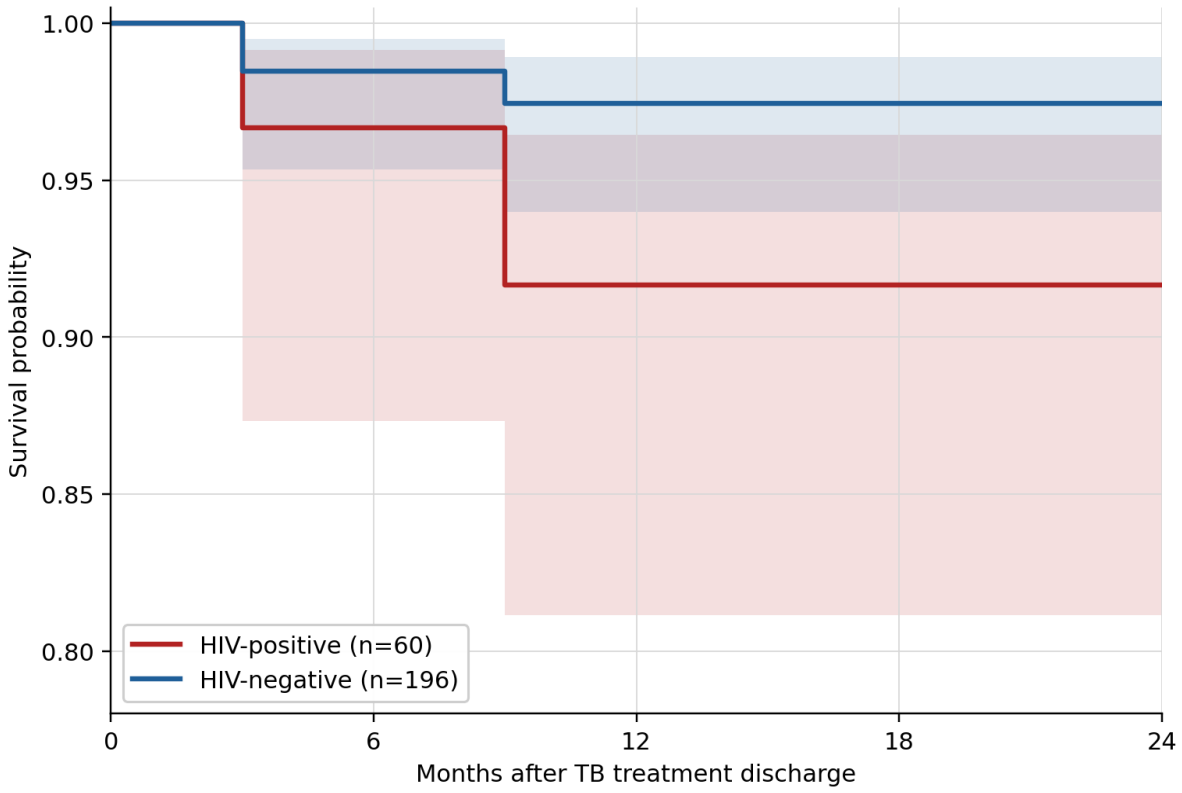


Figure 6.3: Kaplan–Meier survival curves by HIV status within 24 months after TB treatment discharge

Note. Shaded bands represent log–log 95% confidence intervals; Table 6.6 gives numbers at risk.

6.3.2.3 Survival by diabetes/pre-diabetes status

Figure 6.4 and Table 6.7 summarize survival by glycaemic status. Among 44 participants with diabetes or pre-diabetes, one death occurred within six months and one during 6–12 months (two deaths; 4.5%). Among 215 participants with neither condition, four deaths occurred within six months and four during 6–12 months (eight deaths; 3.7%).

At six months, survival was 0.977 (95% CI 0.849–0.997) among participants with diabetes/pre-diabetes and 0.981 (95% CI 0.951–0.993) among those with neither condition. At 12 months, survival was 0.955 (95% CI 0.830–0.988) and 0.963 (95% CI 0.927–0.981), respectively. No further deaths occurred after 12 months.

Table 6.7: Survival probabilities (S(t)) by diabetes/pre-diabetes status within 24 months after TB treatment discharge

Time (months)	At Risk (DM/Pre-DM)	Deaths (cum.)	S(t) DM/Pre-DM	95% CI	At Risk (Non-DM)	Deaths (cum.)	S(t) Non-DM	95% CI
0	44	0	1.000	—	215	0	1.000	—
6	43	1	0.977	0.849–0.997	211	4	0.981	0.951–0.993
12	42	2	0.955	0.830–0.988	207	8	0.963	0.927–0.981
18	42	2	0.955	0.830–0.988	207	8	0.963	0.927–0.981
24	42	2	0.955	0.830–0.988	207	8	0.963	0.927–0.981

Survivors were right-censored at 24 months. All deaths occurred within the first 12 months. Survival probabilities and 95% confidence intervals were derived from Kaplan–Meier estimates. No deaths occurred after 12 months in either group.

The log-rank comparison showed little separation between the glycaemic-status curves (chi-square = 0.067; p = 0.796). Confidence intervals were wide, and the subgroup estimates are descriptive.

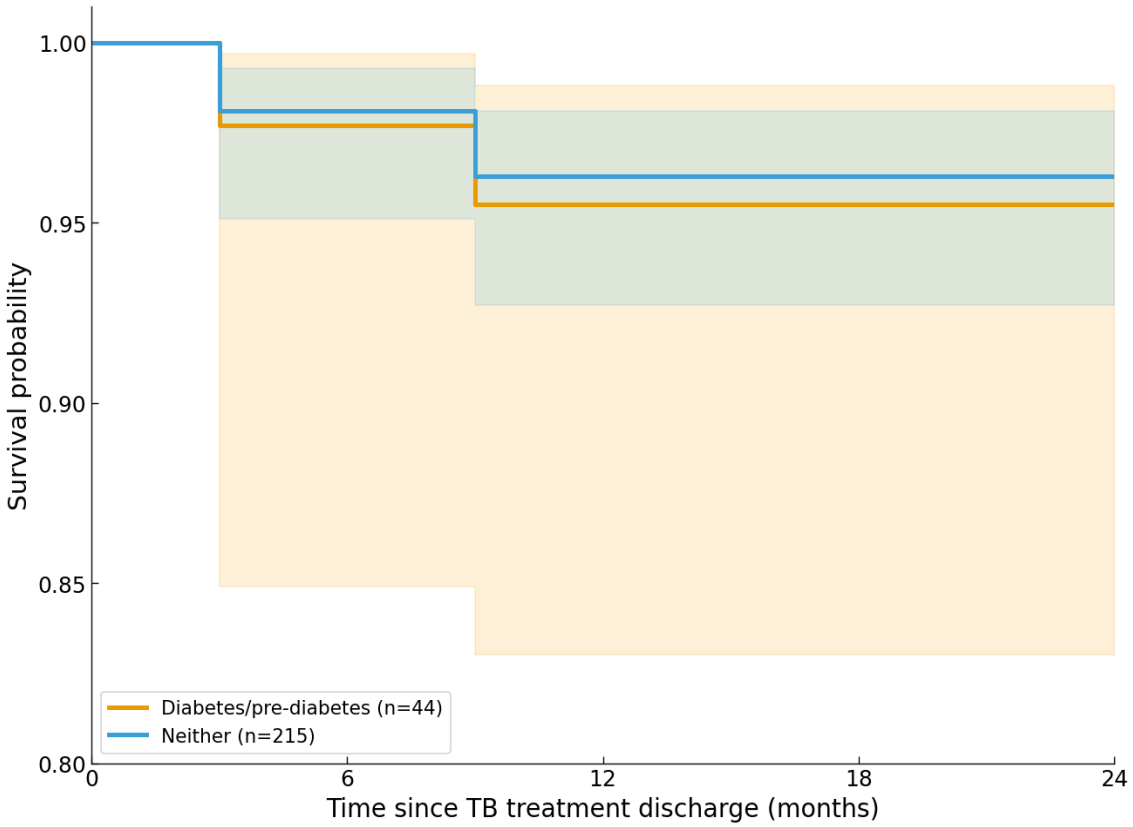


Figure 6.4: Kaplan–Meier survival curves by diabetes/pre-diabetes status within 24 months after TB treatment discharge.

Note. Shaded bands represent group-specific 95% confidence intervals. The curves are descriptive; survivors were right-censored at 24 months and Table 6.7 gives numbers at risk.

6.3.2.4 Survival by Monthly Income Level

Survival by monthly income is shown in Figure 6.5 and Table 6.8. At enrolment, 61 participants (23.6%) reported < UGX 100,000 per month, 153 (59.1%) reported UGX 100,000–500,000, and 45 (17.4%) reported > UGX 500,000.

No deaths occurred in the lowest-income group during the first six months. In that same period, four deaths occurred among those earning UGX 100,000–500,000 and one death among those earning > UGX 500,000. Between six and twelve months, one additional death occurred in the < UGX 100,000 group, three in the UGX 100,000–500,000 group, and one in the > UGX 500,000 group. That produces cumulative deaths of 1, 7 and 2 respectively across the three strata.

At 12 months, survival probabilities were 0.984 (95% CI 0.95–1.00) in the < UGX 100,000 group, 0.954 (95% CI 0.91–0.98) in the UGX 100,000–500,000 group, and 0.956 (95% CI 0.89–1.00) in the > UGX 500,000 group. Because no deaths occurred beyond 12 months, S(24) values were the same as S(12). Curves overlapped considerably, and the three-group log-rank test was chi-square = 1.07 (df = 2; p = 0.587).

Table 6.8: Survival probabilities S(t) by Monthly Income

Survivors right-censored at 24 months; all deaths occurred within 12 months. Greenwood 95% confidence intervals are shown for 12- and 24-month survival probabilities

Income category	N	Deaths <6 mo	Deaths 6–12 mo	Total Deaths (≤12 mo)	S(12)	S(24)	95% CI S(12)	95% CI S(24)
< UGX 100,000	61	0	1	1	0.98	0.98	0.95–1.00	0.95–1.00
UGX 100,000–500,000	153	4	3	7	0.95	0.95	0.91–0.98	0.91–0.98
> UGX 500,000	45	1	1	2	0.96	0.96	0.89–1.00	0.89–1.00

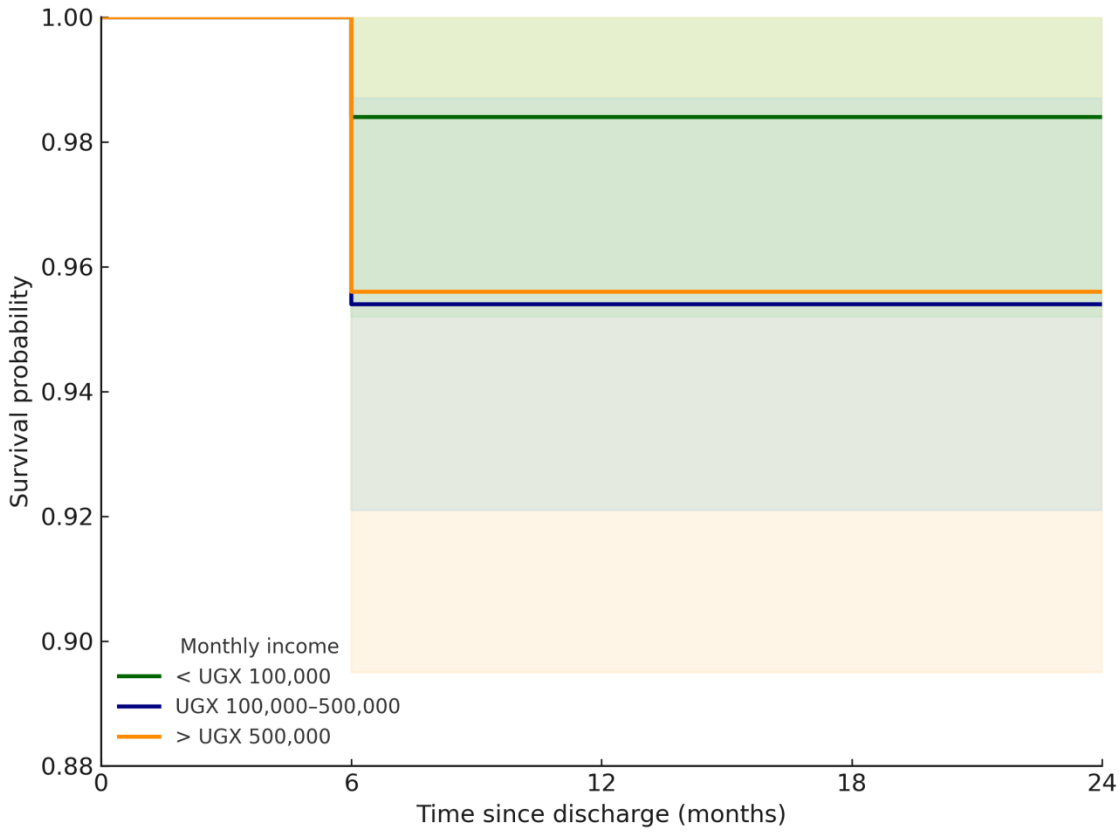


Figure 6.5: Kaplan–Meier survival curves stratified by monthly income within 24 months after TB treatment discharge

Shaded bands represent 95% confidence intervals; survivors were right-censored at 24 months. No deaths occurred after 12 months in any group.

6.3.3 Time-to-event analysis (Cox proportional hazards)

6.3.3.1 Modelling approach

Cox proportional-hazards regression estimated associations with time to death within 24 months after discharge. Time started at discharge, and participants without a recorded death were censored at 24 months. The full exploratory adjusted model included HIV status, diabetes/pre-diabetes, age, sex and income; three participants with unknown HIV status were excluded, giving N = 256. A reduced sensitivity model included HIV status and diabetes/pre-diabetes only. Ties were handled using the Efron method. Proportional-hazards assumptions were assessed using Schoenfeld residuals, recognizing that power was limited by only 10 events.

6.3.3.2 Cox regression results

Table 6.9: Cox proportional-hazards regression for time to death within 24 months

Predictor	Univariable HR (95% CI)	p-value	Adjusted HR (95% CI)	p-value
HIV-positive vs HIV-negative	3.34 (0.97–11.53)	0.057	3.41 (0.98–11.84)	0.054
Diabetes/pre-diabetes vs neither	1.23 (0.26–5.77)	0.796	1.12 (0.23–5.54)	0.889
Age, per 10-year increase	0.93 (0.45–1.89)	0.834	0.87 (0.39–1.93)	0.727
Male vs female	2.41 (0.31–19.04)	0.403	2.35 (0.30–18.65)	0.420
UGX 100,000–500,000 vs < UGX 100,000	2.85 (0.35–23.13)	0.328	2.75 (0.33–22.70)	0.347
> UGX 500,000 vs < UGX 100,000	2.76 (0.25–30.41)	0.408	2.62 (0.24–29.10)	0.433

In univariable Cox models, HIV-positive status had an HR of 3.34 (95% CI 0.97–11.53; p = 0.057). Diabetes/pre-diabetes had an HR of 1.23 (95% CI 0.26–5.77; p = 0.796). Both estimates were imprecise, and only the HIV estimate showed a clearly elevated direction.

Age per 10-year increase had an HR of 0.93 (95% CI 0.45–1.89; p = 0.834), while male sex had an HR of 2.41 (95% CI 0.31–19.04; p = 0.403). The wide confidence intervals were compatible with materially different associations.

Income estimates were finite but highly imprecise. Compared with < UGX 100,000, the univariable HR was 2.85 (95% CI 0.35–23.13; p = 0.328) for UGX 100,000–500,000 and 2.76 (95% CI 0.25–30.41; p = 0.408) for > UGX 500,000.

In the full multivariable model, HIV-positive status had an adjusted HR (AHR) of 3.41 (95% CI 0.98–11.84; p = 0.054), and diabetes/pre-diabetes had an AHR of 1.12 (95% CI 0.23–5.54; p = 0.889). The AHR was 0.87 per 10-year age increase (95% CI 0.39–1.93; p = 0.727) and 2.35 for male sex (95% CI 0.30–18.65; p = 0.420).

Adjusted income estimates remained imprecise: AHR 2.75 (95% CI 0.33–22.70; p = 0.347) for UGX 100,000–500,000 and AHR 2.62 (95% CI 0.24–29.10; p = 0.433) for > UGX 500,000, each compared with < UGX 100,000. No clear independent income association was demonstrated.

In the reduced sensitivity model, the AHR was 3.31 for HIV-positive status (95% CI 0.95–11.48; p = 0.059) and 1.15 for diabetes/pre-diabetes (95% CI 0.24–5.42; p = 0.864). Proportional-hazards diagnostics had limited power with 10 deaths; no gross violation was identified, but all estimates remain exploratory.

CHAPTER SEVEN: DISCUSSION

The discussion is organized according to the three study objectives. Although the study identified several patterns of potential clinical importance, interpretation should take into account that only 10 deaths occurred. Consequently, effect estimates and confidence intervals (95%) are given greater emphasis than statistical significance alone.

7.1 Mortality rate within 24 months after TB treatment discharge

Among the 259 participants, 10 deaths occurred during approximately 503 person-years of follow-up. This corresponded to a cumulative mortality of 3.9% and a crude mortality rate of 19.9 deaths per 1,000 person-years. Five deaths occurred within the first six months and five between six and 12 months, while no deaths were recorded during the second year.

The mortality rate observed in this study is comparable to, although somewhat different from, findings reported in other Ugandan cohorts. Lumu et al. (2023), for example, reported an overall post-TB mortality rate of 15.42 deaths per 1,000 person-years among people living with HIV. Importantly, mortality was highest during the first year after treatment completion and declined thereafter. Although their study population consisted entirely of people living with HIV and was followed for a longer period, the concentration of mortality early after treatment is similar to the pattern observed at Kawaala and Kiswa.

Baluku et al. (2024) reported a higher post-treatment mortality rate of approximately 28.5 deaths per 1,000 person-years among pulmonary TB survivors in rural Uganda and found that the median time from cure to death was less than one year. Their higher mortality may partly reflect differences in study setting and patient characteristics. Participants were recruited from a tertiary hospital where more clinically severe patients may have been treated, whereas the present study was conducted in two urban Health Centre IVs. Differences in follow-up duration, clinical severity and ascertainment of death also limit direct comparison.

The current mortality estimate should nevertheless not be considered unimportant simply because 96.1% of the cohort survived to 24 months. All participants had already been classified as cured or having completed treatment. Deaths occurring after this point demonstrate that treatment success does not necessarily mean complete recovery. Romanowski et al. (2019), in a systematic review and meta-analysis, found substantially higher long-term mortality among people previously treated for TB than among comparison populations. Similar concerns arise

from post-TB lung disease. In Uganda, van Kampen et al. (2019) found substantial chronic respiratory symptoms and radiological abnormalities among people with previous TB (Lumu et al., 2023; Romanowski et al., 2019).

These findings provide a plausible explanation for continued vulnerability after treatment. Pulmonary TB can leave fibrosis, bronchiectasis, loss of lung function and recurrent respiratory symptoms even after bacteriological cure. However, the present study measured all-cause mortality and did not establish medically certified causes of death. It would therefore be inappropriate to attribute the 10 deaths specifically to recurrent TB or post-TB lung disease.

Overall, the mortality findings support the view that the end of anti-TB treatment should not automatically be regarded as the end of clinical risk. Even though mortality was relatively modest in absolute terms, its occurrence among successfully treated patients and its concentration within the first year are important from a programme perspective.

7.2 Predictors of post-TB mortality

The second objective examined clinical, demographic, socio-economic and health-facility characteristics as potential predictors of death. Because only 10 deaths occurred, none of the adjusted analyses produced sufficiently precise evidence to identify a definitive independent predictor and therefore crude and adjusted estimates are interpreted as exploratory associations. However, HIV-positive status showed the most consistent positive association across the different analytical approaches.

7.2.1 HIV co-infection

Five of the 60 HIV-positive participants died compared with five of the 196 HIV-negative participants. Thus, although the absolute number of deaths was the same, mortality was proportionally higher among people living with HIV. The crude odds ratio was 3.45, while adjusted Firth models produced AORs of 3.34 and 3.37. The adjusted Cox model similarly gave an AHR of 3.41 (95% CI 0.98–11.84).

The consistency of this approximately threefold association across several analytical approaches is noteworthy, even though the adjusted confidence intervals were wide and crossed one. Similar findings have been reported elsewhere. Salindri et al. (2024) found that HIV co-infection was associated with substantially increased post-treatment mortality among patients treated for drug-

resistant TB. More directly relevant to Uganda, Bongomin et al. (2025) also reported approximately threefold higher post-treatment mortality associated with HIV.

Lumu et al. (2023) provide additional insight into this relationship. Among Ugandan TB survivors living with HIV, poorer immune status at treatment completion was associated with subsequent mortality. This suggests that HIV-positive TB survivors are not a uniform risk group. A patient who is virally suppressed with good immune recovery may differ considerably from someone with advanced immunosuppression.

The present study did not include detailed measures such as CD4 count, viral load or ART adherence in the adjusted mortality models. Consequently, the observed association cannot be attributed to HIV infection alone. Residual immunosuppression, opportunistic infections or other comorbidities may partly explain the higher mortality.

The Kaplan–Meier analysis supports the same interpretation. Twelve-month survival was 0.917 among HIV-positive participants compared with 0.974 among HIV-negative participants. Taken together, the findings suggest that HIV-positive TB survivors deserve particular attention after treatment completion, although the magnitude of risk requires confirmation in a larger cohort.

7.2.2 Diabetes and pre-diabetes

The analysis showed much less evidence of an association between dysglycaemia and mortality. Among 44 participants with diabetes or pre-diabetes, two deaths occurred compared with eight among 215 participants with neither condition. The adjusted Firth OR was 1.38 (95% CI 0.25–5.43), while the Cox model gave an AHR of only 1.12 (95% CI 0.23–5.54). Survival at 12 months was 0.955 among participants with dysglycaemia and 0.963 among those without, and the log-rank comparison was not significant ($p = 0.796$).

These findings differ from the well-established association between diabetes and adverse outcomes during TB treatment. Huangfu et al., (2019), in a systematic review and meta-analysis, found that diabetes increased the risk of death and other unfavourable TB treatment outcomes. Post-TB guidance also recognizes metabolic disease as an important comorbidity to assess during recovery (Nightingale et al., 2023). However, evidence specifically concerning mortality after treatment completion has been less consistent.

For example, Houck et al. (2023) found that the association between diabetes and mortality was stronger during TB treatment than after treatment. Similarly, Salindri et al. (2024) did not identify diabetes or pre-diabetes as significant independent predictors of post-treatment mortality after adjustment. The present results are therefore not entirely unexpected.

Another important consideration is that most participants in the combined dysglycaemia group had pre-diabetes rather than established diabetes. Only four survivors had diabetes alone, while the remainder of the group largely comprised pre-diabetes. In addition, hyperglycaemia detected during active TB may sometimes improve after treatment because acute infection can temporarily disturb glucose metabolism (Menon et al., 2020).

The appropriate interpretation is therefore that dysglycaemia remained clinically relevant but was not clearly associated with mortality in this cohort. Continued screening and management are still justified because persistent diabetes carries important cardiovascular, renal and infectious risks, but the current findings do not describe it as a confirmed mortality predictor.

7.2.3 Demographic and socio-economic factors

Age showed little difference between those who survived and those who died. Mean age was 35.9 years among survivors and 35.3 years among those who died. The adjusted Cox estimate also showed no clear association. This differs from larger studies such as Choi et al. (2023), where older age was strongly associated with mortality among TB survivors. The relatively young age of the current cohort and the small number of deaths probably limited the ability to detect an age-related gradient.

Nine of the 10 deaths occurred among men, and the adjusted Cox estimate for male sex was above two. However, men also constituted nearly four-fifths of the cohort and the confidence interval was extremely wide. Therefore, the study cannot conclude that male sex was independently associated with mortality. Larger studies have reported higher post-TB mortality among men, potentially reflecting smoking, alcohol use, occupational exposure, comorbidity and differences in healthcare utilization (Choi et al., 2023).

Monthly income also showed no clear pattern. Survival probabilities were similar across the three income groups, and the log-rank test was not statistically significant. This differs from Baluku et al. (2024), who reported unemployment as an important predictor of post-TB mortality

in rural Uganda. However, employment and income capture different aspects of socio-economic position. A single income category may not adequately represent food insecurity, household assets, debt or loss of livelihood following TB.

The wider literature is clear that poverty, food insecurity, unstable work, and housing conditions shape TB trajectories and recovery. Nidoi et al. (2021) showed socio-economic factors were strongly linked to unfavourable TB treatment outcomes in north-eastern Uganda, and Wingfield et al. (2017) demonstrated that socio-economic support can improve TB outcomes by reducing catastrophic costs. The absence of significant associations in the present study therefore should not be taken to mean that socio-economic circumstances are irrelevant. Rather, the available measures and small number of deaths did not allow a reliable independent socio-economic effect to be demonstrated.

7.2.4 Health-facility and follow-up factors

Participant-perceived long waiting time had a positive adjusted association with mortality-AOR of 1.59 (95% CI 0.42–5.44). Although this direction suggested higher mortality among those reporting long waits, the estimate was imprecise. The measure was also subjective; the questionnaire recorded whether participants perceived waiting times to be long but did not specify a numerical threshold. However, Qualitative work from Uganda and other African settings has consistently identified long queues and prolonged waiting times as major deterrents to engagement in chronic care. (Romanowski et al., 2023)

The number of follow-up visits produced apparently large crude odds ratios, particularly among those attending more than twice. This should not be interpreted as evidence that follow-up visits increased mortality. Patients who became ill after treatment were more likely to return to health facilities repeatedly, meaning that increased utilization may have been a consequence of deteriorating health rather than its cause.

This interpretation is supported by qualitative post-TB research. Meghji et al. (2024) found that patients with ongoing respiratory symptoms after TB treatment often needed repeated contact with health services, while both patients and providers experienced uncertainty regarding the appropriate pathway for post-TB care. The key issue is therefore not simply the number of visits, but whether follow-up is timely, purposeful and linked to appropriate investigation and treatment.

Transport costs, stigma, access to care and perceived quality of follow-up also failed to produce clear mortality associations. Given the very small number of deaths in some categories, seemingly protective or harmful point estimates should be treated cautiously. Future studies would benefit from more detailed measurement of health-service use, including reason for attendance, actual waiting time, referral completion and clinical findings.

7.2.5 Nutritional and behavioural factors

Underweight status was not clearly associated with mortality; the adjusted OR was 1.20 with a wide confidence interval. This does not necessarily mean that nutrition is unimportant. Chakhaia et al. (2025) found that failure to gain weight during TB treatment was strongly associated with subsequent mortality among patients with drug-resistant TB. This suggests that change in nutritional status over time may be more informative than one BMI measurement.

Similarly, nutritional support had a crude OR above one, but this should not be interpreted as harmful. Patients receiving nutritional assistance may have been those who were already more vulnerable or undernourished.

Smoking and alcohol could not be evaluated adequately because comparable exposure data were unavailable for survivors. The absence of estimable odds ratios is therefore a data limitation rather than evidence of no association. However, larger studies have reported increased long-term health outcomes and mortality among TB survivors with heavy smoking or harmful alcohol use(Choi et al., 2023; Imtiaz et al., 2017; Nightingale et al., 2023).

7.3 Time-to-event findings

7.3.1 Concentration of mortality within the first year

The Kaplan–Meier analysis showed a clear decline in survival during the first year. Overall survival decreased from 1.000 at treatment discharge to 0.981 at six months and 0.961 at 12 months, remaining unchanged thereafter.

This timing is consistent with other Ugandan research. Lumu et al. (2023) observed their highest post-treatment mortality rate during the first year, followed by declining mortality thereafter. Similarly another study reported a median time from TB cure to death of less than nine months (Baluku et al., 2024). Same early concentration of risk has been reported in other post-TB

cohorts, although excess mortality may persist beyond the initial period (Romanowski et al., 2019; Wang et al., 2025).

These findings suggest that the period soon after treatment completion is an important transition in TB care. Some patients may still be recovering from pulmonary damage, nutritional depletion or other illnesses even after anti-TB treatment has ended. Post-TB lung disease provides one possible pathway, particularly since persistent respiratory abnormalities after TB have also been demonstrated in Uganda (van Kampen et al., 2019). Also the socio-economic consequences may additionally constrain nutrition and timely care (Allwood et al., 2021; Atkins et al., 2022; Nightingale et al., 2023).

Nevertheless, the absence of deaths after 12 months should not be interpreted as evidence that mortality risk becomes zero after one year. The cohort experienced only 10 deaths. Larger studies have documented continuing excess mortality several years after treatment completion (Romanowski et al., 2019). The current study can therefore conclude that all observed deaths were concentrated in the first year, but not that post-TB risk disappears thereafter.

7.3.2 Survival according to HIV and dysglycaemia

HIV status produced a visible difference in survival. By 12 months, survival was 91.7% among HIV-positive participants compared with 97.4% among HIV-negative participants. This difference is consistent with the approximately threefold effect estimates seen in the regression analyses and with other post-treatment studies showing increased mortality among people living with HIV (Lumu et al., 2023; Salindri et al., 2024).

In contrast, the dysglycaemia survival curves were very close together. Twelve-month survival was 95.5% among those with diabetes/pre-diabetes and 96.3% among those without. This supports the regression findings (log-rank test was inconclusive ($p = 0.796$) and reinforces the conclusion that dysglycaemia was not clearly associated with post-treatment mortality in this cohort. Therefore, biological plausibility and evidence from treatment-period studies do not establish a post-treatment mortality effect in these sparse data (Huangfu et al., 2019)

7.3.3 Cox proportional-hazards analysis

The full Cox model produced an elevated but imprecise AHR of 3.41(95% CI 0.98–11.84) for HIV-positive status, compared with 1.12 (95% CI 0.23–5.54) for dysglycaemia. Age, sex and

income were also estimated imprecisely with wide confidence intervals. A reduced model containing only HIV and dysglycaemia produced almost the same findings, with an AHR of 3.31 for HIV and 1.15 for dysglycaemia.

The similarity between the full and reduced models gives some reassurance that the positive HIV association was not produced solely by the choice of covariates. Nevertheless, only 10 events were available, which is insufficient for precise multivariable modelling. Consequently, the Cox estimates should remain explicitly described as exploratory.

This is also why confidence intervals are more informative than isolated point estimates. For example, an AHR of 2.35 for male sex might appear substantial, but the associated confidence interval was 0.30–18.65. Such a wide interval does not permit a reliable conclusion about either the direction or magnitude of the independent association.

The modelling therefore identifies HIV status as the clearest candidate for further study but does not establish a validated prediction rule. Dysglycaemia did not show a clear association in the corrected analysis, although appropriate metabolic care remains important on clinical grounds (Huangfu et al., 2019; Lumu et al., 2023).

7.4 Implications of the findings

Taken together, the findings from all three objectives have implications for clinical practice, programme planning and policy.

The findings suggest that successful TB treatment should be followed by greater attention to the patient's continuing health needs, particularly during the first year. They do not provide evidence for a specific post-TB clinic schedule, but they indicate that treatment completion may be an appropriate point for assessing unresolved symptoms, comorbidities and linkage to continuing care.

HIV-positive TB survivors appear to be the group most clearly deserving closer attention. Ensuring continuity of ART, appropriate review of HIV control and prompt investigation of new symptoms could be incorporated into existing HIV services rather than creating a completely separate programme.

For diabetes and pre-diabetes, the implication is somewhat different. Although dysglycaemia did not show a clear mortality association in this study, patients with persistent abnormal glucose levels still require appropriate NCD care. Repeat assessment may also help distinguish persistent diabetes from transient hyperglycaemia associated with active TB (Menon et al., 2020).

The concentration of deaths within the first year supports evaluating more structured post-treatment follow-up during this period. Migliori et al. (2021) recommend assessment for persistent symptoms, functional impairment and post-TB lung disease after treatment completion. In Uganda, such approaches should be integrated with existing TB, HIV and NCD services rather than introduced without consideration of staff workload and available resources.

Health-facility and service organization is equally important. Karanja et al. (2022) found that stakeholders in African settings considered limited staff, funding and unclear responsibility important barriers to post-TB care. For Kawaala and Kiswa, practical measures such as clearer referral pathways, appropriate triage and review of patient waiting experience may therefore be more realistic starting points than creating a new stand-alone service.

7.5 Strengths and limitations

7.5.1 Strengths

The main strength of this study is that it specifically examined mortality after successful TB treatment, a period that is often absent from routine programme indicators. The use of multiple outcome sources including, facility information and next-of-kin follow-up improved ascertainment of post-treatment vital status. The study also used Firth regression to address sparse outcome cells and complemented this with Kaplan–Meier and Cox methods. Finally, the analysis was guided by a conceptual framework that considered biological, socio-economic, behavioral, and health-facility determinants rather than focusing on only one domain

7.5.2 Limitations

Several limitations remain:

The principal limitation is the small number of deaths (n = 10)-this restricted statistical power and produced wide confidence intervals, particularly in multivariable models (limited the number of variables that could be estimated reliably). The full Cox model should therefore be regarded as exploratory rather than predictive.

A further limitation concerns the precision of death timing. Exact dates were not available for all deaths, and interval reports (<6 months and 6–12 months) were represented by approximate midpoints for survival analysis. This may affect Cox estimates, although it does not alter the finding that all 10 deaths occurred during the first year.

The study measured all-cause mortality and could not reliably assign medical causes of death. In addition, detailed markers of HIV disease control such as CD4 count, viral load and ART adherence were not included in the mortality models. Dysglycaemia combined diabetes and pre-diabetes, with relatively few participants having established diabetes alone.

Some socio-economic and health-facility variables were measured broadly, while smoking and alcohol could not be compared adequately between survivors and those who died.
Perceived long waiting time also lacked a numeric threshold, limiting comparability and introducing possible subjective measurement error

Selection bias is possible because eligibility was restricted to participants enrolled in the parent TB–DM cohort who successfully completed treatment and had ascertainable post-treatment vital status. Included participants may differ from patients who were not enrolled, did not complete treatment, or could not be traced. If excluded or unascertained participants had greater mortality, the study may underestimate risk; if they were healthier or more mobile, the direction could differ. These restrictions also limit generalizability beyond the two urban facilities

Despite these limitations, the study provides useful facility-level evidence that mortality continues after successful TB treatment and that the first year after discharge appears to be the most vulnerable period in this cohort, with HIV showing the most consistent association with mortality.

CHAPTER EIGHT: CONCLUSIONS AND RECOMMENDATIONS

8.0 Conclusions

8.1 Conclusions by study objective

1. Objective 1: Among 259 participants, 10 deaths occurred during 6,036 person-months (approximately 503 person-years). Two-year cumulative mortality was 3.9%, and the crude mortality rate was 19.9 deaths per 1,000 person-years. Five deaths occurred during 0–6 months and five during 6–12 months; none occurred during 12–24 months.

2. Objective 2: HIV-positive status was the strongest potential predictor of mortality in the adjusted models (AORs 3.34 and 3.37), but the confidence intervals were wide and included the null. Dysglycaemia, underweight and perceived long waiting time also did not show precise adjusted effects. With only 10 deaths, no measured characteristic could be confirmed as an independent predictor; the estimates should be regarded as exploratory prognostic evidence.

3. Objective 3: Overall survival fell to 0.981 at six months and 0.961 at 12 months, remaining at 0.961 through 24 months. HIV-positive status was the strongest potential predictor of shorter time to death in the Cox model (AHR 3.41, 95% CI 0.98–11.84), whereas dysglycaemia showed no clear prognostic relationship (AHR 1.12, 95% CI 0.23–5.54). These estimates were imprecise, so the most robust finding was the timing pattern: all observed deaths occurred within the first year after treatment discharge.

8.2 Recommendations

8.2.1 First-year post-TB follow-up

Kawaala and Kiswa Health Centre IVs should consider structured post-TB follow-up during the first 12 months after treatment completion, because all 10 observed deaths in this study occurred during this period. The follow-up should focus on maintaining contact with patients and identifying those who become unwell after treatment completion.

8.2.2 Continuity of HIV care

HIV-positive TB survivors should receive particular attention to continuity of HIV care after TB treatment completion. HIV-positive status consistently showed the strongest elevated mortality estimates across the crude, adjusted Firth and Cox analyses. Because the adjusted confidence

intervals were wide and included the null, this should be interpreted as a group warranting closer attention rather than as a definitively proven high-risk group.

8.2.3 Post-TB mortality surveillance

Kawaala and Kiswa Health Centre IVs should consider routine monitoring of post-TB vital status beyond treatment completion, particularly during the first 12 months. The observed two-year cumulative mortality of 3.9% and crude mortality rate of 19.9 deaths per 1,000 person-years, with all deaths occurring within the first year, demonstrate a post-treatment mortality burden that is not captured by treatment-outcome indicators alone.

8.2.4 Future research

Larger multicentre prospective studies should be conducted to confirm predictors of post-TB mortality and improve the precision and generalizability of the estimates. Future studies should recruit larger cohorts from multiple settings, record exact event dates where possible, and collect detailed HIV markers such as CD4 count, viral load and ART adherence, which were unavailable in the present mortality models.

REFERENCES

Acharya, S., Karanjkar, V., Bhamre, S. P., Palkar, A., Rathod, D., & Setia, M. S. (2024). Factors associated with mortality in HIV-TB co-infected patients during and after the course of TB treatment in high-burden settings, Mumbai, India: A cohort analysis. *Tropical Medicine & International Health*, *29*(1), 23–32. https://doi.org/10.1111/tmi.13948

Alene, K. A., Hertzog, L., Gilmour, B., Clements, A. C. A., & Murray, M. B. (2024). Interventions to prevent post-tuberculosis sequelae: A systematic review and meta-analysis. *eClinicalMedicine*, *70*, 102511. https://doi.org/10.1016/j.eclinm.2024.102511

Allwood, B. W., Byrne, A., Meghji, J., Rachow, A., van der Zalm, M. M., & Schoch, O. D. (2021). Post-tuberculosis lung disease: Clinical review of an under-recognised global challenge. *Respiration*, *100*(8), 751–763. https://doi.org/10.1159/000512531

Atkins, S., Heimo, L., Carter, D., Ribas Closa, M., Vanleeuw, L., Chenciner, L., Wambi, P., Sidney-Annerstedt, K., Egere, U., Verkuijl, S., Brands, A., Masini, T., Viney, K., Wingfield, T., Lönnroth, K., & Boccia, D. (2022). The socioeconomic impact of tuberculosis on children and adolescents: A scoping review and conceptual framework. *BMC Public Health*, *22*(1), 2153. https://doi.org/10.1186/s12889-022-14579-7

Baluku, J. B., Namanda, B., Namiiro, S., Rwabwera, D. K., Mwesigwa, G., Namaara, C., Twinomugisha, B., Nyirazihawe, I., Nuwagira, E., Kansiime, G., Kizito, E., Nabukenya-Mudiope, M. G., Sekadde, M. P., Bongomin, F., Senfuka, J., Olum, R., Byaruhanga, A., Munabi, I., & Kiguli, S. (2024). Death after cure: Mortality among pulmonary tuberculosis survivors in rural Uganda. *International Journal of Infectious Diseases*, *144*, 107069. https://doi.org/10.1016/j.ijid.2024.107069

Bongomin, F., Namusobya, M., Nantale, R., Ebbs, D. S., Batte, C., van Rhijn, N., Baluku, J. B., & Denning, D. W. (2025). Mortality hazards after treatment completion of pulmonary tuberculosis in a tertiary hospital in Uganda. *IJID Regions*, *17*, 100758. https://doi.org/10.1016/j.ijregi.2025.100758

Chakhaia, T., Blumberg, H. M., Kempker, R. R., Luo, R., Dzidzikashvili, N., Chincharauli, M., Tukvadze, N., Avaliani, Z., Stauber, C., & Magee, M. J. (2025). Lack of weight gain and increased mortality during and after treatment among adults with drug-resistant tuberculosis: A retrospective cohort study in Georgia, 2009–2020. *ERJ Open Research*, *11*(3), 00839–02024. https://doi.org/10.1183/23120541.00839-2024

Choi, H., Han, K., Jung, J.-H., Park, S. H., Kim, S. H., Kang, H. K., Sohn, J. W., Shin, D. W., & Lee, H. (2023). Long-term mortality of tuberculosis survivors in Korea: A population-based longitudinal study. *Clinical Infectious Diseases*, *76*(3), e973–e981. https://doi.org/10.1093/cid/ciac411

Conradie, F., Bagdasaryan, T. R., Borisov, S., Howell, P., Mikiashvili, L., Ngubane, N., Samoilova, A., Skornykova, S., Tudor, E., Variava, E., Yablonskiy, P., Everitt, D., Wills, G. H., Sun, E., Olugbosi, M., Egizi, E., Li, M., Holsta, A., Timm, J., … Spigelman, M. (2022). Bedaquiline–pretomanid–linezolid regimens for drug-resistant tuberculosis. *New England Journal of Medicine, 387*(9), 810–823. https://doi.org/10.1056/NEJMoa2119430

Conradie, F., Diacon, A. H., Ngubane, N., Howell, P., Everitt, D., Crook, A. M., Mendel, C. M., Egizi, E., Moreira, J., Timm, J., McHugh, T. D., Wills, G. H., Bateson, A., Hunt, R., Van Niekerk, C., Li, M., Olugbosi, M., & Spigelman, M. (2020). Treatment of highly drug-resistant pulmonary tuberculosis. *New England Journal of Medicine, 382*(10), 893–902. https://doi.org/10.1056/NEJMoa1901814

Cox, D. R. (1972). Regression models and life-tables. *Journal of the Royal Statistical Society: Series B, 34*(2), 187–220. https://doi.org/10.1111/j.2517-6161.1972.tb00899.x

Firth, D. (1993). Bias reduction of maximum likelihood estimates. *Biometrika, 80*(1), 27–38. https://doi.org/10.1093/biomet/80.1.27

Fox, G. J., Nguyen, V. N., Dinh, N. S., Nghiem, L. P. H., Le, T. N. A., Nguyen, T. A., Nguyen, B. H., Nguyen, H. D., Tran, N. B., Nguyen, T. L., Le, T. N., Nguyen, V. H., Phan, T. L., Nguyen, K. C., Ho, J., Pham, D. C., Britton, W. J., Bestrashniy, J. R. B. M., & Marks, G. B. (2019). Post-treatment mortality among patients with tuberculosis: A prospective cohort study of 10 964 patients in Vietnam. *Clinical Infectious Diseases*, *68*(8), 1359–1366. https://doi.org/10.1093/cid/ciy665

Gorvetzian, S., Pacheco, A. G., Anderson, E., Ray, S. M., & Schechter, M. C. (2024). Mortality rates after tuberculosis treatment, Georgia, USA, 2008–2019. *Emerging Infectious Diseases*, *30*(11), 2261–2270. https://doi.org/10.3201/eid3011.240329

Heinze, G., & Schemper, M. (2002). A solution to the problem of separation in logistic regression. *Statistics in Medicine, 21*(16), 2409–2419. https://doi.org/10.1002/sim.1047

Houck, K., Chakhaia, T., Gorvetzian, S., Critchley, J. A., Schechter, M. C., & Magee, M. J. (2023). Diabetes mellitus and tuberculosis treatment outcomes: Interaction assessment between hyperglycemia and human immunodeficiency virus in the state of Georgia, 2015–2020. *Open Forum Infectious Diseases*, *10*(6), ofad255. https://doi.org/10.1093/ofid/ofad255

Huangfu, P., Ugarte-Gil, C., Golub, J., Pearson, F., & Critchley, J. (2019). The effects of diabetes on tuberculosis treatment outcomes: An updated systematic review and meta-analysis. *The International Journal of Tuberculosis and Lung Disease*, *23*(7), 783–796. https://doi.org/10.5588/ijtld.18.0433

Imtiaz, S., Shield, K. D., Roerecke, M., Samokhvalov, A. V., Lönnroth, K., & Rehm, J. (2017). Alcohol consumption as a risk factor for tuberculosis: Meta-analyses and burden of disease. *European Respiratory Journal*, *50*(1), 1700216. https://doi.org/10.1183/13993003.00216-2017

Izudi, J., Tamwesigire, I. K., & Bajunirwe, F. (2020). Treatment success and mortality among adults with tuberculosis in rural eastern Uganda: A retrospective cohort study. *BMC Public Health*, *20*(1), 501. https://doi.org/10.1186/s12889-020-08646-0

Kaplan, E. L., & Meier, P. (1958). Nonparametric estimation from incomplete observations. *Journal of the American Statistical Association*, *53*(282), 457–481. https://doi.org/10.1080/01621459.1958.10501452

Karanja, S., Malenga, T., Mphande, J., Squire, S. B., Chakaya Muhwa, J., Tomeny, E. M., Rosu, L., Mulupi, S., Wingfield, T., Zulu, E., & Meghji, J. (2022). Stakeholder perspectives around post-TB wellbeing and care in Kenya and Malawi. *PLOS Global Public Health*, *2*(9), e0000510. https://doi.org/10.1371/journal.pgph.0000510

Leung, C. L., Jerene, D., Meghji, J., Drage, M., Mbawala, W., Mpagama, S. G., Pell, C., & Mulder, C. (2025). Post-TB sequelae and care: A systematic review and synthesis of qualitative research. *IJTLD Open*, *2*(6), 339–345. https://doi.org/10.5588/ijtldopen.25.0084

Lumu, I., Musaazi, J., Semeere, A., Handel, I., & Castelnuovo, B. (2023). Survival and predictors of mortality after completion of TB treatment among people living with HIV: A 5-year analytical cohort. *BMC Infectious Diseases*, *23*, 238. https://doi.org/10.1186/s12879-023-08217-9

Meghji, J., Msukwa-Panje, W., Mkutumula, E., Kamchedzera, W., Banda, N. P. K., MacPherson, P., & Engel, N. (2024). Respiratory symptoms after TB treatment completion: A qualitative study of patient and provider experiences in urban Blantyre, Malawi. *PLOS Global Public Health*, *4*(9), e0003436. https://doi.org/10.1371/journal.pgph.0003436

Menon, S., Rossi, R., Dusabimana, A., Zdraveska, N., Bhattacharyya, S., & Francis, J. (2020). The epidemiology of tuberculosis-associated hyperglycemia in individuals newly screened for type 2 diabetes mellitus: Systematic review and meta-analysis. *BMC Infectious Diseases*, *20*, 937. https://doi.org/10.1186/s12879-020-05512-7

Menzies, N. A., Quaife, M., Allwood, B. W., Byrne, A. L., Coussens, A. K., Harries, A. D., Marx, F. M., Meghji, J., Pedrazzoli, D., Salomon, J. A., Sweeney, S., van Kampen, S. C., Wallis, R. S., Houben, R. M. G. J., & Cohen, T. (2021). Lifetime burden of disease due to incident tuberculosis: A global reappraisal including post-tuberculosis sequelae. *The*

Lancet Global Health, *9*(12), e1679–e1687. https://doi.org/10.1016/S2214-109X(21)00367-3

Migliori, G. B., Marx, F. M., Ambrosino, N., Zampogna, E., Schaaf, H. S., van der Zalm, M. M., Allwood, B., Byrne, A. L., Mortimer, K., Wallis, R. S., Fox, G. J., Leung, C. C., Chakaya, J. M., Seaworth, B., Rachow, A., Marais, B. J., Furin, J., Akkerman, O. W., Al Yaquobi, F., … Visca, D. (2021). Clinical standards for the assessment, management and rehabilitation of post-TB lung disease. *The International Journal of Tuberculosis and Lung Disease*, *25*(10), 797–813. https://doi.org/10.5588/ijtld.21.0425

Ministry of Health. (2023). *Uganda National Tuberculosis and Leprosy Programme annual report, July 2022–June 2023*. https://www.health.go.ug/wp-content/uploads/2024/01/NTLP-Report-30-Nov-2023-2.pdf

Nidoi, J., Muttamba, W., Walusimbi, S., Imoko, J. F., Lochoro, P., Ictho, J., Mugenyi, L., Sekibira, R., Turyahabwe, S., Byaruhanga, R., Putoto, G., Villa, S., Raviglione, M. C., & Kirenga, B. (2021). Impact of socio-economic factors on tuberculosis treatment outcomes in north-eastern Uganda: A mixed methods study. *BMC Public Health*, *21*, 2167. https://doi.org/10.1186/s12889-021-12056-1

Nightingale, R., Carlin, F., Meghji, J., McMullen, K., Evans, D., van der Zalm, M. M., Anthony, M. G., Bittencourt, M., Byrne, A., du Preez, K., Coetzee, M., Feris, C., Goussard, P., Hirasen, K., Bouwer, J., Hoddinott, G., Huaman, M. A., Inglis-Jassiem, G., Ivanova, O., … Mortimer, K. (2023). Post-TB health and wellbeing. *The International Journal of Tuberculosis and Lung Disease*, *27*(4), 248–283. https://doi.org/10.5588/ijtld.22.0514

Nsonga, J., Dongo, J. P., Mugabe, F., Mutungi, G., Walyomo, R., Oundo, C., Zalwango, S., Okello, D., Muchuro, S., Dlodlo, R. A., & Lin, Y. (2019). Screening tuberculosis patients for diabetes mellitus in a routine program setting in Kampala, Uganda: A cross-sectional study. F1000Research, 8, 872. https://doi.org/10.12688/f1000research.19279.2

Romanowski, K., Baumann, B., Basham, C. A., Khan, F. A., Fox, G. J., & Johnston, J. C. (2019). Long-term all-cause mortality in people treated for tuberculosis: A systematic review and meta-analysis. *The Lancet Infectious Diseases*, *19*(10), 1129–1137. https://doi.org/10.1016/S1473-3099(19)30309-3

Romanowski, K., Cook, V. J., Gilbert, M., & Johnston, J. C. (2023). Using a theory-informed approach to guide the initial development of a post-tuberculosis care package in British Columbia, Canada. *BMC Health Services Research*, *23*(1), 805. https://doi.org/10.1186/s12913-023-09835-4

Salindri, A. D., Kipiani, M., Lomtadze, N., Tukvadze, N., Avaliani, Z., Blumberg, H. M., Masyn, K. E., Rothenberg, R. B., Kempker, R. R., & Magee, M. J. (2024). HIV co-

infection increases the risk of post-tuberculosis mortality among persons who initiated treatment for drug-resistant tuberculosis. *Scientific Reports, 14*, 23834. https://doi.org/10.1038/s41598-024-68605-2

Thu, W. P. P., Hu, T. H., D'Ambrosio, L., Centis, R., Ong, C. W. M., & Migliori, G. B. (2025). Charting the course in post-tuberculosis lung disease: From inflammation to intervention. *Archivos de Bronconeumología*, *61*(12), 757–765. https://doi.org/10.1016/j.arbres.2025.09.017

van Kampen, S. C., Jones, R., Kisembo, H., Rutebemberwa, E., & Kirenga, B. (2019). Chronic respiratory symptoms and lung abnormalities among people with a history of tuberculosis in Uganda: A national survey. *Clinical Infectious Diseases*, *68*(11), 1919–1925. https://doi.org/10.1093/cid/ciy795

Wang, J., Yuan, B., Fang, Y., Zhao, C., Liu, J., & Xiong, K. (2025). Post-tuberculosis morbidities and their associated mortality: Moving from challenges to solutions. *European Respiratory Review*, *34*(178), 250148. https://doi.org/10.1183/16000617.0148-2025

Wingfield, T., Tovar, M. A., Huff, D., Boccia, D., Montoya, R., Ramos, E., Datta, S., Saunders, M., Lewis, J. J., Gilman, R. H., & Evans, C. A. (2017). Socioeconomic support to improve initiation of tuberculosis preventive therapy and increase tuberculosis treatment success in Peru: A household-randomized, controlled evaluation. *The Lancet*, *389*, S16. https://doi.org/10.1016/S0140-6736(17)30412-9

World Health Organization. (2025a). *Global tuberculosis report 2025*. https://www.who.int/teams/global-tuberculosis-programme/tb-reports/global-tuberculosis-report-2025

World Health Organization. (2025b). *WHO consolidated guidelines on tuberculosis: Module 4—Treatment and care*. https://www.who.int/teams/global-tuberculosis-programme/tb-reports-and-publications

APPENDICES

Appendix I: Clearance letter from Overseer

MAKERERE UNIVERSITY
P.O. Box 7072
Kampala UGANDA
Email: info.chbs@musph.ac.ug
Tel: +256-414-543 872/ 031-2-263158
Fax: +256-414-531807
Website: www.sph.mak.ac.ug

SCHOOL OF PUBLIC HEALTH
Department of Community Health and Behavioural Sciences

13th June 2025

The Chairperson, HDREC
MAKSPH, Makerere University
PO. BOX 7062
Kampala, Uganda.

Re: CORRECTIONS MADE BY NALUBEGA MADINAH REG No: 2022/HD07/465U

I was appointed by the panel to oversee corrections to a proposal by Nalubega Madinah I am writing to confirm that the above-mentioned student has made all the required revisions to her proposal entitled **"MORTALITY AND ITS PREDICTORS AMONG TB PATIENTS WITHIN TWO YEARS AFTER TB TREATMENT DISCHARGE AT KAWAALA AND KISWA HCIVS, UGANDA."**

I, therefore, recommend that she proceed with data collection.

Sincerely,

Dr. Edward Buzigi
Community Health and Behavioral Sciences Department

MAKERERE UNIVERSITY
SCHOOL OF PUBLIC HEALTH
APPROVED
VALID UNTIL
★ 17 JUL 2026 ★
RESEARCH & ETHICS COMMITTEE
P. O. BOX 7072, KAMPALA

Scanned with CamScanner

Appendix II: IRB Approval Letter

MAKERERE UNIVERSITY
P.O. Box 7072
Kampala UGANDA
Email: hdrecadmin@musph.ac.ug

Tel: +256-414-543 872/ 031-2-263158
Fax: +256-414-531807
Website: www.sph.mak.ac.ug

SCHOOL OF PUBLIC HEALTH
Research and Ethics Committee

MAKERERE UNIVERSITY SCHOOL OF PUBLIC HEALTH APPROVED VALID UNTIL ★ 17 JUL 2026 ★ RESEARCH & ETHICS COMMITTEE P. O. BOX 7072, KAMPALA

17th July, 2025

Ms. Nalubega Madinah
Master student, (2022/HD07/465U)
School of Public Health, Makerere University

Re: Approval of a research proposal titled: "Mortality and Its Predictors Among TB Patients Within Two Years After TB Treatment Discharge at Kawaala And Kiswa HCIVs, Uganda"

This is to inform you that the Makerere School of Public Health Research and Ethics Committee (MakSPH-REC) has approved your study documents for the above-referenced research study.

Please note that your study protocol number with MakSPH-REC is **679**. Please be sure to reference this number in any correspondence with MakSPH-REC. Note that your study was first approved by the MakSPH-REC on **17/07/2025**, and therefore approval expires at every annual anniversary of this approval date. The current approval is therefore valid until **17/07/2026.**

Continued approval is conditional upon your compliance with the following requirements:

1) No other consent form(s), questionnaire and/or advertisement documents should be used. The consent form(s) must be signed by each subject prior to initiation of any protocol procedures. In addition, each subject must be given a copy of the signed consent form.

2) All protocol amendments and changes to other approved documents must be submitted to MakSPH-REC and not be implemented until approved by MakSPH-REC except where necessary to eliminate apparent immediate hazards to the study subjects.

3) Significant changes to the study site and significant deviations from the research protocol and all unanticipated problems that may involve risks or affect the safety or welfare of subjects or others, or that may affect the integrity of the research must be promptly reported to MakSPH-REC.

CS Scanned with CamScanner

Please complete and submit reports to MakSPH-REC as follows:

a) Renewal of the study approval – complete and return the continuing Review Report – Renewal Request (Form 404A) at least 60 days prior to the expiration of the approval period. The study cannot continue until re-approved by MakSPH-REC.

b) Completion, termination, or if not renewing the project – send a final report within 90 days upon completion of the study.

Yours sincerely,

Dr. Joseph Kagaayi
Chairperson: MakSPH- Research and Ethics Committee

MAKERERE UNIVERSITY
SCHOOL OF PUBLIC HEALTH
APPROVED
VALID UNTIL
★ 17 JUL 2026 ★
RESEARCH & ETHICS COMMITTEE
P.O. BOX 7072, KAMPALA

CS Scanned with CamScanner

Appendix III: Waiver of Informed consent

MAKERERE UNIVERSITY
P.O. Box 7072
Kampala UGANDA
Email: hdrecadmin@musph.ac.ug
Tel: +256 -414-543 872/ 031-2-263158
Fax: +256-414-531807
Website: www.sph.mak.ac.ug

SCHOOL OF PUBLIC HEALTH
Research and Ethics Committee

MAKERERE UNIVERSITY SCHOOL OF PUBLIC HEALTH APPROVED VALID UNTIL 17 JUL 2026 RESEARCH & ETHICS COMMITTEE P.O. BOX 7072, KAMPALA

17th July 2025

Ms. Nalubega Madinah,
Master student, (2022/HD07/465U)
School of Public Health, Makerere University

Re: Approval of the Waiver of Informed Consent Form to utilize secondary data for a study titled: "Mortality and Its Predictors Among TB Patients Within Two Years After TB Treatment Discharge at Kawaala And Kiswa HCIVs, Uganda".

We are pleased to inform you that, the Makerere University School of Public Health Research and Ethics Committee (MakSPH-REC) reviewed and approved the request for Waiver of Informed Consent to utilize de-identified secondary data on Tuberculosis from patient records at Kawaala and Kiswa HCIVs.

The waiver is granted on the understanding that the study that cannot be conducted without the waiver and no identifiable participant information such as names or phone numbers will be used.

Please contact the Administrator of MakSPH-REC on sphrecadmin@musph.ac.ug or telephone number (256773785333) if you have any queries.

Yours Sincerely,

.....

Dr. Joseph Kagaayi

Chairperson: MakSPH- Research and Ethics Committee

Scanned with CamScanner

Appendix IV: Secondary data extraction tool

Secondary Data Extraction Tool for the Study

Research Title

Mortality and Its Predictors among TB Patients within Two Years after TB Treatment Discharge at Kawaala and Kiswa HCIVS, Uganda

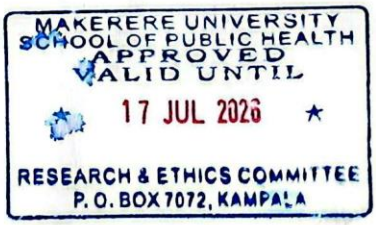
SECTION 1: DEMOGRAPHIC INFORMATION

Participant ID: _____

1. Age: ___ years
2. Sex: ☐ Male ☐ Female
3. Education Level: ☐ None ☐ Primary ☐ Secondary ☐ Tertiary
4. Occupation:
   ☐ Farmer ☐ Trader ☐ Professional ☐ Unemployed
   ☐Others (specify): _____
5. Marital Status: ☐ Single ☐ Married ☐ Divorced/Separated ☐ Widowed
6. Residence: ☐ Rural ☐ Urban
7. Income Level (Monthly):
   ☐ < UGX 100,000 ☐ UGX 100,000–500,000 ☐> UGX 500,000

SECTION 2: CLINICAL CHARACTERISTICS

8. Date of TB diagnosis_____
9. Type of TB diagnosed: ☐ Pulmonary TB ☐ Extrapulmonary TB
10. Mode of TB diagnosis: ☐ GeneXpert ☐ Microscopy ☐ Clinical diagnosis
11. TB Treatment start date: _____
12. TB Treatment completion date: _____
13. TB Treatment Regimen ☐ First line ☐ Second line ☐ MDR/XDR
14. Duration of TB treatment: ☐ 6 months ☐ 9 months ☐ >9 months
15. History of retreatment: ☐ Yes ☐ No
16. HIV Status: ☐ Positive ☐ Negative ☐ Unknown
17. HIV Treatment status ☐ On ART ☐ Not on ART ☐ Unknown



Scanned with CamScanner

18. CD4 count (if HIV positive): ☐ <200 cells/Ml ☐ 200–500 cells/μL ☐ >500 cells/μL

19. Other comorbidities (check all that apply):

☐ Diabetes ☐ Hypertension ☐ Malnutrition ☐ Chronic lung disease

☐ Others (specify): _____

20. Nutritional status: ☐ Normal ☐ Underweight ☐ Overweight ☐ Obese

21. Adverse drug reactions ☐ No ☐ Yes If Yes, specify_____

22. Adherence to TB treatment based on records: ☐ Good ☐ Poor

23. Treatment outcome: ☐ Cured ☐ Completed Treatment ☐ Loss to follow up

☐ Treatment failure ☐ Died

SECTION 3: TREATMENT AND POST-TREATMENT CARE

24. Completion of treatment: ☐ Yes ☐ No ☐ Unknown

25. Follow-Up visits after discharge: ☐ None ☐ Once ☐ Twice ☐ More than twice

26. Availability of nutritional support during treatment: ☐ Yes ☐ No

27. Support system after treatment (e.g., family, community):

☐ Strong ☐ Moderate ☐ Weak/None

SECTION 4: MORTALITY DATA

28. Current Vital Status: ☐ Alive ☐ Deceased

29. If Deceased, Cause of Death:

☐ TB-related complications ☐HIV/AIDS-related conditions

☐ Other infections ☐ Unknown

30. Date of death:_____

31. Time between discharge and death (if deceased)

☐ <6 months ☐ 6–12 months ☐ 12-24 months ☐ >24months

SECTION 5: HEALTH FACILITY INFORMATION

32. Facility Type:

☐ Health Centre IV ☐ District Hospital ☐ Referral Hospital



Scanned with CamScanner

33. Distance to Nearest Health Facility (in km):

☐ <5 km ☐ 5–10 km ☐ >10 km

34. Access to Follow-Up Care at Facility: ☐ Easy ☐ Difficult

35. Integrated care: ☐ Yes ☐ No If yes, specify_____

36. Challenges Faced During Post-Treatment Follow-Up:

☐ Transport costs ☐ Long waiting times ☐ Stigma ☐ Other (specify): _____

SECTION 6: QUALITY ASSURANCE

37. Completeness of Records (from facility records):

☐ Complete ☐ Incomplete

38. Quality of Follow-Up Services (based on participant rating):

☐ Excellent ☐ Good ☐ Fair ☐ Poor



Scanned with CamScanner

Appendix V: Verbal consent script- English version

Verbal Consent Script for Verbal Autopsy Interview

Introduction

Hello. My name is Nalubega Madinah, and I am calling from Makerere University School of Public Health. May I please speak to you?

(If yes, proceed. If not available, politely end call and try again later.)

I am part of a research team conducting a study to better understand the health and causes of death of patients who were treated for tuberculosis (TB) at Kawaala and Kiswa Health Centre IVs between 2019 and 2023. The study is being conducted under the University's approval, and it aims to improve the health services for people recovering from TB in Uganda.

Confirming Identity

Before we proceed, I would like to confirm that I am speaking with the right person. I will ask a few short questions about your relative who was treated for TB.

(Ask for the deceased's full name, age at the time of death, place of residence, and the caller's relationship to the deceased. If information matches, continue. If not, politely end call.)

Assessing Readiness

I understand that this may still be a difficult time for you. Are you feeling emotionally okay to talk about your relative now? It is okay to say no, and we can schedule for another time if you prefer.

(If not okay, I schedule another call. If yes, we continue with interview.)

Explaining the Interview

The interview will take about 15 to 20 minutes. I will ask you some questions about the symptoms your relative may have experienced before they passed away and whether they sought medical care. This will help us understand possible causes of death where medical records are incomplete.

Voluntary Participation and Confidentiality

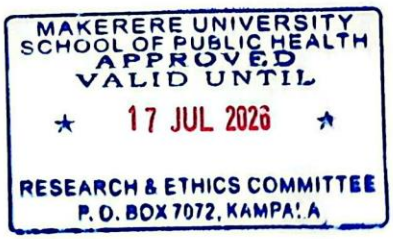
Participation is completely voluntary. You may choose not to answer any question, and you can stop the interview at any time without giving a reason. All your responses will be kept strictly confidential and will only be used for research purposes. We will not record your name or your loved one's name in the final report.

Consent Confirmation

Do you agree to take part in this interview and give your verbal consent?

☐ (If yes, interviewer marks the verbal consent section on the form and begins the interview.)

☐ (If no, thank the participant and end the call respectfully)



Appendix VI: Verbal Autopsy Script- Luganda version

EKIWANDIIKO KYOKUKKIRIZA MUKWATULA OKUDDAMU EBIBUUZO EBIKWATA KUNFA YABALWADDE ABAAFA OBULWADDE BWAKAFUBA

Enyanjula

Halo, Erinya lyange nze Nalubega Madinah nga nkukubila kuva eri Etendekero lya Makerere University elyebyobulamu. Nsobola okwogerako naawe?

(Bwakiriza nga ogenda mumaaso, Bwagaana, maliriza essimu mubuwombefu ogezeeko olulala.)

Ndi omu kukibinja kyabanonyereza okwongera okutegeera ebyobulamu wamu nensonga ezaletera okufa eri abo abalwadde abajjanjabibwako obulwadde bwakafuba ku dwaliro lye'kawaala ne Kiswa HCIVokuva mu mwaka gwa 2019 paka 2023. Okunonyereza kuno kukolebwa nga kwakilizidwa ettendekero lye Makerere era kuluubilwa okulongoosa ebyobulamu eri abantu abali mukuwona obulwadde bwakafuba mu Uganda.

Okukasa obutuufu bwomuntu

Nga tetunaba kweyongerayo, nandyagadde okukakasa nti njogera nomuntu omutuufu. Njakukubuzaayo ebibuuzo bitono ebikwata ku woluganda wo eyali ajanjabwa obulwadde bwakafuba.

(Buuza amanya gomugenzi gombi, emyaka jomugenzi weyafiira, Ekifo weyali abeera, enkolagana ye nomugenzi. Obubaka bwebuba bukwatagana, weyongereyo , webuba tebufanagana, komya essimu mubuwombeefu.)

Okukebera obwetegefu bwomuntu

Nkimanyi nti kano kayinza okubeera akaseera akazibu jooli. Owulira nti olimugumu mu okwogera kuwoluganda lwo kati? Oliwaddembe okugaana , tusobola oketegeka akadde akalala bwoba oyagadde.

(Bwatakiriza, tegeka olukuba olulala, Bwakiriza, genda mumaaso no'kubuuza)

Okunyonyola ebibuuzo

Ebibuuzo bijja kutwala edakiika 15-20. Njakukubuuza ebibuuzo ebikwata ku bubonero owolugandawo bwayinza okuba nga yafuna nga tanaba kufa era oba yafunako obujanjabi

MAKERERE UNIVERSITY
SCHOOL OF PUBLIC HEALTH
APPROVED
VALID UNTIL
17 JUL 2026
RESEARCH & ETHICS COMMITTEE
P.O. BOX 7072, KAMPALA

mudwaliro. Kino kijja kutuyamba okutegeera ensonga eziyinza okuleetera okufa ebiwandiiko byomudwaliro webiba tebigwaayo.

Okwetaba mukunonyereza okwakyeyagalire nokukuuma ebyama

Okwebatamukwo mukunonyereza kwa kyeyagalire. Osobola okusalawo obutaddamu bibuuzo era osobola okuyimiliza ebibuuzo obudde bwonna nga towadde nsonga. Byonaddamu byonna bijja kukumibwa mukyama era bijakozesebwa mukunonyereza kuno kwokka. Erinya lyo ewamu nelyomwagalwawo tebijja kuwandiikibwa wantu wonna mu alipoota esembayo.

Okukakasa okukkiriza

Okkiriza okwetaba mu kubuuzibwa kuno otuwe okukkiriza kwokwatula?

Bwekiba yye, omubuuza nga asaza mu kaboxi kokukiriza kwokwatula nga atandika okubuuza)

Bwekiba nedda, mwebaze omalirize essimu mubuwombeefu.

MAKERERE UNIVERSITY
SCHOOL OF PUBLIC HEALTH
APPROVED
VALID UNTIL
★ 17 JUL 2026 ★
RESEARCH & ETHICS COMMITTEE
P. O. BOX 7072, KAMPALA

Appendix VII: Verbal Autopsy Questionnaire- English version

Appendix II: Verbal Autopsy Questionnaire for the Study

Research Title

Mortality and Its Predictors among TB Patients within Two Years after TB Treatment Discharge at Kawaala and Kiswa HCIVS, Uganda

Verbal Consent Obtained ☐ Yes ☐ No

Section 1: Respondent and Deceased Information

1. **Interview Details:**

Interview ID: _____

Date of Interview: _____ (DD/MM/YYYY)

Deceased ID: _____

2. **Respondent's Information:**

Name of Respondent: _____

Relationship to Deceased:

☐ Parent ☐ Spouse ☐ Sibling ☐ Child ☐ Other Relative ☐No Relation

Did the respondent live with the deceased during the events leading to death?

☐ Yes ☐ No

Respondent's Age: _____ (in years)

Respondent's Sex: ☐ Male ☐ Female

3. **Deceased's Information:**

Name of Deceased: _____

Sex of Deceased: ☐ Male ☐ Female

Age of Deceased: _____ (in years)

Marital Status at Time of Death: ☐ Never Married ☐ Married

☐ Separated ☐ Divorced ☐ Widowed ☐ Cohabiting

Highest Level of Education Completed:

☐ No Formal Education ☐ Primary School ☐ Secondary School

☐ High School ☐ College/University

Occupation: _____

Place of Death:

☐ Home ☐ Health Facility ☐ on the Way to Health Facility

MAKERERE UNIVERSITY
SCHOOL OF PUBLIC HEALTH
APPROVED
VALID UNTIL
★ 17 JUL 2026 ★
RESEARCH & ETHICS COMMITTEE
P. O. BOX 7072, KAMPALA

Scanned with CamScanner

☐ Other (Specify): _____

Date of Death: _____ (DD/MM/YYYY)

Section 2: Medical History and Comorbidities

4. **Previously Diagnosed Medical Conditions** (Check all that apply):

☐ Asthma ☐ Cancer ☐ Diabetes ☐ Heart Disease ☐ HIV/AIDS

☐ Hypertension ☐ Injury/Violence ☐ Malaria ☐ Stroke ☐Tuberculosis (TB)

☐ Other Infectious Illness (Specify): _____

☐ Other Chronic Illness (Specify): _____

5. **Medication History**:

Was the deceased taking any medications regularly during the last 5 years?☐ Yes ☐ No

If yes, list up to 3 medications:

1. _____
2. _____
3. _____

Section 3: Symptoms Leading to Death

6. **Key Symptoms** (Check all that apply):

☐ Fever ☐ Cough ☐ Breathlessness ☐ Chest Pain

☐ Diarrhea/Dysentery ☐ Weight Loss ☐ Paralysis/Stroke ☐Swelling (Edema)

☐ Urinary Problems ☐ GI Tract Problems

☐ Jaundice ☐ Seizures/Fits

7. **Detailed Symptom History:**

If each yes, how long did it last? Months: _____ Days: _____

Additional details (e.g., severity, frequency): _____

Section 4: Healthcare-Seeking Behavior

8. **Healthcare Utilization:**

Did the deceased seek healthcare before death? ☐ Yes ☐ No

If yes, where did they seek care?

☐ Public Health Facility ☐Private Clinic/Hospital ☐ Traditional Healer

☐ Other (Specify): _____

MAKERERE UNIVERSITY
SCHOOL OF PUBLIC HEALTH
APPROVED
VALID UNTIL
★ 17 JUL 2026 ★
RESEARCH & ETHICS COMMITTEE
P.O. BOX 7072, KAMPALA

Scanned with CamScanner

What type of care was received?

☐ Medication ☐ Admission ☐ Other (Specify): _____

Were there any challenges in accessing healthcare? ☐ Yes ☐ No

If yes, specify: _____

9. **Cause of Death:**

What do you think was the cause of death?

_____

Did a healthcare worker provide a cause of death? ☐ Yes ☐ No

If yes, what was the cause of death? _____

Section 5: Social and Behavioral Factors

10. **Stigma and Social Support:**

Did the deceased experience any stigma related to TB or HIV? ☐ Yes ☐ No

Did the deceased receive social support from family or community? ☐ Yes ☐ No

11. **Lifestyle Factors:**

Did the deceased smoke tobacco? ☐ Yes ☐ No

Did the deceased consume alcohol? ☐ Yes ☐ No

Did the deceased have a healthy diet during and after treatment? ☐ Yes ☐ No

Section 6: Follow-Up and Post-Treatment Care

12. **Post-Treatment Follow-Up:**

Did the deceased receive follow-up care after completing TB treatment?

☐ Yes ☐ No

If yes, what type of follow-up care was received?

☐ Regular Check-Ups ☐ Medication Refills

☐ Other (Specify): _____

Were there any challenges in accessing follow-up care?

☐ Yes ☐ No If yes, specify: _____

Section 7: Final Notes

13. **Respondent's Cooperation:** ☐ Good ☐ Poor

Interviewer's Name and Signature: _____



Scanned with CamScanner

Appendix VIII: Verbal Autopsy questionnaire- Luganda Version

Ekiwandiiko kyebibuuzo ebikwaata ku kufa kwomuntu mukunonyereza kuno

Omutwe gw'okunonyereza.

Ebiviirako Okufa eri abalwadde ba'kafuba mumyaka ebiri ejisooka nga bamalirizzayo eddagala lyobulwadde bwa'akafuba ku dwaliro lyeKawaala ne Kiswa HCIV mu Uganda.

Okukkiriza kwo'kwatula kufuniddwa ☐ Iyye ☐ Nedda

Ekitundu ekisooka: Ebikwaata ku addamu ebibuuzo no'mugenzi

1. **Ebikwata kukubuuza:**

Ennamba eyawula okubuuza: _____

Ennaku zomwezi ezokubuuza: _____ (DD/MM/YYYY)

Enamba eyawula omugenzi kubalala mukunonyereza : _____

2. **Ebikwaata ku addamu ebibuuzo**

Erinya lyoyo addamu ebibuuzo: _____

Enkolagana ye nomugenzi:

☐ Muzadde ☐ Mwagalwa ☐ Waluganda olwokumpi ☐Mwana

☐ Owoluganda olwawala ☐Tewali nkolagana

Addamu ebibuuzo yali abeela nomugenzi akaseela keyafunilamu ebyamuletera okufa?

☐ Iyye ☐ Nedda

Emyaka jooyo addamu ebibuuzo: _____

Obutonde bwaddamu ebibuuzo: ☐ Musajja ☐ Mukazi

3. **Ebikwata kumugenzi:**

Erinya lyomugenzi: _____

Obutonde bwomugenzi: ☐ Musajja ☐ Mukazi

Emyaka jomugenzi: _____

Ebyobufumbo akaseera weyafiira: ☐ Tafumbirwangako /Tawasangako ☐ Mufumbo

☐ Bayawukana ☐ ☐ Owagalwa yafa ☐ Sibafumbo naye belaba

Highest Level of Education Completed:

☐ Teyasomako ☐ Primary ☐ Secondary

☐ High School ☐ College/University

Omulimo: _____

MAKERERE UNIVERSITY
SCHOOL OF PUBLIC HEALTH
APPROVED
VALID UNTIL
★ 17 JUL 2026 ★
RESEARCH & ETHICS COMMITT
P.O. BOX 7072, KAMPALA

CS Scanned with CamScanner

Ekifo weyafira:

☐ Waka ☐ Muddwaliro ☐ Mukkubo nga bagenda muddwaliro

☐ Ewalala : _____

Ennakuzomwezi zeyafiirako: _____ (DD/MM/YYYY)

Ekitundu ekyokubiri: Ebikwata ku ndwadde zabadde nazo emabega nezobuwangaazi

4. **Endwadde zebaali bamuzuddemu emabega** (Londako zonna):

☐ Asthma ☐ Cancer ☐ Sukaali ☐ Obulwadde bwomutima ☐ Siliimu

☐ Hypertension ☐ Obutemu/Accident ☐ Musujja gwensili ☐ Okugongobala

☐Akafuba ☐ Obulwadde obulala (Bumenye): _____

5. **Ebikwata ku ddagala:**

Omugenzi alina eddagala lyonna lyeyali amira emyaka etaano emabega

☐ Iyye ☐ Nedda

Bwekiba iyye, tumenyereyo amadagala asatu:

1. _____
2. _____
3. _____

Ekitundu ekyokusatu: Obubonero bweyalina nga anatera okufa

6. **Obubonero obukulu (Londako bwonna bweyalina):**

☐ Musujja ☐ Okukolola ☐ Obutasa bulungi ☐ Obulumi mukifuba

☐ Okuddukana ☐ Okukendeera mu mubiri ☐ Okugongobala ☐Okuzimba☐

Obuzibu mukufuyisa ☐ Obuzibu mulubuto

☐ Okufuuka kyenvu ☐ Okugwa ensimbu

7. **Obunyonyovu bwobubonero bweyalina**

Ku buli kabonero keyalina, kaamala banga ki? Myezi: _____ Ennaku: _____

Ebilala ebikwaata ku bubonero (okugeza amanyi gaakabonero nemirundi jeyakafuna)

_____

Ekitundu ekyokuna: Embeera zokufunamu obuyambi kubikwata kubyobulamu

8. **zokufunamu obuyambi kubikwata kubyobulamu**

Omugenzi yagendako muddwaliro okufuna obujjanjabi nga alwadde? ☐ Iyye ☐ Nedda

MAKERERE UNIVERSITY
SCHOOL OF PUBLIC HEALTH
APPROVED
VALID UNTIL
★ 17 JUL 2026 ★
RESEARCH & ETHICS COMMITTEE
P. O. BOX 7072, KAMPALA

Scanned with CamScanner

Bwekiba iyye, yagenda luddawa okufuna obujjanjabi?

☐ Eddwa lyolukale ☐Eddwaliro lyobwannanyini ☐ Musawo wekinnansi

☐ Ewalala (Wamenye): _____

Yafuna bujjanjabi bufaanana butya?

☐ Ddagala ☐ Baamuwa ekitanda ☐ Ekilala (Kimenye) _____

Yafunamu obuzibu bwonna mukufuna obujjanjabi? ☐ Iyye ☐ Nedda

Bwekiba iyye, bumenye: _____

9. **Ekyavirako okufa:**

Gwe olowooza kiki ekyaviirako okufa kwomugenzi?

_____

_____

Omusawo yabagamba ekyamuviirako okufa? ☐ iyye ☐ Nedda

Bwekiba iyye, kiki ekyamuleetera okufa? _____

Ekitundu ekyokutaano: Ensonga zobwawamu ne embeera zo'buntu

10. **Okusosolebwa nokubudabudibwa:**

Omugenzi yayisibwako mumbeera yokusosolebwa olwokuba alina akafuba oba siliimu?

☐ Iyye ☐ Nedda

Omugenzi yafunako okubudabudibwa okuva eri abomukage, aboluganda nabemikwano?

☐Iyye ☐ Nedda

11. **Ensonga ezikwata kunneyisa:**

Omugenzi yali anywa ku taaba? ☐ iyye ☐ Nedda

Omugenzi yali anywa ku mwenge? ☐ Iyye ☐ Nedda

Omugenzi yali alya bulungi nga alikuddagala lyakafuba ne nga alimazeyo?

☐ Iyye ☐ Nedda

Ekitundu ekyomukaaga: Okugobelerwa wamu nobuyambi nga omazeeyo eddagala lyakafuba

12. **Okugobelerwa nga omazeeyo eddagala lyakafuba:**

Omugenzi yafuna kubudabudibwa nokugobelerwa abasawo bweyali nga amazeeyo eddagala lyakafuba? ☐ Iyye ☐ Nedda

MAKERERE UNIVERSITY
SCHOOL OF PUBLIC HEALTH
APPROVED
VALID UNTIL
★ 17 JUL 2026 ★
RESEARCH & ETHICS COMMITTEE
P. O. BOX 7072, KAMPALA

Scanned with CamScanner