



Functional readiness as the linchpin of integrated tuberculosis and comorbidity care in Pakistan: a health-system and ethical imperative

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ABSTRACT

In Pakistan, for the effective management of tuberculosis and its comorbidities, functional readiness at the point of service delivery, including the preparedness of health facilities in terms of infrastructure, human resources, screening and diagnostics, coordination mechanisms, and culturally sensitive service delivery, is of utmost importance. Despite having a nascent TB services infrastructure, Pakistan's health system faces persistent challenges, such as inadequate diagnostic capacity at basic health units, logistical obstacles in patient referrals, workforce shortages, and sociocultural barriers that impede timely and effective TB comorbidity management. These challenges are exacerbated across all care levels, from primary to tertiary hospitals, and thus restrict the extent and effectiveness of integrated interventions. In this viewpoint, we discuss these barriers in detail and propose that comprehensive health system strengthening to enhance functional readiness and ultimately improve clinical outcomes for patients with TB with comorbid conditions.

Keywords: Tuberculosis (MeSH); Comorbidity (MeSH); Delivery of Health Care, Integrated (MeSH); Health Services Accessibility (MeSH); Health Facilities (MeSH); Health Resources (MeSH); Primary Health Care (MeSH); Health Workforce (MeSH); Health Services Needs and Demand (MeSH); Patient Care Management (MeSH); Health Policy (MeSH); Pakistan (MeSH)

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INTRODUCTION

Pakistan remains one of the world's highest tuberculosis (TB) burden countries, ranking fifth globally and contributing approximately 6.3% of the global TB burden.¹ According to the WHO Global Tuberculosis Report 2025, Pakistan reported an estimated 669,000 new TB cases in 2024, corresponding to an incidence of 264 cases per 100,000 population.¹

TB is frequently complicated by comorbid conditions, including depression, diabetes mellitus, and other chronic illnesses.^{2,3} Evidence suggests that nearly one-fourth of individuals with TB have concurrent diabetes mellitus, while a similar proportion have pre-diabetes.⁴ Depression is also common among patients with TB in Pakistan; although nationally representative data are lacking, hospital-based studies have reported clinically significant

depressive symptoms in approximately 35%–58% of patients, with several studies estimating the prevalence at around one-half of all TB cases.⁵⁻⁷

In high TB-burden countries, the WHO End TB Strategy is increasingly challenged by the rising burden of non-communicable diseases.⁸ Integrated care models for TB and diabetes are therefore gaining importance, although the strength of evidence varies across settings. The WHO Collaborative Framework recommends bidirectional screening, coordinated management, and shared monitoring, as diabetes is associated with delayed bacteriological conversion, relapse, death, and poorer TB treatment outcomes.⁹

Evidence from Malawi showed that facilities implementing integrated TB–diabetes care achieved better treatment success, lower loss to follow-up, and improved long-term retention in diabetes care compared with non-integrated facilities.¹⁰

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Similarly, a systematic review from developing countries reported that integrated TB–DM care improved bidirectional screening and reduced treatment loss to follow-up.¹¹ Another recent review identified political commitment, digital tools, workforce training, standardized protocols, and stronger infrastructure as key enablers of effective TB–DM integration.¹² Although integrating TB care with comorbidity services can improve patient outcomes and reduce disease burden, such integration requires functional readiness at the point of service delivery.¹² In Pakistan, fragmented public–private healthcare delivery, limited resources, and gaps in service readiness continue to hinder seamless integrated care.

Functional readiness at the point of service delivery refers to the availability and coordination of infrastructure, trained human resources, service protocols, and organizational systems required to deliver integrated care effectively, as shown in Figure 1.¹³ In TB–comorbidity integration, this means ensuring access to diagnostic tools, trained staff capable of managing TB and common comorbidities, and efficient referral pathways, preferably through co-located services where feasible.¹² However, functional readiness goes beyond infrastructure alone. It also includes the health system's capacity to provide people-

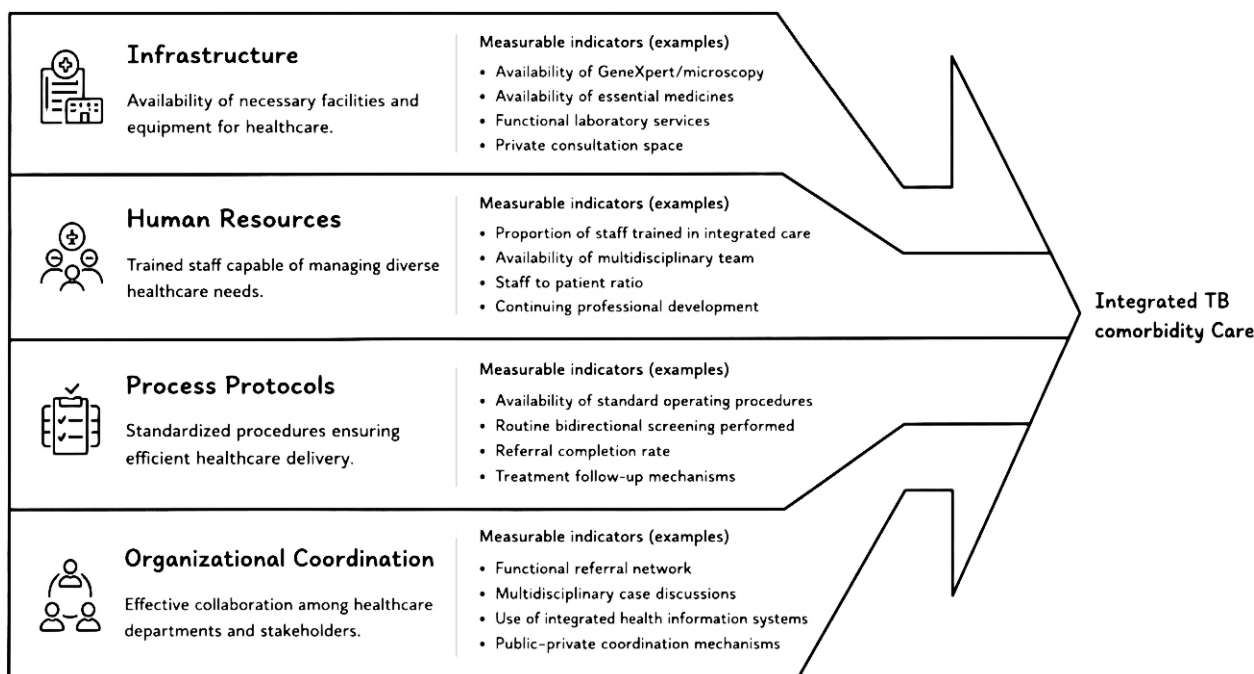


Figure 1: Pillars of Functional Readiness at Point of Service Delivery

centred and coordinated care through competent provider– patient interactions, effective case finding and referral, community engagement, and culturally responsive interventions that support treatment adherence and continuity of care.^{11,14,15}

The significance of functional readiness is highlighted by the fact that without it, integrated TB care efforts lose their scalability, continuity, and, ultimately, their impact on reducing TB morbidity and mortality. In settings where health facilities lack physical infrastructure, trained personnel, or integrated service delivery protocols, patients are at risk of delayed diagnosis, fragmented treatment pathways, and poor clinical outcomes.^{16,17} In Pakistan, health facilities are categorised hierarchically into primary, secondary, and tertiary care based on geographical location, available facilities, and functionality. The TB basic medical units are located across all levels of health facilities, but challenges exist for the integration of comorbidities across all levels.¹⁸

Primary care TB facilities in Pakistan remain the frontline for TB detection, but many are underprepared for integrated TB–comorbidity

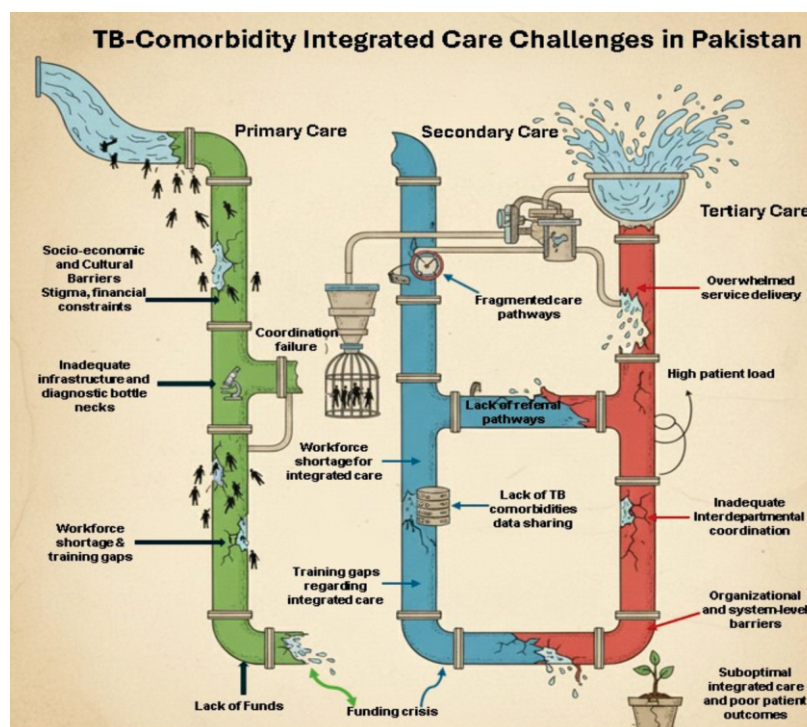


Figure 2: TB Comorbidity integrated care challenges in Pakistan

management. Diagnostic capacity is uneven; the 2022 Pakistan TB programme review reported only 404 Xpert MTB/RIF sites for 2,678 TB basic management units, reflecting limited

on-site access to rapid molecular diagnostics despite improvement since 2015.¹⁹ Chronic underinvestment has left many facilities without adequate diagnostics, trained staff, or effective

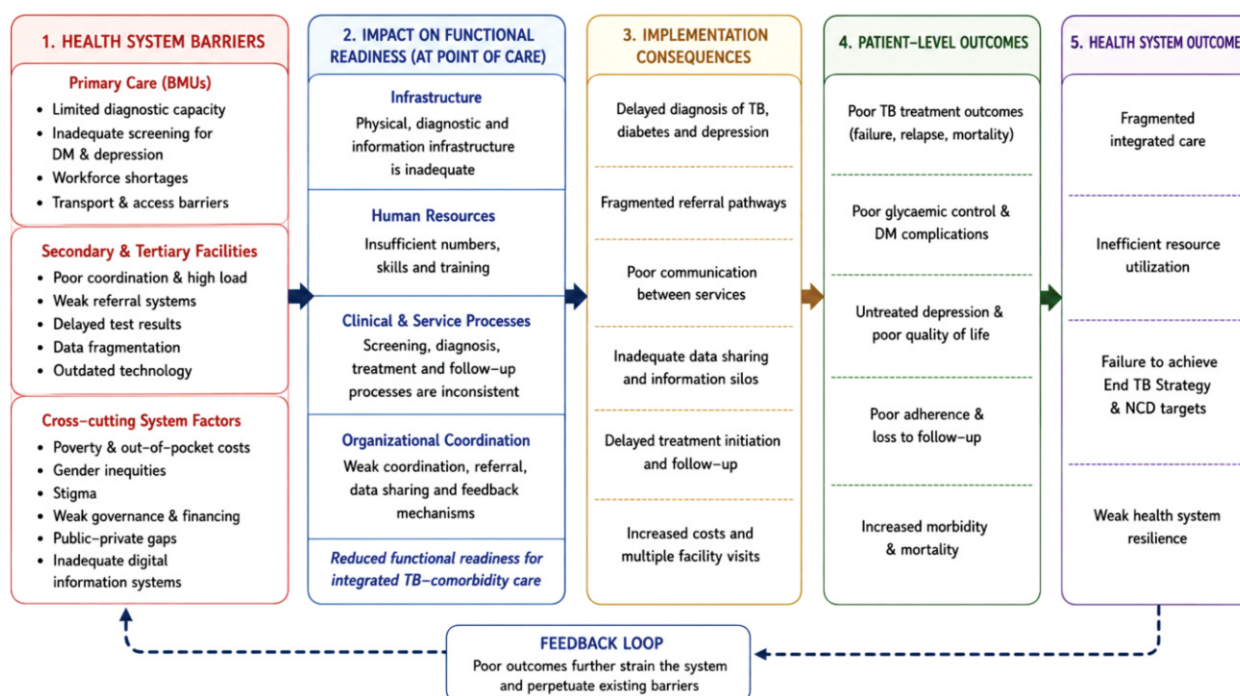


Figure 3: Conceptual model for the interactions between health system barriers, functional readiness, implementation processes, and outcomes for integrated TB-comorbidity care in Pakistan

referral systems.^{20,21} Overstretched healthcare providers, often with limited training in chronic disease and mental health screening, may prioritize acute TB management over comprehensive comorbidity assessment and patient-centred care.¹⁴ Studies from Pakistan have identified inadequate provider training, low confidence in depression screening, workforce shortages, and competing clinical demands as key barriers to integrated TB-comorbidity services.^{12,14} Geographic isolation, transport difficulties, poverty, stigma, and gender inequities further restrict access, particularly in rural areas, creating fragmented care pathways where patients may be lost across the continuum of care.²²

At secondary and tertiary TB facilities, the promise of advanced diagnostics and specialist expertise is undermined by poor coordination, excessive patient loads, and persistent funding constraints (Figure II).

Recent evidence from Pakistan shows that referral pathways for TB-diabetes care are often poorly structured, with weak coordination between TB units and non-communicable disease

services, absence of standardized referral protocols, and limited referral feedback mechanisms. These gaps delay comorbidity diagnosis and contribute to fragmented integrated care.²³ Departments frequently work in silos, and the lack of standardized protocols, electronic health records, and regular training limits opportunities for holistic, patient-centred management.²² Sustainable integration requires investment in infrastructure, workforce capacity, and strengthened referral and data systems across all levels of care.²³ The absence of coordinated diagnostic protocols and interoperable health information systems, particularly between public-sector TB facilities and private healthcare providers, continues to delay diagnosis and referral of TB comorbidities.^{18,22,24} These weaknesses are especially critical in multidrug-resistant TB, where timely intervention is essential. Figure III illustrates how barriers at primary, secondary, tertiary, and broader health-system levels weaken functional readiness for integrated TB-comorbidity care in Pakistan. Reduced readiness leads to delayed diagnosis, fragmented

referrals, poor inter-service communication, and inadequate data sharing, ultimately contributing to delayed treatment, poor adherence, untreated comorbidities, and increased morbidity and mortality.

Cross-Cutting Socio-Economic, Cultural, and Policy Challenges

Beyond facility-level barriers, socioeconomic and cultural inequities further weaken Pakistan's functional readiness for integrated TB-comorbidity care. Financial hardship, low public health spending, and high out-of-pocket costs delay access, particularly among rural and low-income populations. Pakistan's public health expenditure reached Rs 942.2 billion in FY2025 but remained only 0.8% of GDP, limiting investment in primary care, diagnostics, and integrated TB-comorbidity services.²⁵ Gender norms restricting women's mobility and decision-making, along with a shortage of female healthcare providers, further deepen diagnostic and access gaps.¹⁴ Weak governance, fragmented implementation of integrated policies, poor coordination between TB and non-communicable

disease programmes, limited monitoring, and inconsistent private-sector regulation also undermine coordinated care. Stigma and misinformation related to TB and mental health further discourage timely care-seeking. Together, these barriers sustain inequities, fragment service delivery, and limit the delivery of equitable, patient-centred TB care.

Strategies for Enhancing Functional Readiness for Integrated TB Comorbidity Management

Given the multiplicity of challenges, targeted approaches are required to strengthen functional readiness across all healthcare levels in Pakistan. Some potential strategies include the following:

Capacity Building and Workforce Development

Comprehensive training of healthcare workers is essential for integrated TB–comorbidity care. Training should be competency-based and supported by continuous professional development, supervision, and periodic skills assessment to maintain service quality. Evidence from integrated TB–HIV programmes shows that task-sharing with trained community health workers improves case detection, linkage to care, treatment adherence, and continuity of care, supporting its use for TB–comorbidity services in resource-limited settings.^{26,27} Training should also include culturally sensitive communication, early comorbidity screening, and adherence to National Tuberculosis Programme guidelines.

Infrastructure Investment and Diagnostic Upgrades

Investing in infrastructure, especially at the primary and secondary levels, is imperative. Given Pakistan's resource constraints, phased implementation leveraging existing TB programme infrastructure, integrated financing mechanisms, and strategic domestic and donor investments may provide a more feasible and sustainable approach to strengthening integrated TB–comorbidity services.²² Upgrading diagnostic facilities to include reliable sputum microscopy and rapid molecular diagnostic systems, such as GeneXpert (scale up of GeneXpert machines from 411 to 774 machines in Year 2024), and ensuring the consistent maintenance of these tools can dramatically improve case detection. Designing facilities to co-locate services, such as TB care, diabetes screening, and mental health support, can facilitate integrated service delivery and reduce the logistical barriers faced by patients.

Strengthening Referral Systems and Interdepartmental Coordination

Enhancing communication channels between primary, secondary, and tertiary facilities through standardised referral protocols and integrated electronic health records is crucial. Leveraging existing platforms such as the National Tuberculosis Programme's Electronic Nominal Recording and Reporting System (ENRS), while addressing persistent infrastructure limitations and interoperability gaps

with broader health information systems, could substantially strengthen referral coordination and continuity of integrated TB–comorbidity care. Knowledge sharing and interdepartmental collaboration, supported by periodic audits and performance reviews, can reduce delays and ensure that patients receive comprehensive care.²⁸ Moreover, effective coordination with the private health sector through Public-Private Mix (PPM) initiatives can foster standardised care and improve adherence to diagnostic protocols.

Policy Reforms and Increased Domestic Funding

Addressing macro-level barriers requires policy reforms that prioritize integrated TB–comorbidity care through sustained domestic financing, financial risk protection, multisectoral coordination, and accountable programme implementation. Increased domestic funding, reduced out-of-pocket expenditure, and innovative financing mechanisms, such as dedicated health insurance schemes or targeted health taxes, may help reduce financial barriers for patients. Strong governance, transparency, and accountability are equally essential to ensure that investments translate into improved functional readiness and integrated service delivery.²⁹

Community Engagement and Culturally Sensitive Interventions

Overcoming socio-cultural barriers requires strong community engagement. Initiatives that improve

Table I: Strategies for Enhancing Functional Readiness for Integrated TB Comorbidity Management

Strategy Domain	Key Interventions	Expected Impact
Capacity Building	Task-shifting to CHWs, LHWs, pharmacists; culturally sensitive communication training; NTP guideline adherence	Addresses workforce gaps in primary care
Infrastructure Investment	Upgrade diagnostic facilities (microscopy, GeneXpert); co-locate TB, diabetes, mental health services	Improves case detection; reduces logistical barriers
Referral Systems	Standardized protocols; integrated electronic health records; public private initiatives; interdepartmental coordination	Reduces delays; ensures comprehensive care
Policy Reforms	Increase domestic funding; reduce out-of-pocket costs; health insurance schemes; governance transparency	Mitigates financial barriers; improves accountability
Community Engagement	Health literacy campaigns; stigma reduction; female provider recruitment; culturally tailored interventions	Enhances service uptake and adherence

TB health literacy, reduce stigma related to TB and its comorbidities, and promote the role of female healthcare providers can strengthen trust and improve service uptake. Community partnership initiatives in Pakistan have shown that public engagement can support culturally responsive TB care and increase participation in TB-related services.³⁰ Interventions should therefore be tailored to local cultural norms and gender dynamics to ensure that integrated TB–comorbidity services are acceptable, accessible, and trusted by all population groups.

DISCUSSION

Evidence from multiple studies indicates that functional readiness at the point of service delivery is a fundamental requirement for effective TB–comorbidity integration in Pakistan, rather than merely an organizational concern. At the primary care level, BHUs and RHCs form the first line of TB detection, but limited infrastructure, workforce shortages, and weak diagnostic capacity often lead to delayed diagnosis and intervention, particularly in rural areas where geographic and financial barriers are substantial. Secondary care facilities, although relatively better equipped, continue to face coordination gaps and technological limitations. Tertiary centers have more resources but are constrained by high patient loads and interdepartmental silos, limiting truly integrated, patient-centered care. These challenges are closely linked with broader socioeconomic, cultural, and policy barriers that weaken the effectiveness of even advanced diagnostic and treatment services.

Clinical outcomes in TB care are intricately tied to the system's ability to provide integrated, patient-centred services. Evidence from integrated TB–comorbidity programmes has demonstrated improved bidirectional screening, treatment success, continuity of care, and reduced loss to follow-up.^{10,31} When patients with TB comorbidities such as depression or diabetes are treated within a fragmented system, multiple encounters with the health system often lead to gaps in care, poor

adherence, and ultimately, worse outcomes.³² In contrast, a system that exhibits high functional readiness characterised by well-trained staff, accessible diagnostics, integrated referral pathways, and culturally sensitive practices can bridge these gaps and significantly improve patient outcomes.

Moreover, the adoption of task-shifting strategies, in which non-specialist health workers are trained to perform initial screenings and provide basic management for comorbid conditions, has shown promise in mitigating human resource constraints, particularly in primary settings. However, the success of such strategies depends largely on concurrent investments in training, supervision, and infrastructural support, all of which are central to enhancing functional readiness.

The integration of TB–comorbidity care in Pakistan is further challenged by a fragmented health system, where public and private sectors often function separately with limited coordination. Regulatory and policy frameworks remain weak, particularly in relation to standardized operational guidelines, referral protocols, private-sector oversight, and monitoring systems for integrated care. As a result, many service-delivery decisions rely on ad hoc arrangements rather than structured reform. Strengthening these frameworks is essential for scaling up integrated TB–comorbidity care and achieving sustained improvements in service delivery. In addition to systemic and operational barriers, individual patient factors, such as low health literacy, stigma, and gender-related restrictions, play significant roles. Women, in particular, face distinct challenges that require gender-responsive interventions, including women-friendly TB services, engagement of female healthcare workers, community-based outreach, and culturally tailored health education to overcome mobility, stigma, and healthcare decision-making barriers.³³

Although integrated TB–comorbidity care is a promising approach, its success depends on a level of health-system preparedness that is currently

insufficient in Pakistan. Unless gaps in infrastructure, diagnostics, technology, workforce capacity, referral systems, and socioeconomic access are addressed, the benefits of integration will remain limited. Strengthening functional readiness must therefore form the foundation of any effective integrated TB–comorbidity programme.

Pakistan is at a critical point in advancing integrated TB care. Functional readiness at the point of service delivery should be viewed not as an aspirational goal, but as an essential requirement for timely, coordinated, and high-quality care. Addressing barriers across primary, secondary, and tertiary levels will require innovation, sustained investment, and collective action to ensure that patients receive the integrated care they need.

Policy Implications

Policymakers, healthcare providers, and stakeholders must work together to strengthen functional readiness across all TB care delivery points. Building on Pakistan's National Strategic Plan for Tuberculosis Control, these efforts should promote integrated, people-centered care through stronger primary healthcare, bidirectional comorbidity screening, digital health integration, public–private collaboration, and community engagement.

Functional readiness should be recognized as a strategic implementation priority within Pakistan's TB programme, not merely as a facility-level concern. Policy action should focus on embedding integrated TB–comorbidity care into routine services through sustainable domestic financing, workforce development, coordinated referral systems, and performance monitoring to support national TB control priorities.

By building on existing initiatives, including TB–diabetes care⁴ and integrated mental health services,³⁴ and by addressing the system-level gaps identified in this viewpoint, stakeholders can move Pakistan toward a more resilient, responsive, and patient-centred TB care system. A

functionally ready system, supported by adaptive capacity and coordinated service delivery, would be better equipped to manage TB and its comorbidities, improve patient outcomes, enhance quality of life, and strengthen public health infrastructure. The priority now is to translate these insights into practical action plans. Policymakers, healthcare administrators, and international partners must ensure that functional readiness is embedded across all levels of service delivery. Only then can integrated TB–comorbidity care achieve its full potential in reducing disease burden, improving patient well-being, and supporting Pakistan's progress toward global TB targets.

By adopting a holistic approach, Pakistan can transform its TB control programme into a model of integrated and functionally ready care that addresses both TB and its associated comorbidities. Although the path is challenging, strengthening functional readiness can improve outcomes beyond TB control and offer a practical framework for managing chronic and complex diseases in resource-limited settings.

Recognizing functional readiness as both an operational necessity and a strategic priority can drive the systemic changes needed for integrated TB–comorbidity care. This viewpoint calls for coordinated action aligning health policy, resource allocation, service delivery, and community engagement to build a unified, patient-centred, and high-performing TB care system in Pakistan.

CONCLUSION

Functional readiness at the point of service delivery is essential for successful integration of TB comorbidity care in Pakistan. Current gaps in infrastructure, diagnostic capacity, trained workforce, referral coordination, digital systems, and culturally responsive community engagement continue to fragment care across primary, secondary, and tertiary levels. Strengthening integrated TB care therefore requires sustained investment in capacity building,

diagnostic upgrades, standardized referral pathways, domestic financing, governance, and public–private coordination.

Addressing these barriers is not only a health-system priority but also an ethical imperative to ensure timely, equitable, and patient-centred care for vulnerable populations. Embedding functional readiness across all tiers of service delivery can help Pakistan move from fragmented TB management toward integrated, compassionate, and outcome-oriented care.

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CONFLICT OF INTEREST

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