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Prevalence and predictors of unsuccessful tuberculosis treatment outcomes among persons with TB/HIV co-infection in Ghana: a 10-year retrospective study

Alhaji Ibrahim Cobbinah[1*], Jacob Solomon Idan[1,2], Kingsley Boakye[1,3], Anthony Enimil[4,5], Nicholas Karikari Mensah[1,6], Ebenezer Adangabe[1], Sulemana Baba Abdulai[1], Charles Martyn-Dickens[4,7] and Aliyu Mohammed[1]

Abstract

Introduction Unsuccessful treatment outcomes significantly impact tuberculosis control efforts globally particularly among individuals co-infected with Human Immunodeficiency Virus (HIV). This study aimed to assess the prevalence, trends, and associated factors of unsuccessful Tuberculosis (TB) treatment outcomes among persons with TB/HIV co-infection at Komfo Anokye Teaching Hospital in Ghana over a 10-year period.

Methods A retrospective cross-sectional study was conducted using data from the Komfo Anokye Teaching Hospital between January 2012 and December 2022. A total of 1,242 persons with TB/HIV co-infection were included in the study. Unsuccessful treatment outcomes were defined as death, treatment failure, or default. Modified Poisson regression with robust standard errors was performed using Stata version 17.0 to identify predictors of unsuccessful outcomes. Crude and adjusted relative risk ratios with 95% confidence intervals (CI) were reported, and a p-value < 0.05 was considered statistically significant.

Results The prevalence of unsuccessful treatment outcomes for the 10-year period was 24.6% (95% CI: 22.3–27.1). The analysis revealed a decreasing trend of unsuccessful TB treatment outcomes from 47.6% in 2012 to 7.79 in 2022. In the multivariable analysis, older age (≥ 65 years) was associated with a higher risk of unsuccessful outcomes (ARR: 5.6, 95% CI: 2.8–11.1). Conversely, pretreatment weights of 40–54 kg (ARR: 0.5, 95% CI: 0.3–0.7), 55–69 kg (ARR: 0.4, 95% CI: 0.3–0.6), and ≥ 74 kg (ARR: 0.2, 95% CI: 0.1–0.7) were associated with reduced risk. The presence of a treatment supporter also lowered the risk of unsuccessful outcomes (ARR: 0.8, 95% CI: 0.6–0.9).

Conclusion The high prevalence of unsuccessful TB treatment outcomes among persons with TB/HIV co-infection within the 10-year period highlights the need for targeted interventions. Prioritizing care for older patients, improving nutritional support, and promoting treatment supporter involvement will enhance treatment success in Ghana.

Clinical trial number Not applicable.

Keywords Tuberculosis, HIV, Co-infection, Treatment outcomes, Predictors, Ghana

*Correspondence:
Alhaji Ibrahim Cobbinah
Cobbinahalhaji@gmail.com

Full list of author information is available at the end of the article

Introduction

Tuberculosis (TB) remains a significant global health challenge, particularly when compounded by Human Immunodeficiency Virus (HIV) co-infection [1, 2]. This lethal combination continues to pose substantial public health concerns, especially in resource-limited settings [2]. TB, an airborne mycobacterial infection caused by *Mycobacterium tuberculosis*, is curable with early detection and appropriate treatment. However, when left undiagnosed, untreated or unsuccessfully treated, it leads to severe complications and increased mortality, particularly among people living with HIV [3, 4].

Globally, TB/HIV co-infection is estimated at 8.2 per 100,000 population [1]. This co-infection is a major driver of TB-related mortality with an estimated death rate of 2 per 100,000 population worldwide [1, 5]. Approximately 29% of these deaths are attributed to unsuccessful treatment outcomes [1, 5]. Unsuccessful treatment outcomes include treatment failure, death, or defaulting on treatment [6]. The global rate of unsuccessful treatment outcome among persons with TB/HIV co-infection is currently estimated at 16.5% [1].

Africa bears the highest TB/HIV coinfection rate among all WHO regions at a rate of 37 per 100,000 population [1]. The HIV-related mortality rate in Africa is estimated at 9.1 per 100,000 population [1]. The African region also reports an approximately unsuccessful treatment outcome rate of 14.0% [1]. Studies from various African countries have documented different rates of unsuccessful treatment outcomes among persons with TB/HIV co-infection. These rates include 26.9% in Zambia, 27.0% in Botswana, and 38.9% in Zimbabwe [7–9]. In Ghana, TB/HIV co-infection estimated at 14 per 100,000 population [10] remains a critical public health issue, with an estimated mortality rate of 6.8 per 100,000 population [10].

Ghana reports an average unsuccessful treatment outcome rate of 24% among persons with TB/HIV co-infection [11–14]. Regional variations exist within Ghana. The Greater Accra [11] and Volta regions [12] report rates of 23.0%. The Central Region shows a higher rate of 24.0% [13]. In the Ashanti Region, a rural-based study estimated the prevalence at 26.0% [14] however, but there is a significant gap in evidence from its central city, especially given that Kumasi host a major referral center like Komfo Anokye Teaching Hospital (KATH) which manages a diverse proportion of persons with TB/HIV co-infection from both urban and rural areas. The absence of data from such a key healthcare setting limits our understanding of the burden of unsuccessful treatment outcomes among diverse population. This study aims to fill this gap by assessing the prevalence, trends and associated factors of unsuccessful TB treatment outcomes among persons with TB/HIV co-infection at KATH in the Greater Kumasi Metropolis, contributing to evidence-based strategies for improving treatment outcomes and enhancing TB control efforts in Ghana.

Methods

Study design and setting

A retrospective cross-sectional study was conducted to assess the prevalence, trends, and predictors of the unsuccessful TB treatment outcomes among TB/HIV co-infected patients receiving care at KATH from January 2012 to December 2022.

The study was conducted at KATH, a 1,200-bed tertiary referral hospital located in Kumasi, the capital city of the Ashanti Region, Ghana [15]. The Kumasi Metropolis is characterized by a population predominantly engaged in trading and service industries. It has a population density of 6,542.6 persons per square kilometer and an average household size of 3.0 [16]. KATH serves as the main referral center for patients from the rural and urban districts of Ghana, with a catchment population of approximately 10 million people [15]. The hospital was selected for this study because it is the largest TB treatment center in the Ashanti region, managing about 30% of all TB cases in the region [17]. The TB clinic operates under the National Tuberculosis Control Program guidelines and provides comprehensive TB and HIV care services, including diagnostic testing, treatment initiation, and follow-up care [18].

Study participants and sample size

The study population included all TB/HIV co-infected patients who initiated TB treatment between January 2012 and December 2022. Patients with extrapulmonary TB and drug resistance TB were excluded from the study to allow for standardized assessment of treatment outcomes due to different treatment and follow-up protocols in Ghana. Additionally, persons with TB/HIV co-infection with missing treatment outcome data or those transferred to other facilities due to change of residential location or on personal request were excluded, as their outcomes could not be reliably tracked. A total of 1,416 TB cases (pulmonary and extrapulmonary) were initially identified, of which 1,242 met the inclusion criteria and were included in the final analysis (see Fig. 1).

Study variables

The primary outcome variable was unsuccessful treatment [11], defined as TB cases that 'died', 'failed treatment' or 'defaulted' as the recorded treatment outcome per National TB Control Program guidelines [17]. Explanatory variables were 11 in total and were selected based on significance in previous studies [11–14]. They included sociodemographic factors such as age, gender, educational level, marital status, residential status;

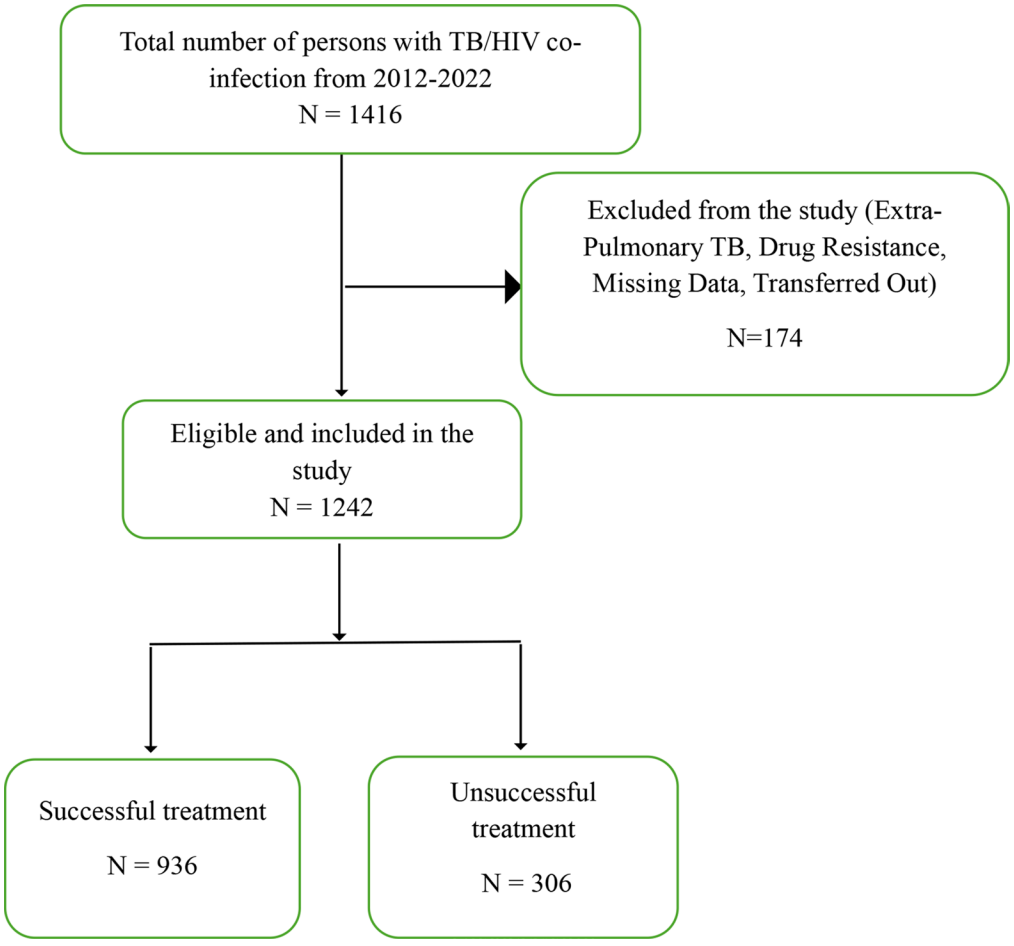

Fig. 1 Flowchart of inclusion of persons with TB/HIV co-infection during the study period

clinical factors including pretreatment weight, TB classification, presence of cavitation on baseline chest X-ray; and treatment-related factors such as patient category (new vs. retreatment), and presence of treatment supporter.

Data sources and management

Data were extracted from the Electronic Tuberculosis Register (ETR) of KATH using a standardized data extraction tool. The ETR has built-in validation checks to minimize entry errors. It is a standard electronic system designed based on the National TB Control Program guidelines for recording and reporting TB data in Ghana. The ETR captures comprehensive information on each TB case, including demographic details, clinical characteristics, treatment regimens, and outcomes. HIV status is routinely recorded for all TB patients as part of the integrated TB/HIV services. Records with missing data were excluded from the final dataset prior statistical analysis. To minimize selection bias, we included all eligible cases within the study period. Information bias was addressed by using standardized definitions for all variables as per the National TB Control Program guidelines [17].

Data analysis

Data were analyzed using Stata version 17.0 [19]. Descriptive statistics, at one decimal point, were used to summarize the characteristics of the study population. The prevalence of unsuccessful treatment outcomes was calculated with 95.0% confidence intervals. Bivariate modified Poisson regression model with robust standard errors analysis was performed to assess the crude association between unsuccessful treatment outcomes and each independent factor since the prevalence of unsuccessful treatment is more than 10.0% [20, 21]. Variables with $p < 0.25$ in the crude regression model were included in the multivariable modified Poisson regression model with robust standard errors to identify independent predictors of unsuccessful treatment outcomes. The output was reported in adjusted relative risk ratios (ARR) with 95% confidence intervals, and a p-value of < 0.05 was considered statistically significant.

Table 1 Sociodemographic characteristics of respondents

Variable	Frequency ($n=1242$)	Percentage (%)
Gender		
Male	604	48.63
Female	638	51.37
Age group [in Years]		
Median (Interquartile range)	35 (13–45)	
< 15	348	28.02
15–24	72	5.80
25–34	170	13.69
35–44	302	24.32
45–54	236	19.00
55–64	92	7.41
≥ 65	22	1.77
Residential Status		
Urban	1,169	94.12
Rural	73	5.88
Distance to the hospital		
< 5 km	319	25.68
≥ 5 km	923	74.32
Treatment Supporter		
Yes	851	68.52
No	391	31.48
Educational status		
No formal education	366	29.47
Primary	293	23.59
Junior High	345	27.78
Senior High	173	13.93
Tertiary	65	5.23
Marital status		
Single	545	43.88
Cohabiting	37	2.98
Married	447	35.99
Widowed	75	6.04
Divorced/separated	138	11.11
Pretreatment weight		
Median (IQR)	42 (22–50)	
0–24	358	78.82
25–39	183	14.73
40–54	496	39.94
55–69	163	13.12
70–75	13	1.05
≥ 75	29	2.33
Cavitation on baseline chest X-ray		
Suggestive	1,200	96.62
Not Suggestive	42	3.38
Category of patient		
New patient	1,167	93.96
Retreatment	75	6.04

Table 2 Treatment outcomes

Treatment Outcome	Frequency ($N=1242$)	Percentage
Successful Outcome [$n=936$ (75.4%)]		
Treatment completed	774	62.3
Cured	162	13.0
Unsuccessful Outcome [$n=306$ (24.6%)]		
Died	265	21.3
Treatment failure	11	0.9
Default	30	2.4

Ethical considerations

This study was approved by the Committee on Human Research, Publications and Ethics (CHRPE) of Kwame Nkrumah University of Science and Technology and Komfo Anokye Teaching Hospital (KATH IRB/AP/097/24). The study was conducted in accordance with the principles of the Declaration of Helsinki regarding ethical standards for research involving human subjects. The need for individual patient consent was waived by the ethics committee as this was a retrospective review of routinely collected data with no direct patient contact, and all data were de-identified prior to analysis to ensure patient confidentiality and privacy.

Results

Sociodemographic characteristics of respondents

Among the 1,242 persons with TB/HIV co-infection included in the study, 51.4% were female and 48.6% were male as summarized in Table 1. The median age of patients was 35.0 years (IQR: 13.0–45.0). The majority of patients (94.1%) resided in urban areas. Also 68.5% of these persons with TB/HIV co-infection had treatment supporters. The median pretreatment weight was 42.0 kg (IQR: 22–50), and 96.6% of patients had suggestive findings on baseline chest X-rays. Most patients (approximately 94.0%) were newly diagnosed with TB, while approximately 6.0% were retreatment cases.

Treatment outcomes

The prevalence of unsuccessful treatment outcomes among persons with TB/HIV co-infection at KATH for the 10-year period was 306/1242 (24.6%, 95% CI: 22.3–27.1) (Table 2). Among the unsuccessful outcomes, 21.3% ($n=265$) of patients died, 0.9% ($n=11$) experienced treatment failure, and 2.4% ($n=30$) defaulted on treatment. Successful treatment outcomes were observed in 75.4% ($n=936$) of the patients, with 62.3% ($n=774$) completing treatment and 13.0% ($n=162$) being cured.

Furthermore, Fig. 2 illustrates the trends in successful and unsuccessful treatment outcomes over the study period (2012–2022). The proportion of successful treatment outcomes generally increased over time.

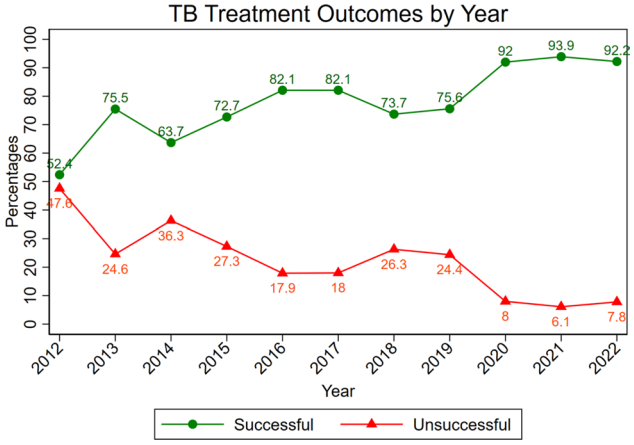

Fig. 2 Trend of Treatment Outcomes

Unsuccessful treatment outcomes also showed a declining trend, with the highest percentage of cases observed in 2012 (47.6%) and the lowest in 2021 (6.1%).

Predictors of unsuccessful treatment

Bivariate and multivariate Poisson regression analyses were performed to identify predictors of unsuccessful treatment outcomes (Table 3). In the multivariable analysis, compared to the reference group (< 15 years old), the relative risk ratio of unsuccessful treatment increased for each age level, with patients aged 65 and above having the highest risk (ARR: 5.6, 95% CI: 2.8–11.1). Patients with pretreatment weights between 40 and 54 kg had a lower risk of unsuccessful outcomes compared to those weighing 0–24 kg (ARR: 0.5, 95% CI: 0.4–0.7). Similarly, patients with pretreatment weights between 55 and 69 kg (ARR: 0.4, 95% CI: 0.3–0.6) and above 74 kg (ARR: 0.2, 95% CI: 0.1–0.7) had lower risk of unsuccessful outcomes. The presence of a treatment supporter was associated with a lower risk of unsuccessful outcomes (ARR: 0.8, 95% CI: 0.6–0.9).

Discussion

The overall prevalence of unsuccessful treatment outcomes in this study was 24.6%. This is higher than the global average of 16.5% and the African regional average of 14.0% for HIV-associated TB cases [1]. This finding reveals the persistent challenges in managing TB/HIV co-infection within the WHO African region. Late TB detection in people living with HIV persists due to limited access to rapid molecular diagnostics like GeneXpert, particularly in rural areas, while stigma and poverty further delay care-seeking and adherence [22, 23].

In Ghana, the prevalence of unsuccessful treatment outcomes among people with TB/HIV co-infection from this current study is relatively comparable across different regions ranging between 23% and 26%. Specifically, this study's prevalence (24.6%) aligns closely with rates reported in the Cape Coast district (24.0%) [13], Greater Accra region (23.0%) [11], Volta region (23.0%) [12], and Kwabre East district (26.0%) [14]. This comparable prevalence across the diverse geographical settings suggests a general challenge in early TB/HIV diagnostic access integrated TB/HIV service delivery, timely and coordinated referral system for treatment, community follow ups and gaps in ART coverage compounded by socioeconomic inequities and localized risk factors such as cultural barriers to TB care coverage [24, 25].

Age was identified as a significant predictor of unsuccessful treatment outcomes, with the risk increasing as age advances. Patients aged 65 years and above had the highest odds of unsuccessful outcomes compared to the reference group (< 15 years old). This finding is consistent with studies from Ethiopia and Eritrea, which reported older age as a predictor of unfavorable treatment results [25, 26]. The increased vulnerability of older adults to poor treatment outcomes may be attributed to age-related immunosenescence and the presence of comorbidities, which can complicate the management of TB/HIV co-infection [27, 28].

Furthermore, pretreatment weight was also found to be a significant predictor of treatment outcomes. Patients weighing between 40 and 54 kg, 55–69 kg, and ≥ 74 kg had a lower risk of unsuccessful outcomes compared to those with lower weights (0–24 kg). Nutrition is key in weight gain and subsequently treatment outcome [29]. This finding aligns with previous studies that have demonstrated the association between better nutritional status and improved TB treatment outcomes [30, 31]. Adequate nutrition plays a crucial role in enhancing immune function and promoting treatment adherence among persons with TB/HIV co-infection [32].

Additionally, the presence of a treatment supporter was associated with a lower risk of unsuccessful outcomes in this study. This finding corroborates the results of previous studies that have highlighted the importance of treatment supporters in ensuring adherence and providing psychosocial support to persons with TB/HIV co-infection [33, 34]. Treatment supporters help patients navigate the challenges associated with TB/HIV co-infection, such as stigma, transportation issues, and communication barriers with healthcare providers [35].

Strengths and limitations of study

The study setting, being a major referral center, offered valuable insights into TB/HIV treatment outcomes among a diverse urban population, and the use of relatively large sample ($n = 1242$) spanning ten years ensured that there is robust statistical power. Additionally, the use of advanced statistics and appropriate methods were strengths of the study. However, the study had some limitations. The adoption of the cross-sectional design, which

Table 3 Associations of pulmonary TB–HIV coinfections by patient characteristics

Patient characteristics	CRR	95% CI	ARR(CI)	95% CI
Gender				
Female (Ref)	1		1	
Male	1.070	0.881-1.300	1.189	0.970–1.456
Age group				
< 15 (Ref)	1		1	
15–24	1.381	0.766–2.489	2.325	**1.254–4.309**
25–34	1.998	**1.353–2.949**	3.178	**1.929–5.235**
35–44	2.908	**2.106–4.015**	4.471	**2.828–7.064**
45–54	2.387	**1.687–3.379**	3.545	**2.232–5.630**
55–64	2.521	**1.658–3.836**	4.092	**2.401–6.974**
≥ 65	3.389	**1.904–6.036**	5.552	**2.782–11.079**
Place of Residence				
Urban (Ref)	1		1	
Rural	1.060	0.711–1.581	0.988	0.636–1.536
Distance to the hospital				
< 5 km (Ref)	1		1	
≥ 5 km	1.165	0.921–1.473	1.114	0.868–1.429
Pretreatment weight				
0–24 (Ref)	1		1	
25–39	1.542	**1.141–2.086**	0.791	0.570–1.097
40–54	1.403	**1.090–1.805**	0.522	**0.384–0.707**
55–69	1.114	0.780–1.589	0.404	**0.272–0.600**
70–75	0.388	0.058–2.581	0.166	0.025–1.119
75 and above	0.695	0.273–1.769	0.156	**0.107–0.702**
Disease Classification				
Smear negative PTB (Ref)	1		1	
Smear Positive PTB	1.401	**1.124–1.746**	1.289	**1.011–1.645**
Cavitation on baseline chest X-ray				
Suggestive (Ref)	1		1	
Not Suggestive	1,166	0.715-1.900	0.897	0.541–1.487
Category of patient				
New patient (Ref)	1		1	
Retreatment	1.698	**1.065–2.707**	1.352	0.828–2.208
Treatment Supporter				
No (Ref)	1		1	
Yes	0.598	**0.493-0724**	0.804	**0.649–0.996**
Educational Status				
No Education (Ref)	1		1	
Primary	0.721	**0.558–0.931**	1.142	0.879–1.483
Junior High	0.681	**0.514–0.901**	0.985	0.735–1.320
Senior High	0.938	0.702–1.255	1.159	0.847–1.585
Tertiary	0.989	0.655–1.493	1.156	0.753–1.776
Marital Status				
Single (Ref)	1		1	
Widowed	1.552	**1.049–2.297**	0.942	0.617–1.439
Divorced/separated	1.534	**1.120–2.099**	0.884	0.621–1.257
Married	1.539	**1.227–1.929**	0.899	0.692–1.170
Cohabiting	1.573	0.930–2.659	0.903	0.534–1.529

CRR: Crude Relative Risk Ratio; ARR: Adjusted Relative Risk Ratio; Ref: Reference category

relied on available patient records, may have underestimated actual treatment outcomes due to missing data. Additionally, the single-center nature of the study, the exclusion of extrapulmonary TB, drug resistant and transferred patients may limit the generalizability of the findings to other settings with different healthcare systems and population characteristics. The lack of detailed data on BMI, HIV status such as viral load and CD4 count at the time of TB diagnosis during the study period were other limitations that may affect the generalizability of findings of this study. Additionally, data on Directly Observed Treatments (DOTs) coverage for each year of the study period were not available, limiting our ability to analyze the impact of program expansion on case detection and treatment success rates. This information would have provided valuable context for interpreting the observed trends in treatment outcomes over the decade studied, particularly in relation to national TB control policy implementations and coverage expansions.

Conclusion

This study highlights the high prevalence of unsuccessful treatment outcomes among persons with TB/HIV co-infection at Komfo Anokye Teaching Hospital in Ghana. Older age, lower pretreatment weight, and the absence of a treatment supporter were identified as significant predictors of unsuccessful outcomes. These findings emphasize the need for targeted interventions such as strengthening TB/HIV collaborative activities such as TB/HIV differentiated services and community adherence support while enhancing nutritional supplementation programs with food vouchers to improve treatment outcomes, particularly among the elderly and persons with lower pretreatment weight. Additionally, promoting the involvement of treatment supporters through training and supervision should be prioritized to reduce the burden of TB/HIV co-infection and achieve the global targets for TB control.

Implication for research and practice

The findings of this study suggest the need for enhanced monitoring protocols for patients aged ≥ 65 years, integration of routine nutritional assessment, counselling and support including food vouchers for patients with lower pretreatment weight into TB/HIV standard care. Formal training, regular supervision, and recognition programs

should also be developed to strengthen the treatment supporter network, actively promoting their involvement from the initiation of therapy. At the policy level, there is a need to review and update national TB/HIV treatment guidelines to incorporate age-specific care considerations, standardized nutritional protocols, and structured treatment supporter programs with clearly defined roles. Additionally, strengthening TB/HIV collaborative activities through differentiated service delivery models and community-based adherence support mechanisms would provide more comprehensive care for people with TB/HIV co-infection.

Abbreviations

ARR	Adjusted Relative Risk
CI	Confidence Interval
CRR	Crude Relative Risk
DOT	Directly Observed Treatment
ETR	Electronic Tuberculosis Register
HIV	Human Immunodeficiency Virus
KATH	Komfo Anokye Teaching Hospital
TB	Tuberculosis
WHO	World Health Organization

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Author contributions
AIC: Conceptualisation, Investigation, Formal Analysis, Writing - Original Draft JSI: Conceptualisation, Formal Analysis, Visualisation, Writing - Original Draft KB: Methodology, Writing - Review & Editing AE: Methodology, Resources, Writing - Review & Editing, Supervision NKM: Data Curation, Validation, Writing - Review & Editing EA: Data Curation, Validation, Writing - Review & Editing SBA: Data Curation, Validation, Writing - Review & Editing CMD: Data Curation, Validation, Writing - Review & Editing AM: Methodology, Writing - Review & Editing, Supervision.

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Data availability
The data supporting the conclusions of this article are not publicly available to protect patient confidentiality. Access to the data may be considered upon reasonable request to the corresponding author.

Declarations

Ethics approval and consent to participate
This study was approved by the Committee on Human Research, Publications and Ethics (CHRPE) of Kwame Nkrumah University of Science and Technology and Komfo Anokye Teaching Hospital (KATH IRB/AP/097/24). The study was conducted in accordance with the principles of the Declaration of Helsinki regarding ethical standards for research involving human subjects. The need for individual patient consent was waived by the ethics committee as this was a retrospective review of routinely collected data with no direct patient contact, and all data were de-identified prior to analysis to ensure patient confidentiality and privacy.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]Department of Epidemiology and Biostatistics, School of Public Health, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
[2]University Health Services, University of Education, Winneba, Ghana
[3]Department of Global Public Health and Bioethics, Julius Center for Health Sciences and Primary Care, University Medical Center, Utrecht University, Utrecht, The Netherlands
[4]Directorate of Child Health, Komfo Anokye Teaching Hospital (KATH), Kumasi, Ghana
[5]Department of Child Health, School of Medical Sciences, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
[6]Public Health Unit, Komfo Anokye Teaching Hospital (KATH), Kumasi, Ghana
[7]Charité Centre for Global Health Charité Universitätsmedizin, Berlin, Germany

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