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Original Article

The Effect of Lateral Flow Urine Lipoarabinomannan Assay Online Blended Training on the Utilisation of Point-Of-Care Tuberculosis Testing in Kajiado, Kiambu, and Machakos Counties, Kenya

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Keywords:

HIV,
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Test,
Point-of-Care,
Primary
Healthcare
Workers,
Tuberculosis.

The Background: Tuberculosis (TB) remains one of the leading causes of mortality globally, with Africa accounting for nearly half of global TB-related deaths. Despite being both preventable and treatable, TB continues to disproportionately affect people living with HIV. Objective: The study aimed to assess the effect of the lateral flow urine lipoarabinomannan assay (LF-LAM) online blended Continuing Professional Development (CPD) on the utilisation of LF-LAM point-of-care TB testing. Methodology: This quasi-experimental study included a sample of Primary Healthcare Workers (PHCWs) who completed CPD training in Kajiado, Kiambu, and Machakos counties between March 10, 2025, and August 30, 2025. The analysis involved pre-and post-intervention comparative analysis. Results: A total of 333 PHCWs responded to the survey, with notably high representation of females (51%) and laboratory officers (59%). Overall mean scores for LF-LAM test knowledge and skills were statistically significant in three domains: Active Case Findings ($p = 0.045$), Biosafety in LF-LAM testing ($p = 0.023$), and data Reporting ($p = 0.012$). Test coverage among presumptive TB patients improved significantly, with 20.5% tested at pre-intervention compared to the LF-LAM positivity rate, which declined from 64.9% to 37.7% (rate ratio = 0.58, 95% CI 0.50–0.68, $p < 0.001$). The number of positives detected per 1,000 PLHIV screened increased from 4.34 to 6.40. Conclusion: The findings revealed favourable change regarding the CPD training program, demonstrating a positive impact on enhancing LF-LAM testing knowledge and competencies among health workers in primary healthcare settings. The observed improvements in TB indicators, including increased active case finding and greater uptake of point-of-care TB testing among people living with HIV (PLHIV), highlight the program's potential to strengthen TB-HIV co-management at the primary care level. To sustain and scale these outcomes, continued mentorship, assurance of commodity security, and integration of LF-LAM testing within broader TB-HIV service delivery pathways are essential.

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INTRODUCTION

Tuberculosis (TB) is the ninth leading cause of death worldwide, and it remains one of the leading causes of death from a single infectious agent, ranking above HIV. According to the World Health Organization (WHO), in the year 2020, 10 million people fell ill globally, with 1.5 million dying, despite it being preventable and treatable, and 46% of the global deaths were in Africa (World Health Organization [WHO], 2021).

Tuberculosis (TB) primarily affects individuals with weakened immune systems, making TB and HIV co-infection particularly common. This dual burden is especially prevalent in countries across Sub-Saharan Africa, which are significantly impacted by the twin epidemics (Okeke et al., 2024). Thus, TB remains one of the leading causes of death in people living with HIV/AIDS (PLHIV) globally (Onyango et al., 2017). According to Temesgen and Ayal (2023), a person infected with HIV is twenty times more at risk of contracting TB and three times more likely to die even when on TB treatment. In 2021, TB caused 1.3 million deaths, and 0.17 million deaths were among PLHIV (WHO, 2025). However, Sub-Saharan Africa continues to bear the highest TB/

HIV burden. By the end of 2021, it was estimated that 38.4 million (33.9-43.8 million) people were living with HIV, and two-thirds (25.6 million) were in Africa (WHO, 2021).

Kenya is listed by the World Health Organization among the 30 high-burden TB states, with a recent prevalence of 426 cases per 100,000 population, as per the National TB Prevalence Survey Report 2016. In the year 2021, Kenya was also listed among the 30 high multi-drug resistant (MDR)/rifampicin-resistant (RR) burden countries. WHO estimates that 1.3% of new TB cases and 4.4% of previously treated TB cases have MDR/RR tuberculosis (Mutabari, Orowe, Karanja & Kipruto, 2022). The number of drug-resistant (DR) TB cases has increased significantly over the years. Rifampicin-resistant TB contributes to approximately 48% of all MDR TB cases (Ministry of Health, Kenya [MOH], 2020).

The MOH Kenya envisions a world that is free of TB with Zero TB deaths, zero TB disease, and Zero TB suffering; by the year 2030, the Ministry of Health targets to reduce TB-related deaths by 90% and TB incidence rates by 80% (MOH, 2024). These targets are to be achieved through interventions that have been encapsulated in three

pillars: patient-centred TB care and prevention, bold policies and supportive systems, and intensified research and innovation. It has been noted that due to immunosuppression, there are significant cases of HIV/TB coinfection.

In 2015, the World Health Organization (WHO) recommended the use of the LF-LAM assay, specifically **Determine™ TB LAM Ag**, for TB diagnosis in HIV-positive adults and children. In Kenya, LF-LAM has been endorsed as part of the national TB guideline for HIV-positive adults who are either inpatients or outpatients presenting with TB symptoms and with CD4 counts ≤ 100 cells/mm³, or who are seriously ill regardless of their CD4 count. It is also recommended for children living with HIV who present with TB symptoms (pulmonary or extrapulmonary) based on the above criteria (Mangu et al., 2024). LF-LAM is a commercially available, useful screening test for TB, particularly in patients with lower CD4 counts. The test detects mycobacterial lipoarabinomannan (LAM) antigen in urine, which is known to be elevated in individuals with HIV/TB co-infection and increases as CD4 counts decrease. The ability to detect mycobacterial antigens in urine allows healthcare workers to conduct TB tests without the need for the infrastructure required for sputum sample collection, making LF-LAM an ideal, infrastructure-independent diagnostic tool for low-resource settings (Global Laboratory Initiative [GLI], 2017). In addition to the ever-dynamic WHO and national LF-LAM guidelines, anecdotal evidence revealed that there is variation in the conduct of the LF-LAM test and in interpreting the results prior to making decisions on the management of various clinical case scenarios. Although there are discrepancies in access to LF-LAM commodities across the Primary Healthcare facilities spectrum, it is paramount to have LF-LAM competencies standardized among various points of care.

Most gold standards for laboratory confirmation of Tuberculosis, including GeneXpert and Smear microscopy, rely on sputum samples, which are difficult to obtain in immunocompromised patients (Alsdurf, Empringham, Miller &

Zwerling, 2021). The LF-LAM assay is the only WHO-recommended TB biomarker that can be detected in urine, an easy-to-collect sample in HIV-positive patients (Stead et al., 2025). Furthermore, point-of-care TB testing enables healthcare workers to make rule-in decisions and initiate early treatment for the patients through early case identification and reduction in loss-to-follow-up from the point of diagnosis to the initiation of treatment (Bulterys et al., 2019). Therefore, a large-scale rollout of LF-LAM, which can detect TB in PLHIV with improved sensitivity, provides a simple and infrastructure-independent approach ideal for low-resource settings. Despite its advantages, LF-LAM remains underutilized due to poor guideline dissemination, limited engagement of frontline healthcare workers, and negative perceptions of TB interventions among healthcare providers. Therefore, our study aimed to assess the effect of online blended Continuing Professional Development (CPD) training on the point-of-care LF-LAM TB test to inform the sustainability and scale-up of the LF-LAM test in resource-limited primary healthcare settings in Kenya.

Continuing Professional Development (CPD) on LF-LAM Testing Program

The CPD program for the Primary Health Care (PHC) Workers on LF-LAM is underpinned by the conviction that quality care and not just quantity is important. Quality care at various points of care, especially in PHC settings, is bound to transform the health of the general population, especially among PLHIV, and consequently impact the livelihoods of a crucial segment of our country's vulnerable population. The Quality of care among PLHIV can be improved and sustained through lifelong learning and continuous professional development of Primary Health Care Workers (PHCWs), focusing on emerging innovations and technologies such as LF-LAM, among other evidence-based global and local solutions. The CPD programme is also anchored on the belief that innovative training approaches are required to ensure PHCWs are up-scaled and updated without interrupting service provision.

The CPD training was delivered via an Online Blended Learning (OBL) format. Phase one focuses on learners' access to learning material through the Amref International University (AMIU) Learning Management System (LMS). The flexible course took 1–2 weeks for participants studying two hours daily or 2–3 days for those with more time. It was accredited by regulatory bodies, including the Kenya Medical Practitioners and Dentists Council (KMPDC), Nursing Council of Kenya (NCK), Clinical Officers Council (COC), and Kenya Medical Laboratory Technicians and Technologists Board (KMLTTB). CPD points were a key motivator, resulting in a 77% course completion rate. Upon completion, participants uploaded certificates to their respective regulatory authority portals for validation. The digitisation ensured that the LF-LAM training could be delivered flexibly and cost-effectively to large numbers of healthcare workers, with built-in monitoring of participation, progress, and completion rates through the LMS dashboard. Phase two involved Facility-based practical demonstrations. Training kits were purchased by AMIU and Abbott Diagnostics and supplied to facilities lacking Kenya Medical

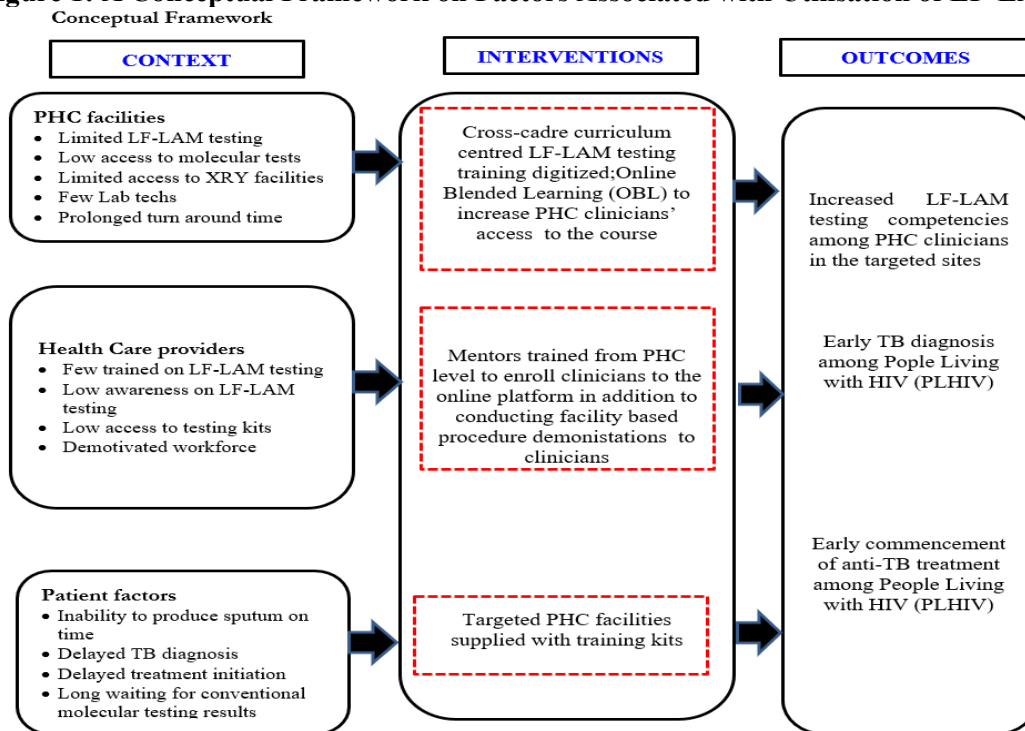
Supplies Authority (KEMSA)-supplied LF-LAM testing kits, enabling mentors to demonstrate the use of LF-LAM kits.

Course Mentors, consisting of health managers, played a crucial role in programme implementation. They were assigned non-teaching roles in the LMS, enabling bulk registration of PHC providers and facilitating course enrollment. Mentors' support ranged from addressing technical issues to conducting LF-LAM testing demonstrations at the facility level.

Conceptual Framework

The study focused on three outcome variables, including: increased LF-LAM testing competencies among Primary Healthcare (PHC) clinicians; Early TB diagnosis among People Living with HIV (PLHIV); and early commencement of anti-TB treatment. Each of these outcome variables was linked to unique interventions that addressed key objectives of the Online Blended CPD training programme. See Figure 1, a visual presentation of the conceptual framework of the study.

Figure 1: A Conceptual Framework on Factors Associated with Utilisation of LF-LAM Services



Source: TBOL project team (2025) |

MATERIAL AND METHODS

Study Design

The study used a quasi-experimental design. The effectiveness of the training programme was assessed using a pre- and post-intervention design. The design was chosen to determine the causal effect of continuous professional development training on LF-LAM service utilisation, accounting for both contextual and external factors. Pre- and post-intervention data among healthcare providers were compared to assess the intervention's impact, with statistical adjustments to address confounders and biases. The study was conducted in three pilot Counties: Kajiado, Kiambu, and Machakos. The selection of the Counties was based on two criteria: (1) the study areas were chosen purposively guided by the fact that they form the implementation sites for the Online Blended Training programme; (2) due to high rates of TB/HIV co-infection, which is attributed to the elevated HIV prevalence contributing to increased TB burden. Data was collected using e-survey shared with the participants using Kobotoolbox link and a secondary data checklist which had been developed based on Integrated Guidelines for Tuberculosis, Leprosy and Lung Disease of 2021 (MOH, 2021). A questionnaire targeting healthcare providers, including nurses, laboratory officers, clinical officers, and midwives, was used to assess the uptake and quality of the online blended training approach, gather feedback on the LF-LAM guidelines and kits, assess turnaround time, and evaluate supply chain management. The study recruited from a pool of primary healthcare workers who undertook the CPD course and obtained a certificate of completion. The sampling frame for primary healthcare providers included clinicians, nurses, doctors, laboratory officers, laboratory technicians, and midwives. The study did not review patient medical records but used a checklist to gather county health-level secondary data through the Kenya Health Information System (KHIS) and TIBU reporting system. Datasets from each county were merged after performing data cleaning and coding to create a master dataset for analysis. The system-level data

helped assess LF-LAM test performance, including LF-LAM positivity, positives per 1,000 screened, number needed to screen, and number needed to test. Measuring these indicators helped determine the effectiveness of the Point-of-Care LAM Test, identification of TB presumptive cases, and patient outcomes. The study focused on three outcome variables, including: increased LF-LAM testing competencies among Primary Healthcare (PHC) clinicians; Early TB diagnosis among People Living with HIV (PLHIV); and early commencement of anti-TB treatment.

Sample Size and Sampling Procedure

No formal sampling procedure was used; instead, PHCWs were invited to participate until data stability was reached. To obtain the list of PHCWs, data was sourced from Amref International (AMIU) Learning Management System (LMS), which captures all learners' profiles, including name, professional cadre, Link health facility, and County. To ensure representation, AMIU generated a list of all PHCWs who had completed the LF-LAM course, using data from the Learning Management System, organised by county. This list was shared with mentors, who contacted participants via email to invite them to take the e-survey. Once enough data was generated, the survey tool was archived to prevent further submissions and officially close data collection.

Statistical Analysis

Data were analysed via the statistical package for social sciences (SPSS) 23 using chi-square (χ^2) tests for categorical variables and paired t-tests. The study population was characterised using study Counties, Gender, professional cadre, and type of primary healthcare facility. The χ^2 test of association between categorical variables, frequencies, and percentages between the groups was used at a level of significance of $p < 0.05$, at 95% CI. The Secondary analyses were performed using health facility indicators, and all continuous variables were presented as absolute numbers, means, and standard deviations. Paired t-test was used to compare the mean scores of knowledge and skills acquisition on Point-of-Care LF-LAM

testing pre-and post-intervention, at a level of significance of $p < 0.05$, with 95% CI.

Ethical Consideration

The Research Ethics Committee of Amref Health Africa approved the study protocol (Number: AMREF-ESRC P1901/2025). Permission to conduct this study was sought from the Department of Health in Kajiado, Kiambu, and Machakos Counties. All counties responded positively, highlighting their full support for the research process. Also, the participant consent statement was embedded in the e-survey link, ensuring protection of participants' rights and welfare through their participation in the study.

MATERIAL AND METHODS

Primary Healthcare Workers Profile

Out of 2,222 primary healthcare providers who enrolled and completed the CPD training on LF-LAM testing, a total of 333 responded to the survey, of which 91 (27%) completed the LF-LAM course from Kiambu, 74 (22%) from Kajiado, and 168 (51%) from Machakos County. In terms of gender, 51% were females, while laboratory Officers contributed the majority, at 59%, followed by clinical officers at 29%, laboratory technicians at 6.6%, Nurses at 5% Medical doctors at 0.9% and midwives at 0.3%.

The majority of the primary health providers were working at a sub-county hospital (level 4 facility), 41%, followed by Health Centres (Level 3 facility), 34%, County Teaching and referral Hospital (Level 5 facility), while the least number of participants were drawn from Dispensaries (Level 2 facility) at 11% (Table 1).

Table 1: Study Participants' Socio-Demographic Information

Variable	Total Frequency, (%) No. (N=333)	Counties			
		Kiambu Frequency, (%) No. (N=91)	Kajiado Frequency, (%) No. (N=74)	Machakos Frequency, (%) No. (N=168)	
Gender					
Male	164 (49%)	39 (43%)	46 (62%)	79 (47%)	
Female	169 (51%)	52 (57%)	28 (38%)	89 (53%)	
Professional Cadre					
Nurse	17 (5.1%)	10 (11%)	3 (4.1%)	4 (2.4%)	
Midwife	1 (0.3%)	1 (1.1%)	0 (0%)	0 (0%)	
Clinical Officer	95 (29%)	33 (36%)	26 (35%)	36 (21%)	
Medical Officer	3 (0.9%)	1 (1.1%)	2 (2.7%)	0 (0%)	
Laboratory Officer	195 (59%)	42 (46%)	37 (50%)	116 (69%)	
Laboratory Technician	22 (6.6%)	4 (4.4%)	6 (8.1%)	12 (7.1%)	
Type of Link Facility					
Dispensary	38 (11%)	10 (11%)	7 (9.5%)	21 (13%)	
Health Centre	112 (34%)	27 (30%)	32 (43%)	53 (32%)	
Sub-County Hospital	136 (41%)	33 (36%)	32 (43%)	71 (42%)	
County Referral	47 (14%)	21 (23%)	3 (4.1%)	23 (14%)	

The Scope of Skills and Knowledge Acquisition on Point-of-Care LF-LAM Testing

Table 2 presents the mean scores for LF-LAM testing knowledge and skills across various competency domains, assessed before and after

the LF-LAM training course (Table 8.2). For Active Case Finding for TB among PLHIV, mean scores were 3.532 (SD = 1.22) pre-intervention and 3.529 (SD = 0.61) post-intervention, yielding a statistically significant difference ($p = 0.045$). Significant improvements were also observed in

Biosafety in LF-LAM testing (pre-intervention: 3.486; post-intervention: 3.492; $p = 0.023$) and in Reporting of LF-LAM test results (3.628 vs. 3.638; $p = 0.012$).

In comparison, no statistically significant differences were found in Conducting LF-LAM

($p = 0.234$), Interpretation of LF-LAM test results ($p = 0.789$), Knowledge of criteria for conducting LF-LAM ($p = 0.156$), Quality assurance in LF-LAM testing ($p = 0.345$), or Commodity management in LF-LAM testing ($p = 0.456$).

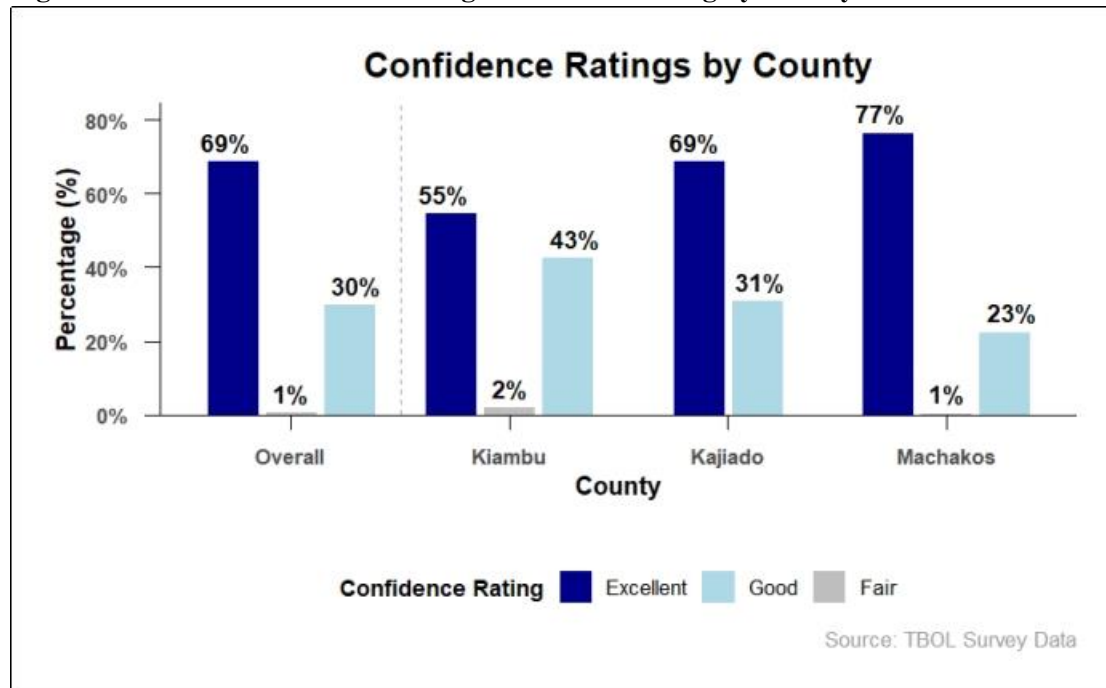
Table 2: Pre-and Post-Intervention LF-LAM Testing Knowledge and Skills Score

LF-LAM Testing Knowledge and Skills Variables	Mean Score (SD)		P-value
	Pre-Intervention	Post-Intervention	
Active Case Finding for TB among PLHIV	3.532 (1.22)	3.529 (0.61)	0.045*
Conducting LF-LAM	3.441 (1.35)	3.447 (0.53)	0.234
Interpretation of LF-LAM Test Results	3.622 (1.32)	3.623 (0.52)	0.789
Knowledge on Criteria for Conducting LF-LAM	3.498 (1.36)	3.502 (0.55)	0.156
Biosafety in LF-LAM testing	3.486 (1.36)	3.492 (0.57)	0.023*
Quality assurance in LF-LAM Testing	3.315 (1.37)	3.322 (0.66)	0.345
Commodity management in LF-LAM Testing	3.372 (1.37)	3.374 (0.63)	0.456
Reporting LF-LAM Test Result	3.628 (1.38)	3.638 (0.52)	0.012*
<i>Notes:</i> Standard deviations shown in parentheses Paired t-test * $p < 0.05$, statistically significant Statistical significance determined using $\alpha = 0.05$			

Confidence Level of Primary Healthcare Providers in Providing LF-LAM Testing

Primary healthcare providers' confidence in providing LF-LAM testing was rated as excellent by 69%, indicating that the course was essential in improving participants' skills and knowledge in LF-LAM testing. In Kiambu County, 54.9% of providers reported excellent confidence, while 42.9% reported good confidence. In Kajiado County, 68.9% of healthcare providers rated their

confidence as excellent, while 31.1% rated it as good. In Machakos County, the majority of healthcare providers reported excellent confidence (76.8%), 22.6% reported good confidence, and 0.6% reported fair confidence. These findings demonstrate that the LF-LAM course enhanced providers' knowledge and skills across various domains of TB testing among PLHIV (**Figure 2**).

Figure 2: PHCWs' LF-LAM Testing Confidence Rating by County

Efficacy of LF-LAM Point-of-Care Testing (POCT) in the Diagnosis of TB Among People Living with HIV

The number of PLHIV screened increased from 24,666 in pre-intervention to 32,680 in post-intervention, representing a 33% increase. Presumptive TB cases also increased substantially (from 806 to 1,289; +60%), corresponding to a change in presumptive rate from 3.27% to 3.95% of all PLHIV screened ($p < 0.001$) (Table 3).

Testing coverage among presumptive TB patients improved significantly, with 20.5% tested at pre-intervention compared to 43.1% post-intervention ($p < 0.001$). LF-LAM positives increased nearly two-fold (107 to 209; +95%). However, the LF-LAM positivity rate declined from 64.9% to 37.7% (rate ratio = 0.58, 95% CI 0.50–0.68, $p < 0.001$), reflecting an increase in Active Case Finding and increased uptake of Point-of-Care LF-LAM testing among PLHIV cases. The number of positives detected per 1,000 PLHIV screened increased from 4.34 to 6.40, and the number needed to screen (NNscreen) decreased from 231/1,000 to 156/1,000, indicating improved efficiency at the screening level. In addition, the number needed to test

(NNtest) to yield one positive increased from 1.54 to 2.66, reflecting reduced yield per test as eligibility criteria widened.

At the county levels, Kiambu County reported the largest increase in the number of PLHIV screened at the Point-of-Care by 53% (from 8,209 to 12,517), while presumptive cases increased by 33% (from 610 to 813). Testing coverage among presumptive improved significantly from 12.8% to 46.6% ($p < 0.001$). LF-LAM positives more than doubled (from 58 to 127), and the positivity rate dropped significantly from 74.4% to 33.5% (Rate Ratio = 0.45, 95% CI 0.37–0.55, $p < 0.001$). Positives per 1,000 screened increased (7.06/1,000 to 10.15/1,000), and NNscreen improved from 142 to 99 while NNtest increased from 1.32 to 2.98 cases.

Kajiado County presented a relatively slight increase in screening (from 15,997 to 19,663; +23%) but a significant increase in presumptive (from 89 to 276; +210%), with the presumptive rate increasing from 0.56% to 1.40%. Testing among presumptive declined slightly from 70.8% to 52.9%, though this difference was not statistically significant. LF-LAM positivity remained relatively stable at 39.7% in pre-intervention to 35.6% in post-intervention; Rate

Ratio = 0.90, 95% CI 0.62–1.31, $p = 0.58$). Case yield per 1,000 screened improved from 1.56/1,000 to 2.65/1,000, with NNscreen decreasing from 640 to 378. Change in NNtest was relatively small, from 2.51 to 2.81 cases.

In Machakos County, the increase in screening was marginal (460 to 500; +9%) and a sharp increase in presumptive cases (107 to 200; +87%). However, the proportion of presumptive tested declined (from 22.4% to 15.0%). All individuals tested were LF-LAM positive in both periods (24/24 and 30/30), yielding a positivity rate of 100%, reflecting the effective application of TB guidelines at the Point-of-Care to identify PLHIV cases that met the criteria and LF-LAM Testing eligibility.

Table 3: Effect of CPD LF-LAM Training on the Point-of-Care Testing

Variable	Overall				Counties											
					Kiambu				Kajiado				Machakos			
	Pre	Post	% Difference	p-Value	Pre	Post	% Difference	p-Value	Pre	Post	% Difference	p-Value	Pre	Post	% Difference	p-Value
PLHIV screened for TB	24,666	32,680	+33%		8,209	12,517	+53%		15,997	19,663	+23%		460	500	+9%	
Presumptive TB identified	806	1,289	+60%)		610	813	+33%		89	276	210%		107	200	+87%	
Presumptive rate (% of screened)	3.27%	3.95%		< 0.001	7.4%	6.5%		0.08	0.56%	1.40%		0.012	23.3%	40.0%		< 0.01
Tested using LF-LAM (% of presumptive)	20.5%	43.1%		< 0.001	12.8%	46.6%		< 0.001	70.8%	52.9%		0.07	22.4%	15.0%		0.21
LF-LAM positives	107	209	+95%		58	127	+119%		25	52	+108%		24	30	+25%	
LF-LAM positivity (% of tested)	64.9%	37.7%		< 0.001	74.4%	33.5%		< 0.001	39.7%	35.6%		0.58	100%	100%		-
Positives per 1,000 screened	4.34	6.40			7.06	10.15			1.56	2.65			52.2	60.0		
Number needed to screen (NNscreen)	231	156			142	99			640	378			19	17		
Number needed to test (NNtest)	1.54	2.66			1.34	2.98			2.52	2.81			1.00	1.00		

Chi-square tests; Statistical test significance; p<0.05

Figure 3: Number of Health Facilities Conducting the LF-LAM Test

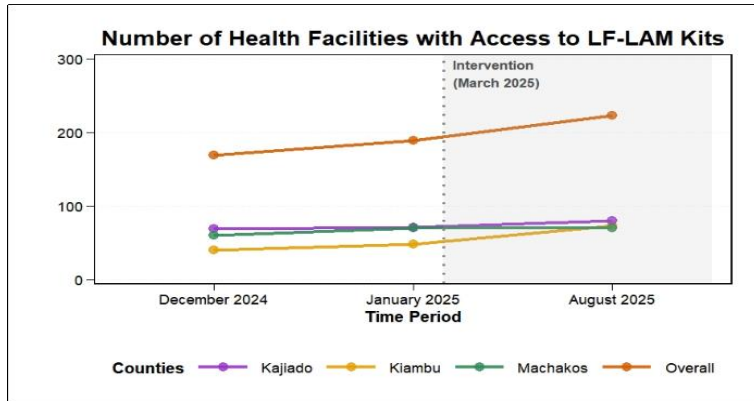


Figure 4: Number of PLHIV Screened for TB

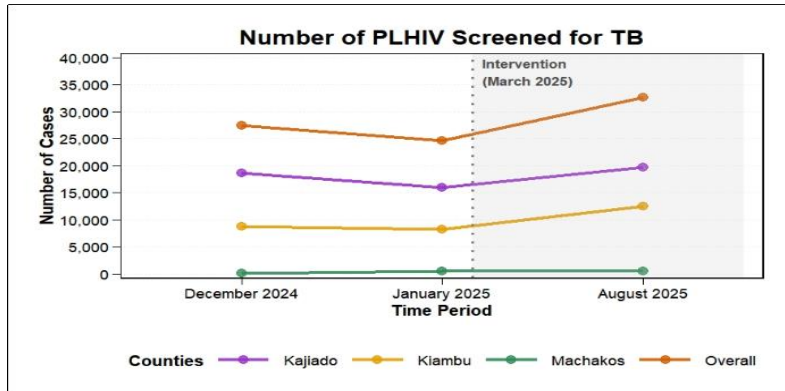


Figure 5: Number of Presumptive TB Cases Identified

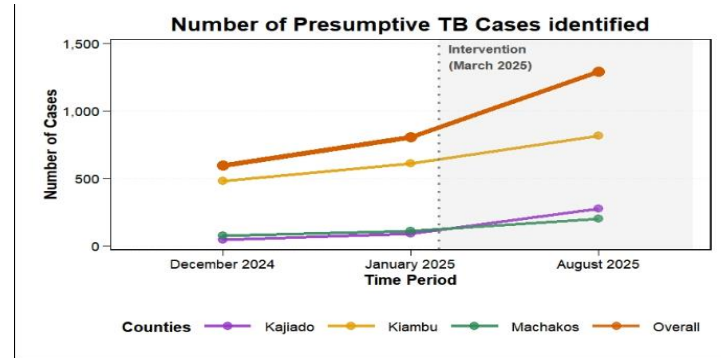
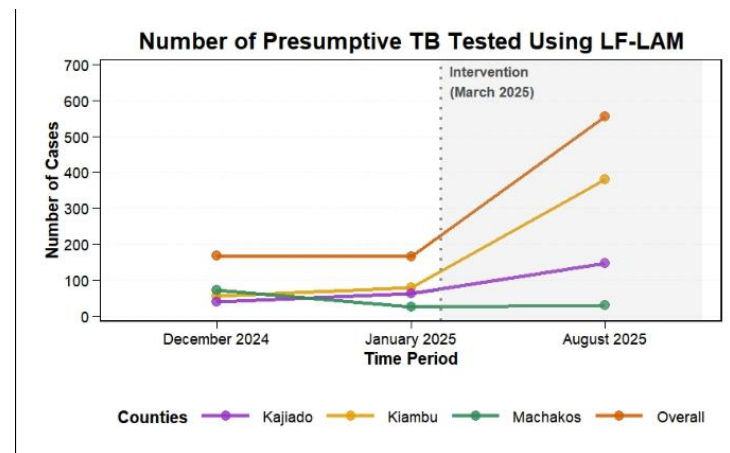


Figure 6: Number of Presumptive TB tested Using LF-LAM



DISCUSSION

The pilot program aims to provide evidence of the effect of the LF-LAM online blended CPD training on the uptake of point-of-care testing to strengthen effective Tuberculosis diagnosis and treatment initiation among PLHIV. The intervention aimed to contribute to the reduction of the current HIV Positive TB incidence through capacity building of PHCWs on how to use innovative approaches, such as LF-LAM, to detect TB early in Urine among PLHIV. Furthermore, this study contributes to existing literature on PHCWs' CPD training to enhance competencies and foster an enabling culture that promotes access to quality health service delivery targeting vulnerable populations (Gaus, Conway & Herrera, 2024) (Alsaqer et al., 2025).

The study provides robust evidence on the positive impact of CPD on PHCWs' knowledge and skills and point-of-care TB tests across primary healthcare facilities in Kajiado, Kiambu, and Machakos Counties. The findings demonstrated statistically significant changes in knowledge and skill sets following the CPD training, particularly in active case finding (ACF), adherence to biosafety standards in LF-LAM testing, and data reporting and use for decision-making. However, in certain LF-LAM knowledge areas, including LF-LAM testing, Interpretation of test results, Quality assurance, and Commodity management, were found to be not statistically significant. These findings were possible since the assessment of knowledge and skill level before the program was retrospective, which might have reduced measurable differences. The findings mirror the body of literature on effective human resource for health (HRH) capacity building. The studies show that scaling up training using the right approach contributes to improved knowledge and skills suitable for new responsibilities or changing roles (Amare et al., 2023; Baloyi & Jarvis, 2020), enabling the provision of patient-centred healthcare services.

Furthermore, the study reported that PHCWs exhibited an excellent level of confidence in performing LF-LAM point-of-care testing. The

program effectively utilised emerging platforms to increase access to course materials, particularly for nurses, clinical officers, and midwives, while also facilitating hospital-based practical learning for hands-on experience in an environment that enabled PHCWs to learn through observation and practice, an opportunity that would not have been possible through online sessions alone. This finding aligns with previous research that found that professional training enhances confidence, clinical performance, and the application of evidence-based practice (Hay, Wilson, Ong, Benson, & Gallego, 2023). For instance, Mwansisya et al. (2022) demonstrated that onsite-mentorship is associated with significant performance improvement, with its result being immediate, especially when it is complementary to a well-designed training in consideration of the context (Mwansisya et al., 2022). The diversity of training approach, and strengthening onsite-mentorship programmes are critical in facilitating the acquisition of a wide range of skills and abilities that health workers are able to apply in day-to-day health service delivery.

Post-intervention findings revealed significant improvement in the delivery and uptake of LF-LAM point-of-care Testing services. Overall, the number of PLHIV screened for TB increased by 33%, while the number of presumptive TB cases rose by 60%, corresponding to an increase in the presumptive rate from 3.27% to 3.95% of all PLHIV screened ($p < 0.001$). Testing coverage among presumptive TB patients also improved from 20.5% at pre-intervention to 43.1% at post-intervention ($p < 0.001$). These outcomes reflect the direct influence of cross-cadre curriculum-centred CPD training, the availability of LF-LAM test kits, and the successful implementation of point-of-care testing. CPD training ensures the PLHIV has access to up-to-date, skilled, relevant PLHCWs. Improved kit availability ensures timely diagnosis and treatment initiation among PLHIV presenting with TB symptoms, thereby reducing diagnostic delays. Therefore, this finding suggests that online training complemented with onsite training under mentorship enables hands-on clinical experience,

which enables PHCWs to effectively implement Point-of-care services, including the identification of eligible patients, the collection of urine samples, performing the test using LF-LAM strips, and initiating all positive cases on TB treatment. The importance of hands-on clinical experience under mentorship is well documented, as it reduces anxiety, enhances confidence, and strengthens accountability in clinical decision-making (Carpio, Covarrubias, Nolledo & Samson, 2025) (Chana, Topping, Willis, Melody, & Pearce, 2024). In this context, CPD serves as an enabler for developing and maintaining clinical competencies that are critical for expanding LF-LAM testing beyond traditional laboratory cadres to include nurses, midwives, clinical officers, and medical doctors. Specifically, the training program helped PHCWs apply LF-LAM test knowledge. The findings also demonstrate that the CPD training not only improved PHCWs' knowledge, skills, and confidence but also strengthened TB management among PLHIV. This program aligns with Kenya's Ministry of Health workforce policy, which advocates adoption of the Training Needs Assessment (TNA) model to bridge performance gaps between current practice and expected standards culture (Muchangi et al., 2025). Under this framework, the program targeted clinical professionals, including nurses, clinical officers, laboratory staff, midwives, and medical doctors, and relevant health practitioners for implementing LF-LAM testing within resource-limited primary healthcare settings. Studies in Sub-Saharan Africa have demonstrated how CPD training is critical in resource-limited settings, especially in tackling the shortage of skilled healthcare workers (Murphy et al. 2014). This reflects the importance of designing a deployment and training policy that is responsive to the healthcare landscape, which is strongly influenced by the rapid evolution in technology and information. Lassi et al (2016) present a case of the impact of evidence-based human resources for health interventions, which leverages training, contextualised Human Resource for Health (HRH) policy, and adequate funding as a hallmark in strengthening health systems (Lassi et al., 2016). This indicates the

significance of this study; for instance, prior to the training, significant knowledge and skill gaps were noted. Many PHCWs, including nurses and clinical officers, were not fully conversant with LF-LAM eligibility criteria, and in some cases, testing was conducted on non-HIV-positive patients. The study findings demonstrate that the CPD training programme significantly improved the utilisation and quality of LF-LAM test services, especially in resource-limited settings, contributing to strengthened TB case detection and management among PLHIV in Kenya.

STUDY LIMITATIONS AND STRENGTHS

While our study provides valuable insights into the effect of lateral flow urine lipoarabinomannan assay training on the utilisation of point-of-care tuberculosis testing, several limitations must be considered. The study relied heavily on hospital-generated secondary data records and self-reported data, which may be incomplete or inaccurate. These data quality issues can affect the reliability of our findings and may introduce bias into the analysis. The effectiveness of the online blended training may vary depending on how consistently and thoroughly it was implemented. The study was based on the assumption that the intervention regions.

Implemented the two phases of the training, online learning and hands-on training with LF-LAM demonstration. However, because LF-LAM kits were limited, this could have affected the implementation of LF-LAM point-of-care services in some regions, leading to variation in their effectiveness and potentially obscuring the true impact of the intervention on the utilisation of LF-LAM Testing services. On the other hand, the study offers significant strengths, especially the large sample size comprising a cross-cadre of primary healthcare workers, which depicts its importance in applicability targeting relevant health practitioners. The design of the CPD curriculum course covered essential areas in TB management in People living with HIV, including Active case finding, LF-LAM testing and quality control, Biosafety, and Infection Prevention and Control in LF-LAM Testing. Quality Assurance

in LF-LAM Testing, Monitoring and Evaluation in LF-LAM Testing, and Commodity Management in LF-LAM Testing. Additionally, the study's use of validated assessment tools provides robust measures of the effect of emerging innovations and technologies such as LF-LAM, ensuring reliability in evaluating training outcomes and their impact on service delivery.

IMPLICATION OF THE STUDY

The study underscores the importance of the Online Blended CPD Training programme for primary healthcare workers. The demonstrated improvement in Knowledge and skills among the target group highlights that structured training programmes leveraging outcome-based approaches are effective in enhancing PHCWs' skills and abilities to implement LF-LAM Point-of-Care testing, particularly in resource-limited PHC settings. In addition to the ever-changing WHO and national LF-LAM guidelines, the success of implementation of LF-LAM Testing could help strengthen TB management among PLHIV by improving Active Case Finding, TB diagnosis, and early initiation into TB care. In addition, the programme design helped address barriers to participation, including the cost of training, time constraints, and hands-on experience, leading to a high completion rate while broadening access to the course materials to diverse groups of professional cadres. Integrating structured CPD training into the National and County health workforce training frameworks will ensure sustainability while enabling scale-up to other regions.

RECOMMENDATION

The following recommendations are put forward for consideration to help improve the effectiveness of the LF-LAM online blended course and utilisation of LF-LAM Testing.

- **Strengthen continuous capacity building:** Implement refresher trainings, mentorship, and supportive supervision to reinforce knowledge and skills in LF-LAM testing and interpretation.

- **Strengthen commodity supply and management:** Operationalise effective supply chain systems to prevent stockouts of LF-LAM kits, ensuring consistent service delivery across primary healthcare facilities.
- **Integrate LF-LAM into TB/HIV care pathways:** Institutionalise LF-LAM testing as part of routine TB screening protocols for PLHIV in all Primary Healthcare Facilities to improve early case detection and linkage to care.
- **Utilisation of data for decision-making:** Strengthen routine monitoring through KHIS and TIBU to track utilisation, identify gaps, and inform resource allocation for Point-of-Care services.
- **Scale blended learning interventions:** Expand the use of online blended learning approaches to other counties, with adaptations to local contexts, as a cost-effective strategy for strengthening diagnostic capacity.
- **Foster multi-sectoral collaboration:** Strengthen engagement with county governments, partners, and Primary Healthcare Facilities to support integrated implementation, mobilise resources, and ensure sustainability of LF-LAM services

CONCLUSION

In conclusion, the study was conducted in three pilot Counties to assess the effect of the lateral flow urine lipoarabinomannan assay online blended CPD training on the utilisation of point-of-care Tuberculosis tests. The findings demonstrate that CPD training complemented with onsite-mentorship enabled Primary Healthcare workers to gain knowledge and skill sets for the effective implementation of LF-LAM Point-of-Care testing services, resulting in a significant change in performance across key indicators in TB service delivery among People living with HIV. Therefore, Online blended CPD training has proven to be significant in improving uptake of LF-LAM services. However, further studies employing an appropriate design would be

recommended to effectively evaluate the long-term effect of CPD training on the uptake of LF-LAM test services in Kenya.

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