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"STRENGTHENING EARLY DISEASE DETECTION THROUGH COMMUNITY-BASED SCREENING: A COMPREHENSIVE REVIEW OF TUBERCULOSIS, NON-COMMUNICABLE DISEASES, AND COMMON MENTAL DISORDERS."

Tejas Shah[1], Parth Thakar[2*], Venu Shah[3]

[1] Associate Professor, Community Medicine Department, GMERS Medical College and Hospital, Dharpur- Patan
[2] *Assistant Professor, Community Medicine Department, GMERS Medical College and Hospital, Dharpur- Patan
[3] Professor, Community Medicine Department, GCS Medical College, Hospital & Research Centre, Ahmedabad

***Corresponding Author:** Dr. Parth Thakar
*Community Medicine Department, GMERS Medical college and Hospital, Dharpur- Patan, Unjha-Patan Highway, Pincode- 384266

Abstract

Introduction

Tuberculosis (TB), non-communicable diseases (NCDs), and common mental disorders contribute substantially to the global and Indian disease burden, particularly in low-resource settings where delayed diagnosis remains a persistent challenge. Facility-based services alone have been unable to close the diagnostic gap, making community-based screening an essential strategy for early identification and timely referral.

Aims and Objectives

The review aims to evaluate the role, effectiveness, and challenges of community-based screening models for TB, NCDs, and mental health disorders. Specific objectives include synthesizing global, national, and Gujarat-based evidence, assessing screening strategies and innovations, and identifying gaps and opportunities for strengthening community-level early detection.

Methodology

A narrative review was conducted using PubMed, Google Scholar, Scopus, WHO databases, and national programme reports. Keywords related to community screening, TB detection, NCD screening, and mental health assessment were used. Inclusion criteria focused on community-based, CHW-led, or household-level screening approaches. Data were synthesised thematically across disease groups and screening strategies.

Content Review / Results

Evidence indicates that community-based TB screening through active case finding, contact tracing, and AI-supported chest radiography increases case detection by 30–60%. Community screening for NCDs improves early identification of hypertension, diabetes, and obesity, especially when integrated with household visits and digital tools. Mental health screening using PHQ-9, GAD-7, AUDIT, and mhGAP protocols enhances detection of depressive and anxiety disorders in underserved populations. Integrated multi-disease screening models, supported by Health and Wellness Centres, digital technologies, and AI tools, improve efficiency and scalability.

Conclusion
Community-based screening models substantially improve early detection of TB, NCDs, and mental health disorders. Integrating screening into routine CHW workflows, supported by digital tools and strong referral systems, is essential to advance Universal Health Coverage and national health goals. Future efforts must prioritize scalability, digital integration, supply-chain stability, and sustained community engagement.

Keywords: Community-based screening; Tuberculosis; Non-communicable diseases; Mental health; Early detection; Active case finding; Digital health.

Introduction

Early detection of priority health conditions is central to achieving Universal Health Coverage (UHC) and reducing preventable morbidity and mortality worldwide. Tuberculosis (TB), non-communicable diseases (NCDs), and common mental disorders collectively account for a significant proportion of the global disease burden, particularly in low- and middle-income countries. According to the WHO Global TB Report 2023, an estimated 10.3 million people developed TB in 2022, with 1.3 million deaths, making TB one of the top infectious killers globally [1]. Delayed case detection remains a key barrier to reducing transmission, as nearly 3 million cases remain either undiagnosed or unreported annually [2].

NCDs contribute an even larger share of global mortality. The WHO estimates that 74% of global deaths (41 million annually) are attributed to NCDs, primarily cardiovascular diseases, diabetes, cancers, and chronic respiratory diseases [3]. A substantial proportion of these deaths are preventable through early detection and timely management. Mental health disorders similarly represent a growing challenge: depression is now among the leading causes of disability worldwide, while anxiety and substance use disorders significantly impair social and economic functioning [4]. Despite this, nearly 70% of individuals with mental health conditions in low-resource settings remain untreated due to poor detection rates and limited service availability [5].

India bears a disproportionate share of this burden. The country accounted for 27% of the global TB cases in 2022, with approximately 2.4 million new cases notified under the National TB Elimination Programme (NTEP) [6]. Late diagnosis remains a critical barrier, particularly in rural and marginalized communities. India is also witnessing a rapid rise in NCDs, with the National NCD Monitoring Survey reporting that 28.5% of adults have hypertension, 12% have diabetes, and 41% are overweight or obese [7]. Mental health conditions affect an estimated 14% of the population, with common mental disorders showing higher prevalence in rural and underserved settings, yet limited screening at community level [8].

Gujarat reflects similar patterns. The India TB Report 2024 notes that Gujarat contributes approximately 5–6% of India's total TB notifications, and while the state has scaled up active case finding and digital diagnostics, pockets of rural and tribal districts still experience diagnostic delays [9]. For NCDs, the NFHS-5 (2019–21) data show that 15.4% of men and 17.5% of women in Gujarat have elevated blood sugar, while 23.5% of men and 25.3% of women have hypertension—figures consistent with the rising national trend [10]. Mental health screening in Gujarat remains limited, despite district-level reports indicating increasing stress, depression, and substance-use patterns, particularly among young adults and rural populations.

In this context, community-based screening has emerged as a crucial strategy to improve early detection by bringing diagnostic opportunities directly to households and underserved populations. Led by community health workers (ASHAs, ANMs, CHOs) and supported by digital tools, integrated community-level screening for TB, NCDs, and mental disorders strengthens case finding, improves referral linkages, and reduces the treatment gap. This review synthesizes available evidence on the scope, effectiveness, innovations, challenges, and policy implications of community-based screening, with special emphasis on models relevant to the Indian and Gujarat context.

Methodology

This narrative review was conducted using a structured approach guided by PRISMA principles to identify and synthesise evidence on the role of community-based screening in early detection of tuberculosis (TB), non-communicable diseases (NCDs), and common mental disorders. A comprehensive search of PubMed, Scopus, Google Scholar, WHO Global Health Observatory, and national program documents (including NTEP, NPCDCS, NMHP, NFHS-5, and India TB Reports) was undertaken for studies published between 2000 and 2024. Keywords and Boolean combinations such as *"community-based screening," "active case finding AND tuberculosis," "NCD screening AND community health workers," "mental health screening AND ASHA," "door-to-door screening," "integrated screening models," "India,"* and *"Gujarat"* were used to ensure broad yet specific coverage of relevant literature.

Studies were included if they assessed community- or household-level screening strategies led by frontline health workers and focused on early detection of TB, NCDs (hypertension, diabetes, obesity), or common mental disorders. Exclusion criteria eliminated studies that were clinic-based, lacked empirical outcomes, or focused solely on hospital diagnostics. Of the 1,324 records identified, duplicates were removed, titles and abstracts were screened, and full-text assessment resulted in the inclusion of 72 studies that met all criteria.

Data extraction captured study characteristics, screening strategies, diagnostic outcomes, community health worker involvement, digital innovations, and operational challenges. Due to heterogeneity in study designs, populations, and outcome measures, a thematic narrative synthesis approach was employed to interpret findings across disease domains.

Quality assessment was performed using JBI checklists for observational studies and Cochrane risk-of-bias tools for experimental research, while national program documents were verified with government datasets. As this review analysed previously published studies, no ethical approval was required; however, emphasis was placed on including studies that had obtained formal ethical clearance and demonstrated community engagement.

Figure 1: Methodology Preview

<table>
<tr><td colspan="2">Literature Identification</td></tr>
<tr><td colspan="2">• Databases: PubMed, Scopus, Google Scholar, WHO Global Health Observatory (GHO), National Programme Reports
• Time period: 2000–2024
• Search terms: "community-based screening", "active case finding", "NCD screening", "mental health screening", "ASHA/CHW-led screening", "India"
• Boolean operators: AND, OR, NOT</td></tr>
<tr><td colspan="2">SCREENING & SELECTION (PRISMA-Lite Pathway)</td></tr>
<tr><td>• Records identified: 1324
• Titles and abstracts screened</td><td>• Records identified after screening: 1012
• Full texts reviewed
• Studies included: 72</td></tr>
<tr><td>ELIGIBILITY CRITERIA</td><td>DATA EXTRACTION</td></tr>
<tr><td>Inclusion
• Community-based or household-level screening
• Tuberculosis (TB), Non-Communicable Diseases (NCDs), or mental health disorder early detection
• CHW / ASHA / ANM / CHO-led screening
• Studies from LMICs (focus on India and Gujarat)
Exclusion
• Clinic- or hospital-only screening</td><td>• Study characteristics (place, population)
• Screening strategy used
• Diagnostic yield
• Workforce roles (ASHAs, CHOs, ANMs)
• Digital tools / AI / mobile systems used</td></tr>
</table>

• Editorials or commentaries with data • Studies unrelated to early detection	• Barriers and operational challenges
QUALITY ASSESSMENT	**SYNTHESIS METHOD**
• JBI appraisal for observational studies • Cochrane Risk of Bias (RoB) tool for interventional studies • Cross-checked government reports with national datasets	Narrative thematic synthesis due to heterogeneity Themes: • TB screening • Community-based NCD screening • Mental health detection • Integrated screening innovations • Digital and AI-enabled approaches • Operational gaps • Policy implications

Community-Based Screening for Tuberculosis

In addition to delayed diagnosis, gaps along the tuberculosis care cascade—particularly pre-treatment loss to follow-up—remain substantial in high-burden countries, underscoring the importance of community-based linkage and treatment initiation mechanisms [11]. Analyses of tuberculosis care cascades in high-burden countries show that 15–25% of diagnosed TB patients are lost before treatment initiation, highlighting substantial pre-treatment loss to follow-up and the need for community-based linkage mechanisms to ensure timely treatment initiation. [11]. Evidence shows that active case finding (ACF) in communities—through door-to-door symptom screening, household contact tracing, and mobile chest X-ray camps—can increase TB case detection by 30–60% in high-burden settings [12].

Recent global assessments report that over 1.28 billion adults worldwide live with hypertension, yet fewer than 50% are diagnosed and only about 20% achieve adequate control, underscoring persistent gaps in detection and long-term management that justify population-level screening strategies [13].

Gujarat has shown similar positive impacts. According to the India TB Report 2024, the state screened 12.8 million people through community campaigns, detecting ~45,000 presumptive and 5,700 confirmed TB cases, with community screening contributing substantially to total notifications. Mobile diagnostic vans equipped with AI-enabled chest radiography in Chennai reduced the time to diagnosis by 30–40%, helping identify cases earlier among migrants and slum populations [14].

Evidence from digital health intervention studies indicates that mobile health–based follow-up and remote monitoring can improve medication adherence and cardiovascular risk factor control by 10–25%, particularly for hypertension and diabetes, compared with usual facility-based care alone [15].

Community-Based Screening for Non-Communicable Diseases

Community-based screening has emerged as a cornerstone of preventive care for non-communicable diseases, particularly in underserved and rural populations where routine health-seeking is limited. Globally, NCDs are responsible for nearly 74% of all deaths, and hypertension alone affects about 1.28 billion adults, with almost half remaining undiagnosed. Evidence from outreach-based models shows that simple interventions such as door-to-door blood pressure measurement, capillary blood glucose testing, and basic cardiovascular risk profiling can substantially bridge this diagnostic gap. When delivered by trained community health workers, these strategies have been shown to improve early detection rates by approximately 20–40%, highlighting their value in shifting NCD care from late presentation to early identification and prevention [16].

In India, this preventive approach has been institutionalized through the Health and Wellness Centre (HWC) framework, which mandates population-based screening of adults aged 30 years and above for major NCDs, tuberculosis symptoms, and common mental health conditions. Under the National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS) and the Ayushman Bharat–HWC initiative, large-scale community screening has been rapidly expanded across districts. Programme reports from 2022–2023 indicate that more than 350 million adults were screened for hypertension and diabetes nationwide, resulting in a marked increase in early case detection and timely referral to primary care facilities. These findings from national programme data underscore the role of HWCs in strengthening primary-level prevention and continuity of care through systematic community-based screening and referral linkages [17].

Meta-analytic evidence shows that individuals with diabetes mellitus have a 2–3-fold higher risk of developing active tuberculosis and experience poorer TB treatment outcomes, supporting integrated TB–diabetes screening and coordinated care approaches[18]. Community-based NCD screening through ASHAs and CHOs has improved early detection in rural districts, with studies from Rajasthan showing up to 30% higher detection rates when screening is integrated into household visits and village health days [19]. The use of digital BP monitors, glucometers, and mobile reporting apps has further enhanced coverage, reducing documentation gaps and improving referral linkage to primary care centres [20].

Integrated Multi-Disease Community Screening Models

Integrated community-based screening models—combining TB, NCDs, and mental health assessment—have gained global acceptance for improving efficiency, reducing costs, and strengthening continuity of care [21-23]. It is also important to study the diagnostic yield as one of the studies conducted to find in Lesotho noted that although the intervention helped reduce diagnostic delays and improved linkage to services, the diagnostic yield remained low [24]. Evidence from large-scale programmes in Africa and Asia shows that integrating TB with HIV, diabetes, and hypertension screening can increase case detection by 25–45% while lowering operational costs by 15–30% due to shared workforce and logistics [25, 26]. Community screening platforms that utilise multi-disease tools, mobile health vans, and digital triage applications have also demonstrated strong feasibility in low-resource settings.

In India, integrated screening has expanded under the Health and Wellness Centres (HWCs) platform, which mandates community-level screening for five major NCDs, TB symptom screening, and basic mental health assessment[27].Implementing integrated household visits leads to increase in the uptake of screening compared to disease-specific campaigns, with improved referral linkages and reduced duplication of CHW workload. Combined TB–diabetes and TB–HIV screening models are now recommended nationally because diabetes increases TB risk by 2–3 times, and HIV coinfection increases poor outcomes significantly [28].

Gujarat has piloted integrated community screening through mobile diagnostic units and FHW-led village health days, where adults are screened simultaneously for hypertension, diabetes, anemia, and TB symptoms. Programme data from 2023 show that integrated screening increased follow-up rates by 35% and early diagnosis of both TB and NCDs in high-burden tribal blocks such as Dahod and Narmada [29]. Digital innovations—including AI-enabled chest X-rays, mobile NCD applications, and unified community health registers—have further strengthened efficiency by reducing missed cases and ensuring real-time monitoring [30].

Operational Challenges in Community-Based Screening

Despite strong evidence of benefit, community-based screening for TB, NCDs, and mental disorders faces several operational challenges that affect coverage, quality, and follow-up. A major barrier is human resource constraints: community health workers are often overburdened with multiple programmes, resulting in limited time for systematic screening, incomplete coverage, and variable data quality. Multi-country analyses show that CHWs in LMICs frequently manage 10–15

different programme tasks, leading to fatigue and compromised performance in screening and follow-up [31]. In addition, gaps in training and supervision affect the accuracy of measurements (BP, glucose, anthropometry) and the correct use of mental health tools, which can reduce the sensitivity and specificity of community screening [32].

Supply chain and logistics issues are another recurring constraint. Stock-outs of sputum cups, reagents, glucometer strips, or BP machine batteries can disrupt screening campaigns, particularly in remote rural and tribal areas. Evaluations from Indian NCD and TB programmes have documented interruptions in 15–30% of planned screening sessions due to logistic bottlenecks and delayed replenishment [33]. Stigma and sociocultural barriers further limit participation in screening, especially for TB and mental health. Fear of social exclusion, misconceptions about TB transmission, and internalised stigma around depression and anxiety can lead to under-reporting of symptoms and refusal of home visits, with qualitative studies from South Asia consistently highlighting these themes [34].

Finally, referral and follow-up gaps reduce the impact of screening. Even when risk is identified at the community level, a proportion of individuals never reach facilities for confirmatory testing or treatment initiation. Programme data from integrated screening pilots indicate that 20–40% of high-risk or positive-screened individuals are lost between community identification and facility-level confirmation, mainly due to distance, indirect costs, and lack of perceived need [35]. Addressing these operational challenges through better CHW support, reliable logistics, stigma-reduction strategies, transport or teleconsultation support, and strong feedback loops between community and facility levels is essential for realising the full potential of community-based screening models.

Innovations, Policy Framework, and Future Directions

Recent innovations have strengthened the impact of community-based screening by improving accuracy, speed, and reach of early disease detection. Digital tools such as AI-enabled chest radiography, mobile NCD screening applications, tele-mental health platforms, and unified digital health IDs have enabled more efficient triage and real-time monitoring in remote settings. Large-scale evaluations in Asia and Africa show that AI-supported chest X-ray interpretation improves TB detection sensitivity and reduces the need for expert radiologists, while digital platforms for hypertension and diabetes monitoring enhance continuity of care by enabling rapid referrals and automated alerts [36]. Similarly, app-based PHQ-9 and GAD-7 screening tools have improved feasibility of mental health detection in community settings, particularly when supported by remote supervision from mental health professionals.

Policy frameworks in India have increasingly embraced integrated community-based screening as part of national health strategies. Under Ayushman Bharat, Health and Wellness Centres mandate population-based screening for NCDs, TB symptom assessment, and basic mental health services. National TB Elimination Programme guidelines also recommend community screening in high-risk groups, while the National Mental Health Programme integrates mhGAP-based community outreach to address detection gaps. Gujarat has further operationalised these frameworks through mobile diagnostic vans, ASHA-facilitated multi-disease screening, and digital monitoring systems in tribal districts, contributing to improved early detection rates and reduced diagnostic delays [37].

Looking ahead, future directions include the greater use of AI-driven decision support, portable point-of-care diagnostics, and integrated digital health ecosystems that link community-level data with primary and tertiary care. Strengthening supervision structures for CHWs, reducing stigma through community engagement, and improving referral pathways are critical for maximising screening impact. Evidence shows that multi-disease, digitally supported community screening models are cost-effective, scalable, and capable of addressing overlapping burdens such as TB–diabetes comorbidity and mental health–NCD interactions. Continued investment in digital infrastructure, CHW capacity building, and interoperable health information systems will be essential to achieving meaningful improvements in early detection and health outcomes in both India and Gujarat [38].

Discussion

Community-based screening has emerged as a pivotal approach in addressing the rising burden of tuberculosis (TB), non-communicable diseases (NCDs), and common mental disorders, particularly in low-resource settings such as India and Gujarat. The global epidemiological landscape underscores substantial detection gaps across these conditions, with millions remaining undiagnosed due to poor access, delayed care-seeking, stigma, and limitations of facility-based services. The findings of this review reinforce that bringing screening to households through trained frontline workers significantly improves early identification, referral, and treatment uptake.

For TB, delayed diagnosis continues to contribute to transmission and mortality. Global estimates indicate that nearly three million individuals are "missing" from TB care each year due to under-reporting or inadequate access to diagnostics [1,2]. Community-based active case finding, contact tracing, and AI-enabled chest radiography have demonstrated substantial improvements in detection both globally and in India. Evidence shows that targeted ACF yields 30–60% higher detection of symptomatic individuals than passive case finding, while household contact screening identifies 4–7% of active TB cases, highlighting its substantial epidemiological value [12,14]. National campaigns in India have screened over 250 million individuals, identifying large numbers of presumptive and confirmed TB cases, demonstrating the effectiveness of decentralised population screening models [6,13]. Gujarat's adoption of mobile diagnostic vans and AI-supported chest X-ray reading has further reduced diagnostic delays and improved identification among hard-to-reach populations [9,15].

The rising burden of NCDs globally and in India similarly underscores the need for early, community-led detection. WHO data emphasise that NCDs contribute to 74% of global mortality [3,16]. In India, national surveys report high prevalence of hypertension (28.5%) and diabetes (12%), yet awareness and control remain suboptimal [7,17]. Community-based BP and glucose screening models, when implemented by ASHAs, ANMs, or CHOs, substantially increase the early detection of high-risk individuals and facilitate linkage to primary care. Gujarat's community-level screening under NHM and NPCDCS has demonstrated improved detection—up to 30% higher in rural settings—when integrated with routine household visits and village health days [18,19]. Digital innovations such as mobile NCD applications and real-time reporting further enhance efficiency and continuity of care [20].

Mental health conditions remain profoundly underdiagnosed in India, where almost 80% of affected individuals do not receive treatment [8]. Community-based mental health screening using PHQ-9, GAD-7, AUDIT, and WHO mhGAP tools has shown high feasibility and enables early identification of common mental disorders. CHW-led screening pilots in India have reported 8–12% positivity for moderate-to-severe depressive symptoms, demonstrating their ability to detect unmet mental health needs in rural and tribal communities. Integration with telepsychiatry platforms and referral pathways within Health & Wellness Centres has further strengthened early intervention.

Integrated multi-disease screening models—combining TB, HIV, diabetes, hypertension, and mental health—offer cost-effective and scalable solutions. Systematic reviews indicate that integrated screening improves overall detection rates while reducing programmatic costs through shared logistics and workforce [26]. In India, the Ayushman Bharat–HWC platform formally institutionalises integrated screening at population level, providing a structured platform for multi-disease outreach [27]. Gujarat's use of mobile vans and integrated community health records has improved follow-up and continuity of care in underserved districts [29].

Despite the robust evidence supporting community-based screening, several operational challenges persist. CHWs often juggle multiple programmes, leading to overwork and reduced quality of screening—a finding consistently reported across LMIC evaluations [31,32]. Supply-chain disruptions, including stock-outs of glucometer strips, sputum cups, and batteries for BP monitors, frequently interrupt scheduled screening activities [33]. Stigma surrounding TB and mental illness continues to suppress symptom disclosure and follow-up, particularly among women and rural

populations [34]. Moreover, attrition along the referral chain remains a critical bottleneck, with 20–40% of positively screened individuals failing to reach facilities for confirmatory diagnosis [35].
Key opportunities lie in digital innovation, AI-enabled diagnostics, and portable point-of-care technologies. AI-supported chest radiography has shown high accuracy in TB triage and is particularly valuable in regions with limited radiology expertise [36]. Digital health records, telemedicine platforms such as e-Sanjeevani, and algorithm-based NCD risk scoring can greatly enhance community screening workflows and clinical decision-making [37]. Community-centred digital models integrating TB, NCD, and mental health data have been shown to improve detection and follow-up in several Indian pilot programmes [38].
Overall, the evidence strongly supports the expansion of community-based, integrated, and digitally supported screening strategies to accelerate early detection across TB, NCDs, and mental health conditions. Strengthening CHW training, ensuring reliable supply chains, reducing stigma, and enhancing referral linkages will be essential for optimising these programmes. With sustained investment and innovation, community-driven screening can substantially improve population health outcomes and advance progress toward India's UHC and SDG targets.

Conclusion

Community-based screening represents a transformative strategy for improving early detection of tuberculosis, non-communicable diseases, and common mental disorders in low-resource settings such as India and Gujarat. The review highlights that decentralised, CHW-led, and digitally supported screening initiatives significantly increase the identification of undiagnosed cases, reduce diagnostic delays, and strengthen linkage to appropriate care. Approaches such as active case finding for TB, door-to-door NCD screening, and the use of simple mental health tools (PHQ-9, GAD-7, AUDIT, mhGAP) demonstrate strong feasibility and measurable population health benefits. Integration through platforms like Health & Wellness Centres further enhances reach and cost-effectiveness. Emerging digital innovations—including AI-enabled chest radiography, telemedicine, and mobile health applications—offer promising avenues for scaling up and modernising community screening efforts. Overall, strengthening community-based detection systems is essential to meet national and global commitments related to UHC, SDG targets, the WHO END TB Strategy, and the Global NCD Action Plan.

Limitations

Community-based screening, despite its demonstrated benefits, faces several operational and structural limitations. The effectiveness of screening often varies due to workload pressures on community health workers, inconsistent quality of training, and frequent supply-chain interruptions that result in shortages of essential materials such as glucometer strips, BP batteries, and sputum cups. Stigma surrounding conditions like TB and mental illness continues to impede honest symptom disclosure and community participation, especially among socially vulnerable groups. Additionally, a significant proportion of individuals identified as high-risk are lost to follow-up due to inadequate referral mechanisms, long travel distances, and poor health awareness. Data management challenges—particularly reliance on paper-based systems in some areas—further slow reporting and hinder timely decision-making. These limitations highlight the need for more robust systems and stronger institutional support to maximise the impact of community screening.

Recommendations

Strengthening community-based screening requires a focused set of practical and scalable strategies. Priority should be given to enhancing CHW capacity through regular skill-based training, supportive supervision, and the use of simple digital decision-support tools. Integrating multi-disease screening—combining TB symptom checks with BP, glucose, and mental health assessments—can improve efficiency and reduce missed opportunities. Expanding digital innovations, including AI-supported diagnostics, telemedicine, and electronic health records, can

streamline workflows and improve follow-up. Ensuring uninterrupted supplies through stronger logistics systems, reducing stigma through targeted community engagement, and improving referral pathways using reminders, CHW accompaniment, and teleconsultation can significantly increase treatment uptake. Overall, investment in training, technology, and community engagement will be essential to scale up effective screening models and sustain their long-term impact.

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