Performance of CAD4TB Artificial Intelligence Technology in TB Screening Programs Among the Adult Population in South Africa and Lesotho

Nonhlanhla Nzimande

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NTP Lesotho provided data from the National Tuberculosis Prevalence Survey in Lesotho based on a data-sharing agreement

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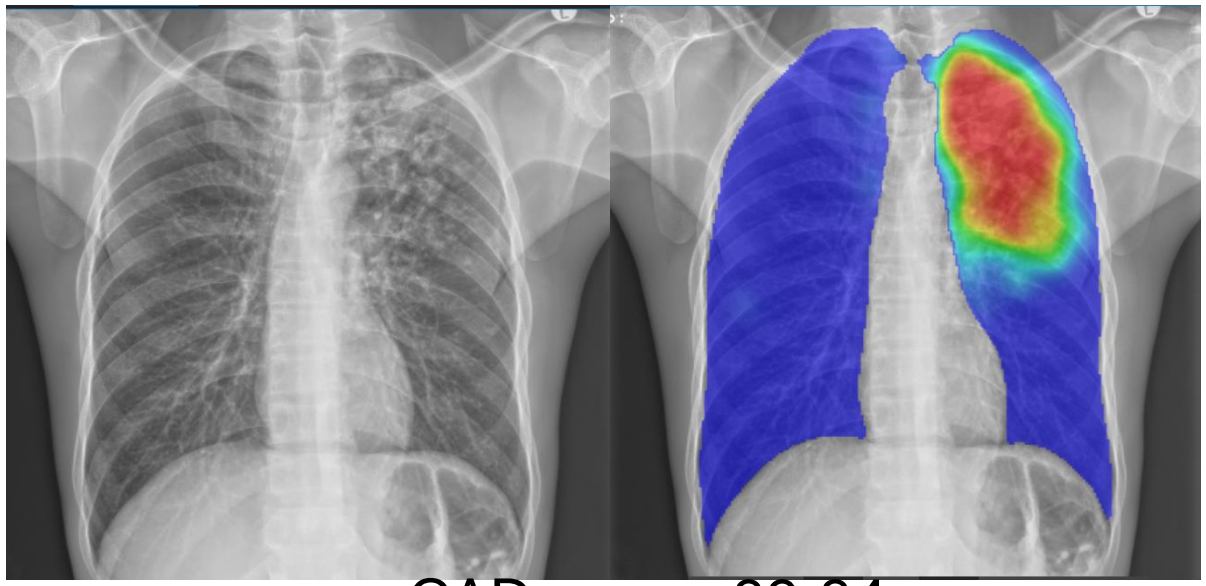
Introduction

- TB is still a significant public health concern:
  - ❑10.6 million developed TB in 2022
  - ❑1.3 million TB-related deaths
  - ❑Over 4 million undiagnosed cases
- Low and middle-income countries most vulnerable
- Urgency to reduce diagnostic gap
- WHO TPP recommendation of triage tests (90% sensitivity & 70% specificity)
- In 2021, WHO endorsed the use of AI products for chest X-rays in TB screening

CAD4TB



CAD score: 89.84

TB Triage+ study

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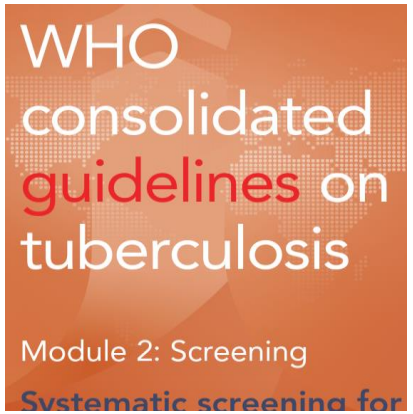
Rationale

a) WHO endorsement of Computer-Aided Detection (CAD)



3.2 Use of computer-aided detection software for automated reading of digital chest radiographs

10. Among individuals aged 15 years and older in populations in which TB screening is recommended, computer-aided detection software programmes may be used in place of human readers for interpreting digital chest X-rays for screening and triage for TB disease *(new recommendation: conditional recommendation, low certainty of evidence).*

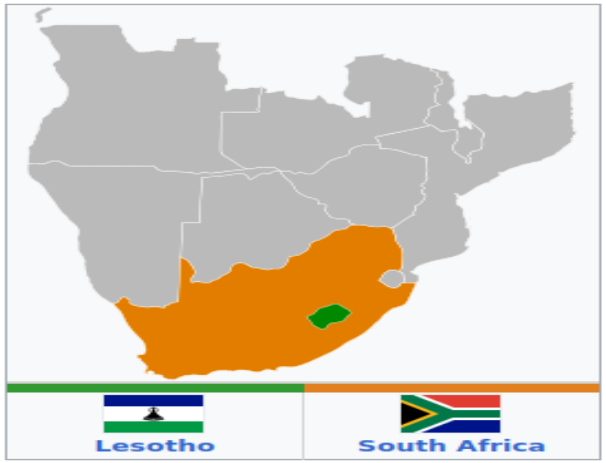
Retrospective case-control accuracy study

Two parent studies

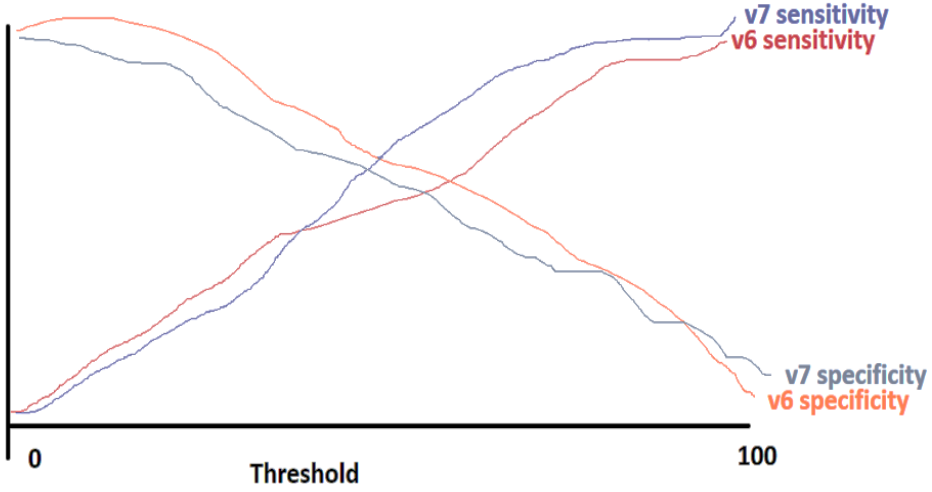
- ❑TB Triage+ accuracy study
- ❑Lesotho TB National Prevalence study

- Aim
- Objectives

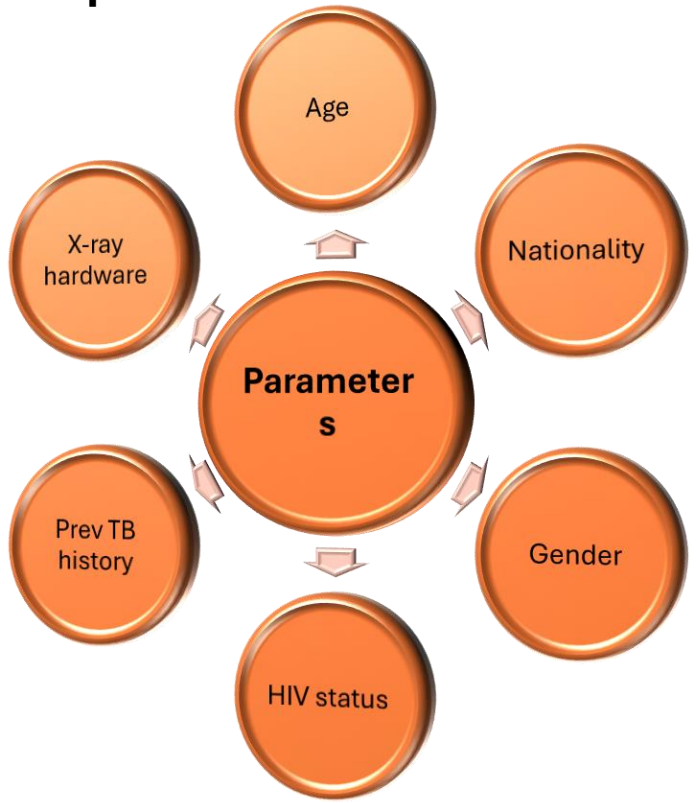
b) Focus on African Populations



c) Threshold-specific CAD analysis



d) Effects of various parameters on CAD



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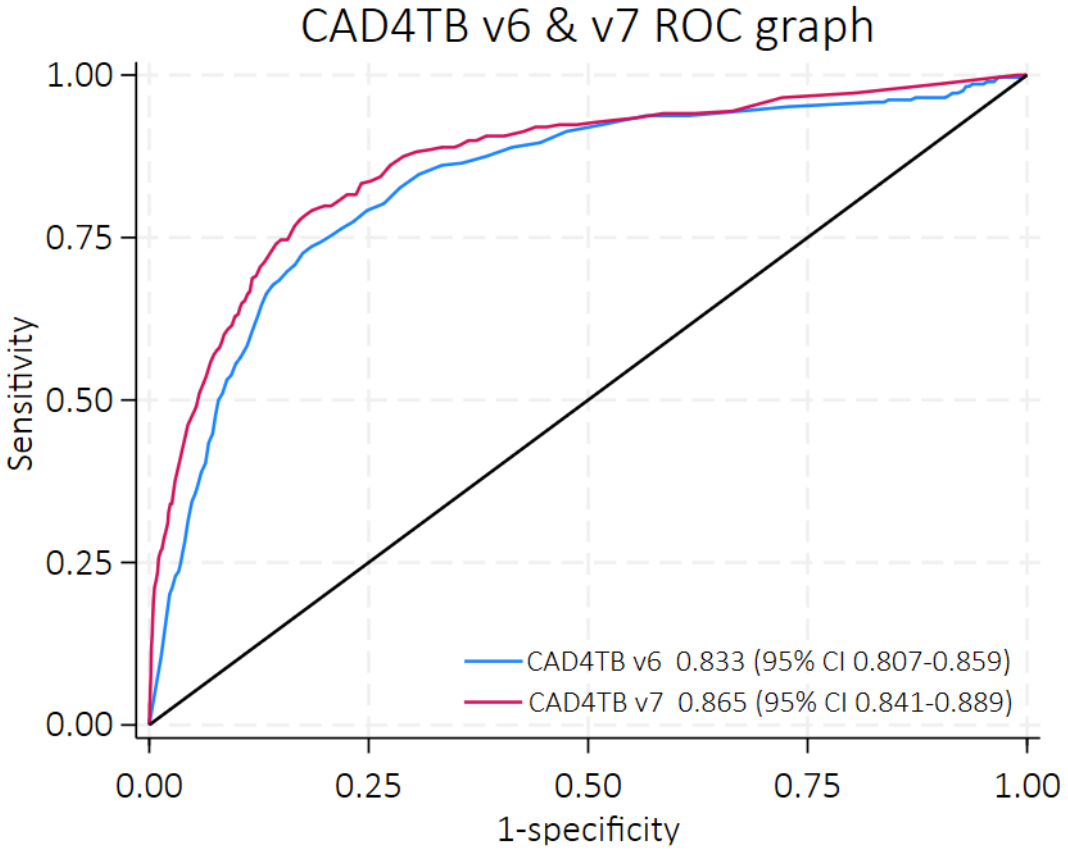
Participants' characteristics

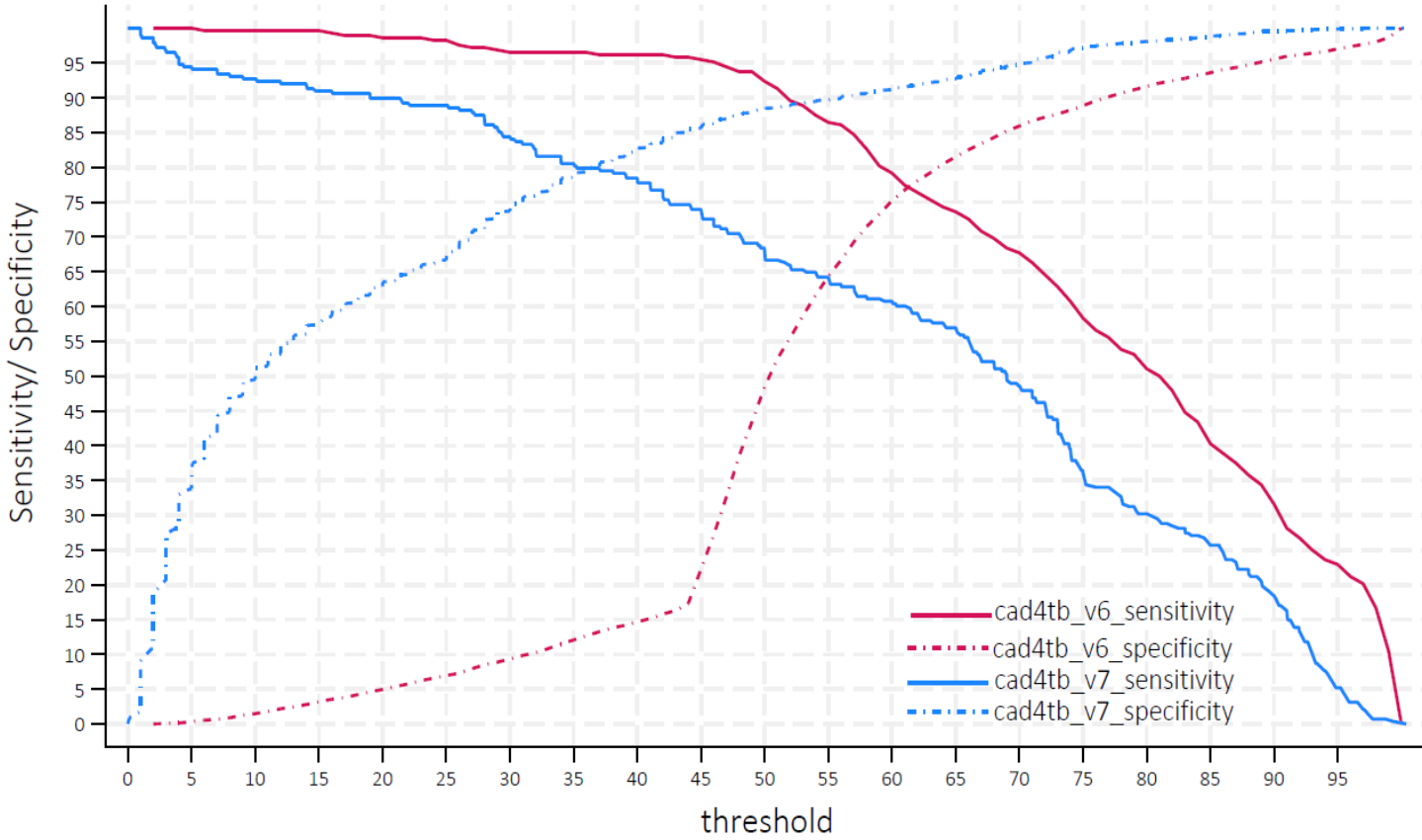
	TB negative 6 236, (95.59%) N, (%)	TB positive 288, (4.41%) N, (%)	Total (6 524) N, (%)
Age (yrs.) Mean, SD	49, 18.63	48, 17.61	49, 18.59
Age group			
15-19	306 (4.91)	7 (2.43)	313 (4.80)
20-29	797 (12.78)	44 (15.28)	841 (12.89)
30-39	1 005 (16.12)	59 (20.49)	1 064 (16.31)
40-49	959 (15.38)	50 (17.36)	1 009 (15.47)
50-59	1 096 (17.58)	40 (13.89)	1 136 (17.41)
60-69	1 104 (17.70)	47 (16.32)	1 151 (17.64)
70-79	664 (10.65)	32 (11.11)	696 (10.67)
80+	305 (4.89)	9 (3.12)	314 (4.81)
Sex			
Male	3 139 (50.34)	191 (66.32)	3 330 (51.04)
Female	3 097 (49.66)	97 (33.68)	3 194 (48.96)
Country			
South Africa	477 (7.65)	65 (22.57)	542 (8.31)
Lesotho	5 759 (92.35)	223 (77.43)	5 982 (91.69)
Study name			
TB Triage+	1 086 (17.42)	134 (46.53)	1 220 (18.70)
**LPS	5 150 (82.58)	154 (53.47)	5 304 (81.30)
HIV status			
HIV negative	4 075 (65.35)	143 (49.65)	4 218 (64.65)
HIV positive	1 673 (26.83)	122 (42.36)	1 795 (27.51)
Unknown	488 (7.83)	23 (7.99)	511 (7.83)
*Hardware			
H1	609 (9.77)	69 (23.96)	678 (10.39)
H2	477 (7.65)	65 (22.57)	542 (8.31)
H3	1 842 (29.54)	48 (16.67)	1 890 (28.97)
H4	2 436 (39.06)	89 (30.90)	2 525 (38.70)
H5	872 (13.98)	17 (5.90)	889 (13.63)
Prev TB			
No	5 146 (82.52)	230 (79.86)	5 376 (82.40)
Yes	1 090 (17.48)	58 (20.14)	1 148 (17.60)
CAD4TB			
*v6 -median, IQR	52.19, 17.84	76.47, 19.28	53.26, 18.59
*v7- median, IQR	20.03, 22.09	61.70, 27.37	21.87, 23.93

****Hardware (hardware used in image acquisition)**
H1= Canon Inc.: CXDI Control Software NE;
H2=Vieworks Co.,Ltd: FXRD-1717VA;
H3=Samsung Electronics: SDR-AGR40CW: SMD4343WS;
H4=Samsung Electronics: DGR-RN2N22/WR: SMD4343WS;
H5=SEDECAL DR: Copyright(C) SEDECAL Corp

Results



Threshold independent analysis



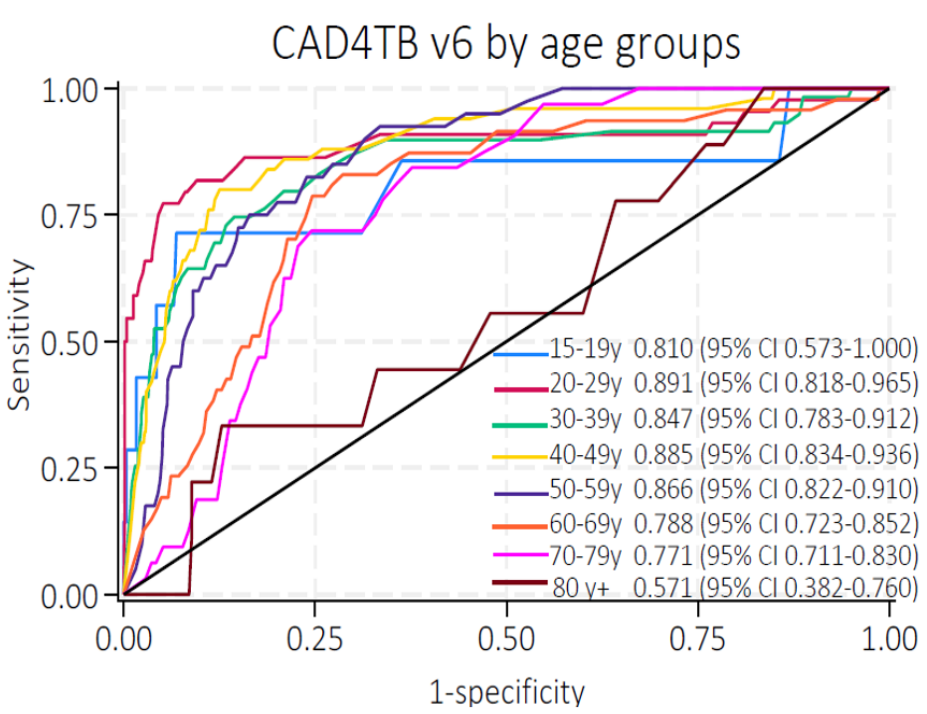
Threshold dependent analysis

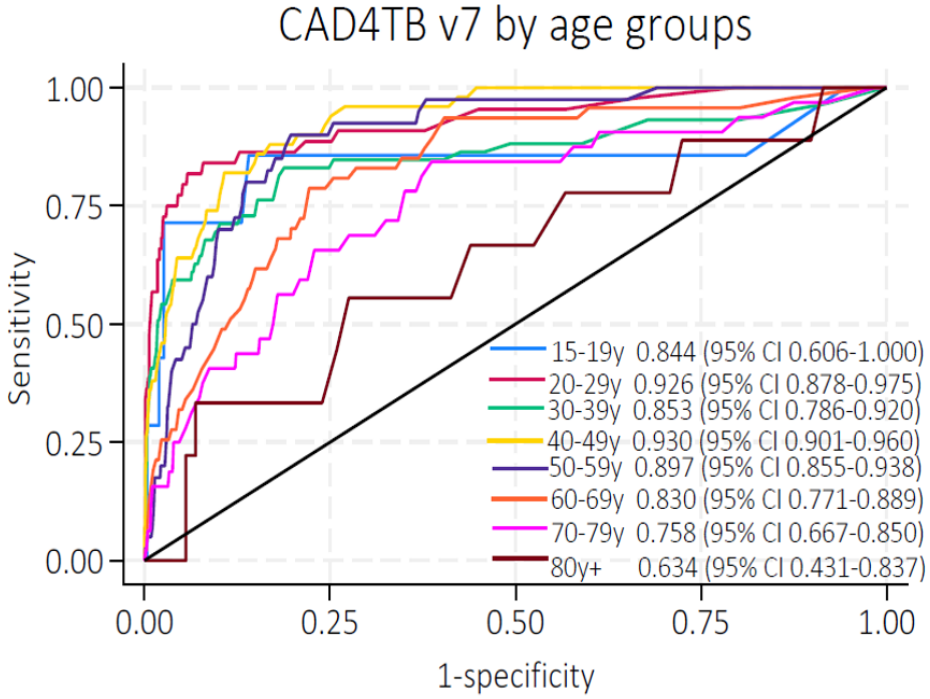
v6- min 90% sens, 54% spec

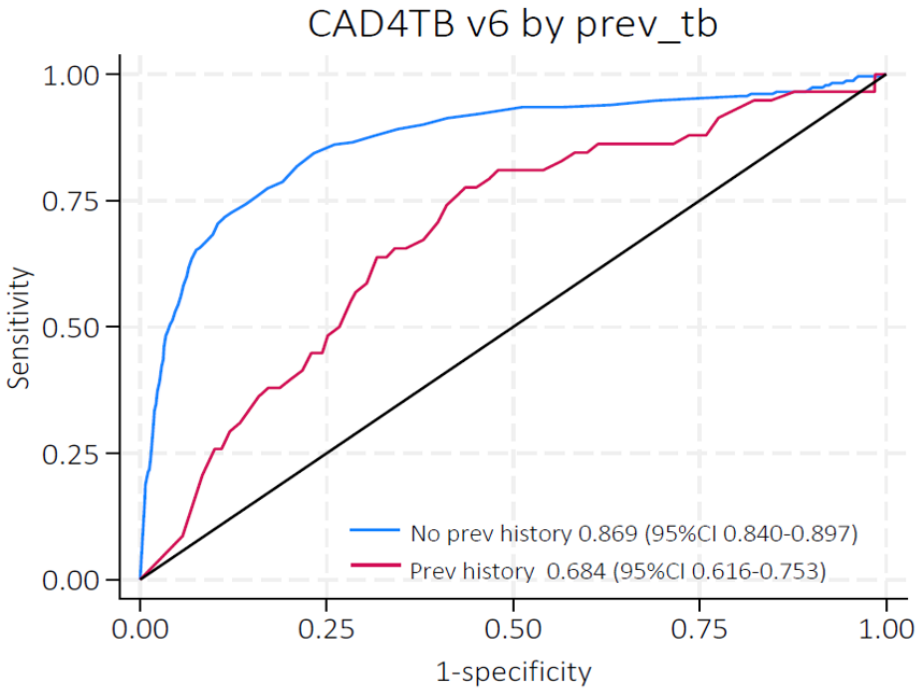
v6- min 70% spec, 83 sens

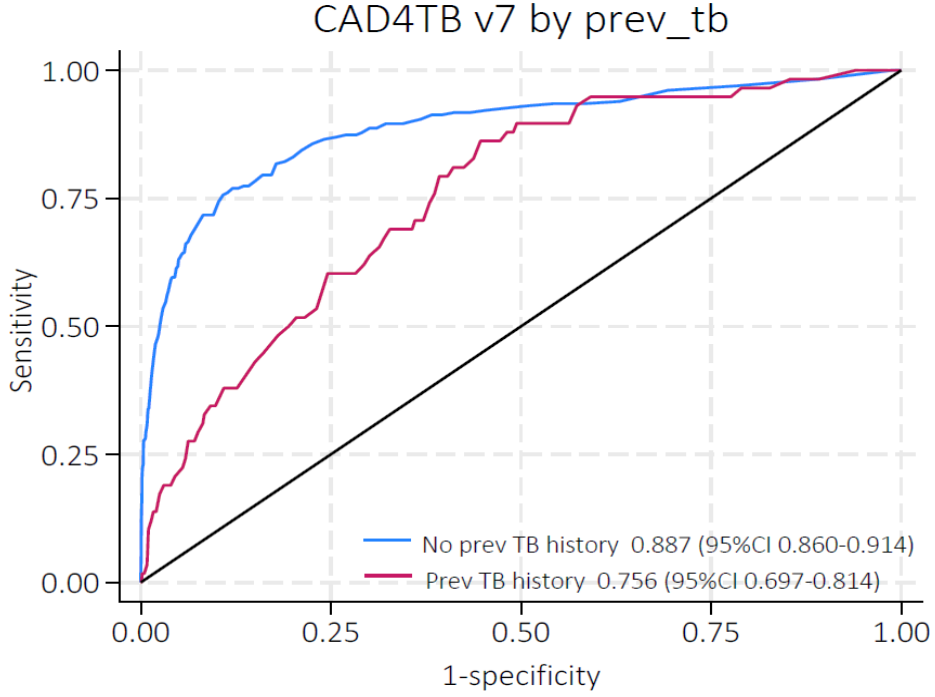
v7- min 90% sens, 65% spec

v7- min 70% spec, 88% sens

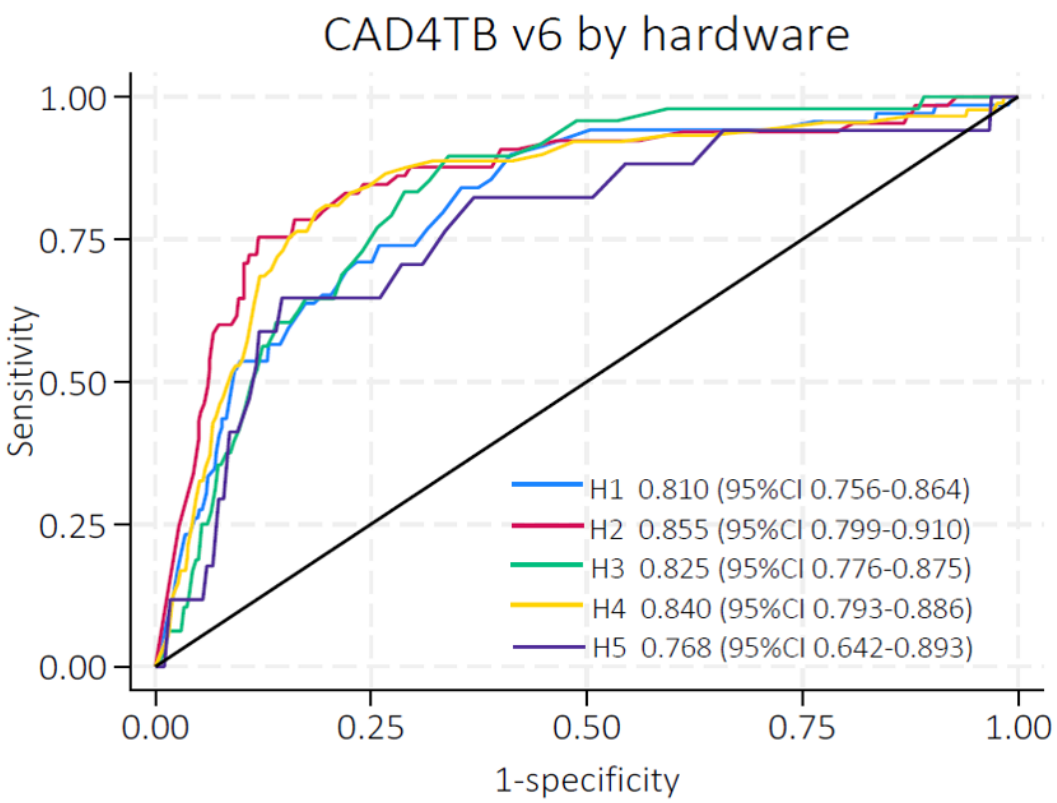


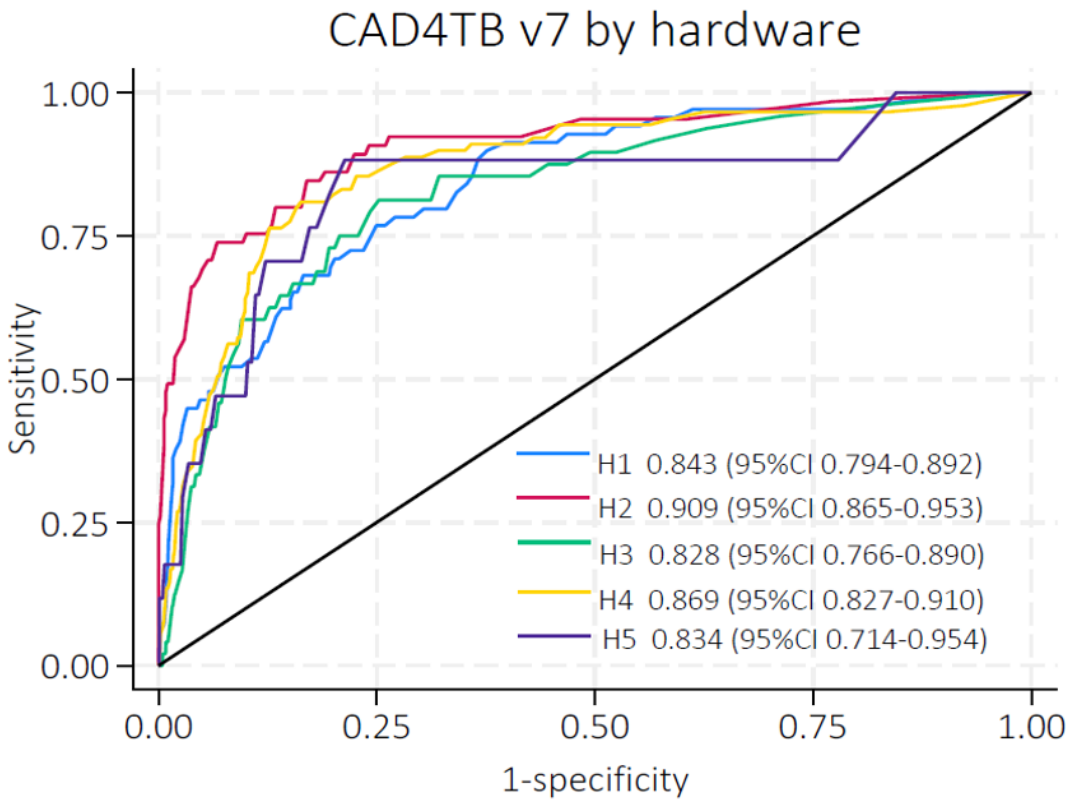






Notable performance differences between age groups and previous history of TB





Notable performance differences between hardware used in image acquisition

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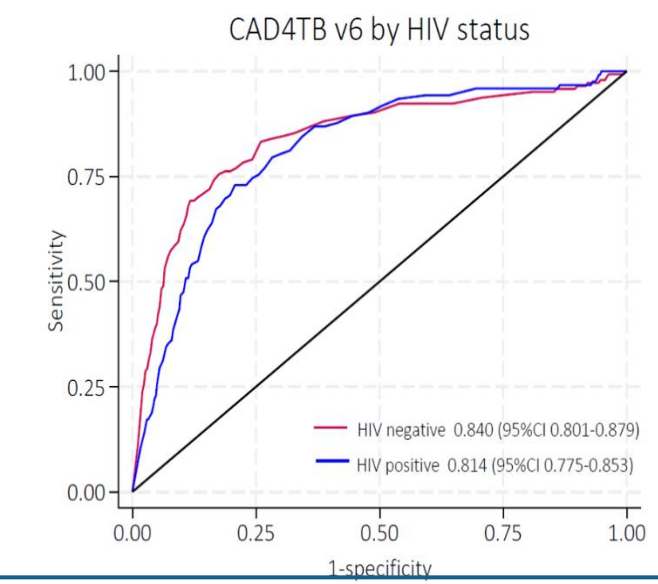

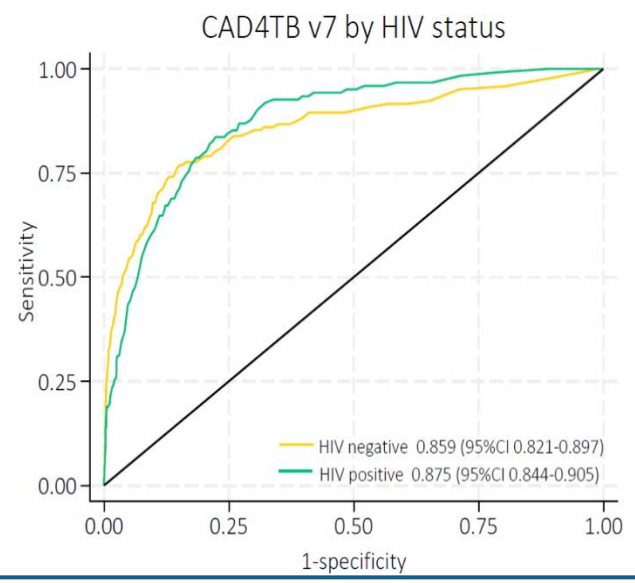

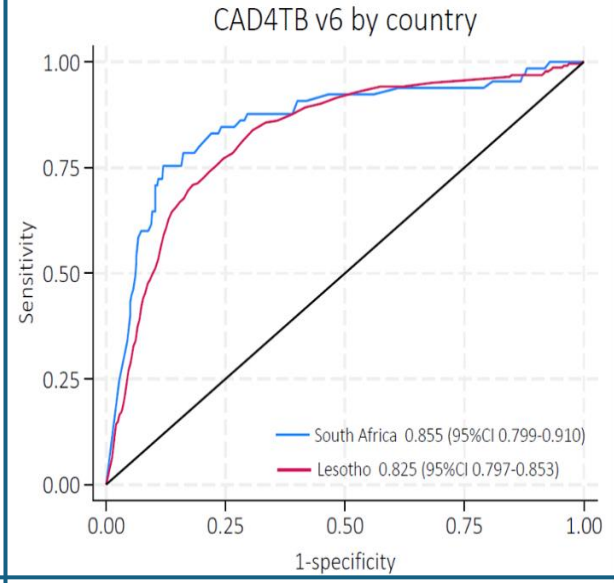

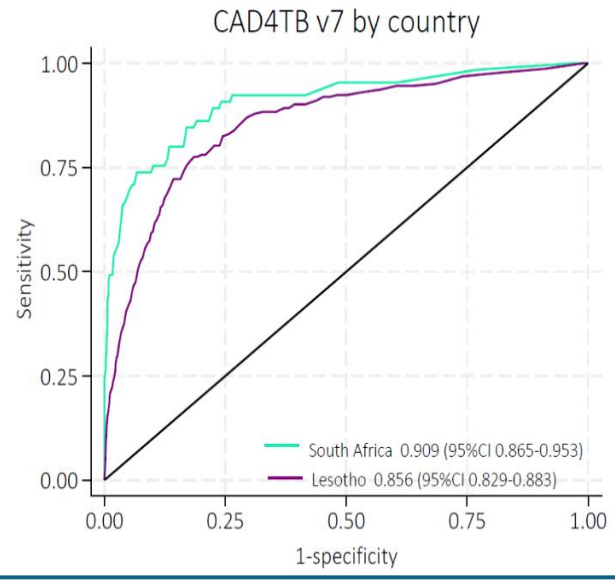

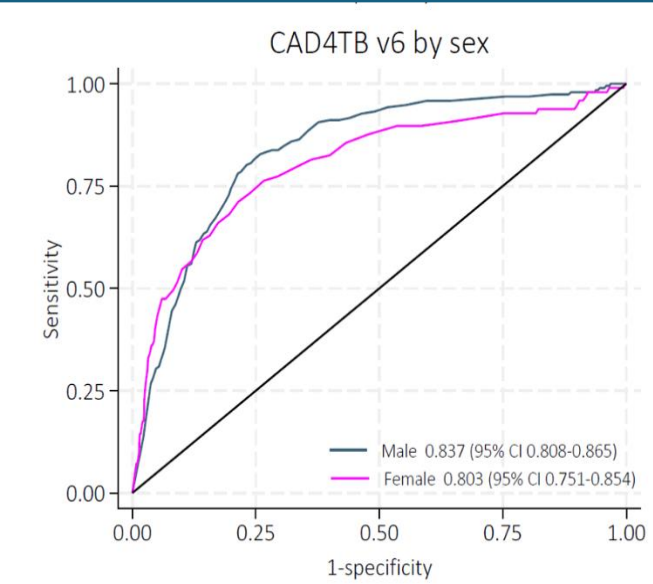

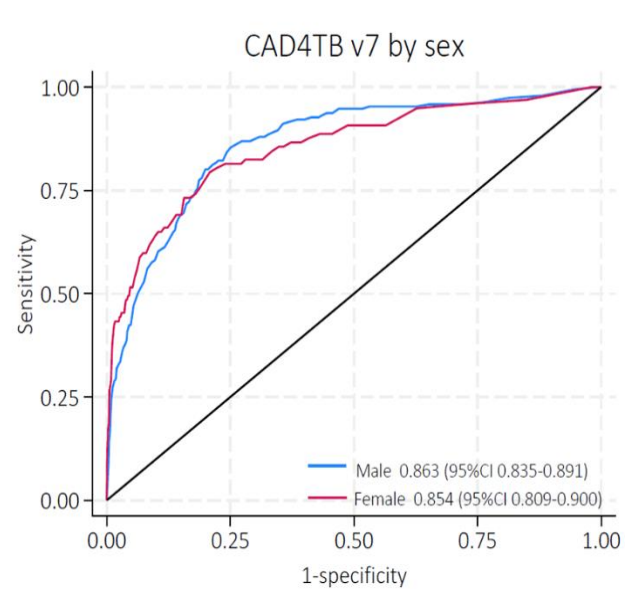

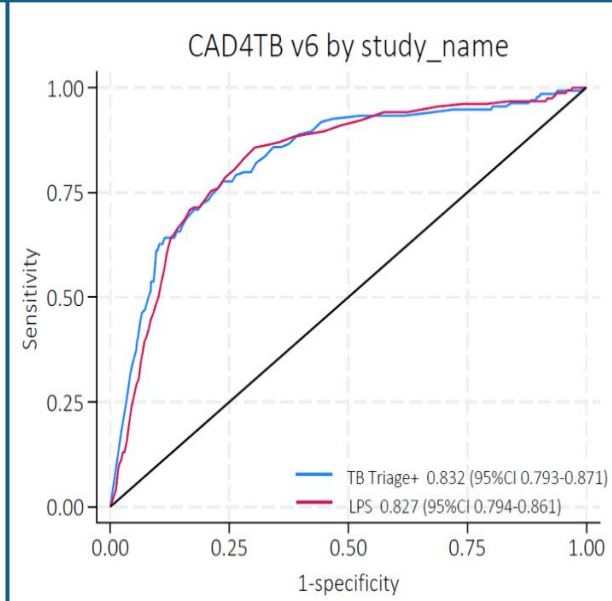

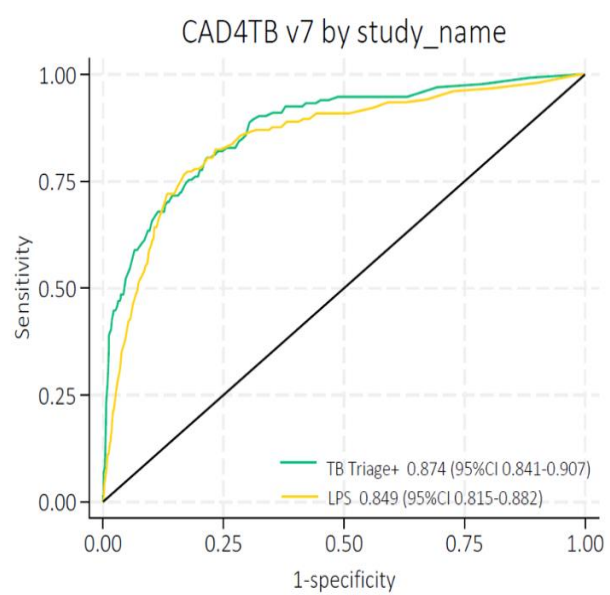

No performance difference between the subgroups

Conclusion

CAD4TB - effective TB screening tool in high TB-burdened and resource-constrained settings

1. **Performance (area under ROC)**
   - Version 7 shows improved performance
   - Better in younger groups, better in groups with no history of TB
   - Variability noted across different hardware (significant?)
2. **Thresholds**

The threshold needed for a particular level of sensitivity/specificity is very different for v6 and v7

3. Both versions did not meet the **WHO TPP –triage test** (attributable to variability in analysed data?)

Acknowledgements

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