Can we optimize the TB response amid funding constraints using evidence-based, cost-effective strategies

M.A Yassin,[1] A. Rashid,[1,2] E. Wandwalo[1]

[1]The Global Fund to Fight AIDS, Tuberculosis and Malaria, Geneva, Switzerland;

[2]Independent Consultant, Dar-es-Salaam, United Republic of Tanzania.

Correspondence to: Mohammed Yassin, Chemin Du Pommier 40, Le Grand-Saconnex 1218, Geneva, Switzerland. E-mail: Mohammed.Yassin@theglobalfund.org

Running head: Optimizing the TB response

[Taxonomy keywords: Tuberculosis; Diagnostics; Pharmacology and therapeutics; Viral, bacterial and zoonotic infections]

Article submitted 27 November 2025. Final version accepted 29 December 2025.

SUMMARY

BACKGROUND: Despite progress in the TB response, including through the Global Fund's catalytic efforts, funding gaps and inefficiencies threaten efforts to sustain gains and accelerate the TB response. Recent donor funding cuts have further strained programs in low- and middle-income countries.

METHODS: A mixed-method, combining desk, literature review and Key Informant Interviews with national TB programs, technical experts and partners, was conducted using standardized tools. Findings were triangulated to identify strategies/approaches that improve efficiency, access and outcomes.

RESULTS: We identified cost-effective strategies that optimize resources and tools to sustain and expand access to services amid declining funding. Strategies to enhance efficiency include screening using digital X-rays (with artificial intelligence), testing samples (including pooled samples) with molecular diagnostics, decentralizing care, engaging communities and private sector and integrating TB services with broader health system. Cost-saving measures involve integrated sample transport and supervision, integrating TB with other diseases such as HIV, diabetes, undernutrition, task-shifting, shorter treatment regimens, digital tools, and e-learning. Emphasis was also placed on innovative financing, domestic resource mobilization and country ownership.

CONCLUSION: Accelerating to end TB requires integrated and efficient strategies, innovative financing, and increased domestic resources, ensuring provision of equitable and high-quality TB services while strengthening the health system and ensuring sustainability.

KEY WORDS: tuberculosis; funding cuts; innovations along TB care, Global Fund, digitalization, innovative financing

TB remains a major global public health threat, with an estimated 10.7 million people with TB and 1.23 million deaths in 2024[1]. The rise in TB incidence between 2021 and 2023 is largely attributed to the widespread service disruptions during COVID-19, which caused TB notifications to drop from 7.1 million in 2019 to 5.8 million in 2020. These declines contributed to a substantial increase in undiagnosed and untreated people with TB, thereby exacerbating transmission and increased incidence and mortality. However, in 2024, the highest ever number of people with TB were notified (8.3 million) signaling a full recovery and improvement in case finding[2]

The Global Fund has been instrumental in advancing the global response to HIV, TB, and malaria, helping save approximately 70 million lives over the past two decades. Its strategic investments have catalyzed innovation, fostered market shaping, and facilitated the adoption of cutting-edge technologies including artificial intelligence (AI)–enabled digital X-rays for screening, rapid molecular diagnostics, and shorter, more effective, patient-friendly treatment. These efforts have improved access, treatment coverage, and greater efficiency in TB care. Between 2002 and 2024, the Global Fund allocated over $11 billion to TB programs in low- and middle-income countries (LMIC), helping reduce TB mortality by 40%. In 2024 alone, over 7.4 million people received TB treatment, including 120,000 treatment for drug-resistant TB (DR-TB), and 5.6 million received TB preventive treatment (TPT).[2]

Achieving the global targets of ending TB by 2030 requires increasing investments to $22 billion by 2027 and $35 billion by 2030 as committed at the 2023 United Nation High-Level Meeting[3]. These investments could prevent up to one million deaths annually and yield $46 in return per $1 spent, driving major health and socioeconomic gains[4]. However, the global TB response remains severely underfunded, with only 27% ($5.9 billion) of the $22 billion available in 2024, with major gaps in critical health products in the Global Fund Grant Cycle 7 (2024-2026). Recent TB funding cuts and reductions have further disrupted programs, especially in LMIC[5]. In this context, enhancing programmatic efficiency is crucial to protect hard-won gains, maximize resources, sustain progress toward ending TB, and strengthen resilient and integrated health systems.

The aim of our study was to draw evidence on cost-effective, scalable TB interventions that optimize resources and tool to address funding gaps, inefficiencies, inequities and offering key lessons to support sustainable and resilient global TB response.

METHODS

This study employed a mixed-methods approach, combining review of the literature and reports with key informant interviews (KIIs). Guided by a health systems approach, it focused on structural, institutional, and individual factors influencing TB Programs efficiency and optimization, amid funding constraints. The literature and desk reviews were targeted and designed to synthesize the most relevant recent evidence for practical recommendations. These covered publications from 2019 -2024, a period marked by significant shifts in TB funding, policy, and service delivery, particularly due to COVID-19 and changing donor landscapes and priorities. Sources included peer-reviewed articles, policy briefs, commentaries, case studies, and organizational reports, identified through PubMed, Google Scholar, and organizational websites, using key words and MeSH terms: “TB”, “efficiency”, “integration”, “innovation”, “cost-effectiveness”, “sustainability”, and “optimization”. This helped identify evidence-based practices, implementation gaps, and opportunities to improve intervention design and delivery. KIIs were conducted with six purposively selected stakeholders from international TB organizations, academic and research institutions, national TB programs, ministries of health, and non-governmental organizations, using standardized, pre-tested questions. Inclusion criteria targeted individuals with direct roles in TB program design, implementation, financing, or private sector engagement. Written informed consent was obtained, interviews were recorded and transcripts were validated by participants.

The qualitative data were thematically analyzed, with findings grouped into key themes to capture common patterns, divergent perspectives, and emerging insights. Results from the KIIs were triangulated with evidence from the desk review to provide a nuanced understanding of effective, scalable interventions and practical strategies to address gaps, strengthen efficiency, and optimize resources. The study was approved by the Global Fund and written consents were obtained from participates of the KIIs.

RESULTS

We identified scalable, cost-effective strategies to enhance TB program efficiency and optimize resources, highlighting stakeholders’ experience and health system dynamics for

sustainability. Integrating TB services within the existing program emerged as a major driver of efficiency.

Integrating outreach TB services

Community-based outreach models that combine contact investigation, diagnostics, treatment, and TPT in a single household visit reduce costs, improve case detection, enhance treatment adherence and improve access to TPT. A randomized trial in Cameroon and Uganda found integrated household contact management cost effectively reduced child TB deaths (ICER <$1,000/DALY)[6]. Similarly, people-centered treatment support was also cost-effective, with minimal differences in unit costs per cured patient.[7] Community-health workers' (CHW) engagement further improved reach and efficiency through screening, tracing, and sputum collection and provision of TPT[8].

> CHWs can simultaneously screen household members for TB disease, support TPT, identify and bring back patients who were lost to follow-up , collect and transport sputum or other specimens from community members to health facilities for testing. KII- National TB Control Program (NTP), Kenya.

Innovations and optimization of screening and diagnosis

Combining chest X-rays (CXR), computer-aided detection (CAD/AI), and rapid molecular tests like Xpert MTB/RIF into mobile outreach improves detection and reduces diagnostic delays, especially among high-risk, underserved populations. In Zambia, the "one-stop TB services" model integrating CXR, CAD, and Xpert improved affordability and detection[13]. In Pakistan, AI enabled mobile chest camps with predictive mapping yielded over four cases per camp[14] versus 2 in untargeted camps[15]. In the Philippines, ACF using vans with CXR and Xpert MTB/RIF improved TB detection among high-risk and underserved groups[16]

> AI tools, such as CAD for X-rays, have potential for cost reduction and improved accuracy in TB screening, and diagnosis of non-TB conditions, increasing the utility of diagnostic platforms in high-burden areas. KII-Liverpool School of Tropical Medicine (LSTM), UK

In high-throughput settings, CAD4TB screening costs as low as $0.25[17], and handheld X-ray benefit remote areas. Yet, many programs underutilize CXR, leading to inefficiencies.

> AI-powered X-ray technology offers significant potential to enhance TB screening, particularly in high-burden settings, by improving the efficiency of ACF and targeting individuals for screening. KII-Stop TB Partnership (STP), Switzerland.

Pairing AI-assisted X-ray screening, molecular diagnostics, and sputum pooling expanded diagnostic coverage while conserving resources. A recent modeling in Zambia, Bangladesh, Nigeria, and Vietnam showed up to 61.5% reduction in cartridge use and a 34% - 160% increase in diagnostic coverage[18].

> Utilizing low-cost, rapid screening tools could ensure that diagnostic tests are reserved for people with a high pre-test probability of TB, optimizing resource use. KII-LSTM, UK

> Sputum pooling is an efficient approach for settings with low TB positivity rates, conserving GeneXpert cartridges, and increasing testing capacity. KII-STP Switzerland.

TrueNat's extended battery life suits its use in decentralized setting[22]. In Nigeria, stool-based TrueNat improved pediatric TB diagnosis, lowered costs, and was cost-effective[23]. In India, Cy-TB test for TB infection was cost-effective, with bulk procurement offering further savings[24]

Optimizing treatment and transitioning to shorter regimen

Decentralizing and integrating DR-TB services have generated substantial savings per patient treated in Ethiopia ($219-$276)[9] and India ($25,000)[10]. Shorter DR-TB and TPT regimens further improve efficiency through saving between $3,596 and $8,174 in Belarus, Georgia, Kazakhstan and Moldova[11]. In Brazil and South Africa, expanding access to shorter TPT regimens (e.g., 3-month Isoniazid and rifapentine - "3HP") among people living with HIV substantially reduced TB cases, deaths, and DALYs[12]. Incorporating new shorter regimens like 6-month BPaL/M (bedaquiline, pretomanid, linezolid with/without moxifloxacin) into routine TB care was feasible and resource-efficient[11].

> Shorter DR-TB regimens such as the BPaL/M, and the services can be incorporated into routine TB programs with appropriate support to patients requiring critical care or hospitalization. KII – Management Sciences for Health (MSH), Ethiopia

Strengthening workforce capacity through community health workers and e-learning

CHWs are central to cost-effective TB care. In Ethiopia, integrating ACF with health extension workers (HEWs – salaried CHWs) was 43.4% more cost-effective than passive case finding [30], and HEWs delivered community-based treatment at 39% of facility costs with similar outcomes [31]. In Pakistan, household visits by Lady Health Workers (salaried-CHWs) identified four times more TB cases at $120 per case [32] and detected symptoms 47 days earlier than private providers [33]. In India, TB survivors/"TB Champions" improved case finding, adherence, and reduced stigma, while in Vietnam, CHWs using mobile CXR boosted Xpert testing and TB notifications [34]

> Facility-based screening using X-rays could help detect more people with TB. However, there will always be a segment of the population that cannot access health care, necessitating active outreach efforts. KII-Global TB Partner

> Community-level strategies may need to prioritize more prevalent co-morbidities like diabetes or undernutrition depending on local epidemiological data. KII-LSTM, UK

> Innovations in health worker training also demonstrated potential for improved efficiency. In China, shifting from in-person to online training expanded access and reduced costs[35]

> Community-based approaches help overcome barriers such as lack of awareness, financial barriers and stigma – TB diagnosis may lead to social exclusion. KII-Global TB Partner

Enhancing private sector engagement to expand access and improve efficiency

Innovative private sector engagement (PSE) models such as Affordable and Quality TB Tests (IPAQT), Public-Private Interface Agencies (PPIA) and Patient-Provider Support Agency (PPSA) in India have transformed TB service delivery. IPAQT enhanced Xpert testing tenfold and reduced prices by 30%-50%[36]. PPIAs reached 50% of private patients at $228 per

DALY[37]. The PPSA model was adopted and scaled up through the Global Fund support and transitioned to domestic funding, ensuring sustainable PSE[38] In Pakistan, PSE models have expanded early diagnosis, improved case notifications, and treatment adherence by integrating diverse private providers, offering patients greater flexibility[21].

> Many patients initially access health services through private providers. Engaging private providers improves access to care while leveraging existing private health care infrastructure, thereby enhancing program efficiency. KII-NTP, Kenya.

> The introduction of negotiated payment systems for services like GeneXpert testing in private facilities helps recover costs. Supporting private providers through capacity building, supervision, and program linkages serves as indirect motivation. KII- MSH, Ethiopia.

When effectively coordinated, PSE particularly where people first seek care outside the public sector, and community-based interventions can reduce diagnostic gaps, improve treatment coverage, and accelerate progress towards End TB targets.

> Effective two-way communication between public and private providers can help reduce diagnostic delays, ultimately benefiting both patients and health systems. KII-LSTM, UK.

Regulatory mechanisms like Mandatory Case Notification (MCN) law can help institutionalizing TB reporting by private providers, reducing reliance on incentives, ensuring compliance. However, laws alone are inadequate and require enactement, simplification including through and digitalization of recording and reporting.

> If MCN law is operationalized, there may be no need for financial incentives to encourage private providers to report cases. KII-Mercy Corps Pakistan.

Integrating TB within the broader health system and services

Integration of TB services with broader health programs including for co-morbidities such as HIV, Diabetes and Mother and Child Health (MCH) also improves efficiency and outcomes, when tailored to local context. TB-diabetes screening in Ethiopia tripled TB yield among diabetic patients[25], Zimbabwe's 3HP delivery for TPT through a Fast Track HIV care model,

achieved 96% completion and high satisfaction [26]. However, differentiating integration by tailoring it to the local context and disease burden was also emphasized.

> While TB-HIV integration has advanced, broader integration with other health conditions requires careful balancing of individual and population-level priorities. KII-LSTM, UK

Integrating specimen transport systems across TB, HIV, and other programs reduce costs and turnaround times, and enhance traceability[19]. In Zimbabwe, this approach cut per-sample costs by 44%, tripled annual sample volume, and reduced rejection of samples[19]. Robust specimen transport systems in the Philippines[20] and Pakistan[21] reduced logistics costs and improved coordination, in resource-constrained settings.

> Transporting patient samples to diagnostic facilities while allowing patients to remain in their communities increases access and reduces costs. KII - MSH, Ethiopia

> Establishing unified systems for sample transport ensures efficient use of existing resources, avoiding duplication across disease programs. KII-NTP, Kenya

A study in Zambia found integrating systematic TB screening in primary health care, hindered by complex screening algorithms for children, stigma, and COVID-19, highlighting the need for local adaptation and health system strengthening[27].

> Diabetes and Hepatitis C testing can also be incorporated into screening for TB at the community level to reduce the cost and duplication of services, making healthcare delivery more efficient. KII-Mercy Corps, Pakistan

In Pakistan, TB screening among antenatal care (ANC) attendants was feasible, and important to prevent maternal and neonatal complications despite low yield[28]. Modeling from Cameroon and Kenya showed that integrating TB care into child health is effective, particularly in counties with high service coverage and TB detection[29]

> In MCH clinics, healthcare workers are encouraged to screen children for TB during routine visits, this ensures early detection and management of TB cases among pediatric patients, KII-NTP Kenya.

Immunization campaigns, ANC visits, and polio eradication campaigns were also noted as viable touchpoints for integrating TB screening and awareness-raising activities[39] Table 1

distils key options and considerations to enhance efficiency and sustain TB responses in two buckets, which could be adapted to local context and resources.

DISCUSSION

Guided by structural, institutional, and behavioral interaction concepts[40,41] , our analysis identified five interconnected strategies— integration, optimization, care cascade alignment, multisectoral engagement, and financing – to improve TB program efficiency amid declining donor support and inform policy across diverse contexts.

1. Integrating TB services within TB programs

Both the literature review and KIIs highlighted that integrating TB services, combining contact investigation, diagnosis, treatment, and TPT, enhances efficiency, reduces fragmentation, and improves patient outcomes. Shorter DR-TB and TPT regimens, decentralized and integrated into routine care, enable earlier treatment, fewer visits, and higher completion, while community-based delivery supports continuity. Integrating TB and DR-TB reduces inefficiencies. Decentralized screening using digital CXR, CAD/AI, and molecular testing improves case detection, reduces delays, and increases efficiency in high-burden or underserved settings.The analysis also highlighted the value of expanding specimen transport networks to centralize diagnostic testing while maintaining community-based sample collection, reducing costs and turnaround times. Effectiveness depends on system factors: supply chains, workforce, data, and financing, and requires coordinated TB program operations to maintain efficiency and quality.

2. Leveraging innovation and optimization of tools for screening and diagnosis

Optimizing existing TB tools and technologies can enhance program efficiency, particularly in high-burden and resource-constrained settings. The strategic integration of these tools into routine program delivery enables earlier diagnosis, reduces operational costs, and improves overall diagnostic coverage. Evidence indicates that portable molecular platforms expand diagnostic access, decentralize services and reduce delays, while newer screening and diagnostics tools, offer affordable alternatives, when scaled through bulk procurement and

appropriate training. Sputum pooling offers a cost-efficient solution in low-positivity settings (e.g., positivity rate among tested of <30%), reducing cartridge use by over half without compromising sensitivity and enabling wider testing coverage. Underutilization of advanced tools like digital CXR and AI-enabled platforms, due to limited workforce, poor integration, and quality gaps, hinders efficiency. AI also enables multi-disease screening within a single system, improving cost-effectiveness and impact, especially in high-volume or integrated healthcare settings.

3. Optimizing algorithms and approaches along the cascade of care

Optimizing diagnostic and treatment algorithms across TB care cascade, using CXR before molecular testing, and integrating AI-powered CAD, reduces confirmatory molecular testing, leading to significant cost savings and increased throughput and expands early case detection. Community-based ACF with mobile CXR screening, and TPT provision, is more cost-effective than passive case finding, improving diagnostic access and early notifications. Transitioning from traditional classroom-based training to blended or fully online training for healthcare workers broadens access to continuing education, reduces travel and accommodation and maintains workforce capacity without compromising quality.

4. Integrating TB within boarder health systems and services

Evidence indicates that integrating TB services with broader health programs, including common co-morbities and con-conditions such as HIV, NCDs, nutrition, and MCH improves efficiency, reduces duplication, and strengthens case finding, treatment and care. Combined screening for TB and related conditions further enhances diagnostic yields by identifying co-morbidities earlier among high-risk groups. Integrated sample transport systems streamline multi-disease logistics, reducing turnaround times and costs while strengthening lab networks. AI-enabled digital chest X-ray enhances TB screening and detects other conditions such as chronic lung diseases, cardiovascular issues, and cancers, increasing diagnostic value. Aligning TB supervision, monitoring, and evaluation with programs like HIV and malaria, further improves efficiency by reducing duplication and consolidating resources.

5. Optimizing TB responses through governance, stakeholder engagement, and innovative financing

Engaging private providers, including pharmacies, general practitioners, and laboratories, expands access to affordable TB services. Innovative PSE models that incentivize private sector participation have improved case detection, treatment adherence, and program efficiency by integrating diverse providers and tailoring interventions to local contexts. Training and supporting pharmacists and other frontline private providers with digital tools, referrals and innovative financing, including negotiated diagnostic payment schemes, improves TB coverage and accountability, while MCN laws and effective public-private coordination, reduce diagnostic delays, and benefit both patients and health systems. Community-driven interventions remain a cornerstone of effective TB response, improving access, reducing diagnostic delays, and increasing patient retention. Task shifting to CHWs improves efficiency and supports continuity of care.. Engaging community leaders and TB survivors reduces stigma and barriers hindering care-seeking and improves access and adherence. Combining community outreach campaigns with mobile screening and diagnostics and expanding affordable and quality TB testing in the private sector increase uptake and reduced costs. Moreover, strengthening and diversifying financing mechanisms is essential for sustainable TB programs. Increased domestic investment enhances service continuity, reduces reliance on external aid, and supports long-term epidemic control [42]. Social protection and health insurance schemes expand coverage, lower out-of-pocket costs, and improve outcomes by addressing socioeconomic barriers. Improved coordination—such as integrating TB services into insurance programs and supporting private-sector TB clinics—helps align resources and maximize impact. Promising innovative financing strategies include TB-specific taxes, performance-based budgeting, blended financing, and mechanisms like debt swaps and D4H arrangements. For example, Germany and Indonesia converted €75 million of debt into TB and malaria investmetns[43]

Table 2 summarizes oppoertunities to leverage additional financing for TB responses. Financial support for TB patients and their families reduces economic barriers, while performance-based financing can enhance efficiency, program outcomes, and resource use. Evidence from PSE in TB care shows that context-specific combinations of PBF and non-financial incentives sustain provider motivation and TB service delivery[44]. Despite limited scope and timeline, our assessment offers practical and scalable options to sustain TB gains and strengthen patient-centered systems amid evolving funding challenges. Achieving impact

requires combining efficiency with sustained investment, context-specific adaptation, and a focus on accessible, high-quality and equitable care to all.

CONCLUSION

Sustaining and accelerating TB progress requires bold leadership, domestic investments, cross-sector partnerships scaling proven solutions. Efficiency gains must be backed by sustained funding, commitment, and focused actions including advancing research, South–South knowledge exchange, and ensuring innovations and adaptation to end TB.

Acknowledgements

We are grateful to all key informants: A. Tahir, B. Kalottee, D Datiko, I. Kathure, J. Creswell and T Wingfield, who generously shared their time and insights. We would like to thank E. Waititu for feedback.The opinions and recommendations are the authors and not necessarily those of the Global Fund.

Conflicts of interest: none declared.

References

1. World Health Organization. Global Tuberculosis Report 2025. (2025).

2. The Global Fund. Results Report 2025. doi:https://www.theglobalfund.org/en/results/.

3. World Health Organization. United Nations General Assembly High-Level Meeting on the Fight Against Tuberculosis . (2023).

4. Pretorius, C. et al. One Million Lives Saved per Year: A Cost-Benefit Analysis of the Global Plan to End Tuberculosis, 2023-2030 and beyond. J Benefit Cost Anal 14, 337–354 (2023).

5. Clark, R. A. et al. The potential impact of reductions in international donor funding on tuberculosis in low-income and middle-income countries: a modelling study. Lancet Glob

Health https://doi.org/10.1016/S2214-109X(25)00232-3 (2025) doi:10.1016/S2214-109X(25)00232-3.

6. Brough, J. et al. Public Health Impact and Cost-Effectiveness of Screening for Active Tuberculosis Disease or Infection Among Children in South Africa. Clinical Infectious Diseases 77, 1544–1551 (2023).

7. Chavez-Rimache, L., Ugarte-Gil, C. & Brunette, M. J. The community as an active part in the implementation of interventions for the prevention and care of tuberculosis: A scoping review. PLOS Global Public Health vol. 3 Preprint at https://doi.org/10.1371/journal.pgph.0001482 (2023).

8. Seidman, G. & Atun, R. Does task shifting yield cost savings and improve efficiency for health systems? A systematic review of evidence from low-income and middle-income countries. Hum Resour Health 15, (2017).

9. Rosu, L. et al. Cost of treatment support for multidrug-resistant tuberculosis using patient-centred approaches in Ethiopia: a model-based method. Infect Dis Poverty 12, (2023).

10. Brooks, M. B., Pingali, V., Nicholson, T. & Keshavjee, S. Cost of inaction: a framework to estimate the economic cost of missing a patient with tuberculosis in the Indian context. BMJ Open 13, (2023).

11. The Global Fund. Results Report 2024. https://www.theglobalfund.org/en/results/ doi:https://www.theglobalfund.org/en/results/.

12. Nsengiyumva, N. P. et al. Scaling up target regimens for tuberculosis preventive treatment in Brazil and South Africa: An analysis of costs and cost-effectiveness. PLoS Med 19, (2022).

13. The Global Fund. The TB Quarterly Update Innovations Contents. https://www.theglobalfund.org/media/uh1lxjub/tb_2025-07-quarterly-tuberculosis_update_en.pdf (2025).

14. EPCON. Finding TB Cases in Pakistan: Using AI for Active Case Finding.

15. Tahir, A., et al. Reviewing a model of public-private mix employed for tuberculosis control in Pakistan. Pakistan Journal of Public Health 12, 23–27 (2022).

16. Morishita, F. et al. Bringing state-of-The-Art diagnostics to vulnerable populations: The use of a mobile screening unit in active case finding for tuberculosis in Palawan, the Philippines. PLoS One 12, (2017).

17. Bashir, S. et al. Economic analysis of different throughput scenarios and implementation strategies of computer-aided detection software as a screening and triage test for pulmonary TB. PLoS One 17, (2022).

18. Codlin, A. J. et al. Expanding molecular diagnostic coverage for tuberculosis by combining computer-aided chest radiography and sputum specimen pooling: a modeling study from four high-burden countries. BMC Global and Public Health 2, (2024).

19. Muchenje, W. Zimbabwe Integrated Sample Transportation System (ISTS) Case Study. https://doi.org/10.13140/RG.2.2.29469.72160 (2017) doi:10.13140/RG.2.2.29469.72160.

20. Cephieid. Connecting the dots: Optimizing TB diagnostics in the Philippines. Devex.

21. Rashid, A. et al. Maximizing tuberculosis services through private provider engagement – A case study from Pakistan. J Clin Tuberc Other Mycobact Dis 39, (2025).

22. Treatment Action Group. TAG Applauds Price Reduction of Molbio's Truenat Diagnostics for Tuberculosis. Online Web Page (2023).

23. Mafirakureva, N. et al. Evaluating the health impact, health-system costs and cost-effectiveness of using TrueNat on stool samples compared to usual care for the diagnosis of paediatric tuberculosis in primary care settings: a modelling analysis. PLoS Global Public Health 2025;5(6):e0004016.

24. Muniyandi, M. et al. Evaluating the cost-effectiveness of Cy-Tb for LTBI in India: a comprehensive economic modelling analysis. Int Health 17, 259–269 (2025).

25. Management Science for Health. Technical Brief Integrating Service Delivery for TB and Diabetes Mellitus-An Innovative and Scalable Approach in Ethiopia. (2017).

26. Mapingure, M. P. et al. Integrating 3HP-based tuberculosis preventive treatment into Zimbabwe's Fast Track HIV treatment model: experiences from a pilot study. J Int AIDS Soc 26, 26105 (2023).

27. Zulu, D. W., Silumbwe, A., Maritim, P. & Zulu, J. M. Integration of systematic screening for tuberculosis in outpatient departments of urban primary healthcare facilities in Zambia: a case study of Kitwe district. BMC Health Serv Res 22, (2022).

28. Ali, R. F. et al. Integrating tuberculosis screening into antenatal visits to improve tuberculosis diagnosis and care: Results from a pilot project in Pakistan. International Journal of Infectious Diseases 108, 391–396 (2021).

29. Mafirakureva, N. et al. Cost-effectiveness of integrating paediatric tuberculosis services into child healthcare services in Africa: a modelling analysis of a cluster-randomised trial. BMJ Glob Health 9, (2024).

30. Woldesemayat, E. M. Cost-effectiveness of follow-up of chronic coughers in detecting smear-positive tuberculosis in South Ethiopia. ClinicoEconomics and Outcomes Research 13, 737–744 (2021).

31. Datiko, D. G. & Lindtjørn, B. Cost and cost-effectiveness of treating smear-positive tuberculosis by health extension workers in Ethiopia: An ancillary cost-effectiveness analysis of community randomized trial. PLoS One 5, (2010).

32. Hussain, H. et al. Cost-effectiveness of household contact investigation for detection of tuberculosis in Pakistan. BMJ Open 11, (2021).

33. Mercy Corps. Engagement of Lady Health Workers Leading to Early Diagnosis: A Cross Sectional Study. http://www.medscape.com/viewarticle/407989] (2018).

34. Mac, T. H. et al. Optimizing Active Tuberculosis Case Finding: Evaluating the Impact of Community Referral for Chest X-ray Screening and Xpert Testing on Case Notifications in Two Cities in Viet Nam. Trop Med Infect Dis 5, (2020).

35. Wang, Z. Y. et al. Process evaluation of E-learning in continuing medical education: evidence from the China-Gates Foundation Tuberculosis Control Program. Infect Dis Poverty 10, (2021).

36. Dabas H, et al. Initiative for Promoting Affordable and Quality Tuberculosis Tests (IPAQT): a market-shaping intervention in India. BMJ Global Health. 2019;4:e001539.

37. Arinaminpathy, N. et al. Engaging with the private healthcare sector for the control of tuberculosis in India: cost and cost-effectiveness. BMJ Glob Health 6, (2021).

38. Yassin, M. A. et al. Leveraging Global Fund's investments to expand innovative public-private provider engagement in TB. IJTLD Open 2024;1(6):250–257.

39. Ugwu, C. et al. Integrating TB screening into house-to-house polio vaccination campaigns. Public Health Action 13, 7–11 (2023).

40. Umberson, D. & Karas Montez, J. Social Relationships and Health: A Flashpoint for Health Policy. J Health Soc Behav 51, S54–S66 (2010).

41. Short, S. E. & Mollborn, S. Social determinants and health behaviors: Conceptual frames and empirical advances. Current Opinion in Psychology 2015;5:78–84

42. Hallett, T. B. et al. The case for optimal investment in combating HIV, tuberculosis, and malaria: a global modelling study. The Lancet 406, 261–270 (2025).

43. The Global Fund. Innovative Finances: Debt Swaps (Debt2Health). https://www.theglobalfund.org/en/how-we-raise-funds/innovative-finance/debt-swaps-debt2health/ (2025).

44. The Global Fund. Private Sector Engagement in Tuberculosis Care. https://resources.theglobalfund.org/media/tslodd32/cr_private-sector-engagement-tb-care_report_en.pdf (2025) doi:https://resources.theglobalfund.org/media/tslodd32/cr_private-sector-engagement-tb-care_report_en.pdf.

Table 1. Summary of options to enhance efficiency and sustain and accelerate TB response.

S#	Enhancing efficiency in TB Programs	Integrating TB services with other programs and sectors and contribute to Resilient and Sustainable System for Health (RSSH)
1	Combine contact screening as well as TB screening in other high-risk groups with diagnosis, treatment and provision of TPT	Integrate disease screening (such as TB, HIV, diabetes, maternal health and nutrition) across health programs for comprehensive care
2	Decentralize Drug-Resistant-TB and integrate it with Drug-Sensitive-TB activities.	Strengthen and empower Community Health Workers for disease detection, treatment adherence, and delivery of integrated health services across multiple conditions
3	Promote cost-effective, shorter treatment regimens for DR-TB and TPT and children with DS-TB.	Expand and integrate sample transport networks constructed on national/local platforms and systems for TB and other diseases.
4	Optimize resources by combining screening using digital Chest X-Ray with AI, sputum sample pooling and WHO-recommended rapid molecular diagnostics	Promote multi-disease screening/testing platforms which could contribute to RSSH and pandemic preparedness and response
5	Digitalize TB recording and reporting, enhance interoperability and strengthen surveillance system.	Utilize digital and online platforms for training and community engagement.
6	Invest in new low-cost and more sensitive and specific tools for screening/diagnosis when available and recommended	Leveraging digital solutions for integrated health surveillance and reporting

RSSH = resilient and sustaible systems for health, TPT = TB preventive treatment, AI = arterficial intellegnce

Table 2. Innovative financing strategies and approaches for consideration depending on context**.**

S#	Innovative financing strategies (What)	Examples (How)
1	Mobilize resources for TB programs	• Leverage local fundraising, philanthropy, and community trust through awareness campaigns • Explore community-based and social health insurance models to cover TB costs. • Promote inter-ministerial coordination to integrate TB services into insurance programs
2	Innovative funding streams	• Introduce TB-specific taxes (e.g., tobacco excise tax) and performance-based budgeting. • Implement district-level self-financing. • Blended financing – for example together with World Bank, Asian Development Bank, African Development Bank, Islamic Bank, Gates Foundation, Global Financing Facility. • Debt Swap, Debt for Health (D4H)
3	Financial assistance and performance-based payment models	• Expand financial assistance for TB patients and families through local initiatives. • Introducing performance-based financing (PBF) to incentivize implementation of efficient interventions