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Tuberculosis treatment outcome of TB/HIV co-infected patients at Adare Hospital, Hawassa City Administration, Sidama Region

Endrias Markos Woldesemayat[1*] and Taye Gari[1]

Abstract

Background There is lack of evidence on the TB treatment outcomes of TB/HIV co-infected patients who received anti-TB treatment in Sidama region. In this study, we aimed to assess the treatment outcome of TB/HIV co-infected patients receiving care at Adare Hospital in Hawassa City, Sidama Region.

Methods A cross sectional study based on retrospective data among TB/HIV co-infected cases was conducted at Adare Hospital. The unit TB registry and antiretroviral therapy (ART) registry were reviewed for the period between September 1, 2016 and August 31, 2022 to measure TB treatment outcomes. Target population for this study was all TB/HIV co-infected cases aged 15 years or more treated at Adare Hospital in the Hawassa City Administration. The data sources for this study were the unit TB register at the TB clinics, patient charts, and the ART register of the facility. Data were entered and analysed using the statistical package SPSS version 26. A summary descriptive analysis was calculated. Bivariable and multivariable analyses were performed to identify associations between variables.

Results During the study period, 298 TB/HIV co-infected cases were treated for TB in the Hospital. Thirty three (11.1%), of the cases had an unfavourable TB treatment outcome. The risk of an unfavourable treatment outcome was over three times higher among re-treated TB cases than among the new TB cases (AOR = 3.3, 95% CI (1.4, 7.9)). The risk of death was higher among stage-IV HIV cases (AOR = 8.1, 95% CI (2.3, 28.9)), and among participants who used non-communicable diseases medications during the cohort period (AOR = 7.3, 95% CI (1.6, 33.6).

Conclusion TB treatment success rate among TB/HIV co-infected cases in the current study was comparable to many other reports. There are factors that contributed for unsuccessful TB treatment outcome. Cautious follow-up of cases and managing these factors could help in improving the TB treatment outcome.

Keywords Adare, Hawassa, Treatment outcome, HIV, Sidama, Tuberculosis

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Introduction

Ethiopia is among the 30 high TB burden countries [1] with an estimated incidence rate of 119 per 100,000 populations in 2022 [1]. HIV/AIDS predisposes for TB infection and activates the progression to active TB among individuals who have recently been infected, as well as increases TB recurrence [2]. Tuberculosis is the most common opportunistic infection in HIV patients [3]. The risk of progression from latent to active TB is higher among peoples living with HIV (PLHIV) than among those without HIV infection [3]. Evidences suggests that having TB/HIV co-infection significantly increased the likelihood of mortality [4–6] and lowered the cure rate and treatment success rates [4, 7] which could be due to the high pill burden. Management in TB/HIV co-infection is complicated by factors like adherence challenges, overlapping side effects of medications, immune reconstitution inflammatory syndrome, and drug interactions [1]. These could affect the TB treatment outcome among TB/HIV co-infected patients.

In Gondar, 77.3% of TB/HIV co-infected patients had successful TB treatment outcome, with 10.4% cured and 66.9% completed their TB treatment [8]. In another setting, 88.2% treatment success rate of directly observed treatment short course (DOTS) has been reported among PLHIV [7]. Regarding factors associated with treatment outcome, TB/HIV co-infected patients have multiple factors that can adversely affect their treatment outcomes. Age and TB classification were significantly associated with the treatment outcome of TB among TB/HIV co-infected people [9]. Patients who did not receive DOTS and those who received shorter treatment duration below 6 months had higher odds for unsuccessful TB treatment outcome [1]. Having advanced clinical status was another predicting factor for poor treatment outcomes among TB/HIV co-infected cases [10]. During the advanced clinical stage, TB/HIV co-infected patients have other comorbidities [11], which could adversely affect the TB treatment outcome. In this regard, more factors could be responsible for poor TB treatment outcomes among PLHIV. However, there is a lack of sufficient data on TB treatment outcomes and associated factors among TB/HIV co-infected patients in Ethiopia. Determining the treatment outcome of TB and contributing factors among this group of population could contribute to the control effort of TB.

Despite the continued DOTS in Sidama region, the treatment outcomes of TB/HIV co-infected cases have not been studied in the region. A previous study assessed the treatment outcome for all forms of TB cases (smear-positive, smear-negative and extra pulmonary TB) in the region; however, it was not specific for TB/HIV co-infected cases [12]. Therefore, in the current study, we aimed to determine the treatment outcome and associated factors of TB/HIV co-infected patients at Adare Hospital Hawassa City Administration, Sidama Region, Ethiopia.

Methods and materials

Study design, area and period

A cross sectional study was conducted among TB/HIV co-infected patients in Hawassa City Administration of the Sidma Region, Ethiopia. The study was conducted at Adare Hospital in the Hawassa City Administration. Hawassa City is the capital of Sidama Region. The city is located at a distance of 275 km south of Addis Ababa, with an estimated population of 400,000. The Region has 36 districts including the town administrations. The estimated population in the region is about 4 million. Of over 100 hospitals and health centres found in the region, 35 provide services both the TB and HIV care. These facilities have TB registry and anti-retroviral therapy (ART) registry in their respective clinics where TB/HIV co-infected patients are registered and treated according the DOTS strategy which is operating under the National Tuberculosis and Leprosy Control Program (NTLCP) of Ethiopia. Adare Hospital is one of the health facilities in the region which provides TB and HIV care for patients with TB/HIV co-infection. The DOTS strategy includes providing recommended drug therapy for all registered TB cases, provider-initiated counselling and testing (PICT) of all registered TB cases for HIV, and ART linkage for ART for all eligible HIV-positive TB cases. The ART registry is used to register for confirmed HIV cases. Data were collected from May to July 2023. DOTS completed TB/HIV co-infected patients between September 1, 2016 and August 31, 2022 were included in the study.

Population

Source population

The target population for this study was patients with TB/HIV coinfection at least 15 years of age who have received first line anti TB treatment at Adare Hospital in the Hawassa City Administration. The source population of the study was all TB/HIV co-infected patients at least 15 years of age who completed first line anti-TB treatment during the study period found at Adare Hospital, Hawassa City Administration of Sidama Regional state, South Ethiopia. The study was carried out at Adare Hospital which provides the DOTS and ART to TB/HIV co-infected patients in the Hawassa City Administration. TB/HIV co-infected individuals at least 15 years of age who have been diagnosed with active TB disease based on the Ethiopian national TB guidelines recommendations in the facility and have started and completed a course of anti-TB treatment regimen within the specified study period were included in the study.

Sample size and sampling procedures

The sample size was calculated using the Openepi statistical software [13]. TB treatment success rate for TB/HIV co-infected cases in Addis Ababa was 88.2% [6]. By considering 95% confidence interval and a design effect of 1, we calculated a sample size of 180 participants to be involved in the study. Based on objective number 2, we considered the following assumptions. A power of 90, percent of unexposed with the outcome 63, an adjusted OR of 0.46 for TB treatment category relapse [14], we calculated a sample size of 288 and then after adding a 10% of this we decided to have a size of 316 PLHIV. Then we decided to use the largest sample size, which was 316 TB/HIV co-infected cases to be included in the study. However, we retrieved data for 298 TB/HIV co-infected cases during the study period.

Adare Hospital was purposively selected to be included in the study as it has a large number of TB/HIV co-infected cases among facilities in the city administration. Then, DOTS completed TB/HIV co-infected patients between September 2016 and August 2022 were recruited to be involved in the study. We were able to get a relatively complete records of the PLHIV in the stated period.

Data collection tools and procedures

Data was collected using pre-tested data extraction format. The format was developed in English by considering variables to be studied that are found in the patient's TB registry and patient chart and selected characteristics from the ART registry. This helped us get as many variables as possible and control potential confounders. The TB registry, patients' chart and the ART registry were identified the DOTS providing clinic and the ART clinic which were then reviewed. First, we identified the ART registry and specifically identified the TB/HIV co-infected cases and collected HIV related data from the registry and their patient chart. Then, names of these cases were taken to see in the measure TB related variables and the TB treatment outcome. Trained health professionals with at least B. Sc. degree in health field and currently working in the TB treatment and ART units of the facility collected the data. A supervisor followed the day to day data collection process. Data collectors received training on inclusion and exclusion criteria of the study participants, and recording of the right information from the registration books and/or patient's follow-up medical chart, how to link cases from the TB registry to the ART registry. The data source for this study was the unit TB register at the TB clinics and the ART follow-up form and patients chart and the ART follow-up sheet of the patients. All patients diagnosed with active TB were recorded on anti-TB treatment registry and monitored throughout the course of TB treatment period.

Study variables

Treatment outcome of TB patients who were on anti-TB treatment regimens was the primary outcome variable. Death among the TB/HIV co-infected cases was the secondary outcome measure considered in the study. Predictor variables included in the study were socio-demographic characteristics such as age, sex, address, marital status and etc.; patient related factors such as weight, HIV status, HIV treatment status (ART); TB related variables such as TB type, category of TB; HIV related characteristics such as the BMI, ART regimen at TB diagnosis, co-trimoxazole treatment at TB diagnosis, WHO staging in TB diagnosis, TB prophylaxis, adherence; and having of other morbidities or non-communicable diseases (NCDs) such as asthma. empythema, chronic bronchitis, cardiac diseases, hypertension and diabetes mellitus.

Operational definitions

The following operational definitions were used in the study.

Cured TB cases are pulmonary TB patient with bacteriological confirmed TB at the beginning of treatment who were smear or culture negative in the last month of treatment and on at least one previous occasion.

Treatment completed a patient who completed treatment but without evidence of failure BUT with no record to show that sputum or culture results in the last month of treatment and on at least one previous occasion were negative, either because tests were not done or because results are unavailable.

Treatment failure a TB patient whose sputum smear or culture is positive at month 5 or later during treatment period.

Died a patient who dies during the course of TB treatment irrespective of the cause.

Lost to follow up a patient who has been on treatment for at least four weeks and whose treatment was interrupted for eight or more consecutive weeks.

Not evaluated a TB patient for whom no treatment outcome is assigned. This includes cases "transferred out" to another treatment unit as well as cases for whom the treatment outcome is unknown to the reporting unit.

Moved to MDR-TB a patient who has been diagnosed as having DR-TB as per the national guideline prior to being declared as' Failure' and is placed on DR-TB TB treatment.

Treatment success is the sum of cured cases and treatment completed cases.

Recurrent TB was defined as the diagnosis of a subsequent episode of TB following treatment completion or cure at the end of the most recent course of treatment, which was identified from the record. However, relapsed TB cases are patient who become (and remained) culture negative while receiving therapy but after completion of therapy becomes culture positive again or has clinical or radiographic deterioration that is consistent with active TB.

Retreatment TB cases are TB cases who have been treated previously for one month or more with anti-TB drugs and diagnosed again with the diseases. It include relapses, treatment after failure, or loss to follow-up on a first-line treatment regimen [15].

Adherence to ART is a documented adherence level to ART medications; Good (≥95% or <2 doses missed per month or <3 doses missed per 2 months), fair (85–94% or 3–5 doses missed per 30 doses or 3–9 doses of 60 doses), and poor (less than 85% or >6 doses of the 30 doses or >9 dose of 60 doses.

Data quality control

Before the actual data collection, the data abstraction format was pre-tested in another health facility. 5% of the sample size were identified to conduct the pre-test. Data collectors and supervisor were trained on issues related to the data collection process. During data collection, the supervisor checked the data collection process. At the end of each data collection day, the investigators and supervisors checked the completeness of filled data collection format. All filled data abstraction format were checked before data entry by principal investigator.

Data processing and analysis

Data collected by a KOBO Collect tool were exported to and analysed using the statistical package SPSS for windows (SPSS Inc., Chicago, IL, USA) version 26. Descriptive analysis was done by calculating various summary statistics and frequency measures. Age was recoded into age groups. TB treatment outcome was recoded in two groups. Treatment outcomes 'Cured' and 'Treatment completed' were regrouped together as favourable treatment outcomes or treatment success. The other treatment outcomes were grouped in to unfavourable treatment outcomes. Death was categorized as died or alive.

Bi-variable and multivariable logistic regression model was done to test the association between the independent and the outcome variables. All explanatory variables with P-value of <0.2 in the bi-variable analysis were entered into multiple logistic regression model. P-value of less than 0.05 or a 95% confidence interval not crossing the null value were considered as a cut-off point for statistically significant association between the dependent and independent variables. The strength of association between determinant variables and outcome variable was measured through prevalence ratios.

Ethics approval and consent to participate

Ethical approval to carry out the study was obtained from the Hawassa University College of Medicine and Health Sciences Institutional Review Board (IRB) Reference number IRB 279/15 on the date 30/03/2023. The need for informed consent to participate was also waived by the ethics committee that approved the study. An official letter of support was obtained from the Sidama Region Public Health Institute (SRPHI). Permission was obtained from Adare Hospital. As the study was based on secondary data, no consent was needed to obtain from the study participants including the consent for minors. The IRB has approved the waiver of informed consent to participate in the study. The data collected were anonymous, and the confidentiality of the data was maintained. The data were handled by the researchers only.

Results

Demographic characteristics of TB HIV co-infected patients

As it is stated in Table 1, a total of 298 TB/HIV co-infected cases were treated for TB at Adare Hospital of Hawassa City Administration, Sidama Region. All of these cases were included in the study. Of these, 167 (56.0%) were male, 135 (45.3%) were below 35 years of age, 79 (26.5%) completed at least secondary education, and 159 (53.9%) had a job. Regarding marital status, 119 (39.9%) were married. The majority of the participants, 120 (40.3%), had a BMI score below 18.5 at HIV diagnosis.

Clinical characteristics of the study participants

Table 2 shows the clinical characteristics of the study participants. A high proportion of the study participants 121 (40.6%) had smear-positive TB. Re-treatment TB cases constituted 36 (12.1%). Thirty three (11.1%), of the cases had unfavourable TB treatment outcome. Treatment completed cases constituted 167 (56.0%), cured cases were 98 (32.9%), and dead cases were 15 (5.0%). Recurrent TB was reported in 22 (7.4%) of the participants.

Table 1 Sociodemographic characteristics of the study participants

Variables	Number	Percent
Sex		
Male	167	56.0
Female	131	44.0
Age in years		
Below 35	135	45.3
At least 35	163	54.7
Education		
No education	21	7.0
Primary	72	24.2
Secondary and above	79	26.5
Missing	126	42.3
Occupation		
Employed	159	53.4
House wife	29	9.7
Student	20	6.7
Missing	90	30.2
Marital status		
Married	119	39.9
Others	144	48.3
Missing	35	11.8
BMI at HIV diagnosis		
18.5-24.99	159	53.3
Below 18.5	120	40.3
Over 24.99	19	6.4

BMI: body mass index; HIV: Human Immune Virus

At HIV diagnosis, 51 (17.1%) participants were at stage 4, and 153 (51.3%) were at stage 3 of the WHO clinical HIV staging. However, 85 (28.5%) were in stage 4 and 196 (65.8%) were at stage 3 of the WHO staging at TB diagnosis. Twenty four (8.1%) of the study participants were on fluconazole prevention therapy (FPT). ARV adherence was poor for 30 (10.1%) of the study participants. Only nine (3%) of the study participants had recorded ARV side effects. Non-communicable disease medications were received by 16 (5.4%) of the study participants during the follow-up period. Hypertension and diabetes mellitus were recorded among 40 (13.4%) and 17 (5.7%) of the participants, respectively.

Risk factors of unfavourable TB treatment outcome and death among TB/HIV co-infected cases

As presented in Table 3, both in a bivariate and a multivariate logistic regression analysis, the TB treatment category showed a statistically significant association with unfavourable TB treatment outcome. The odds of unfavourable treatment outcome was over three times higher among re-treated TB cases than among the new TB cases Adjusted Odds Ratio (AOR)=3.3, 95% CI (1.4, 7.9)). Regarding the deaths of the study participants, WHO staging, taking NCD medications, and ARV medication adverse effects were the variables which showed associations with the death. Table 4 shows risk factors analysis of death during TB treatment. Stage 4 AIDS cases had higher odds of death (AOR=8.1, 95% CI (2.4, 28.9)). The odds of death among people who used NCD medication during the cohort period was over seven times higher than among those who did not use these medications (AOR=7.3, 95% CI (1.6, 33.6).

Discussion

The overall TB treatment success rate among TB/HIV co-infected cases in the current study was high, (88.9%). A significant proportion (5%) of the study participants died during the course of TB treatment. Re-treatment TB cases had an increased odds of an unsuccessful TB treatment outcome. The odds of death during TB treatment was higher among patients in HIV clinical stage four cases. The odds of death due to TB was higher among cases who had been using NCD medication during the cohort.

According to previous reports, being diagnosed with HIV infection after TB was an independent risk factor for unsuccessful outcomes of anti-TB treatment [16–19]. Studies in other settings also revealed that TB/HIV co-infected patients had a lower treatment success rate of TB compared for non-HIV infected [7, 19, 20]. The overall TB treatment success rate observed in the current study was comparable to previous reports from Ethiopia, 88.2% [7], and from other settings like China, 83.8% [18], from rural South Africa, 82.2% [21], from Kenya, 84% [16], and with the pooled estimate of successful TB treatment outcomes which was 83.7% [17]. However, it was lower than the treatment success rate reported among non HIV infected participants in Addis Ababa; 94.4% [22].

The proportion of mortality among the current study participants was comparable to the reports from other settings; 6.9% in Cameroon [14] and 5.5% in Gahana among HIV negative individuals [20]. But it was lower than other reports, 21.5% among HIV-positive individuals in Ghana [20], 7.6% in Kenia [16], 10.5% in rural South Africa [21], 7.3% in another report from Kenya [23], and 29.4% in Cameroon [24]. The proportion of death in the current study is also lower than that reported in Northwest Ethiopia among non-ART cohort; 29.3% [25], HIV co-infected TB patients in Addis Ababa, Ethiopia; 8.3% [7] and the death during TB treatment among TB-HIV co-infected patients in Botswana:13.6% [26]. The difference in the proportion of deaths among participants in the current study and other reports could be related to the difference in the presence of comorbidities. Less than 14% of our study participants had chronic diseases like hypertension and diabetes mellitus. Managing these conditions could contribute to an improved treatment success rate among PLHIV in Hawassa. Having high proportion of participants in the advanced stage of HIV

Table 2 Clinical characteristics of the study participants

Variables	Number	Percent
TB type		
Smear-positive	121	40.6
Smear-negative	75	25.2
Extra pulmonary	102	34.2
TB treatment category		
New	262	87.9
Retreatment	36	12.1
TB treatment outcome		
Unfavourable	33	11.1
Favourable	265	88.9
TB treatment outcome		
Treatment completed	167	56.1
Cured	98	32.9
Died	15	5.0
Not evaluated	11	3.7
Lost follow up	5	1.7
Other	2	0.6
TB recurrence		
No	276	92.6
Yes	22	7.4
HIV stage at HIV diagnosis		
Stage 1	44	14.8
Stage 2	50	16.8
Stage 3	153	51.3
Stage 4	51	17.1
HIV staging at TB diagnosis		
Stage 1	8	2.7
Stage 2	9	3.0
Stage 3	196	65.8
Stage 4	85	28.5
Fluconazole prevention therapy		
Yes	24	8.1
No	274	91.9
ARV adherence		
Good	263	88.3
Fair	5	1.7
Poor	30	10.1
ARV side effects		
Yes	9	3.0
No	289	97.0
ARV changes		
Yes	125	41.9
No	173	58.1
HIV status		
On ART	163	54.7
Not on ART	135	45.3
NCDs medications during the follow-up		
Yes	16	5.4
No	265	88.9
Missing	17	5.7
Hypertension		
Yes	40	13.4
No	258	86.6

Table 2 (continued)

Variables	Number	Percent
Diabetes Mellitus		
Yes	17	5.7
No	281	94.3

ARV: Antiretroviral, TB: tuberculosis, ART: antiretroviral therapy, HIV: human immune virus, NCD: non communicable diseases

Table 3 Risk factors of unfavourable TB treatment outcome among TB/HIV co-infected cases in Hawassa

	TB treatment outcome		COR (95% CI)	AOR (95% CI)
Variable	**Unfavourable**	**Favourable**		
Age				
Below 35	14	121	0.9 (0.4–1.8)	
At least 35	19	144		
Sex				
Male	20	147	1.2 (0.6–2.6)	
Female	13	118		
TB type				
Smear-positive TB	13	108	1	1
Smear-negative TB	6	69	0.7 (0.3-2.0)	0.8 (0.3–2.3)
Extra pulmonary TB	14	88	1.3 (0.6–2.9)	1.4 (0.6–3.2)
TB treatment category				
New	23	239	1	1
Retreatment	10	26	4.0 (1.7–9.3)	3.3 (1.4–7.9)
HIV status				
On ART	22	141	1	1
Not on ART	11	124	0.6 (0.3–1.2)	0.7 (0.3–1.6)
ARV adherence				
Good	26	237	1	1
Fair or poor	7	28	2.3 (0.9–5.7)	2.0 (0.8–5.4)

ARV: anti-retroviral, ART: anti-retroviral therapy, CI: confidence interval, COR: crude odds ratio, AOR: adjusted odds ratio, HIV: human immune virus, TB: tuberculosis

Table 4 Risk factors of death among TB/HIV co-infected cases in Hawassa

Variable	Death		COR	AOR
	Yes	No		
Age				
Below 35	3	132		
At least 35	12	151	3.5 (0.9–12.7)	
Sex				
Male	10	157	2.2 (0.6–7.2)	
Female	5	126		
HIV staging at TB diagnosis				
Stage 1,2,3	5	208	1	1
Stage 4	10	75	5.5 (1.8–16.8)	8.1 (2.3–28.9)
NCD medication taking				
Yes	3	13	5.3 (1.3–21.5)	7.3 (1.6–33.6)
No	11	254	1	1
ARV adherence				
Good	11	252	1	1
Fair or poor	4	31	2.9 (0.9–9.9)	2.9 (0.8–11.4)
ARV side effects				
Yes	2	7	6.1 (1.1–32.1)	6.5 (0.9–43.6)
No	13	276	1	1

ARV: anti-retroviral, NCD: non communicable diseases, CI: confidence interval, COR: crude odds ratio, AOR: adjusted odds ratio

could also be another factor for the observed differences among the reports.

In the current study, re-treated TB cases had an increased odds of an unsuccessful TB treatment outcome. Similarly, a previous report from Southern Ethiopia confirmed that the risk of unsuccessful treatment outcome was higher among patients in the re-treatment category [27]. Unsuccessful TB treatment outcomes can be due to various factors, such as medication non-adherence, drug resistance, or other medical conditions. Retreatment of TB cases may have these problems as they may be taking many medications. They can have a high burden of other morbidities than the new TB cases living with HIV. More follow-up care of TB HIV co-infected TB cases may be helpful for a successful TB treatment outcome among them. These conditions may be higher among the TB/HIV confected cases due to the pill burden, or reduced immunity.

Age and experiencing anti-TB treatment side effect were factors significantly associated with treatment outcome among TB HIV co-infected cases in other setting in Ethiopia [7, 28]. Also, successful TB treatment outcome was associated with being female in a Cameroonian study report [14]. Unfortunately, none of these factors

associated with TB treatment outcome in the current study.

Presence of other conditions like having anaemia, having opportunistic infections and being bedridden were important risk factors of mortality among TB/HIV co-infected cases during TB treatment [29–32]. These conditions are prevalent among PLHIV in the advanced stages of HIV. In the current study, the odds of death was higher among TB/HIV co-infected cases in stage IV of the WHO AIDS staging than among cases in stage I, II, III. This could be due to the presence of lower prevalence of morbidities among PLHIV in the other stages than those cases found in stage IV [11]. TB cases among PLHIV in the lower stages might have less comorbidities than those found at stage IV.

In the current study, the odds of death due to TB was higher among cases who used NCD medication during the TB cohort. Taking NCD medication increased the risk of death by about nine times. Among the studied people nearly 6% had diabetes mellitus and over 13% had hypertension. Our finding is in agreement with studies report from other settings [24, 33]. According to a report by Ako A and et al. death in TB/HIV co-infected patients during TB treatment was associated with non-AIDS comorbidities not receiving ART [24]. A report by Roya AN. Confirmed that, diabetes mellitus was among the major risk factors for death of TB patients [33]. As expected having comorbidities increases the pill burden and the risk of medication adverse effects, which may contribute to an increased risk of death of TB/HIV co-infected patients. More follow-up care is required for TB/HIV co-infected cases with such comorbidities.

The point estimate of our analysis showed a reduced odds of death among cases with good ARV adherence, however the association was not statistically significant. In contrary to this, other reports showed the presence of association between death and adherence to ART among TB/HIV co-infected cases [29, 34]. ARV treatment adverse effect was not among the predictors of mortality in TB/HIV co-infected children in Ethiopia [35]. This is in agreement with the finding in the current study. The current study showed association between ARV adverse effect and death in the bivariable analysis, however, the association was not maintained in the multivariable analysis.

Strengths of this is study was that we included all TB/HIV co-infected cases treated during the study period, as it is a retrospective study based on secondary data. However, as we are relying on retrospective analysis of routinely collected data there are missing values for variables such as education, occupation, marital status, CD4 count, viral load and having of non-communicable diseases multi-morbidity. So some of these variables have been omitted from the report. Related to this, our risk factors analysis could be limited due to these missing cases. The other limitation observed in in this study is that, the inadequacy of sample size to calculate the risk factors of death, which was shown by insufficient cases in the cells for estimating associations for all variables we calculated. The sample size however, was adequate to measure association between TB treatment outcome and range of factors. Lastly, not collecting time data could be another limitation as a result this we were not able to show the effect of COVID-19 on the treatment outcome of TB among our study participants.

In conclusion, the TB treatment success rate among TB/HIV confected cases in the current study was comparable to many other reports. A number of study participants died during the course of TB treatment. Unsuccessful TB treatment outcomes were more common among re-treated TB cases. There was a higher risk of death among PLHIV at WHO stage four cases than those in other stages. There was a higher risk of death due to TB among cases who had been using NCD medication during their cohort period. Cautious follow-up and management of related conditions among the TB retreatment cases, and cases with other morbidities may improve the TB treatment outcome among the TB/HIV co-infected cases among the studied population.

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Author contributions
EMW: Data curation, investigation, conceptualization, formal analysis, writing original draft and review and editing. TG: Data curation, conceptualization, investigation, formal analysis, writing original draft, review and editing.

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Data availability
The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Ethical approval to carry out the study was obtained from the Hawassa University College of Medicine and Health Sciences Institutional Review Board (IRB) Reference number IRB 279/15 on the date 30/03/2023. The need for informed consent to participate was also waived by the ethics committee that approved the study. An official letter of support was obtained from the Sidama Region Public Health Institute (SRPHI). Permission was obtained from Adare Hospital. As the study was based on secondary data, no consent was needed to obtain from the study participants including the consent for minors. The IRB has approved the waiver of informed consent to participate in the study. The data collected were anonymous, and the confidentiality of the data was maintained. The data were handled by the researchers only.

Consent for publication
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Competing interests
The authors declare no competing interests.

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