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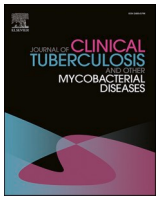

Missed opportunities for TB diagnostic testing among people living with HIV in Zimbabwe: Cross-sectional analysis of the Zimbabwe Population-based HIV Impact Assessment (ZIMPHIA) survey 2015–16

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ABSTRACT

Background: Using data from the Zimbabwe Population-based HIV Impact Assessment survey 2015–2016, we examined the TB care cascade and factors associated with not receiving TB diagnostic testing among adult PLHIV with TB symptoms.

Methods: Statistical Analysis was limited to PLHIV aged 15 years and older in HIV care. Weighted logistic regression with not receiving TB testing as outcome was adjusted for covariates with crude odd ratios (ORs) with $p < 0.25$. All analyses accounted for multistage survey design.

Results: Among 3507 adult PLHIV in HIV care, 2288 (59.7 %, 95 % CI:58.1–61.3) were female and 2425 (63.6 %, 95 % CI:61.1–66.1) lived in rural areas. 1197(48.7 %, 95 % CI:46.5–51.0) reported being screened for TB symptoms at their last HIV care visit. In the previous 12 months, 639 (26.0 %, 95 % CI:23.9–28.1) reported having symptoms and of those, 239 (37.8 %, 95 % CI:33.3–42.2) received TB testing. Of PLHIV tested for TB, 36 (49.5 %, 95 % CI:35.0–63.1) were diagnosed with TB; 32 (90.3 %, 95 % CI:78.9–100) of those diagnosed with TB received treatment. Never having used IPT was associated with not receiving TB testing.

Conclusion: The results suggest suboptimal utilization of TB screening and diagnostic testing among PLHIV. New approaches are needed to reach opportunities missed in the HIV/TB integrated services.

1. Introduction

Tuberculosis (TB) remains a pressing global health priority among people living with HIV (PLHIV). PLHIV were 20 times more likely to fall ill with TB than those without HIV in 2017 [1]. In sub-Saharan Africa, TB parallels the HIV epidemic [2]. Sub-Saharan Africa accounted for 25 % of the estimated 10.4 million new TB cases in 2016 and 75 % of HIV-associated TB cases (1.03 million cases) that occur each year [3]. Furthermore, TB is the leading cause of death among PLHIV in the region, accounting for 86 % of global deaths from HIV-associated TB in 2016 [3].

The sizeable burden of TB/HIV coinfection could be substantially reduced by intensified TB screening and timely TB diagnosis and treatment, which when coupled with antiretroviral therapy (ART) halves active TB recurrence among PLHIV [4]. Between 2000 and 2017, TB diagnosis and treatment supported by ART averted an estimated 9 million global TB deaths among PLHIV [3]. Furthermore, TB preventive therapy (TPT) has been shown to reduce the incidence of TB among PLHIV by 33 % to 62 % [5]. The World Health Organization (WHO) End TB Strategy aims to get 90 % of PLHIV on TPT by 2025 [6]. Nevertheless,

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there are persistent gaps in TB care among PLHIV. Globally, an estimated 49 % of all people with TB/HIV coinfection do not know they are coinfected and, consequently, do not receive care [7]. In sub-Saharan Africa, this contributes to the ongoing TB epidemic in the region. In 2017, the TB treatment coverage in the WHO Africa region was 52 %, the lowest among all regions [3].

Zimbabwe is one of WHO's 30 countries with high TB burden, multidrug resistant (MDR) TB and TB-HIV coinfection [3]. Although Zimbabwe began scale-up of HIV care services, including HIV testing of patients with TB in 2005 [6], the burden of HIV-associated TB remains high. In 2017, 63 percent of incident TB cases in Zimbabwe were among PLHIV, and TB mortality among TB patients with HIV co-infection was 38 (27–51) per 100,000 population, a rate three-fold higher than among TB patients without HIV infection [3]. The Zimbabwe Ministry of Health and Child Care (MOHCC) has established collaborative TB/HIV activities and guidelines which aim to ensure 1) integrated TB and HIV services at the same time and location; 2) early initiation of ART among PLHIV; 3) delivery of the Three I's for HIV/TB (intensified TB case finding (ICF), isoniazid preventive treatment (IPT), and infection control for TB (IC), and 4) delivery of HIV services to patients with presumptive or diagnosed TB [8]. National guidelines indicate that all PLHIV should be screened for TB symptoms at each HIV care visit [8] and patients with symptoms suggestive of TB should be linked to diagnostic testing using chest X-ray or sputum-smear microscopy. This was further updated in 2016 to recommend the use of GeneXpert MTB/RIF® (Cepheid, Sunnyvale, CA, USA) as the initial diagnostic test [9].

Some published literatures have documented poor linkage to TB diagnostic testing in the TB care cascade among PLHIV in southern Africa [10,11]. Furthermore, a systematic review on 16 studies in Africa and Asia shows a suboptimal utilization of TB testing among people with TB symptoms, regardless of HIV status [12]. However, there is a dearth of evidence as to what extent PLHIV with TB symptoms are being identified and subsequently linked to TB diagnostic and treatment services. All previously published studies on TB care cascade in Zimbabwe have focused only on pre-TB treatment loss to follow up (LTFU) among those diagnosed with TB [13–15] or linkages in the TB care cascade among presumptive TB cases [16] and were not population-based. To improve the uptake of TB diagnostic testing and intervene with missed opportunities in the TB care cascade among PLHIV, it is critical to find out and understand factors associated with not receiving TB testing among PLHIV. Here, we examined the TB care cascade and explored factors associated with not receiving TB testing among PLHIV, using data from the nationally representative Zimbabwe Population-based HIV Impact Assessment (ZIMPHIA) done in 2015–16. Receiving TB testing was chosen as the outcome of interest because it is the first step for those who report TB symptoms (i.e. potentially have TB) to get treated in the TB care cascade. In a smaller study with program data in Harare, only 22 % of PLHIV with presumptive TB received TB testing in 2016, the same year the ZIMPHIA was conducted [16]. Evidence from our analysis would provide additional insights from a population level by documenting the proportion of PLHIV receiving TB testing from a population based survey with rigorous study methods. To our knowledge, this is the first study with nationally representative sample in Zimbabwe to document the proportions of PLHIV in the TB care cascade back in 2015–2016, which would be an important piece of evidence to future longitudinal evaluation on the progress of HIV/TB integrated services in the country.

2. Methods

2.1. Study setting

The 2015–2016 ZIMPHIA assessed the prevalence of HIV and key HIV-related health indicators and behaviors in a nationally representative sample of individuals from randomly selected households across Zimbabwe. In stage one of the two-stage stratified cluster sampling design, 499 enumeration areas were selected from the Zimbabwe Population Census 2012, using a probability proportional to size method. In stage two, a sample of households was randomly selected from each cluster, using an equal probability method with an average of 30 households per cluster (range: 15–60). A total of 15,009 households responded to household questionnaires, from which 27,035 individuals aged 15 years old or older completed individual questionnaires and 24,660 individuals participated in biomarker testing which includes GeeniusTm HIV-1/2 supplemental assay (Bio-Rad, Hercules, CA, USA) CD4 count, HIV viral load (VL) and assays for recent HIV infection (SediaTMLAg-Avidity EIA, Sedia Biosciences Corporation, Portland, OR, USA). Prior to administering questionnaires, electronic informed consent was obtained from individuals age 16 years and above and emancipated minors aged 15 years who slept in the household the night before the survey. For more information on the ZIMPHIA questionnaires, please visit the PHIA project website: https://phia-data.icap.columbia.edu/datasets?country_id=6.

2.2. Study design and objectives

This was a cross-sectional study using the data of 3507 adult self-reported PLHIV (i.e., aged 15 years and above) in HIV care who completed both the individual questionnaire and biomarker testing in the ZIMPHIA 2015–16. The study objectives were to examine the TB care cascade and explore factors associated with not receiving TB testing among PLHIV diagnosed with TB in Zimbabwe.

2.3. Measurement

Sociodemographic and behavioral variables considered in the analysis were sex, age group, rural/urban residence, education level, religion, province of residence, current pregnancy status (women only), duration of HIV infection (recent vs long-term), current ART status, previous or current IPT use, taking co-trimoxazole (CTX), CD4 count, VL, and hazardous drinking. Hazardous drinking was defined by the Alcohol Use Disorders Identification Test (AUDIT) designed by WHO [17] and dichotomized into hazardous or non-hazardous drinking. All the variables except CD4 count, VL, and recent HIV infection were self-reported.

For this analysis, the self-reported indicators in the TB care cascade were 1) being screened for TB symptoms at the last HIV care visit, 2) having any TB symptoms (i.e. any cough, fever, night sweats, or weight loss) in the past 12 months, 3) receiving a TB diagnostic test (chest x-ray or/and sputum-smear microscopy) in the past 12 months, being diagnosed with TB in the past 12 months, and being treated for TB in the past 12 months. All TB care cascade indicators, except the symptom screening, were restricted to the past 12 months at the time of interview and among persons who responded "yes" to the previous cascade question (Table 1).

2.4. Statistical analysis

Univariate analysis was used to summarize unweighted counts and weighted percentages for sociodemographic and behavioral characteristics of the survey respondents, which were stratified by the TB care cascade indicators. Associations between covariates of interest and receiving a TB diagnostic test were assessed using chi-square tests and crude odd ratios (ORs) with 95 % confidence intervals (CI). In multiple variable analysis, weighted logistic regression was adjusted for covariates of which crude ORs with $p < 0.25$ during bivariate analysis. Additionally, tests for interaction were performed to explore any potential interaction with the outcome variable. Covariates were added to a regression model one by one in the order of having the largest reduction in −2 log likelihoods until no significant reductions in the model deviance occurred. Analyses were restricted to the operable sample size of subjects with all complete data on the covariates.

Table 1
Demographic characteristics of total adult PLHIV (N = 3507), ZIMPHIA, 2015–2016.

Variable	Unweight counts	Weighted %	95 % CI
	3507	100	
Sex			
Male	1219	40.3	(38.7–41.9)
Female	2288	59.7	(58.1–61.3)
Age in years			
15–19	147	5	(4.1–5.9)
20–29	526	16.7	(15.3–18.1)
30–39	1094	32.7	(31.1–34.4)
40–49	963	27.2	(25.6–28.7)
50–59	508	12.2	(11.1–13.3)
60+	269	6.2	(5.3–7.1)
Residence			
Rural	2425	63.6	(61.1–66.1)
Urban	1082	36.4	(33.9–38.9)
Education level			
No education	140	3.4	(2.7–4.0)
Primary	1360	35.1	(33.0–37.1)
Secondary	1879	57.2	(55.1–59.3)
More than secondary	126	4.3	(3.3–5.4)
Missing	2		
Religion			
Traditional	75	2	(1.4–2.5)
Catholic/Protestant	823	23.6	(21.7–25.6)
Pentecostal	653	19.1	(17.2–21.0)
Apostolic	1434	39.3	(37.0–41.7)
Muslim/Other	47	1.4	(0.8–1.8)
None	473	14.6	(13.0–16.2)
Missing	2		
Province			
Bulawayo	401	7.8	(6.8–8.8)
Harare	334	17.1	(15.1–19.2)
Manicaland	286	9.8	(8.3–11.1)
Mashonaland Central	317	8.1	(6.7–9.5)
Mashonaland East	308	10.1	(8.5–11.8)
Mashonaland West	336	11.2	(9.1–13.3)
Mashonaland North	437	7.1	(6.3–7.8)
Mashonaland South	407	7.9	(6.6–9.1)
Midlands	312	10.4	(8.6–12.2)
Masvingo	369	10.5	(8.8–12.2)
Pregnant status[a]			
Currently pregnant	75	3.5	(2.6–4.4)
Not currently pregnant	2176	96.5	(95.6–97.4)
Missing	37		
Hazardous drinking			
Yes	310	10.2	(8.8–11.4)
No	3155	89.8	(88.5–91.2)
Missing	42		

[a] Pregnant status was females only.

Accounting for the population-based sampling design of ZIMPHIA, appropriate weights and degrees of freedom were used to calculate weighted percentages and ORs. All analyses were performed using SAS 9.4 statistical software (*SAS Institute Inc., Cary, NC, USA).*

2.5. Ethical approval

Ethical approval was obtained from Medical Research Council of Zimbabwe, Research Council of Zimbabwe, U.S Centers for Disease Control and Prevention, Columbia University and WESTAT. Written informed consent was obtained from eligible participants in Shona or Ndebele.

3. Results

3.1. Characteristics of study population

The demographic and clinical characteristics of the study population are summarized in Tables 1 and 2. Total of 3,507 self-reported PLHIV in HIV care were included in the analyses. Of those, approximately 60 % were women, and the median age was 37.7 years (interquartile range: 30.0–45.8). The majority had either primary education or secondary education and were living in rural areas. One in ten (10.2 %) were hazardous drinkers. Most (99.1 %) had a long-term HIV infection based on recency testing and 60.8 % had VL suppression. Given that the survey was conducted before the 'Treat All' approach for ART was implemented, the ART coverage was 64.7 %.

3.2. TB care cascade

Of 2515 adult PLHIV in HIV care who responded to the TB screening question, only 1197 (48.7 %, 95 % CI:46.4–51.0 %) reported having been screened for TB symptoms at their last HIV care visit. Of 2519 PLHIV in HIV care who responded to the TB symptom question, 639 (26.0 %, 95 % CI:23.9–28.1 %) had at least one TB symptom in the past 12 months. Of 624 PLHIV with TB symptoms who responded to the TB investigation question, 239 of them (37.8 %, 95 % CI: 33.3–42.2 %) underwent diagnostic testing for TB. Of them, 49.2 % (95 % CI: 42.4–55.9 %) received sputum-smear microscopy, 19.0 % (95 % CI: 13.1–24.8 %) received chest x-ray, and 31.9 % (95 % CI: 26.0–37.8 %)

Table 2
Clinical characteristics of total adult PLHIV (N = 3507), ZIMPHIA, 2015–2016.

Variable	Unweight counts	Weighted %	95% CI
	3507	100	
Recency of HIV infection[b]			
Recent	31	0.9	(0.5–1.3)
Long term	3471	99.1	(98.7–99.5)
Missing	5		
ART			
Currently on ART	2350	64.7	(62.7–66.7)
Not currently on ART	1156	35.3	(33.3–37.3)
Missing	1		
IPT use			
Ever	424	12.6	(11.3–14.0)
Never	2993	87.4	(86.0–88.7)
Missing	90		
Taking CTX			
Yes	1955	76.5	(74.5–78.5)
No	628	23.5	(21.5–25.5)
Missing	924		
CD4 count (cells/μl)			
<200	548	17	(15.4–18.5)
200–349	906	26.3	(24.7–27.9)
350–500	900	24.8	(23.2–26.3)
>500	1150	31.9	(30.3–33.6)
Missing	3		
Viral load suppression[c]			
No	1280	39.2	(37.1–41.3)
Yes	2222	60.8	(58.7–62.9)
Missing	5		

[b] Recency of HIV infection was determined based on results of Lag Avidity EIA tests.

[c] Viral load suppression was defined as <1000 copies/ml.

received both tests. Given that the survey was conducted before GeneXpert MTB/RIF test was implemented in Zimbabwe, no one reported use of GeneXpert MTB/RIF test. Of 73 PLHIV who received diagnostic testing and responded to the TB diagnosis question, 36 of them (49.5 %, 95 % CI: 35.8–63.1 %) reported being diagnosed with TB. The majority of 36 PLHIV who was diagnosed with TB reported receiving TB treatment (90.3 %, 95 % CI: 78.9–100 %) reported receiving TB treatment (Fig. 1).

3.3. Factors associated with not receiving TB testing

To explore factors associated with not receiving TB diagnostic testing, 624 PLHIV who reported TB symptoms and answered the TB diagnostic testing question (response rate: 97.6 %) were included in the analysis (Table 3). In the bivariate analysis, those who reported never receiving IPT were 1.85 times more likely to not receive TB testing. There was a dose–response relationship between CD4 count and receiving TB diagnostic testing; a higher CD4 count was associated with greater odds of not receiving TB testing (Table 3).

The final multivariate regression model included rural/urban residence, IPT use, CTX intake, CD4 count, and sex as an effect modifier. After adjusting for these covariates, females with CD4 $>$ 500 cells/μl were less likely to receive TB diagnostic testing compared to females with CD4 $<$ 200 cells/μl (aOR: 2.22, 95 % CI: 1.08–4.56) (Table 3). IPT use was no longer significantly associated with not receiving TB testing.

4. Discussion

We used nationally representative data to explore factors associated with receiving TB diagnostic testing among symptomatic adult PLHIV who were in HIV care. Approximately half reported being screened for TB symptoms at their last HIV care visit and only 38 % of PLHIV who

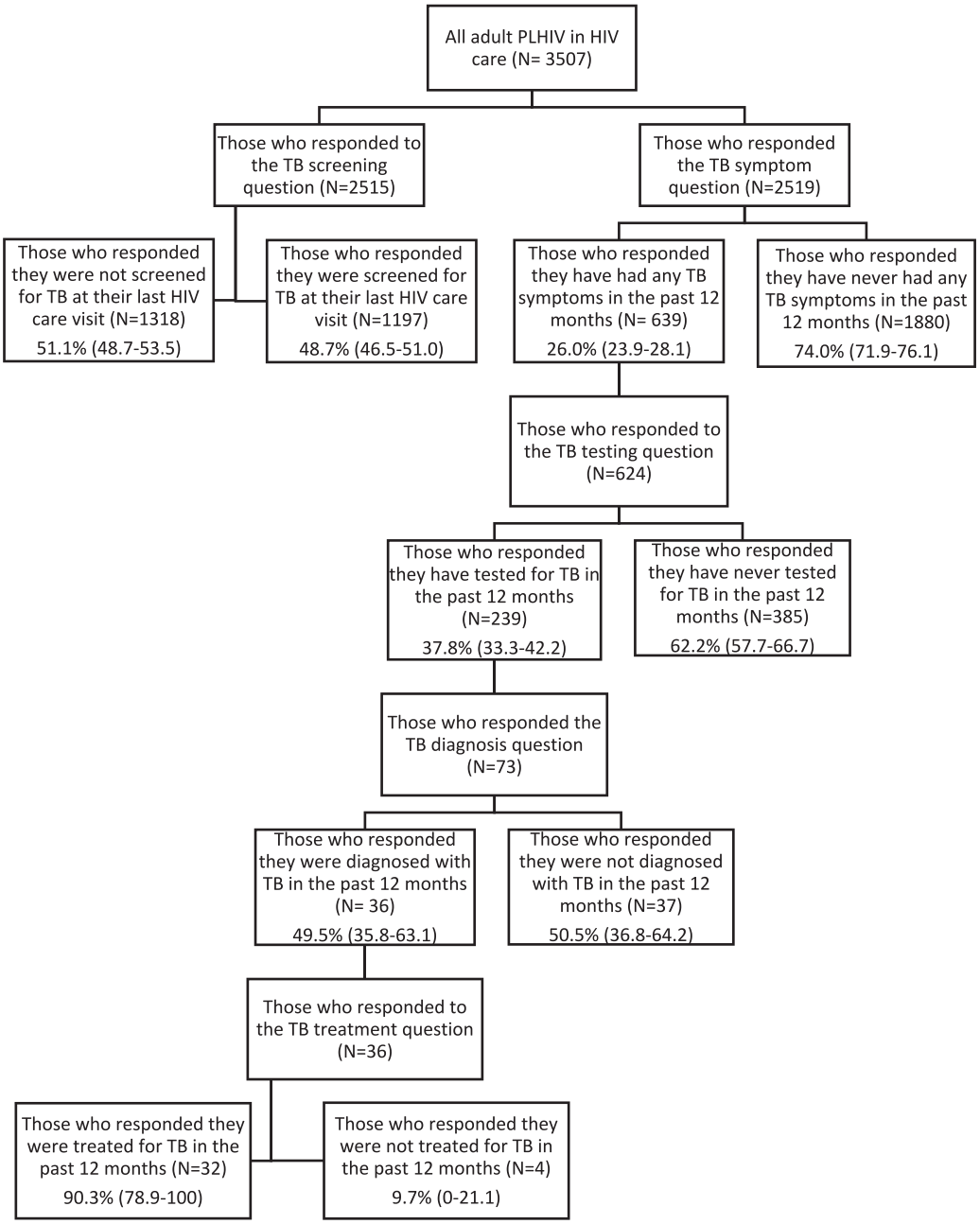

Fig. 1. TB care cascade among adult PLHIV in HIV care in Zimbabwe, ZIMPHIA 2015–16.

Table 3
Bivariate and multivariate analysis of factors associated with not receiving TB diagnostic testing among PLHIV with TB symptoms, ZIMPHIA, 2015–2016 (N = 624). Multivariate analysis stratified by sex are displayed in the columns for adjusted OR (aOR).

Variable†	Not receiving TB testing *Unweighted Counts* 385	Weighted % (95 % CI) 62.2 (57.8–66.7)	OR (95 % CI)	aOR[d] (95 % CI) Male	aOR[d] (95 % CI) Female
Sex					
Male	139	41.8 (35.6–48.0)	1.19 (0.81–1.73)		
Female	246	58.2 (52.0–64.4)	(ref)		
Age in years					
15–19	10	3.4 (1.0–5.7)	1.22 (0.32–4.10)		
20–29	37	9.1 (5.9–12.4)	1.40 (0.60–3.26)		
30–39	113	31.6 (26.6–36.5)	1.07 (0.52–2.20)		
40–49	131	35.5 (30.3–40.6)	1.47 (0.73–3.00)		
50–59	64	14.2 (10.3–18.1)	1.67 (0.74–3.74)		
60+	30	6.3 (3.7–8.9)	(ref)		
Residence					
Rural	304	73.3 (67.5–79.1)	1.39 (0.91–2.12) (ref)	0.81 (0.31–2.08)	1.62 (0.87–3.03) (ref)
Urban	81	26.7 (20.9–32.5)		(ref)	
Education level					
No education	22	5.1 (2.8–7.3)	0.76 (0.23–2.54)		
Primary	170	39.3 (34.0–44.5)	0.90 (0.34–2.35)		
Secondary	180	51.8 (46.3–57.3)	0.70 (0.26–1.87)		
More than secondary	13	3.8 (1.6–6.1)	(ref)		
IPT use					
Ever	51	15.2 (10.0–20.5)	(ref)	(ref)	(ref)
Never	325	84.8 (79.5–90.0)	1.85 (1.05–3.26)	2.07 (0.78–5.50)	1.72 (0.84–3.54)
ART					
On ART	355	91.0 (87.8–94.2)	(ref)		
Not on ART	30	9.0 (5.8–12.2)	0.94 (0.51–1.72)		
Taking CTX					
Yes	291	78.2 (73.3–83.2)	(ref)	(ref)	(ref)
No	90	21.8 (16.8–26.7)	1.39 (0.87–2.24)	1.83 (0.70–4.74)	1.24 (0.65–2.37)
CD4 count (cells/μl)					
CD4 < 200	63	19.0 (14.8–23.2)	(ref)	(ref)	(ref)
CD4 200–349	96	26.7 (21.6–31.7)	1.32 (0.78–2.24)	1.65 (0.69–3.94)	1.24 (0.62–3.51)
CD4 350–500	86	21.6 (17.5–25.8)	1.35 (0.79–2.30)	1.49 (0.60–3.72)	1.35 (0.61–2.98)
CD4 > 500	140	32.7 (27.5–37.8)	1.78 (1.05–3.01)	1.09 (0.35–3.40)	2.22 (1.08–4.56)

[d] Multivariable analysis was stratified by an effect modifier, sex.

reported TB symptoms underwent testing. However, TB treatment was initiated in the majority of PLHIV diagnosed with TB and responded to the TB diagnosis question. The analysis also showed that never having used IPT was associated with not receiving TB testing.

The low uptake of TB diagnostic testing observed in this study aligns with findings from a previous study using program data in Harare where only 22 % of PLHIV with presumptive TB received TB diagnostic testing [16]. Low uptake of TB testing among high-risk groups including PLHIV has been documented in other sub-Saharan African countries, highlighting the linkage to TB testing as a common challenge in high burden settings [10–12].

On the other hand, we found that 90.5 % of PLHIV who were diagnosed with TB in the past 12 months received TB treatment (pre-treatment loss to follow-up (LTFU): 9.5 %), which could be a marked improvement upon previous studies in Zimbabwe [14,15]. However, this should be interpreted cautiously since the majority of those who reported getting tested for TB did not respond to the TB diagnosis question and, potentially those who reported their TB diagnosis status were those who comply TB treatment. Additionally, our estimates depend on self-report, which might include recall bias and social desirability bias; people may remember having symptoms if they were severe but may not necessarily remember or know what they were tested for at a clinic. Therefore, a true proportion of patients on TB treatment could be lower than what we found, as previous studies using program data have reported higher pre-treatment LTFU. In Guruve, a rural district in Zimbabwe, a cohort study using district TB register data reported a pre-treatment LTFU of 12 % [14]. In an urban cohort in Bulawayo, Zimbabwe, secondary program data showed pre-treatment LTFU increased from 12.1 % in 2012 to 24.9 % in 2016 [15]. Furthermore, the low pre-treatment LTFU in our findings may reflect additional challenges in TB service delivery, because the low rate of receiving TB testing may have effectively filtered out those least likely to follow up for treatment. The implementation of case-based surveillance, allowing for longitudinal tracking of individual patients, will be useful to clarify this.

Between 2013 and 2021, the national TB/HIV guidance in Zimbabwe recommended that all PLHIV in HIV care be screened for TB symptoms at each ART visit (2–3 months), using WHO's four-symptom checklist, followed by diagnostic evaluation if the symptom screen is positive [7]. The low utilization of TB symptom screening and TB diagnostics in this study highlight critical gaps that existed in TB care among PLHIV in Zimbabwe in 2015–2016. In 2021, WHO updated the recommendation that all PLHIV in high burden settings should get tested with molecular rapid diagnostic testing. More recently, novel approaches to TB testing among PLHIV, such as targeted universal testing for TB (TUTT) and

computer-aided digital chest x-ray (DCXR-CAD), has been explored in high burden settings [18,19]. Since 2022, Zimbabwe, with the support from PEPFAR, has implemented the TUTT approach to optimize TB screening among PLHIV [20]. Future study should investigate and document the impact of the TUTT on the linkage in the TB care cascade in Zimbabwe.

There are limitations to this analysis. First, when the ZIMPHIA survey was conducted, the 'Treat-All Initiative' to treat all PLHIV with ART irrespective of CD4 counts had not been scaled up [8]. PLHIV in HIV care who had not been initiated on ART would come to clinic for clinic review only, while PLHIV who were on ART would come to clinic for ART pick-up and clinic review. However, TB symptom screening is to be conducted at clinic review for all PLHIV in HIV care. Our results show there is no association between ART status and receiving TB testing. Second, due to the mismatch in the time periods of the TB screening question and other TB care cascade questions (i.e. "at the last HIV care visit" vs. "in the past 12 months"), some study participants could have reported TB symptoms after the last HIV care visit, where TB screening takes place. This may underestimate the uptake of TB testing. Third, there were moderately large proportions of missing responses for TB screening and TB symptom questions (28.3 % and 28.2 % of total PLHIV in HIV care respectively). These are a mix of those who declined to answer, not remember and true missing. Given the slow uptake of HIV/TB integrated services back then, it is highly possible that people might not know that questions about TB symptoms at a clinic were TB screening questions. Recall bias from being asked to trace back to the past 12 months might play a role as well, as opposed to being asked about a shorter period (ex. the past few months). In addition, there are some inherent limitations of cross-sectional surveys. Particularly, biological testing information such as CD4 counts is as of the time of the survey while some behavioral questions such as receiving TB testing capture behavioral information before the time of the survey. This requires cautious interpretation of results. Another limitation is recall bias and social desirability bias pertaining to the self-reporting nature of the survey. As discussed earlier, we cannot rule out a possibility of social desirability bias in the higher proportion of PLHIV receiving TB treatment compared to the data from previous studies. In addition, there might be bias of misdiagnosis among patients with HIV/TB co-infection if another HIV-related condition leads to treatment and recovery before receiving TB diagnostic testing.

5. Conclusion

Among a nationally representative sample of PLHIV from the ZIMPHIA survey 2015–2016, we found that the frequency of routine TB screening and use of TB testing among PLHIV with symptoms were low. The low screening observed may be a bottleneck in suboptimal utilization of TB testing. To strengthen Zimbabwe's TB/HIV collaborative programs, future interventions should maximize opportunities to ensure that all PLHIV receive high-quality TB screening at each HIV care visit and that presumptive TB cases are linked to TB diagnostic and treatment services, including TB preventive treatment, if TB is effectively ruled out.

Ethical statement

Ethical approval was obtained from Medical Research Council of Zimbabwe, Research Council of Zimbabwe, U.S Centers for Disease Control and Prevention, Columbia University and WESTAT. Written informed consent was obtained from eligible participants in Shona or Ndebele.

Informed Consent

Prior to administering questionnaires, electronic informed consent was obtained from individuals age 16 years and above and emancipated minors aged 15 years who slept in the household the night before the survey. For more information on the ZIMPHIA questionnaires, please visit the PHIA project website: https://phiadata.icap.columbia.edu/datasets?country_id=6.

CRediT authorship contribution statement

Mayuko Takamiya: Conceptualization, Formal analysis, Writing – original draft. **Kudawashe Takarinda:** Conceptualization, Methodology, Project administration, Supervision, Validation, Writing – review & editing. **Shrish Balachandra:** Funding acquisition, Resources, Supervision, Writing – review & editing. **Godfrey Musuka:** Conceptualization, Data curation, Investigation, Project administration, Validation, Writing – review & editing. **Elizabeth Radin:** Data curation, Project administration, Validation, Writing – review & editing. **Avi Hakim:** Conceptualization, Project administration, Supervision, Writing – review & editing. **Michele L. Pearson:** Data curation, Investigation, Methodology, Validation, Writing – review & editing. **Regis Choto:** Data curation, Project administration, Supervision, Writing – review & editing. **Charles Sandy:** Data curation, Project administration, Writing – review & editing. **Talent Maphosa:** Investigation, Methodology, Validation, Writing – review & editing. **John H. Rogers:** Conceptualization, Data curation, Formal analysis, Methodology, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Transparency Declaration

The lead author affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

Disclaimer

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