Highlights of CAD4TB Publications

Performance

CAD4TB had the highest overall accuracy (73.8% specificity at 90% sensitivity), was significantly more specific than other algorithms, and achieved the minimum WHO target accuracy for a TB triage test.	[India, Madagascar, South Africa, Tanzania, the Philippines, South Africa, and Vietnam: Worodria W et al. 2024] (preprint)
The AUC (95% CI) of CAD4TB against the microbiological reference standard (Xpert Ultra and/or sputum culture positivity) was 0.90 (0.82-0.97).	[South Africa, Zambia, Zimbabwe: Scott A et al. International Journal of Infectious Diseases. 2024]
The newer version (CAD4TB 7) significantly outperformed the predecessor (CAD4TB 6), performing better than human readers and meeting WHO TPP values.	[Bangladesh: Qin ZZ et al. PLOS Digital Health. 2022]
CAD4TB v7 and two other CAD software solutions emerged from this evaluation as excellent alternatives for human CXR interpretation, performing on par with the Expert Reader and significantly better than the Intermediate Reader.	[Vietnam: Codlin A et al. Nature Scientific Report. 2021]
CAD4TB met the WHO's TPP at 90% sensitivity.	[Qin ZZ et al. The Lancet Digital Health. 2021]
CAD4TB performs significantly better than experienced human readers in detecting TB-related abnormalities.	[Qin ZZ et al. The Lancet Digital Health. 2021] [Tanzania: Breuninger et al. PLOS One. 2014]
CAD4TB is an accurate tool for community-based TB screening for prevalence surveys in Kenya. CAD4TB 6 met the optimal WHO TPP.	[Kenya: Mungai B et al. PLOS Global Public Health. 2022]
CAD4TB is on par with human expert readers.	[Vietnam: Codlin A et al., Nature Scientific Report, 2021], [South Africa: Fehr et al., npj digital medicine, 2021], [G. Tavaziva et al., Clinical Infectious Diseases, 2021], [Pakistan: Murphy et al., Nature Scientific Reports, 2020] [Philippines: Philipsen et al., IJTLD, 2019], [London: Melendez et al., IJTLD, 2018], [Zambia: Melendez et al., IJTLD, 2017], [South Africa: Hogeweg et al., IEEE Trans Med Imaging, 2015], [Tanzania: Steiner et al. Public Health Action. 2015]
In a community-based multi-disease screening survey in an HIV-endemic rural area, CAD4TB achieved comparable sensitivity and specificity to the radiologist. CAD4TB has the	[South Africa: Fehr et al. npj digital medicine. 2021]

potential to replace radiologists for triaging CXRs in prevalence surveys.	
In Tanzania, CAD4TB performance was significantly better than a clinical officer's.	[Tanzania: Breuninger et al. PLOS One. 2014]

Efficiency & Effectiveness

The number of cases that can be quickly analysed by CAD4TB compared to manual reading by human radiologists demonstrates the efficiency of the technology in resource-limited countries such as Tanzania.	[Tanzania: Mzurikwao D et al., Research Square. 2024] (preprint)
CAD has the potential to be a useful and cost-effective screening tool for TB in a resource-poor HIV-endemic African setting, assisting active case finding strategies to break the TB transmission cycle.	[Kenya, South Africa, Zambia: Scott AJ et al. Open Forum Infectious Diseases. 2024]
In the context of community-based ACF in endemic TB/HIV settings, using POC Xpert and x-ray screening with CAD analysis is both feasible and had high diagnostic yield for TB and COVID-19.	[South Africa, Zambia, Zimbabwe: Scott AJ et al., International Journal of Infectious Diseases. 2024]
The combined use of digital X-ray and CAD4TB in this project replaced the human processing and interpretation of X-ray and contributed to the high CXR coverage. The proportion of people diagnosed with TB who had symptoms was very small. This suggested that most of the detected TB cases (>80%) were asymptomatic and were captured by the contribution of CXR.	[Papua New Guinea: Dakulala P et al., BMC Public Health. 2024]
An experimental calibration method achieved a viable CAD threshold for testing. High CAD scores can identify subclinical TB and those at risk of progression to bacteriologically confirmed TB disease in the near term.	[Nigeria: Eneogu RA et al. PLOS Global Public Health. 2024]
Delft Light portable digital X-ray and CAD4TB in parallel with the WHO 4-symptom screen achieved a lower pre-diagnostic loss of presumptive TB cases. The W4SS + portable X-ray with CAD screen-based intervention was more efficient for TB case yield: four times the number of TB cases yield than symptom-only-based screening intervention.	[Nigeria: Babayi et al. Public Health Action. 2023]

CAD may provide viable options to increase TB detection, especially in low-resource areas where there may be no available expert radiologists.	[Gelaw SM et al. PLOS Global Public Health. 2023]
Ultra-portable X-rays with CAD were overall well received to decentralise radiological assessment for TB.	[Qin ZZ et al. PLOS ONE. 2023]
The per-screen costs for the two CAD software programs with a perpetual licensing costing structure are considerably lower than the cost with radiologists for high throughput in ACF scenarios. With high throughput scenarios, the per-screen cost for CAD4TB is 73% lower than a radiologist for ACF and 61% lower for facility-based screening.	[Pakistan: Bashir S et al. PLOS ONE. 2022]
TB screening using Delft Light Backpack X-ray and CAD4TB during community-based ACF in hard-to-reach Niger Delta communities of Nigeria showed a high TB prevalence among participants. Nationwide deployment of the instrument in hard-to-reach areas is recommended.	[Nigeria: Odume B et al. Public Health Action. 2022]
CAD4TB v7 had a significantly higher AUC than v6, 0.903 (95% CI: 0.897–0.908) compared to 0.823 (0.816–0.830). CAD4TB 7 results in a steep initial increase of Xpert test saved. Until a threshold of 75, greater numbers of Xpert tests can be saved using CAD4TB v7.	[Bangladesh: Qin ZZ et al. PLOS Digital Health. 2022]
A combination of chest X-ray analysis by CAD4TB and symptomatology is of immense value in screening a large population at risk in a developing, high-burden country. It is significantly a more effective tool for screening and early diagnosis of TB in individuals who would otherwise go undiagnosed.	[Pakistan: Nishtar et al. Pak J Med Sci. 2022]
Using CAD4TB can save molecular tests such as Xpert tests.	[Qin ZZ et al. The Lancet Digital Health. 2021], [Pakistan: Habib et al. Scientific Reports. 2020], [Pakistan: Zaidi et al. Nature Scientific Reports. 2018], [Bangladesh: Rahman T et al. European Respiratory Journal. 2017]
All five AI algorithms (incl. CAD4TB) significantly outperformed the radiologists and reduced the number of Xpert tests required by 50% while maintaining a sensitivity above 90%.	[Qin ZZ et al. The Lancet Digital Health. 2021]

Triage using AI-based CXR interpretation can be cost-effective and even cost-saving relative to standard practice among persons with suspected TB in Pakistan. These results are likely applicable to other low-income, high-TB-burden settings.	[Pakistan: Nsengiyumva et al. Open Forum Infectious Diseases. 2021]
Community-based screening with innovative activities, comprising sensitive screening and diagnostic tools, including a digital X-ray and CAD4TB, effectively improves TB case detection.	[Pakistan: Wali A et al. Public Health Action. 2021]
CAD4TB, as a triage tool to pre-screen people with diabetes for Xpert testing, can improve case-detection while potentially reducing program costs with more rational use of expensive molecular tests.	[Pakistan: Habib et al. Nature Scientific Reports. 2020]
In Pakistan, the cost per screened subject using CAD4TB v6 is almost half in comparison to screening without, while almost 2.5 times higher daily throughput.	[Pakistan: Murphy et al. Nature Scientific Reports. 2020]
Used as a pre-screening system in TB-endemic regions, CAD4TB allows for the testing of much larger numbers of subjects at a fraction of the cost.	[Pakistan: Murphy et al. Nature Scientific Reports. 2020]
In the Philippines, CAD4TB as a second reader showed a 22% increase in TB detection and could help detect additional TB-positive cases that were initially missed at limited additional costs.	[Philippines: Philipsen et al. IJTLD. 2019]
In Pakistan, CAD4TB, as a triage tool, could minimise the use of expensive molecular tests in low-resource settings.	[Pakistan: Zaidi et al. Nature Scientific Reports. 2018]
Reduces cost per identified TB case and the cost per screened subject by almost half.	[Philippines: Philipsen et al., Nature Scientific Reports. 2015]
Useful where trained human readers are scarce.	[Zambia: Muyoyeta et al. PLOS One. 2014]

Paediatric TB

The performance of CAD4TB v7 to identify TB in children (<13 years) significantly improved after fine-tuning it with a set of well-characterised paediatric chest x-rays. CAD has the potential to be a useful additional diagnostic tool for paediatric tuberculosis.	[South Africa: Palmer et al. PLOS Glob Public Health. 2023]

Key and Vulnerable Populations

TB / HIV

Urine SILVAMP-LAM/Determine-LAM plus dCXR-CAD4TB diagnostics identified more hospitalised PHIV with TB than usual care.	[Malawi: Burke, RM et al. Clinical Infectious Diseases. 2024]
In a community-based multi-disease screening survey in an HIV-endemic rural area, CAD4TB achieved comparable sensitivity and specificity to the radiologist. HIV serostatus did not impact CAD4TB's performance.	[South Africa: Fehr et al. npj digital medicine. 2021]
Digital CXR using CAD4TB with universal HIV screening significantly increased timelines and completeness of HIV and TB diagnosis.	[Malawi: MacPherson et al. PLOS MEDICINE. 2021]
Combined use of mobile X-ray and CAD4TB to identify TB among high-risk groups to improve early TB diagnosis can deliver a major contribution to TB control in Romania.	[Romania: Mahler B et al. BMJ Open. 2021]
In an HIV-negative population, CAD4TB v6 met WHO-recommended minimal accuracy for pulmonary tuberculosis triage tests.	[Pakistan: Khan FA et al. The Lancet Digital Health. 2020]

Diabetes

CAD4TB performance was stable regardless of diabetes status.	[India, Madagascar, South Africa, Tanzania, the Philippines, South Africa, and Vietnam: Worodria W et al. 2024]
CAD4TB offers good diagnostic accuracy as triage for TB screening among diabetes patients.	[Pakistan: Habib et al. Nature Scientific Reports. 2020]
CAD4TB with X-ray systems allowed not only rapid and systematic triage to Xpert testing but also found quantitatively more TB-like abnormalities in those with Diabetes Mellitus.	[Bangladesh: Paul KK et al., Science Direct. 2020]
In Indonesia, CAD4TB has the potential as a triage tool for TB screening in people living with diabetes, thereby significantly reducing the need for microbiological examination.	[Indonesia: Koesoemadinata RC et al. IJTLD. 2018]

Screening in Prison

Screening by mobile X-ray systems with automated interpretation could reduce the number of confirmatory tests required and enable screening to be more rapid in high-burden TB settings while still maintaining sufficient sensitivity.	[Brazil: Soares et al., The Lancet Regional Health – Americas. 2023]

The inclusion of digital CXR in systematic TB screening detected additional TB cases among inmates that would otherwise have been missed, and using CAD4TB may also improve the performance of the screening algorithm.	[South Africa: Kim et al., IJTLD. 2020]
High uptake of new screening tools, such as digital X-rays with CAD4TB, may be particularly feasible, reliable, and highly acceptable in prison settings.	[Pakistan: Wali et al. BMC Public Health. 2019]
CAD4TB reliably evaluates CXRs from a mostly asymptomatic prison population, with a performance comparable to local readers in Tanzania.	[Tanzania: Steiner et al., Public Health Action. 2015]

Non-TB Abnormalities

CAD4TB has the potential to simultaneously provide information on other non-TB abnormalities that might be of clinical relevance in communities alongside TB. CAD can be useful to LMICs where there is no routine screening for non-TB abnormalities, and there is often a shortage of qualified radiologists.	[Zambia, South Africa: Ngosa D. et al. BMC Infect Dis. 2023]

Silicosis

CAD4Silicosis achieved a high AUC of 0,926 and 0,903 against readers 1 and 2 (silicosis classified as ILO≥1/1). On the 90% sensitivity criterion, a specificity of 82.6% against reader 1 and 74.9% against reader 2.	[South Africa: Ehrlich R et al. Int. J. Environ. Res. Public Health. 2022]