Using DCXR with CAD to augment TB screening in primary healthcare facilities in South Africa

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Right to care

Treating Health Seriously

Pilot project

NDOH piloted DCXR with CAD to augment TB screening:

- 6 districts with highest estimates of missing cases
- W4SS followed by DCXR with CAD:

  1 or more TB symptom/s and/or
  DCXR suggestive of TB → Xpert MTB/RIF Ultra

- Primary health care facilities and communities

PHC facility-based DCXR units:

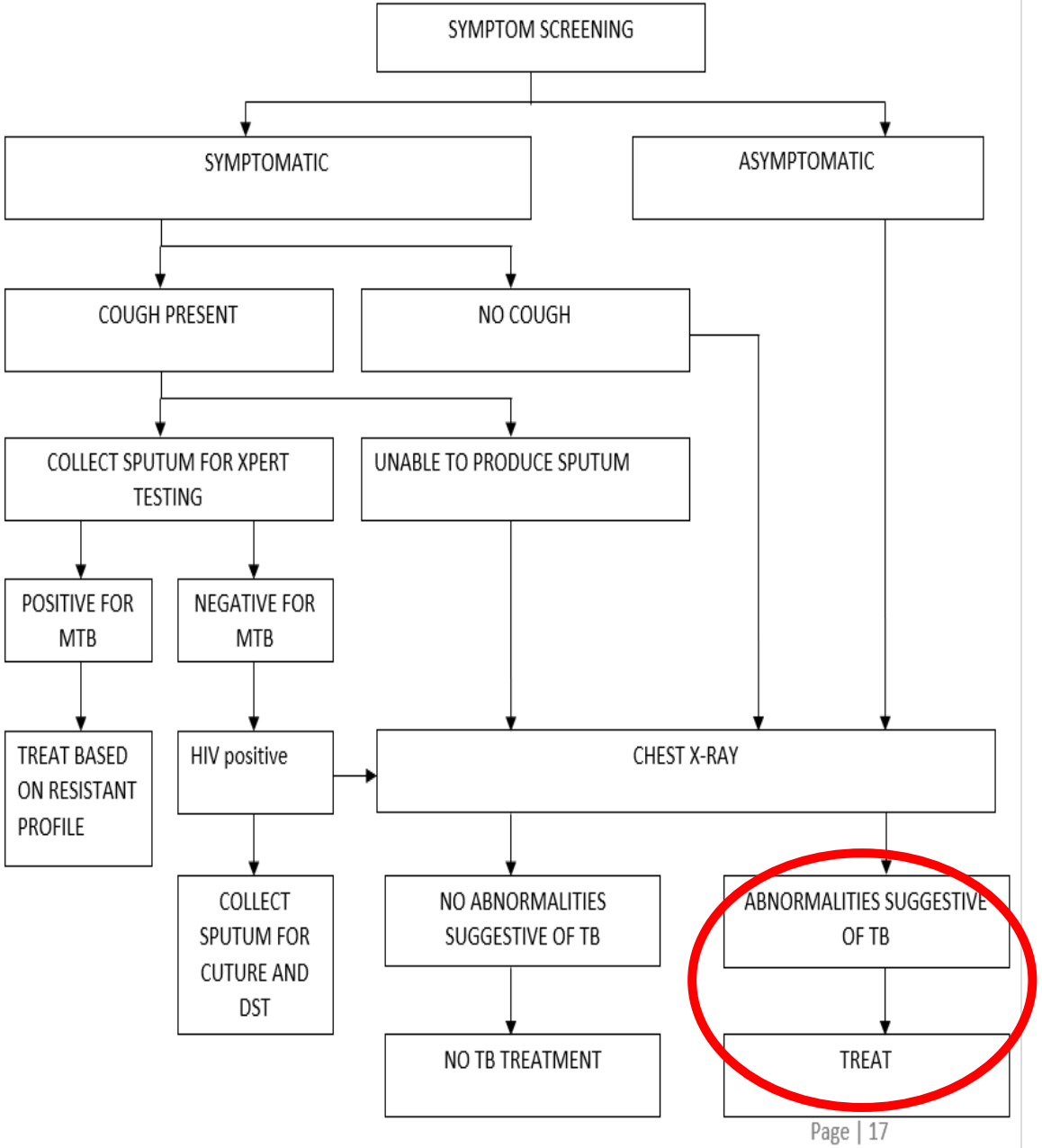
- 15 semi-mobile, containerized DCXR units, CAD software (qXR from qure.ai)
- Data collection into LYNX-HCF platform
- 23 high TB burden facilities between 12 November 2020 and 31 March 2022
- Eligibility criteria:
  - High risk for TB – PLHIV, TB contacts, prior TB, diabetics
  - Asymptomatic patients
  - Symptomatic patients without cough/unable to produce sputum
  - Negative lab result in PLHIV with TB symptoms

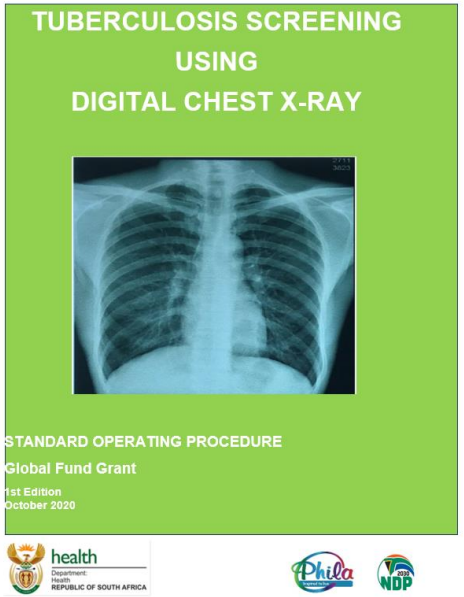
Evaluation

Fidelity to protocol
Outcomes
Efficiency
Cost drivers

- Cross sectional
- Mixed methods
  - Qualitative data collection:
    - Project material
    - Key informant interviews
    - Process mapping and direct observation
  - Quantitative data collection:
    - Project data from LYNX-HCF:
      - Descriptive statistics: DCXR sites and head counts, client characteristics
      - NNT = number who screened positive/number confirmed positive on Xpert
      - TB Yield = number and the TB yield associated with each tool
    - DHIS
      - Proportion of head count testing positive = proportion of patients older than 5 years attending the facility who were diagnosed with confirmed TB on Xpert

Diagnostic Algorithm





- Finalised after implementation started
- Inconsistent implementation
  - Targeting groups at high risk for TB
  - Targeting asymptomatic patients

Source: NDOH. ***Tuberculosis screening using digital chest x-ray. Standard operating procedure.*** Global fund Grant. 1st edition.

TB Screening Process

Client recruitment or referral to DCXR Unit → Client interview and TB symptom screening → Chest X-ray screening → ≥ 1 symptom and/or DCXR suggestive of TB → Sputum collection for Xpert

Referral from:
- Facility clinicians
- Surrounding clinics and GPs
- Community health workers

Active recruitment from target waiting areas in facility
"Walk-ins" in response to ACSM

Normal	• No abnormalities detected
Abnormal	• Abnormal signs but not suggestive of TB
Suggestive of TB	• High likelihood of active TB
Invalid X-ray	qXR cannot interpret the X-ray

Unusual inputs

"Every HIV (positive) patient, every chronic patient, must automatically (go) via the DCXR container, regardless of (TB) symptoms"

DOH facility nurse, chronic area

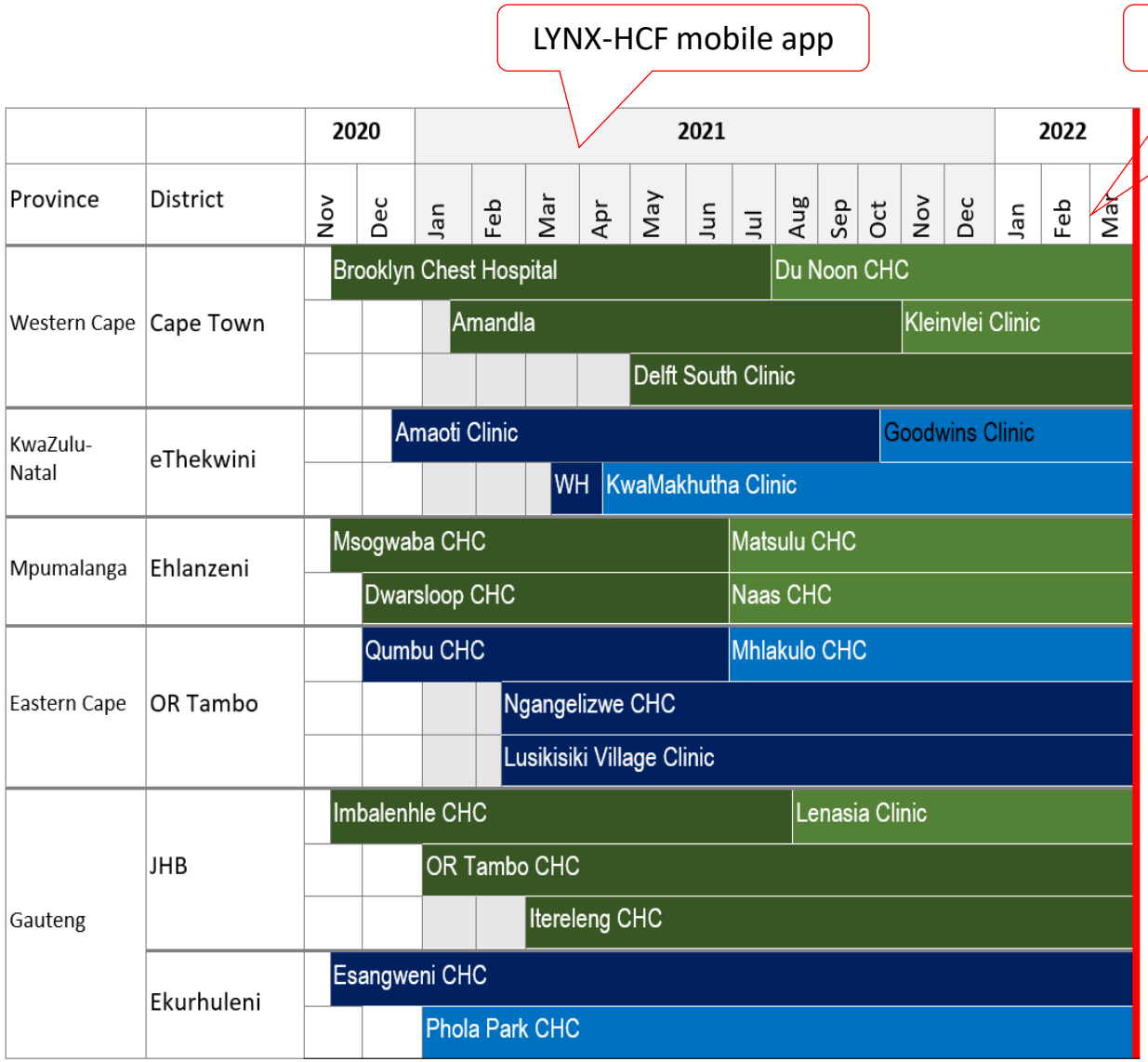
"(TB screening using) DCXR is primarily to identify which asymptomatic patients should have Xpert, and we prioritise people with chronic conditions, chiefly, HIV and Diabetes Mellitus, for DCXR"

DOH Facility OM

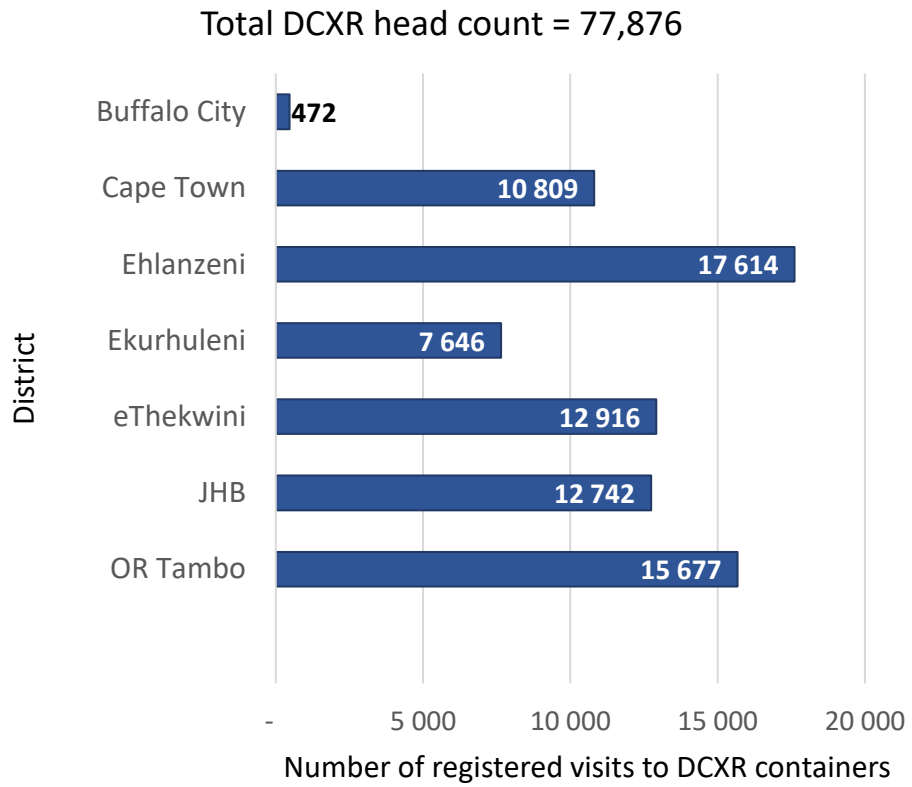
"The TUTT study informed the priorities for DCXR TB screening"

SR QIP manager

Placement of DCXR units, head counts and client characteristics



Placement of DCXR containers in facilities over time

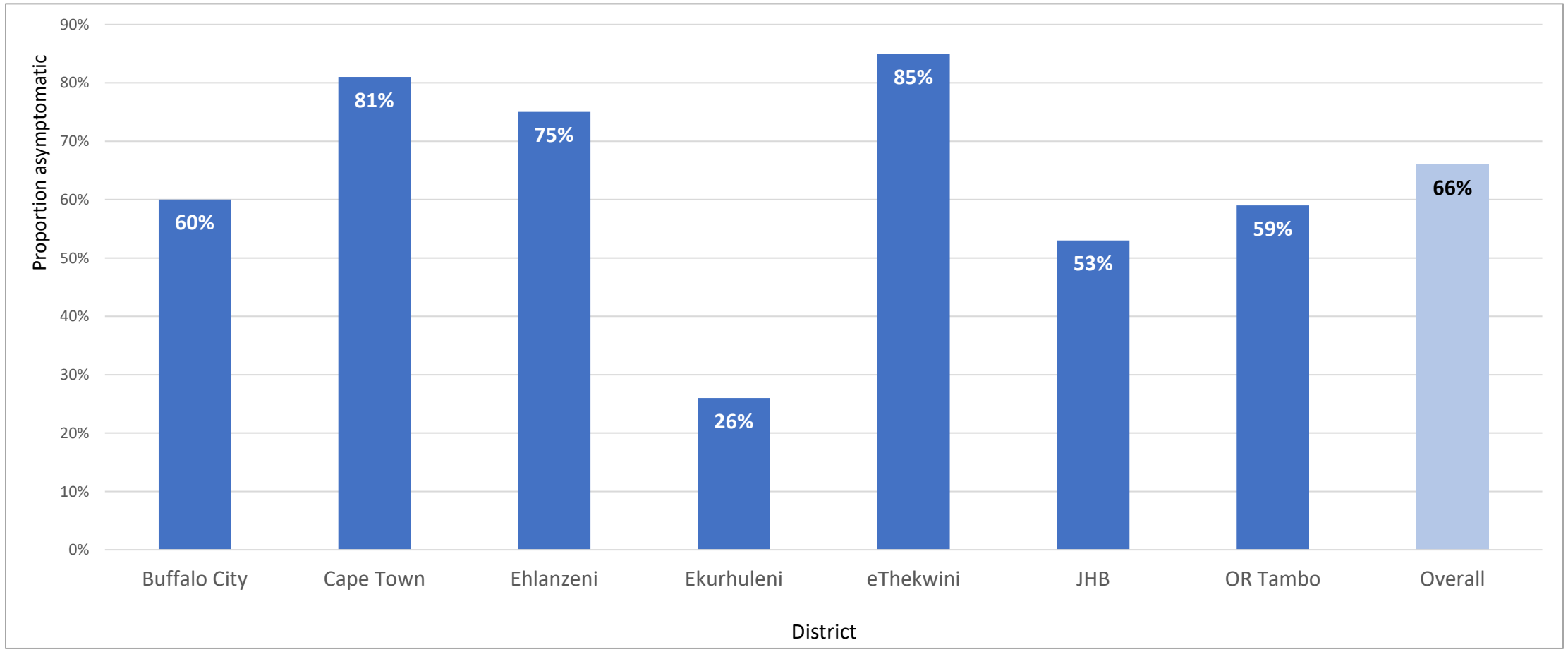


- Site: 97% of head count at facilities
- Sex: 61% were female
- Age: 38 years (IQR = 27 to 50)
  2% were under 5 years

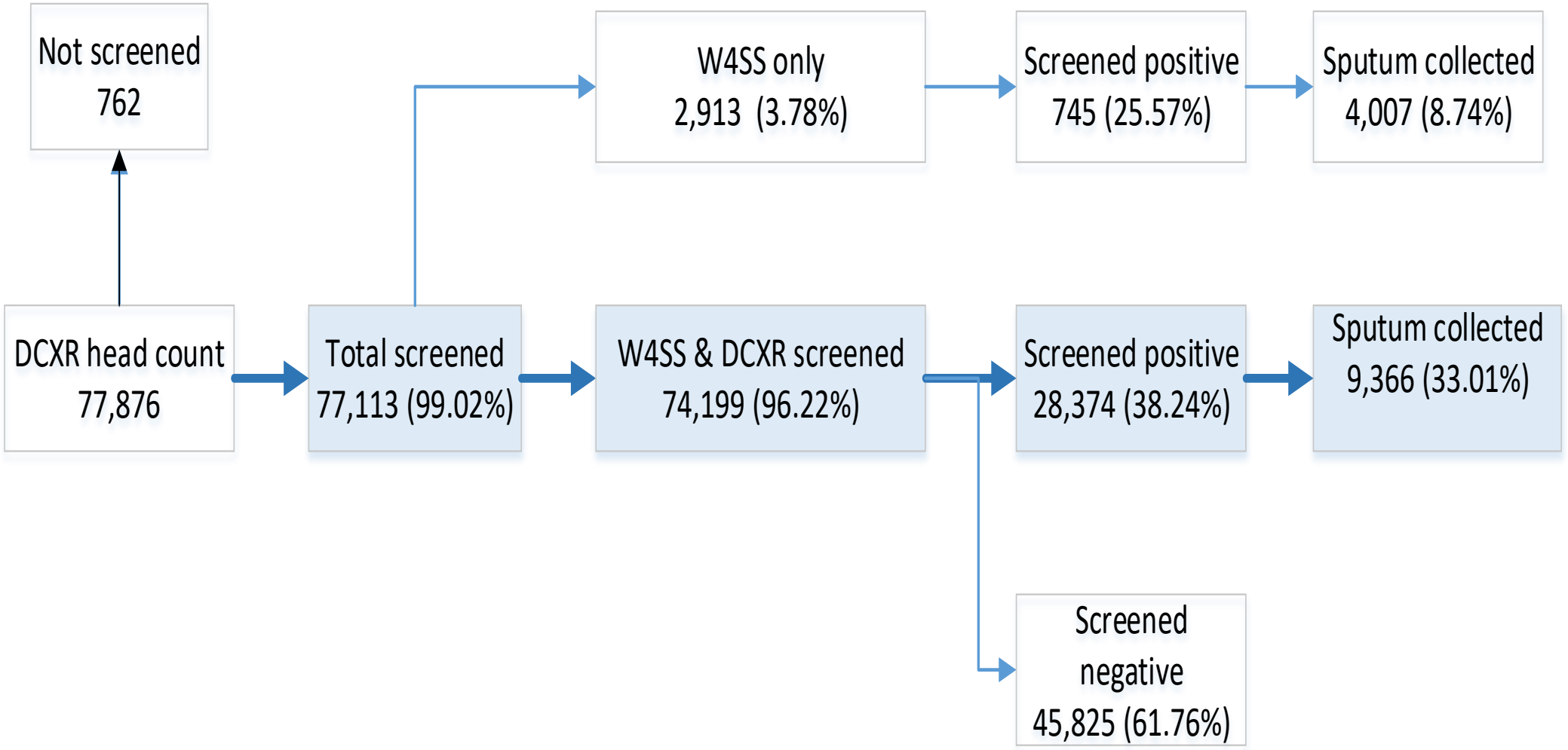
ALGORITHM - areas of diversity and uncertainty

- Target population
  - TB symptomatics or asymptomatics?
  - High risk groups
  - Integration with TUTT strategy? (some districts/facilities already testing all PLHIVs every 6 months and all contacts)
  - Children under 5?
  - Non chest X-rays
- Eligibility for Xpert Ultra test
  - All DCXR Abnormals or DCXR TB Suggestives?
  - Frequency of DCXR screening in high-risk groups
- Treating CXRs?
  - When can we treat without waiting for Xpert result?
  - When do we refer to clinic doctor?

Proportion of DCXR attendees who are TB asymptomatic, overall and by district



TB screening and testing cascade



Target population coverage

	Buffalo City	Cape Town	Ehlanzeni	Ekurhuleni	eThekwini	JHB	OR Tambo	Total
HIV STATUS								
Positive	22%	21%	36%	31%	23%	41%	36%	25,023 (32%)
Negative	54%	63%	57%	58%	48%	56%	62%	44,701 (57%)
Unknown	22%	15%	6%	9%	28%	2%	0.4%	7,389 (9%)
HISTORY OF PRIOR TB								
Yes	20%	12%	6%	9%	6%	7%	4%	5,493 (7%)
No	78%	86%	93%	89%	92%	92%	94%	71,208 (91%)
CLOSE TB CONTACT								
Yes	8%	7%	4%	11%	7%	4%	4%	4,234 (5%)
No	87%	91%	96%	87%	79%	96%	94%	70,786 (91%)
Unknown	5%	1%	1%	1%	13%	0.4%	0.2%	2,052 (3%)
DIABETIC								
Yes	5%	4%	3%	4%	3%	4%	5%	3,063 (4%)
No	90%	93%	96%	85%	83%	95%	93%	71,226 (91%)
Unknown	4%	1%	0.5%	9%	14%	0.4%	0.2%	2,783 (4%)

Clinical pathways

- DCXR containers not operating at capacity
  - Process is slower than anticipated, even without technical glitches
  - Technical glitches slow down the tablets, communication with DCXR container PC
  - **In most cases, clinic pathways have not adapted to optimise DCXR TB screening, and do not incentivise dedicating time to have an Xray**
- DCXR head count boosted by feeding symptomatic patients to the container
- Best practices:
  - Systems to protect place in queue
  - Facility clinicians reinforce importance of DCXR TB screening to high priority patients and facilitate this
  - Intentional placement to increase visibility of the DCXR container coupled with quality, dedicated TB screening at gate

Data management

- Exclusion of folder number precludes option for integration
- TB Case ID register – Only has field for CXR as a diagnostic tool (similarly with TIER)
- Lynx HCF needs further tweaking of interface to optimise completeness and accuracy
  - This depends on regular DQAs to identify gaps and shortcomings with feedback to LTE
  - NDOH and SRs must take lead on this but can only do this if they interact actively with the data every week
- Lynx HCF is a very powerful monitoring tool and it is underutilised due to limited data visualisation (user limitations, not app limitations)
- Not enough feedback of rates and yields. Would like weekly snapshot reports via email or WhatsApp radiographer
- Not enough reporting to OMs, facility clinicians

Diagnostic yield per screening strategy

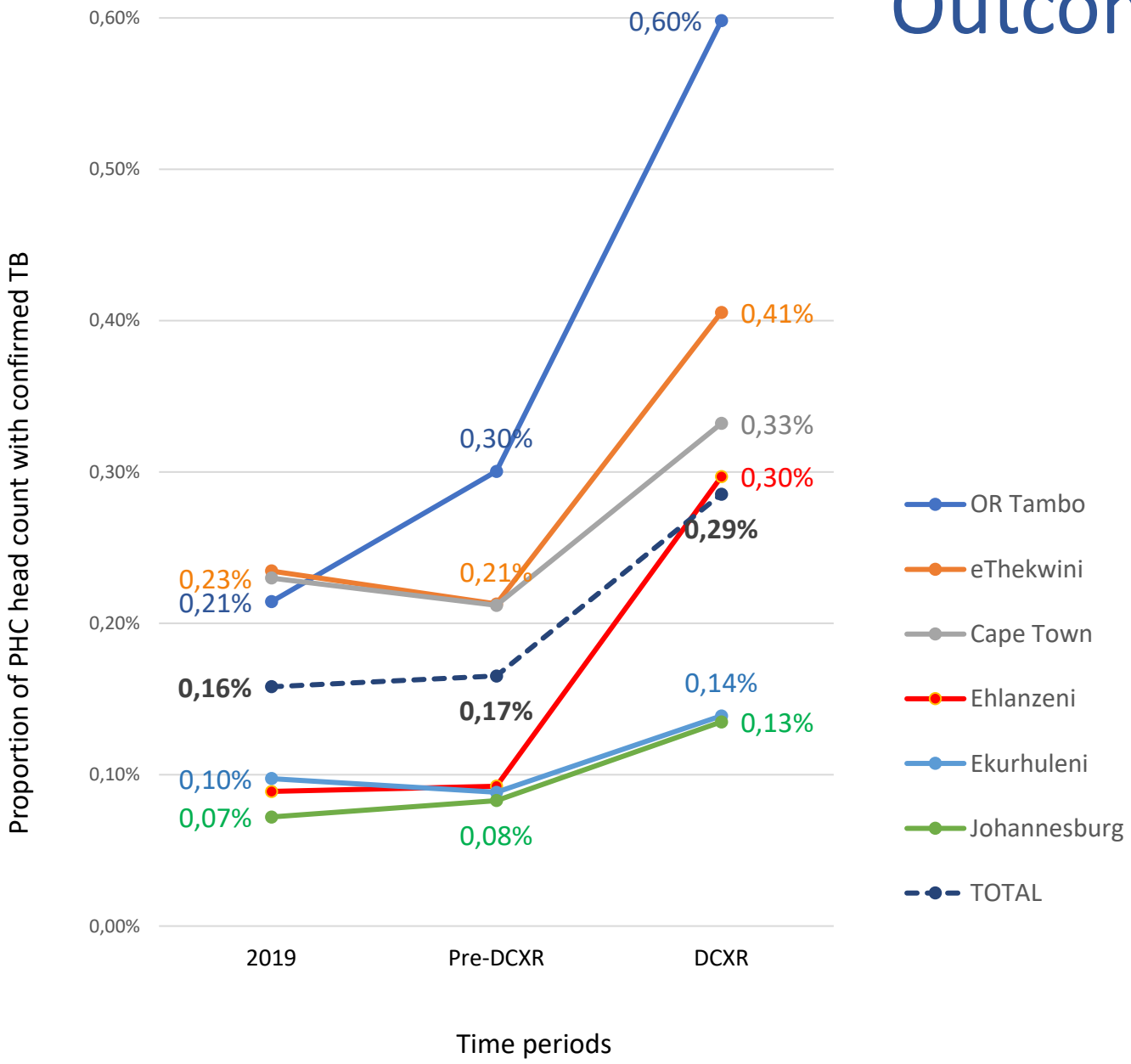
TB screening modality	Number screened	Screened positive	Xpert Ultra test results	Xpert Ultra positive	TB yield	NNT
Symptom screening alone[a]	77,113	26,001 (33.7%)	7,551 (29.0%)	949	1.2% 949/77,113	25 26,001/949
DCXR alone[b]	74,200	7,053 (9.5%)	4,168 (59.1%)	1,021	1.4% 1,021/74,200	7 7,053/1,021
Symptom screening and/or DCXR	74,119	28,374 (38.3%)	9,024 (31.8%)	1,216	1.6% 1,216/74,119	23 28,374/1,216

[a] *Excludes 763 clients who do not have a symptom screening result*

[b] *Excludes 3,676 clients who did not have a valid DCXR result*

- Sub-optimal sputum collection for Xpert testing (38% overall)
- TB symptom screening and DCXR screening diagnose more TB than either symptom screening or DCXR alone
- DCXR TB screening outperforms optimized TB symptom screening
  - DCXR alone finds 84% of all people with microbiologically-confirmed TB, with 46% of the number of Xpert tests

Outcome of DCXR TB screening



- Proportion of the PHC head count testing positive (PTP) increased during DCXR container periods relative to 2019
- PTP ratio = PTP in DCXR period/PTP in 2019

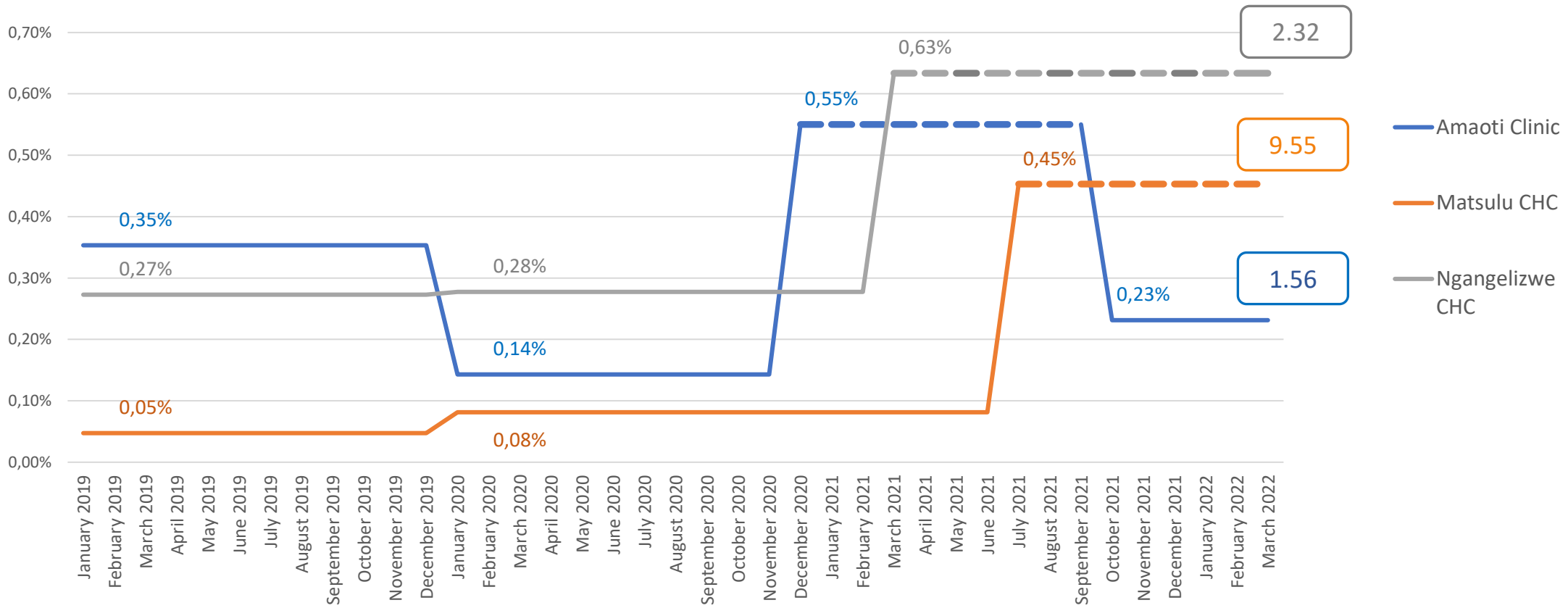
District	PTP ratio*
OR Tambo	2.79
eThekwini	1.73
Cape Town	1.44
Ehlanzeni	3.34
Ekurhuleni	1.42
Johannesburg	1.87
TOTAL	**1.80**

* $P < 0.05$

Proportion of the PHC head count testing positive (> 5-year-olds)

Data source: DHIS

Comparing index period (2019) with pre-DCXR period, DCXR period (----), and post-DCXR period



PTP ratio = PTP in DCXR period/PTP in 2019

Limitations

- COVID disruptions
- Sub-optimal sputum collection
- Differential implementation :
  - Targeting of high-risk groups
  - Targeting of people who do not report classic TB symptoms
  - Clinical pathways that incentivise DCXR attendance
- Comparison is with optimised vs standard of care TB symptom screening
- Xpert trace results not captured
- Poor data validation, underuse of LYNX-HCF capacity
- Did not measure impact: transmission, morbidity, mortality
- Did not model cost-effectiveness

Conclusions

- **Parallel TB symptom and DCXR screening at health facilities increased TB yield and proportion of the facility head count testing positive at PHC facilities**
- DCXR TB screening alone outperformed **optimised** TB symptom screening alone
- DCXR alone finds 84% of all cases diagnosed with parallel screening, with less than half the number of Xpert tests
- Impact undermined by:
    - COVID disruption
    - Low sputum collection rate - poor sputum supervision, privacy and nebulisation coverage
    - Lack of consensus on algorithms
    - Poor targeting of high-risk group

Recommendations

- Ensure 100% sputum collection
- Clarify algorithm for facility-based DCXR - **Target people with high TB risk**
- Strengthen integration with DOH data systems
- Use LYNX-HCF capacity for data validation, weekly MEL, responsiveness
- Revisit Lynx HCF data elements, reports and data visualisation requests
- Capture Xpert trace results
- Rework the SOP and the algorithm and **consult thoroughly**:
  - Involve TB Think Tank Missing cases group
  - Integrate with TUTT approach
  - Involve provincial and district TB managers in local tweaking
  - If it changes, update it rapidly and disseminate
- Leadership: NDOH take ownership and market, drive and monitor change management process with DOH at provincial and district levels

Way forward

- Further evaluation/review of current roll-out:
  - Post COVID
  - Review of facility placed vs community place
- Improve/align algorithm
- Look at where we can use DCXR for community screening
- Work with SAPHRA to allow use of mobile machines
- Cost-effectiveness work to be prioritised

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