Gaps related to screening and diagnosis of tuberculosis in care cascade in selected health facilities in East Africa countries: A retrospective study

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ABSTRACT

Introduction: East Africa countries (Tanzania, Kenya, and Uganda) are among tuberculosis high burdened countries globally. As we race to accelerate progress towards a world free of tuberculosis by 2035, gaps related to screening and diagnosis in the cascade care need to be addressed.

Methods: We conducted a three-year (2015–2017) retrospective study using routine program data in 21 health facilities from East Africa. Data abstraction were done at tuberculosis clinics, outpatient departments (OPD), human immunodeficiency virus (HIV) and diabetic clinics, and then complemented with structured interviews with healthcare providers to identify possible gaps related to integration, screening, and diagnosis of tuberculosis. Data were analyzed using STATA™ Version 14.1.

Results: We extracted information from 49,454 presumptive TB patients who were registered in the 21 facilities between January 2015 and December 2017. A total of 9,565 tuberculosis cases were notified; 46.5% (4,450) were bacteriologically confirmed and 31.5% (3,013) were HIV-infected. Prevalence of tuberculosis among presumptive pulmonary tuberculosis cases was 17.4%. The outcomes observed were as follows: 79.8% (7,646) cured or completed treatment, 6.6% (634) died, 13.3% (1,270) lost to follow-up or undocumented and 0.4% (34) treatment failure. In all countries, tuberculosis screening was largely integrated at OPD and HIV clinics. High patient load, weak laboratory specimen referral system, shortage of trained personnel, and frequent interruption of laboratory supplies were the major cited challenges in screening and diagnosis of tuberculosis.

Conclusion: Screening and diagnostic activities were frequently affected by scarcity of human and financial resources. Tuberculosis screening was mainly integrated at OPD and HIV clinics, with less emphasis on the other health facility clinics. Closing gaps related to TB case finding and diagnosis in developing countries requires sustainable investment for both human and financial resources and strengthen the integration of TB activities within the health system.

1. Introduction

Tuberculosis (TB) remains the top infectious killers worldwide [1]. In 2018, an estimated 10 million people fell ill with TB, and 1.5 million (including 251,000 among people living with HIV) died from the disease [2], while sub-Saharan represented about one-quarter of all TB cases with over 50% HIV co-infected [2]. Of the estimated 10 million new TB cases, only 7 million were notified, leaving 3 million cases missed or unreported. This suggests critical gaps in screening and testing that contribute to the substantial burden of undiagnosed cases, which in turn

result in poor health outcomes and disease propagation [3].

East Africa countries-Tanzania, Kenya, and Uganda are among high TB burden countries [2], with reported TB incidence rates of 292, 253, and 200 per 100,000 population respectively in 2018 [2]. Case detection rates in the region remain low and even lower among women and children [2]. The WHO End TB Strategy, which has been adopted in all East African countries emphasizes systemic screening of contacts and risk groups as critical components [4,5].

Challenges related to early TB detection and treatment have been reported ranging from individual level to the health system. Such challenges include poor health-seeking behavior, limited symptoms that delay seeking health care, poor access to health and costs involved in seeking TB care [6–9]. In addition, the use of poor or less sensitive diagnostic tools, frequently stockout of medicines and laboratory equipment, and lack of proper training and motivation among health-care workers are some of the challenges related to the health care system [6,10,11]. The present study assessed current clinical practices and possible gaps related to screening and detection of TB in the selected facilities within the East Africa region.

2. Methods and materials

2.1. Study design and setting

This was a retrospective study design that involved review of health facility TB data for the past three-years (2015–2017), complemented with structured interviews with the healthcare providers on possible challenges related to screening and diagnosis of TB at a health facility level. The study was conducted in 21 health facilities (7 per country) in three East African countries of Tanzania, Kenya, and Uganda. These sites were purposely selected under the EXIT-TB project funded by the European and Developing Countries Clinical Trials Partnerships (EDCTP) that aimed to accelerate intensified TB case finding to increase TB case detection including women and children receiving TB care, reducing TB transmission and mortality in the region. Four facilities were from urban and three from rural settings of each country. Fig. 1 showing locations of each of the 21 health facilities.

2.2. Study population

We collected information for all TB presumptive patients and those diagnosed with TB during the stated period. We extractoutine
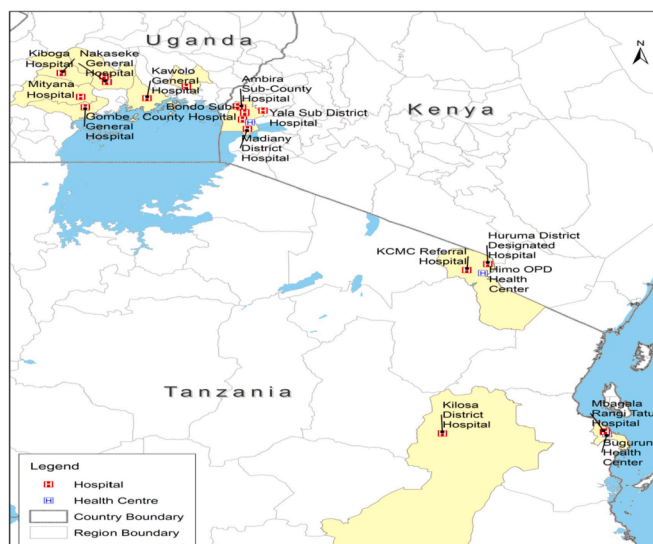

Fig. 1. Map showing the location of 21 health facilities in the three East Africa countries.

programmatic data on TB screening, diagnosis, notification, treatment, HIV/TB co-infection and clinical outcomes from both the laboratory and unit TB registers of the 21facilities. Furthermore, we conducted interview with clinicians; head of TB unit and Reproductive and Child Health (RCH), and HIV clinics. During these interviews, we collected information on the staffing level and distribution, availability of GeneXpert, laboratory supplies, X-ray services and maintenance of diagnostic devices for TB. We also explored TB screening activities at service delivery points and patients pathway.

2.3. Data collection and analysis

We used tablets loaded with Open Data Kit (ODK) technology for data collection and management. Data were exported to STATA™ Version 14.1 (Stata Corp LP, College Station, Texas, USA) for cleaning and analysis. Results were summarized using descriptive statistics including means, standard divisions, frequencies, and graphs.

3. Results

3.1. Health facilities' descriptions

All 21 facilities had TB, HIV, and RCH clinics; whereas only 7 (33.3%) had diabetic clinics (Table 1). The majority (19, 90.5%) of the surveyed facilities had GeneXpert machines, while 66.7% (14) had X-ray services. The daily patient flow and several healthcare workers varied by type and location of the health facility. With exception of Uganda, none of the facilities in Kenya and Tanzania had cough centers (specialized outpatients department responsible to manage patients triaged for cough management). In Tanzania and Kenya, patients with a cough are managed at the OPD with all other patients. Fig. 2 shows routine patient pathways for presumptive TB at a health facility.

3.2. TB Notification and treatment outcomes

Data abstraction was done for 49,454 presumptive TB patients who were registered in 19 health facilities while Gombe and Kiwoko hospitals from Uganda and St Elizabeth health centre from Kenya had missing records for presumptive cases. Of these presumptive cases, 40,591 were from Tanzania, 5,900 from Uganda, and 2,963 from Kenya. A total of 9,565 TB patients were notified in all facilities; 967 cases were from the three facilities that had missing records for presumptive cases hence excluded in computation of TB prevalence among presumptive cases. The overall TB prevalence among presumptive cases was 17.4% (8,598) and prevalence per country was 40.2% (2,369) in Uganda, 25.4% (754) in Kenya, and 13.5% (5,475) in Tanzania. Among the 9,565 TB patients, 46.5% (4,450) were bacteriologically confirmed. Of the clinically diagnosed patients, 77.6% (3,967) were smear-negative pulmonary TB patients. Most of the clinically diagnosed TB cases were from Tanzania 56.0% (3,166), while Uganda and Kenya had an almost similar proportions; 49.8% (1,363) and 49.7% (586) respectively. Fig. 2 shows the distribution of clinically diagnosed TB cases by country and over the three years respectively. Overall, there was an increase in bacteriologically confirmed pulmonary TB cases from 45.8% in 2015 to 49.5% in 2017 (Fig. 3).

Table 2 presents TB notifications by country for the 3 years period. The majority (95.8%, 9165) of all notified TB cases were new TB cases. The remaining cases (i.e., 4.2%) were either relapse, treatment failure, or defaulters. Proportion of the previously treated cases was 5.5% (65) in Kenya, 4.5% (124) in Uganda, and 3.7% (211) in Tanzania. There was an almost two-fold increase in previously treated cases from 75 (2.9%) in 2015 to 165 (5.1%) in 2016. Overall, half of the previously treated cases (52.8%, N = 2011) were bacteriologically confirmed cases.

Of the 9,565 TB patients, 31.5% (3,013) were HIV seropositive. Overall, there was a decreasing trend of the TB/HIV co-infection cases as shown in Fig. 4. The highest percentage of HIV/TB co-infection was

Table 1
Characterization of the study sites.

| Country	Facility name	Facility level	Setting	GeneXpert	X-ray	Had diabetic clinic	Had TB clinic	Had RCH clinic	Had HIV clinic
Tanzania	Kilosa	District hospital	Urban	1	1	Yes	Yes	Yes	Yes
	Sinza	District hospital	Urban	1	1	Yes	Yes	Yes	Yes
	Mbagala rangi 3	District hospital	Rural	1	1	No	Yes	Yes	Yes
	Buguruni	Health center	Urban	0	1	No	Yes	Yes	Yes
	KCMC	Teaching hospital	Urban	1	1	Yes	Yes	Yes	Yes
	Huruma	District hospital	Rural	1	1	No	Yes	Yes	Yes
	Himo	Health center	Rural	1	0	No	Yes	Yes	Yes
Uganda	Mityana	District hospital	Rural	1	1	Yes	Yes	Yes	Yes
	Kawolo	Regional hospital	Urban	1	1	No	Yes	Yes	Yes
	Nakaseke	District hospital	Urban	1	1	Yes	Yes	Yes	Yes
	Kiboga	Regional hospital	Urban	1	0	No	Yes	Yes	Yes
	Iganga	Regional hospital	Rural	1	1	No	Yes	Yes	Yes
	Gombe	Regional hospital	Urban	1	0	No	Yes	Yes	Yes
	Kiwoko	Regional hospital	Rural	1	1	No	Yes	Yes	Yes
Kenya	Yala subcounty	District hospital	Urban	1	0	No	Yes	Yes	Yes
	Siaya country	Regional hospital	Urban	1	1	No	Yes	Yes	Yes
	Ukwala subcounty	District hospital	Urban	1	0	No	Yes	Yes	Yes
	Bondo subcounty	Referral hospital	Urban	1	1	Yes	Yes	Yes	Yes
	Madiany subcounty	District hospital	Rural	1	0	No	Yes	Yes	Yes
	Ambira subcounty	District hospital	Rural	1	0	Yes	Yes	Yes	Yes
	St. Elizabeth Lwak	Health center	Rural	0	1	No	Yes	Yes	Yes
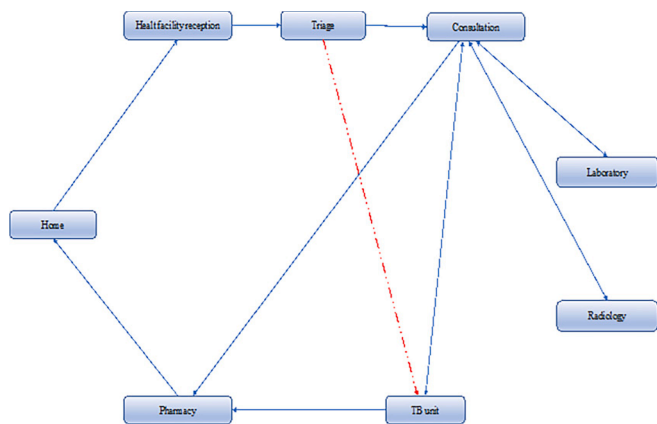
Fig. 2. Tuberculosis patients' pathway in health facilities in three countries. Red dotted line was an additional route for Uganda only. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

observed in Kenya.

Table 3 shows treatment outcomes among TB patients who were enrolled in care between January 2015 and December 2017. Overall, 79.8% (7,646) had successful treatment outcomes (i.e., cured or completed their TB treatment). On the other hand, 20.3% (1936) TB patients who were in care had unfavorable treatment outcomes; 1.8% (34) had treatment failure, 32.7% (634) died, and 65.6% (1,270) were either lost to follow up or their treatment outcome information could not be retrieved.

3.3. TB Services

Coverage for health insurance scheme was 37% for Tanzania, 46.7% Kenya and only 5% for Uganda facilities. TB services were freely provided in all facilities i.e., smear examinations and culture for monitoring patients' responses to treatment, anti-TB drugs, and supplementary drugs (vitamin B6). However, presumptive TB patients paid for costs related to registration, consultation fees, and X-ray in case needed, unless patients were covered by health insurance scheme. Such payment varied between public and private-owned facilities, health facility level, and types of the chest X-ray in use (i.e., whether conventional or digital X-ray). The average cost for X-rays was United States Dollar ($) 4.35. All

the studied facilities conducted TB screening at OPDs and HIV care and treatment units in all three countries. Less than one-third of facilities had integrated TB screening activities in the RCH department including the antenatal unit, postnatal care, delivery, and family planning. Furthermore, 5 of the 7 diabetic clinics were practicing active symptomatic TB screening. Cough of at least two weeks was the main symptom screened among TB presumptive patients.

During interviews, clinicians highlighted the following challenges related to screening and diagnosis of TB: insufficient resources (both financial and human resources) and interrupted supply of reagents and supplies at the laboratories (Table 4).

3.4. Management of facility data

Facility data were handled through both paper-based and electronic records in all health facilities through the health management information system (HMIS).

3.5. TB Diagnostics services

All selected hospitals had at least two TB diagnostic tools including smear microscopy and/or GeneXpert assay and chest X-ray. The GeneXpert assays were maintained and supplied by the government through the National TB programs in Tanzania and Uganda. In Kenya, the servicing was done by an NGO named Centre for Health Solutions. A major concern related to GeneXpert assay across the facilities was a shortage of cartridges supply and a shortage of trained personnel. Other mentioned challenges were heavy workload and faulty machines. Due to a lack of GeneXpert assay in some facilities, patients' samples were being referred to a nearby health hospitals with GeneXpert through a specimen referral system. Clinicians also indicated that there was a delay in returning the results to a respective facility. In addition, shortage of Radiologists and X-ray films were observed as the main challenges facing the X-ray department.

4. Discussion

In the present study, we report treatment outcomes, current TB screening and diagnosis practices as well as challenges related to screening and detection of TB inprogrammatic settings in the three East Africa countries. TB screening was mainly done among patients attending OPDs and HIV clinics, while given less emphasis in other departments such as diabetic and RCH clinics. Intensifying TB screening
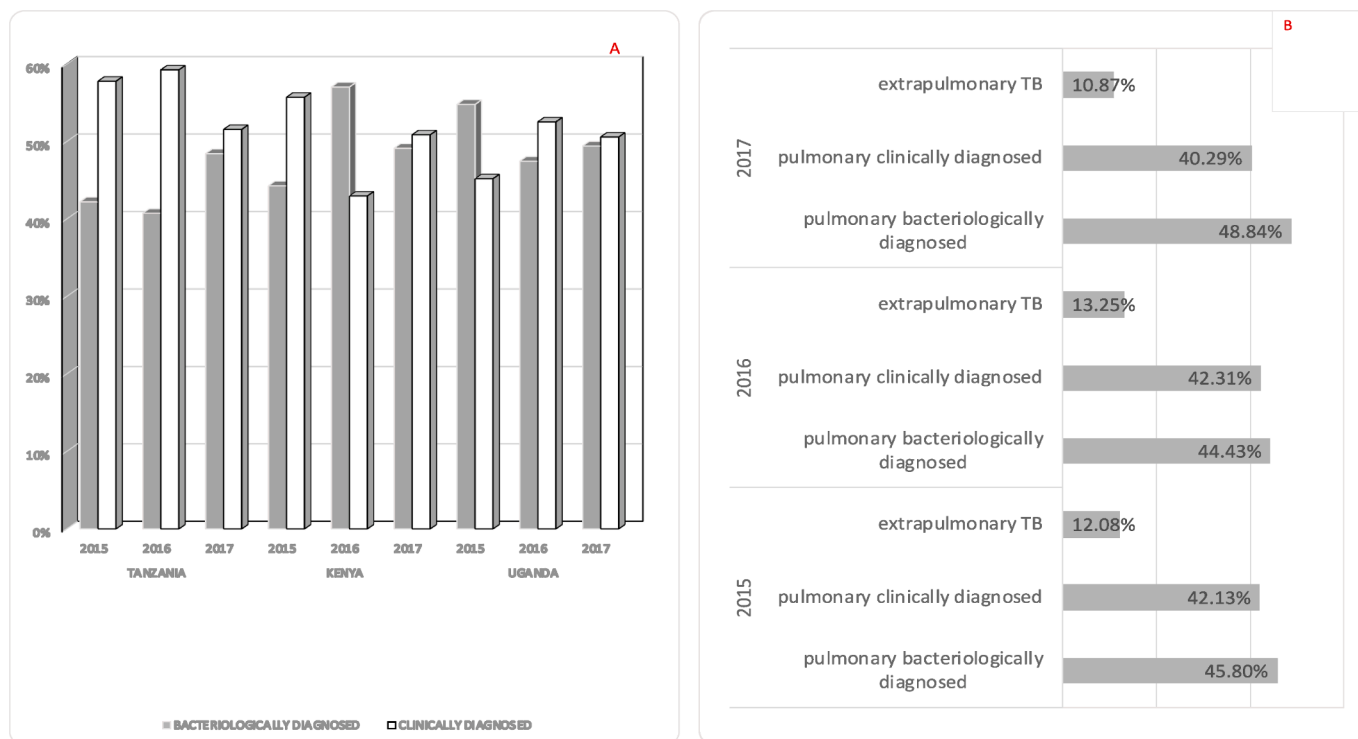
Fig. 3. Distribution of clinically diagnosed TB cases by country (A) and over the three years (B).

Table 2
TB cases notification by country over the three years (2015–2017).

	Bacteriologically diagnosed			Clinically diagnosed			Extra-pulmonary		
	New n (%)	Previously treated n (%)	Total	New n (%)	Previously treated n (%)	Total	New n (%)	Previously treated n (%)	Total
Tanzania									
2015	657(98.1)	13(1.9)	670	717(98.6)	10(1.4)	727	188(98.9)	2(1.1)	190
2016	765(94.4)	45(5.6)	810	876(95)	46(5.0)	922	244(95.3)	12(4.7)	256
2017	969(96.3)	37(3.7)	1006	781(94.9)	42(5.1)	823	244(98.4)	4(1.6)	248
Kenya									
2015	141(93.4)	10(6.6)	151	113(94.2)	7(5.8)	120	68 (97.1)	2(2.9)	70
2016	201(93.5))	14(6.5)	215	92(93.9)	6(6.1)	98	63 (98.4)	1(1.6)	64
2017	213(94.2))	13(5.8)	226	141(93.4)	10(6.6)	151	81(97.6)	2(2.4)	83
Uganda									
2015	353(93.6))	24(6.4)	377	251(98.4)	4(1.6)	255	53 (94.6)	3(5.4)	56
2016	375(93.1)	28(6.9)	403	330(97.1)	10(2.9)	340	103(97.2)	3(2.8)	106
2017	565(95.4)	27(4.6)	592	508(95.7)	23(4.3)	531	73(97.3)	2(2.7)	75
Total	4239(95.5)	211(4.7)	4450	3809(96.0)	158(4.0)	3967	1117(97.3)	31(2.7)	1148

into RCH services, diabetic and other clinics would increase TB case detection and patients receiving care is hereby recommended. Literature suggests that the magnitude of TB among women attending RCH clinics is high [12–14] and people with diabetes are at increased risk of infections and reactivation because their immuno-compromised status [15]. Ending TB and diabetes requires a joint response to ensure that all people with TB and those with diabetes have access to much-needed care on both fronts [16], and the WHO recommends systematic screening for TB in people with diabetes especially in settings with high TB prevalence [17].

Furthermore, TB screening based on self-reported cough of two weeks or more has its setbacks; previous studies have documented a significant proportion of missed TB cases among patients with cough duration of less than 2 weeks [18,19]. In most cases, these patients had coughed for a longer duration, but failed to accurately report it. In addition, pathways for TB patients in East African countries are still complicated and quite long which could be contributing to missed TB cases. A widely available diagnostic tools for TB could reduce delays and onward transmission and improve treatment outcomes.

The observed challenges facing TB screening and diagnosis included insufficient financial and human resources, interrupted supply of laboratory reagents, breakdown and poor maintenance of diagnostic tools as well as diagnostic delays especially for referral specimens. Most of the identified challenges are commonly reported in the region and other resource-limited settings [20–23]. Robust operational agenda on TB, expanding multisectoral collaboration, attracting more funding, and speed scaling up-rapid diagnostics tools, laboratory capacity, and staffing should be prioritized. Prevalence of TB among presumptive TB patients was high; previous studies have reported a varying TB prevalence among different study population e.g., one study in Tanzania using GeneXpert assay reported a TB prevalence rate of 23.7% among presumptive pulmonary TB individuals TB [24], while studies in Ethiopia and Nigeria reported prevalence rates of 10% and 14.7%, respectively [25,26].

Even though GeneXpert has been revolutionizing the diagnosis of TB, in developing countries, only less than half of its notified TB cases are
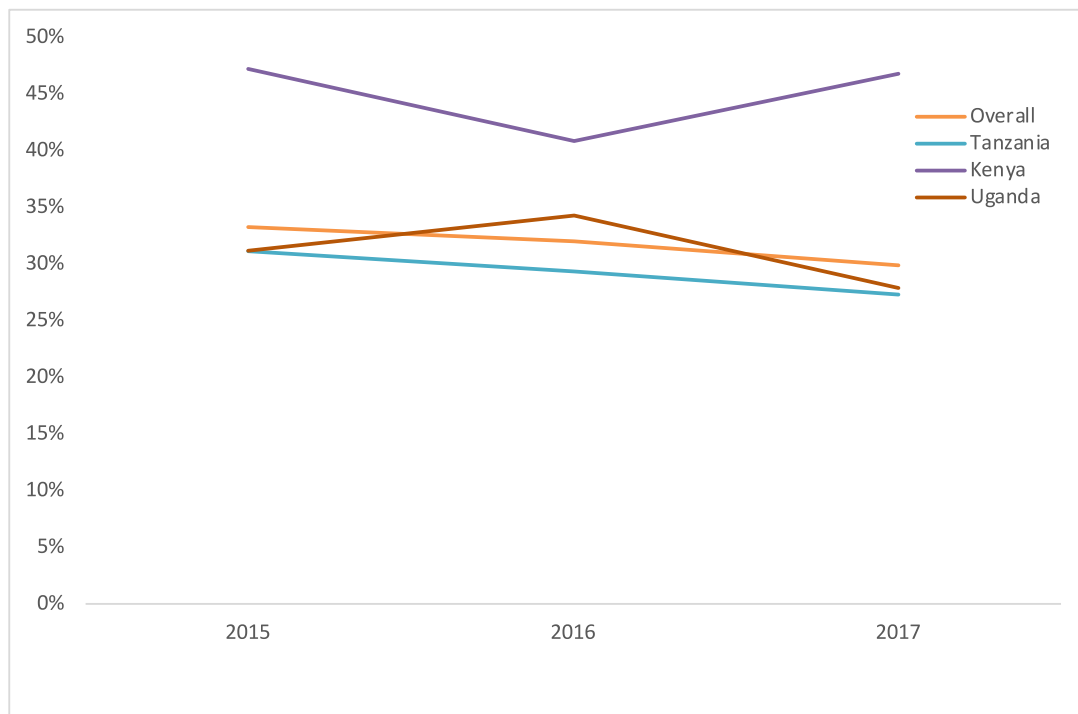
Fig. 4. Trend of the TB/HIV co-infection over the three years (2015–2017).

Table 3
TB case outcomes by country.

	Enrolled	Cured n (%)	Completed n (%)	Failed n (%)	Died n (%)	Loss to follow-up n (%)
Tanzania						
2015	1892	631 (33.4)	1034(54.7)	3(0.2)	102 (5.4)	122(6.5)
2016	1930	562 (29.1)	943(48.9)	5(0.3)	100 (5.2)	320(16.6)
2017	2753	1068 (38.8)	1178(42.8)	6(0.2)	98 (3.6)	403(14.6)
Kenya						
2015	519	205 (39.5)	220(42.4)	3(0.6)	46 (8.9)	45(8.7)
2016	365	165 (45.2)	116(31.8)	2(0.6)	30 (8.2)	52(14.3)
2017	350	147 (42.0)	117(33.4)	1(0.3)	33 (9.4)	52(14.9)
Uganda						
2015	440	131 (29.8)	192(43.6)	3(0.7)	52 (11.8)	62(14.1)
2016	631	188 (29.8)	296(46.9)	1(0.2)	77 (12.2)	69(10.9)
2017	704	145 (20.6)	308(43.8)	10(1.4)	96 (13.6)	145(20.6)
Total	9584	3242 (33.8)	4404 (40.0)	34 (0.4)	634 (6.6)	1270 (13.3)

Table 4
Summary of challenges for TB screening and diagnosis.

TB screening	Diagnosis of TB
• Inadequate staffing	• Frequently breakdown and poor machines maintenance of the diagnostic machines
• Negligence by clinicians to screen TB	• Inadequate diagnostic machines
• Difficulties to screen TB children including sample collection	• Weak laboratory specimen referral system
• Lack protective gear	• Delay of laboratory results and poor record keeping
• High workload	• Inadequate supply shortage
• Screening activities being done mainly at OPD and HIV clinic and less emphasize in other units such as diabatic and maternal clinics	• Lack of biosafety cabinet and respirators
• Poor record keeping	• Lack of functional Air conditioner in the laboratory
• Screening mainly relied on self-reported and cough for a period of two or more weeks	• Inadequate laboratory technicians and radiology experts
	• Poor quality X-rays and high servicing costs
	• Stock outs of upplies (cartilage, triple packaging materials, sputum containers and films)
	• Lack of biosafety cabinet and respirators

bacteriologically confirmed as found by our study compared to 80% reported in the developed world [27]. Tanzania had more clinically diagnosed TB cases while Kenya and Uganda reported equal proportions. Clinical diagnosis is made based on suggestive symptoms and radiographic features of TB. This method has limited sensitivity, specificity, and requires specialist expertise for reading and interpretation of the X-ray results. Understanding and addressing key drivers for clinically diagnosed TB in this era of molecular diagnostics remain of both clinical and programmatic relevance, especially in TB/HIV endemic settings.

Generally, case notification increased in all three countries from 2015 to 2017, corroborates with the previous reports in most African countries [2]. Kenya had the highest number of TB cases notified for all three years followed by Tanzania. A decline in the HIV/TB co-infection rates in all three countries was noted, and the findings are in lined with the recent reported trends in most sub-Saharan countries [28]. This can be explained by emphasis on TB/HIV integrated services and scaling-up the use of antiretrovirals and Isoniazid Preventive Therapy among people living with HIV globally, which in turn contributes to the decline of both TB incidences and HIV prevalence [2].

Previously treated cases (relapse, default, or treatment failure cases) were exceptionally lower (less than 5%), compared to 18.4% reported in

India [29]. The treatment success rate was 79% which is still lower compared to the 85% target set by the World Health Assembly [2]. Poor documentation as observed in could be contributing to this large number of unsuccessful treatment outcomes. A high loss to follow-up rate was observed in all three countries with an overall rate of 13.3%. Strengthening follow-up interventions to ensure all diagnosed TB patients are timely linked to care and complete treatment remain of paramount importance.

In the present study, high patient load, weak laboratory specimen referral system, shortage of trained personnel, and frequent interruption of laboratory supplies such as GeneXpert cartridges were the major cited challenges in the screening and diagnosis of TB. These challenges have been cited to compromise TB diagnosis in Africa [30,31]. Although TB diagnosis using acid-fast bacilli (AFB) and GeneXpert as well the treatment was free, patients still had to incur direct costs for registration, X-ray, and travels during treatment. These findings are in line with previous observation in Uganda that also highlighted costs as a barrier towards successful TB management [8,30].

This study has some limitations. The retrospective design and paper-based records incompleteness and missing data that may affects the generalizability of our findings. However, large sample size and coverage in three East Africa countries, triangulation of data using different data sources supplemented with structured interviews helped to mitigate/minimize the limitations related to the design.

5. Conclusion

Although the burden of TB remain high in East Africa countries, integration of TB screening and diagnosis is mainly limited at general OPD and HIV clinics. Yet this integration was hampered by frequent interruption of laboratory supplies and considerably high patient load. A sustained progress towards ending the epidemic would requires a sustainable TB diagnostic capacity, improved screening and detection mechanisms and expansion of the integration to other service outlets such as diabetic, maternal and child health clinics.

6. Declarations

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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