Why addressing tuberculosis in prisons should be a public health priority

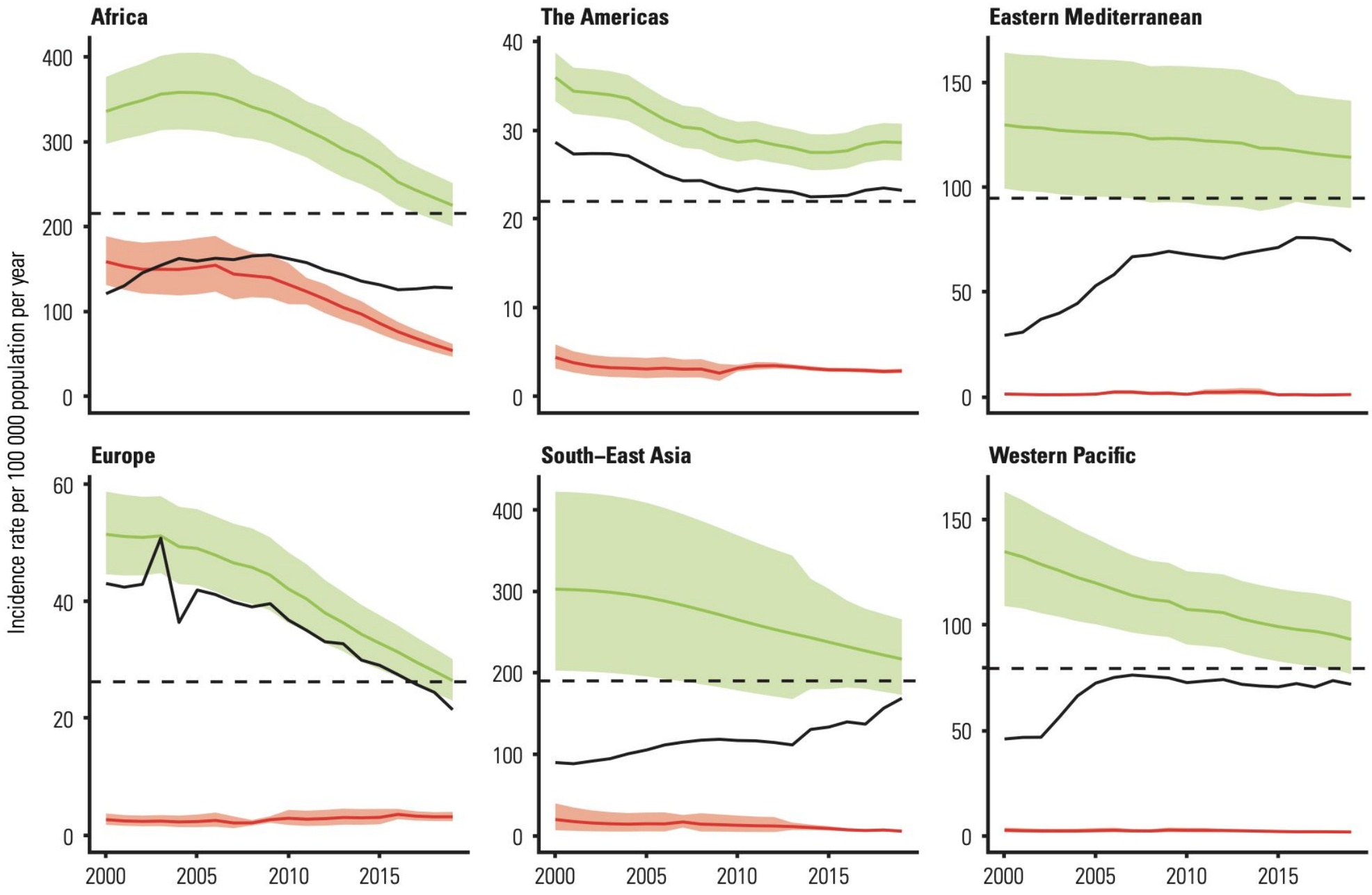
Swiss TPH Hybrid Symposium
The Tuberculosis Pandemic– a Call to Action
22 March 2023

Jason Andrews
Division of Infectious Diseases and Geographic Medicine
Stanford University

FIG. 4.11

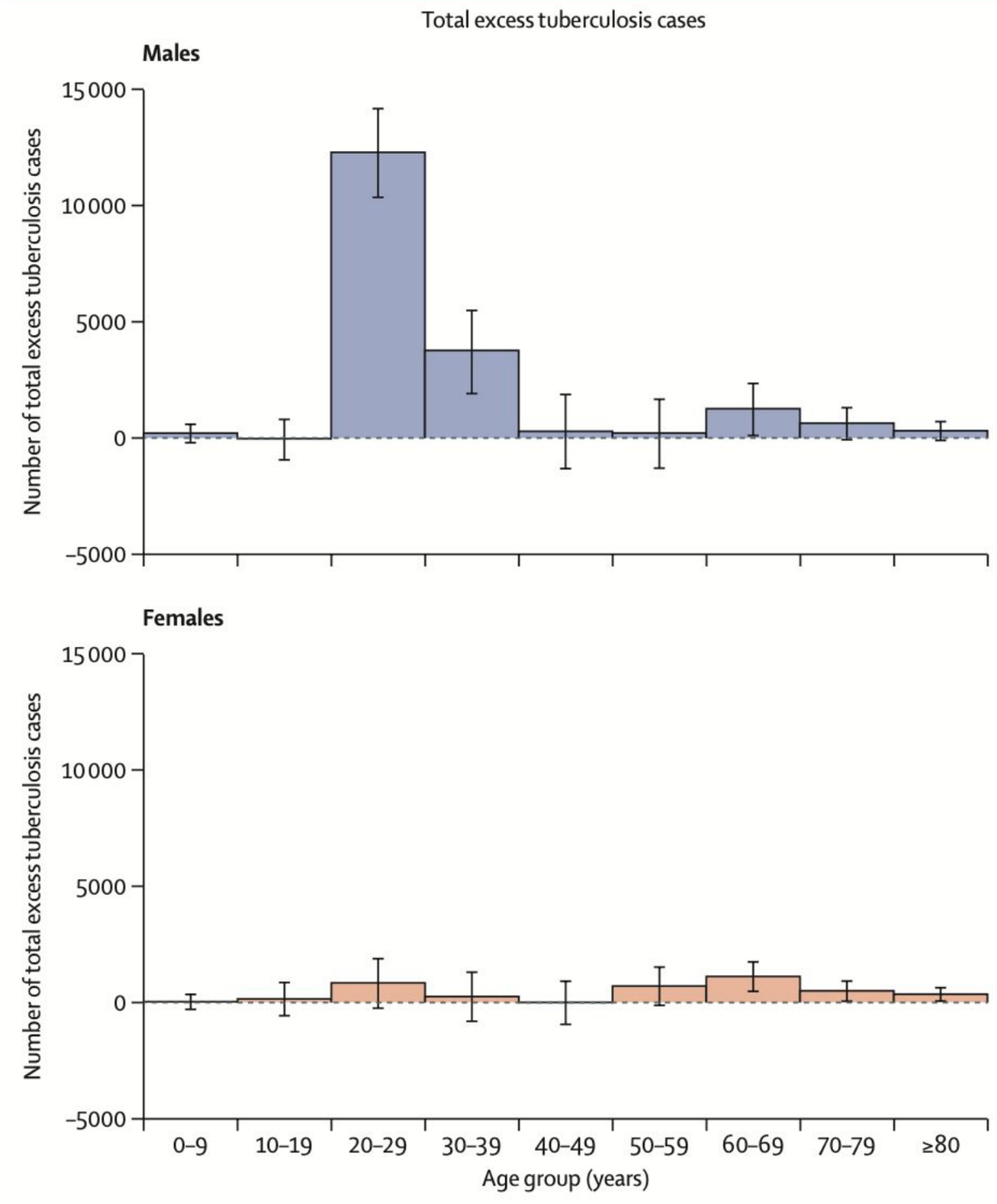
Trends in estimated TB incidence rates by WHO region, 2000–2019

Total TB incidence rates are shown in green and incidence rates of HIV-positive TB are shown in red. The black solid lines show notifications of new and relapse cases for comparison with estimates of the total incidence rate. Shaded areas represent uncertainty intervals. The horizontal dashed line shows the 2020 milestone for incidence of the End TB Strategy.



Excess tuberculosis cases and deaths following an economic recession in Brazil: an analysis of nationally representative disease registry data

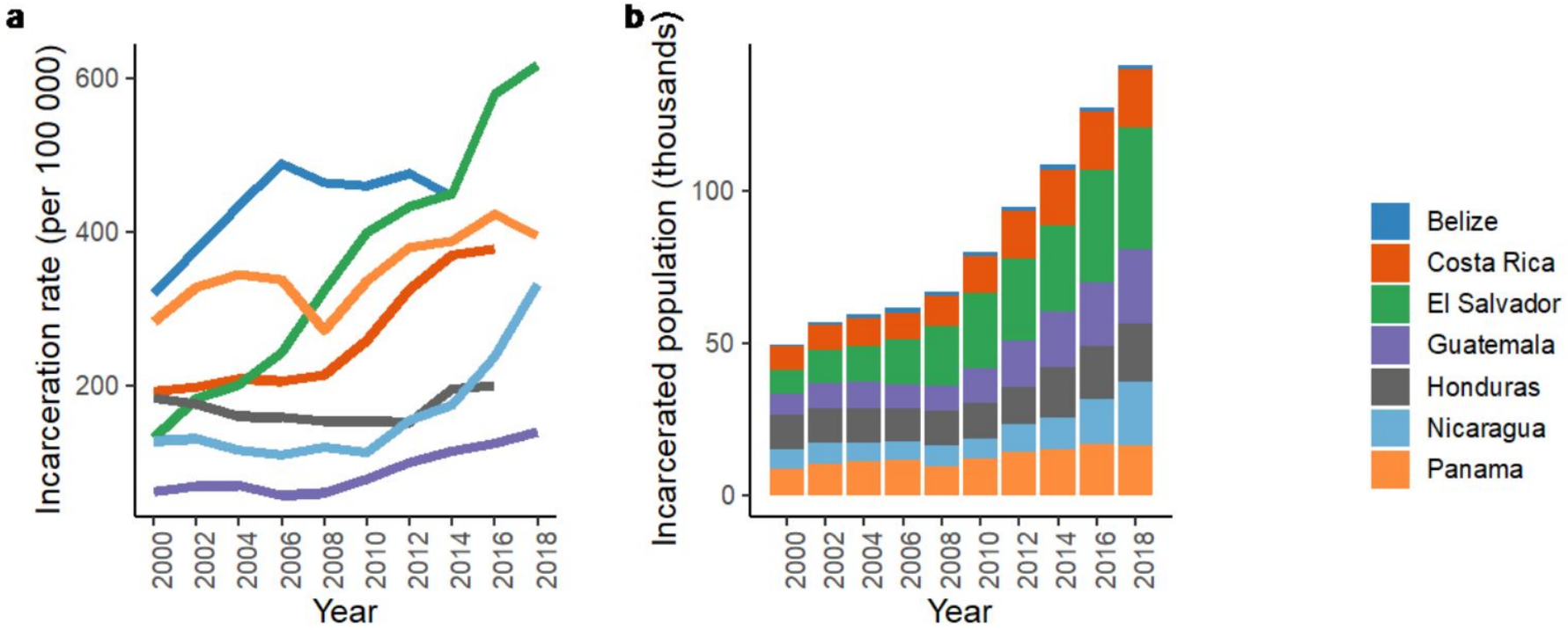
Yunfei Li, Rodrigo de Macedo Couto, Daniele M Pelissari, Layana Costa Alves, Patricia Bartholomay, Ethel L Maciel, Mauro Sanchez, Marcia C Castro, Ted Cohen, Nicolas A Menzies



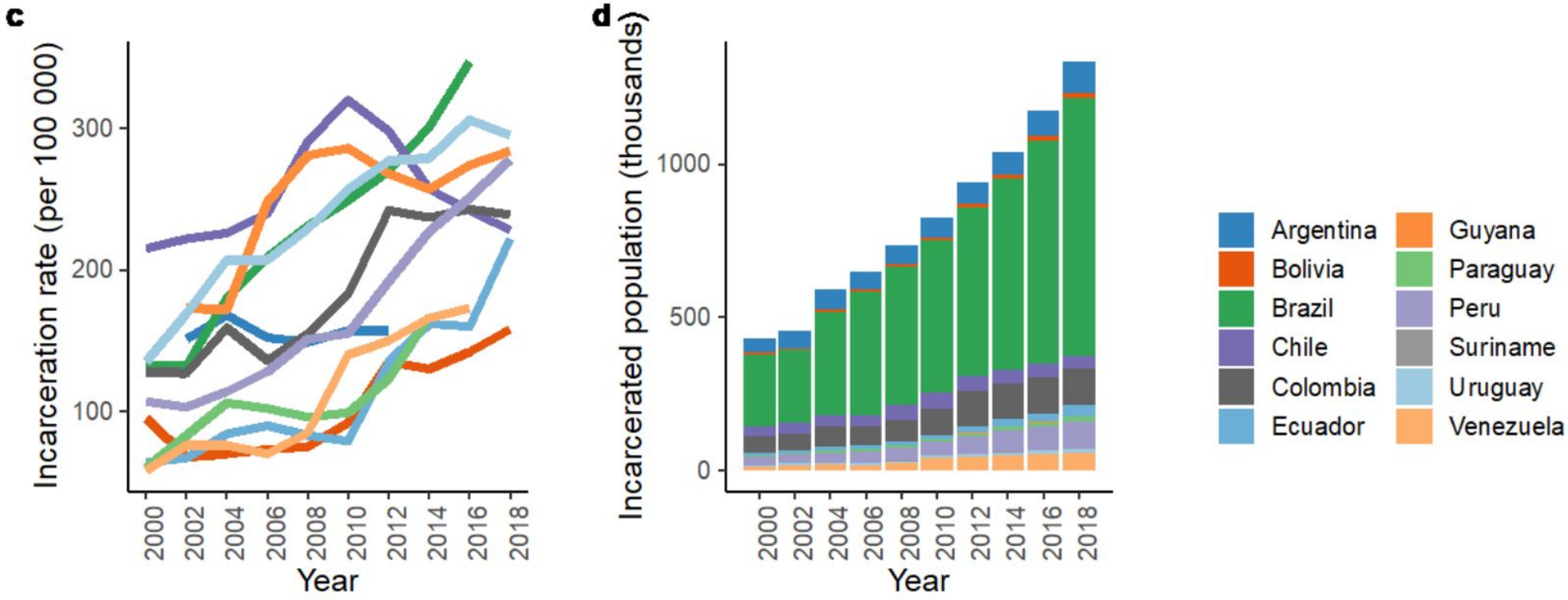
Li et al, *Lancet Glob Health*, 2022

Incarceration trends

Central America

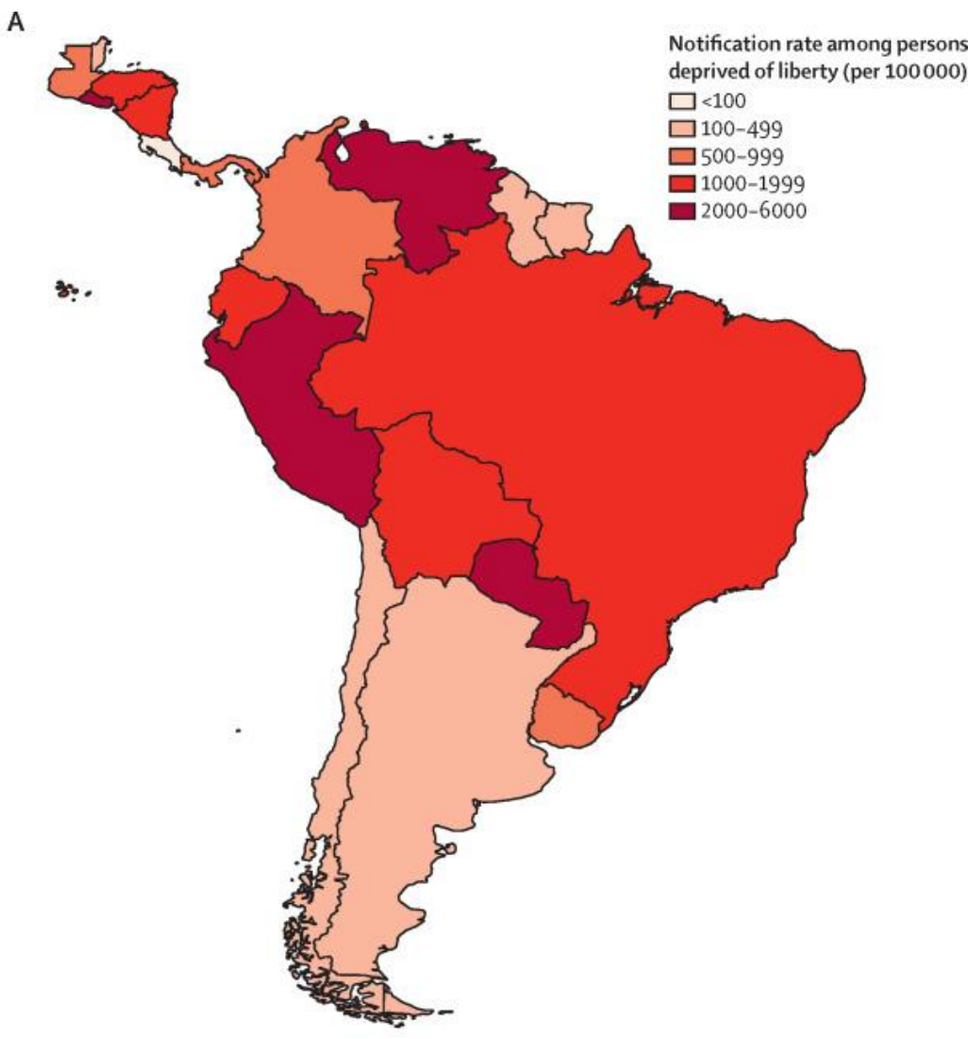


South America

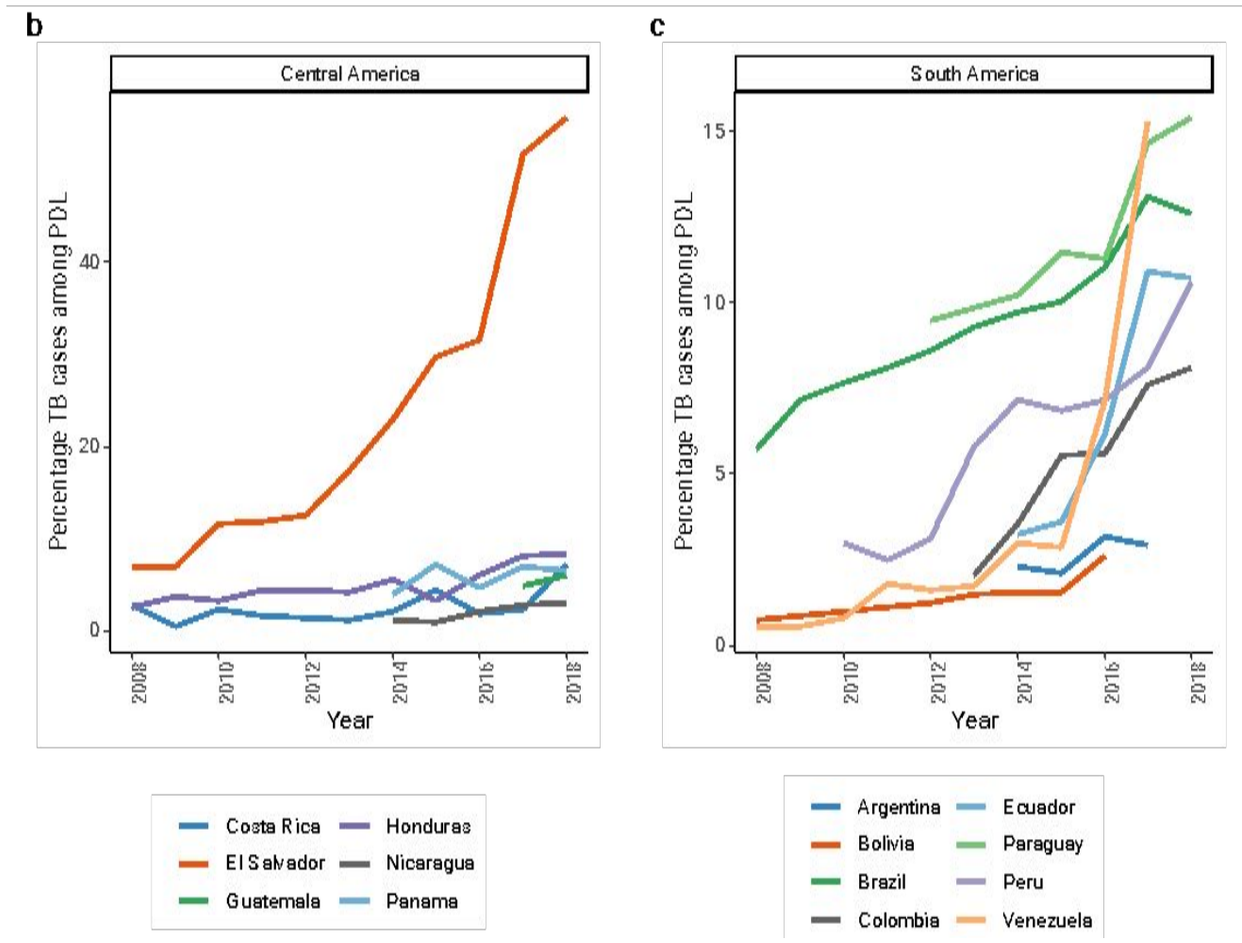


Walter, Martinez et al, *Lancet*, 2021

Incidence and concentration of TB in prisons in Latin America



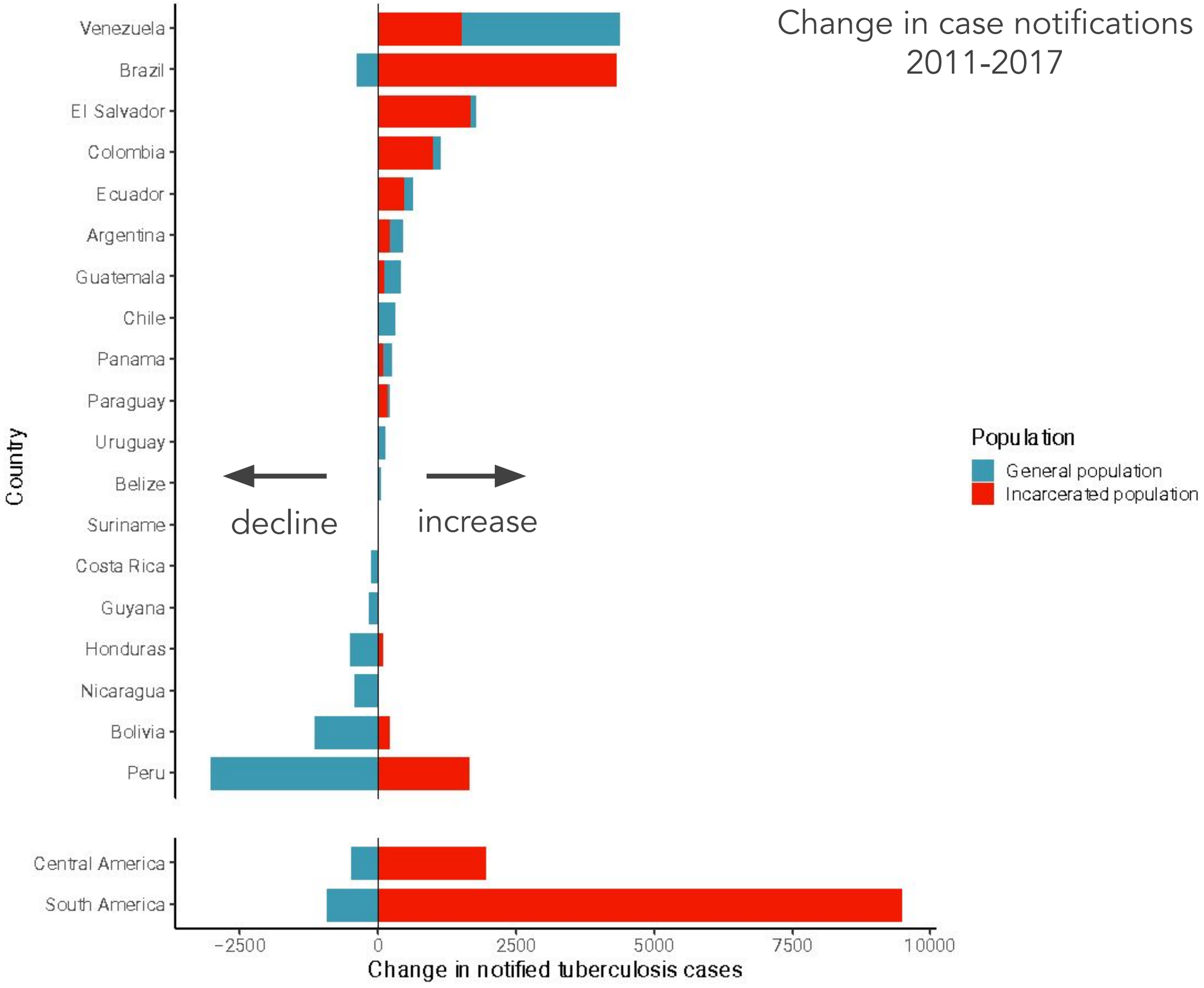
TB notification rates in prisons



Percent of all TB cases occurring in prisons

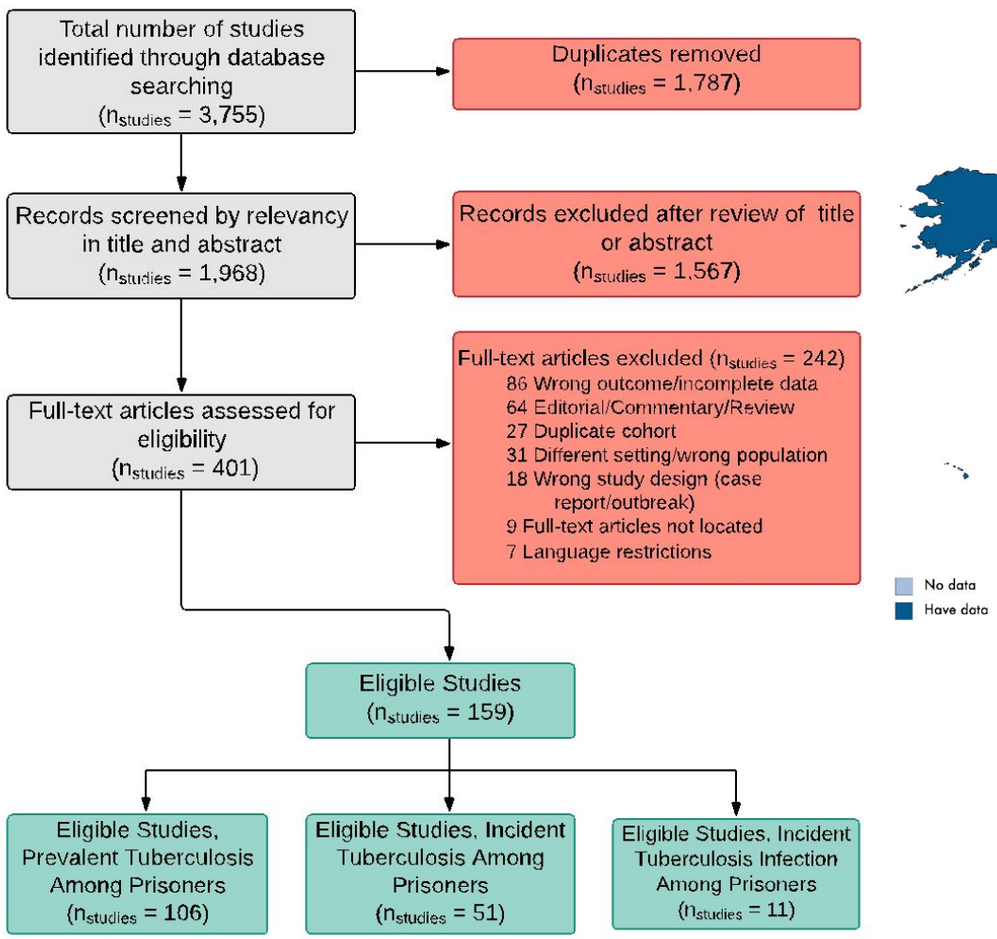
Walter, Martinez et al, *Lancet,* 2021

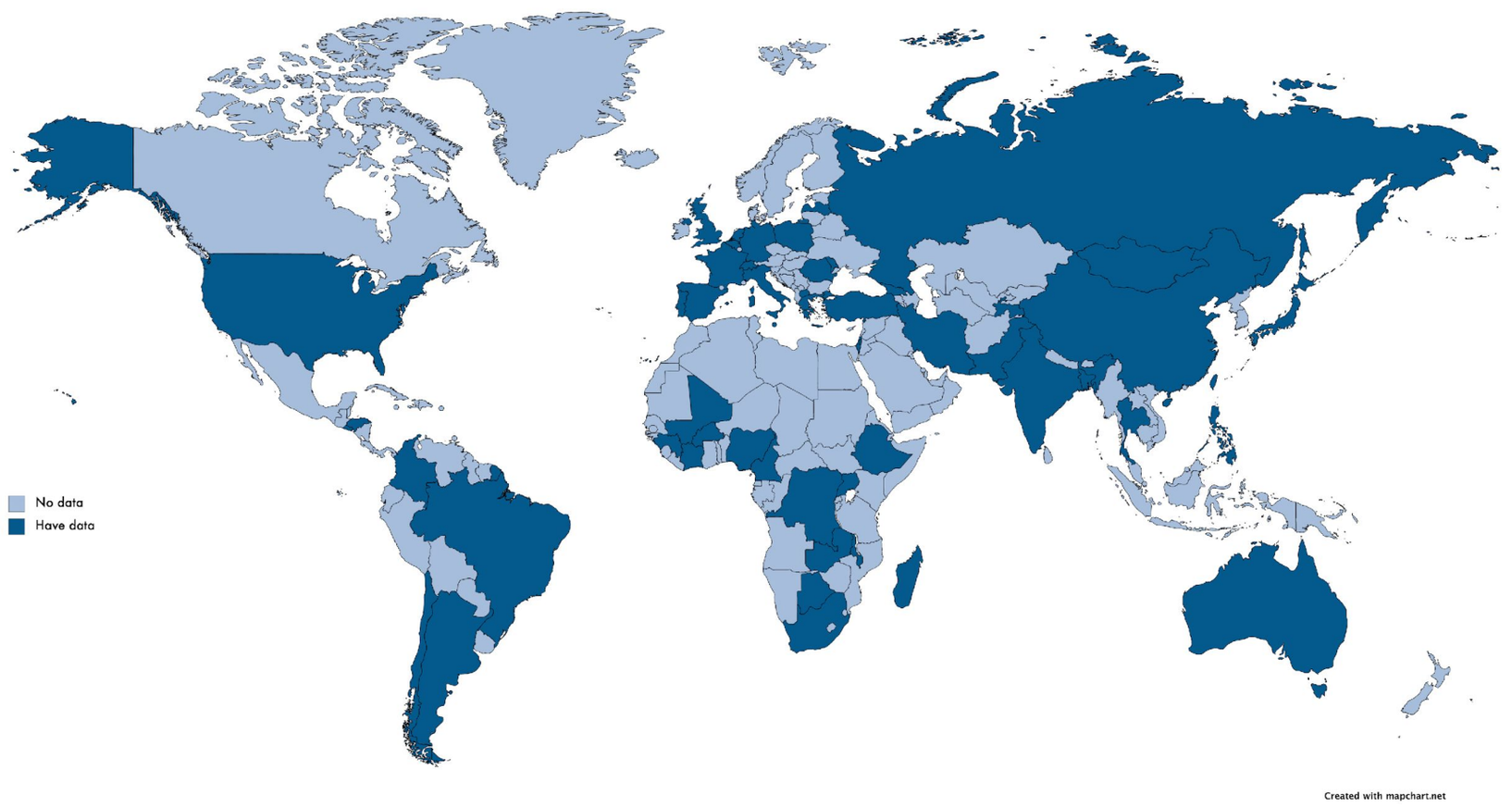
Change in case notifications 2011-2017



Walter, Martinez et al, *Lancet*, 2021

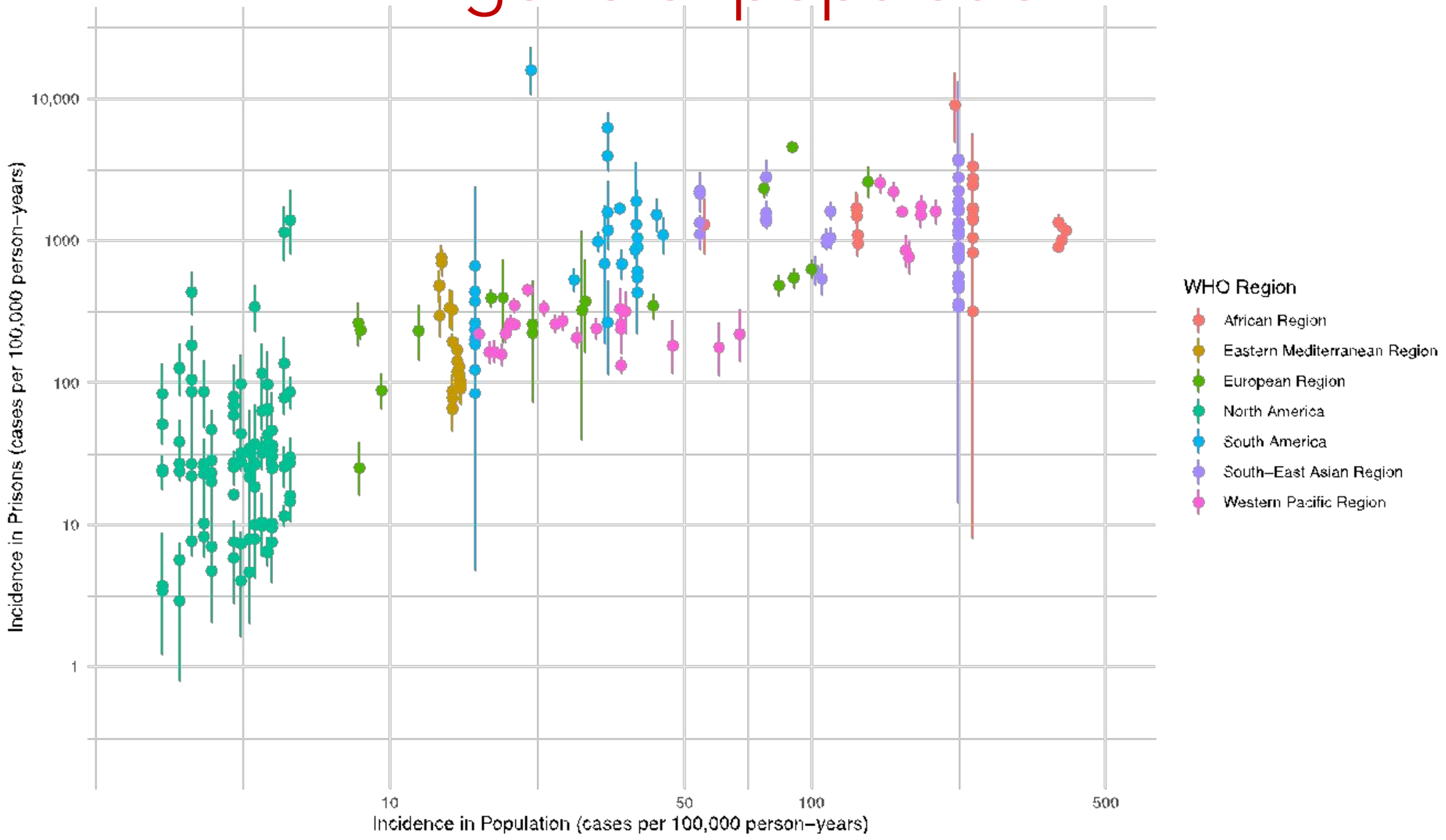
Prevalence and incidence of TB in prisons





Cords, Martinez et al, *Lancet Public Health*, 2021

TB incidence in prisons compared with the general population



TB incidence rate ratio in prisons compared to the general population

- North America: 4.1
- Africa: 12.6
- Southeast Asia: 11.7
- South America: 26.9

Cords, Martinez et al, *Lancet Public Health*, 2021

HIV

Smoking

Limited Access to Diagnostics

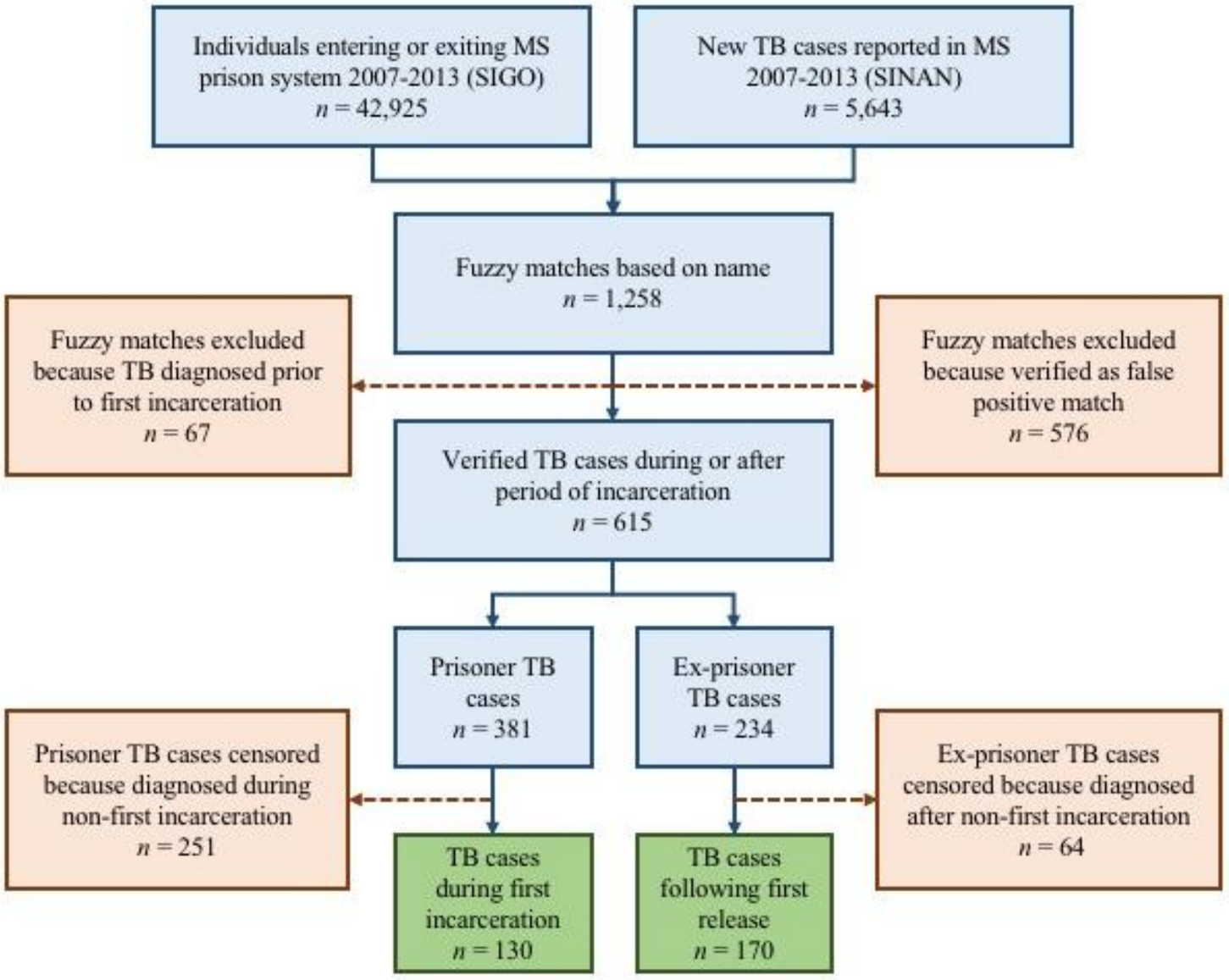
Overcrowding

Poor Ventilation

Drug Use

photos: Andrea Santos

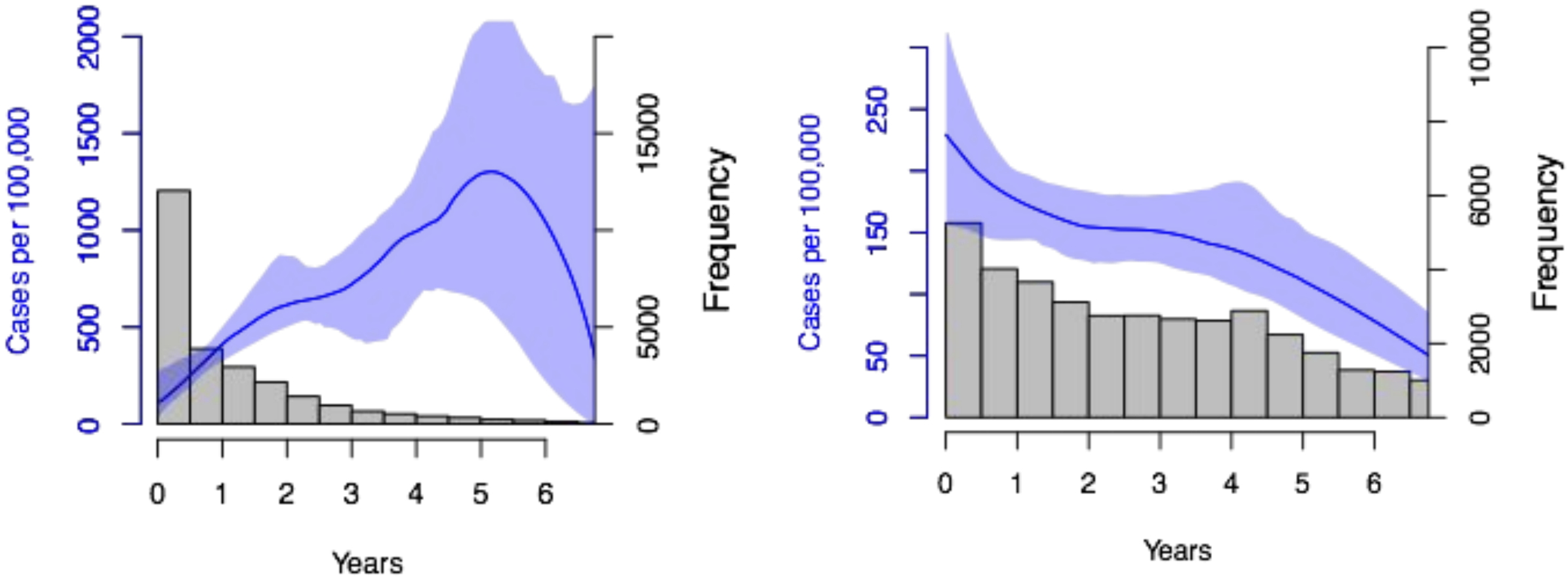
What role does TB in prisons have in TB in the community



Mabud T, *et al. PLoS Medicine*, 2019

TB incidence duration and after incarceration

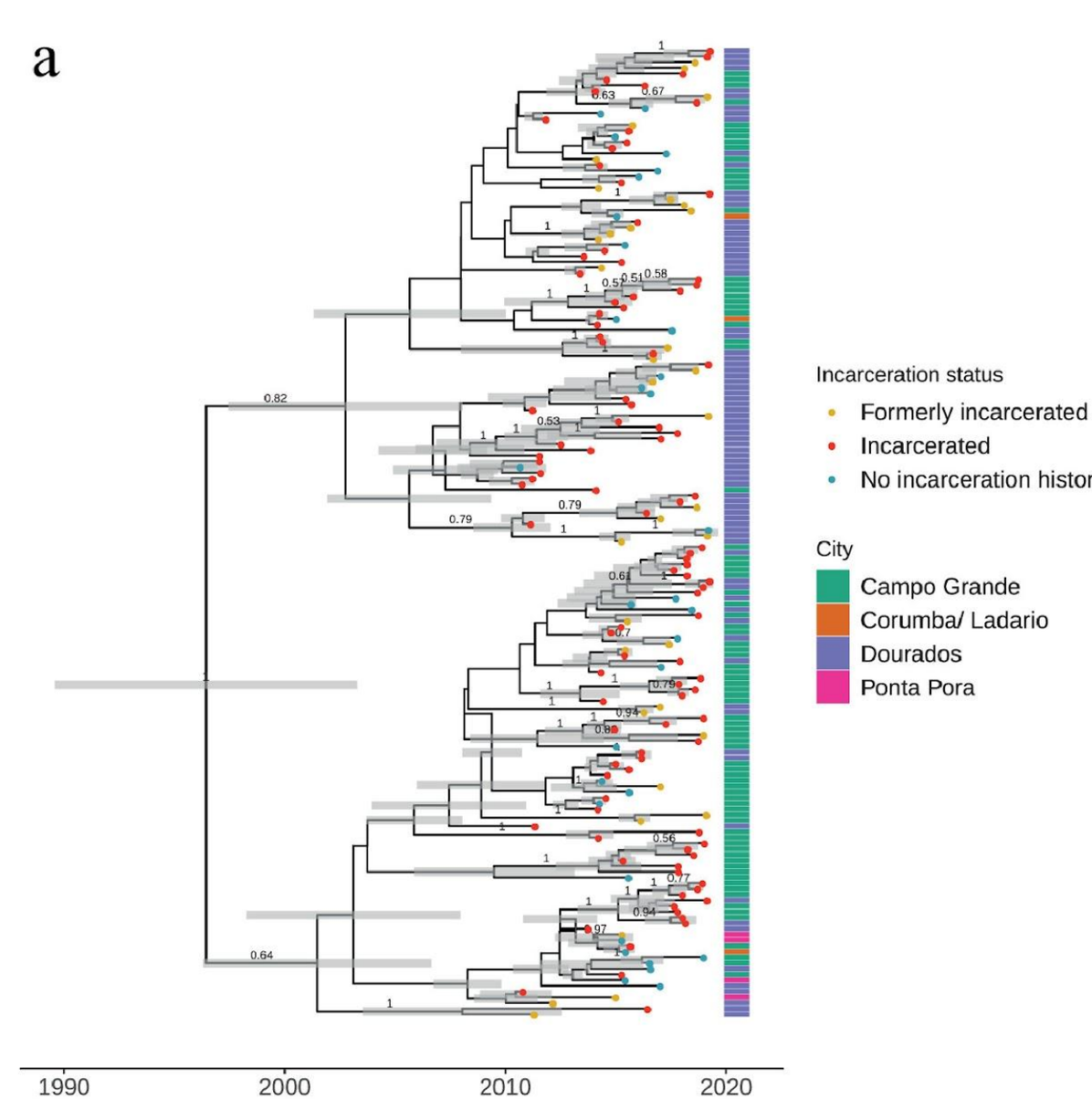
Prevalence of LTBI at first incarceration: <10%

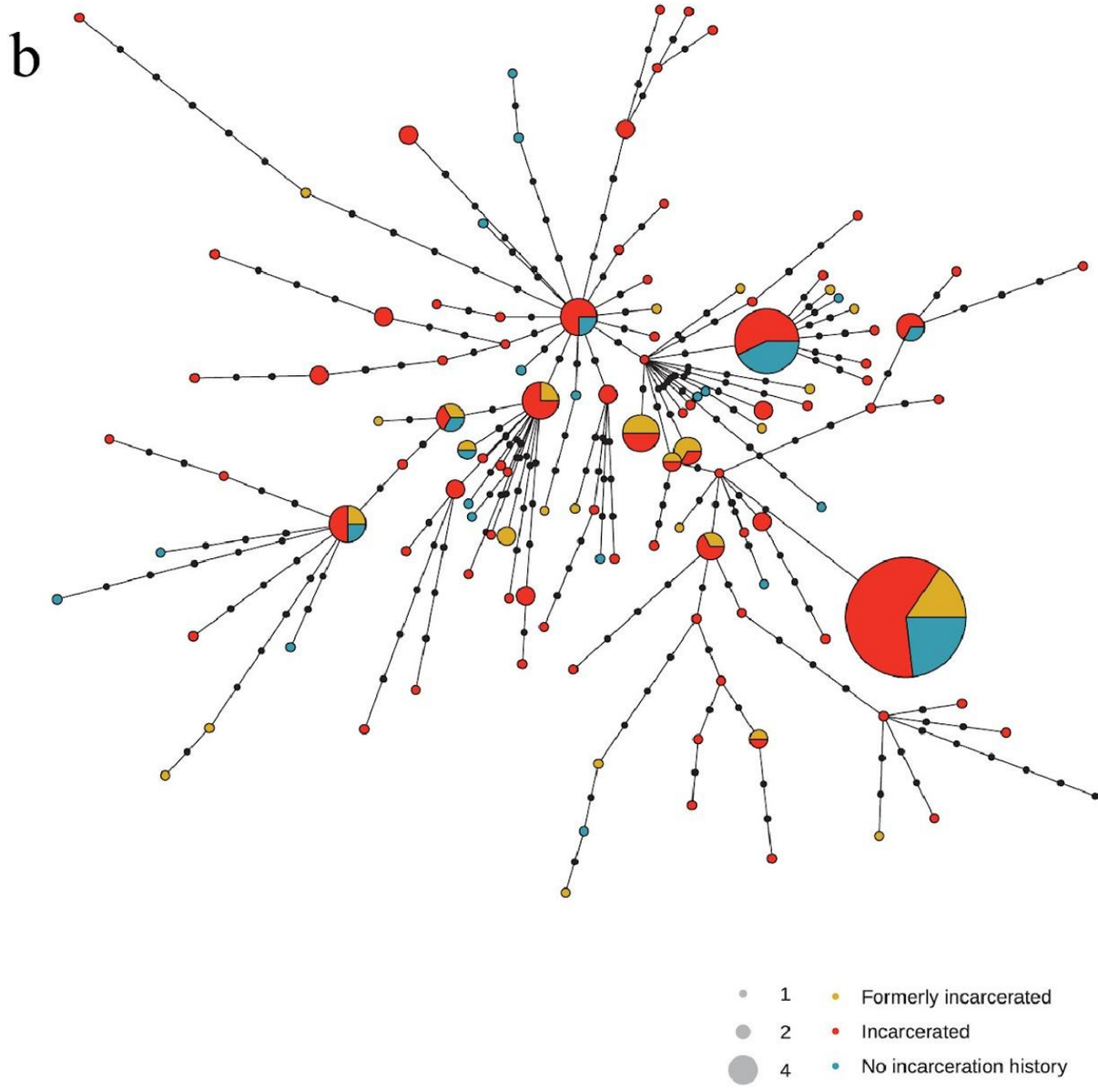


~50% of TB cases among people with incarceration are notified in community

Mabud T, *et al. PLoS Medicine*, 2019

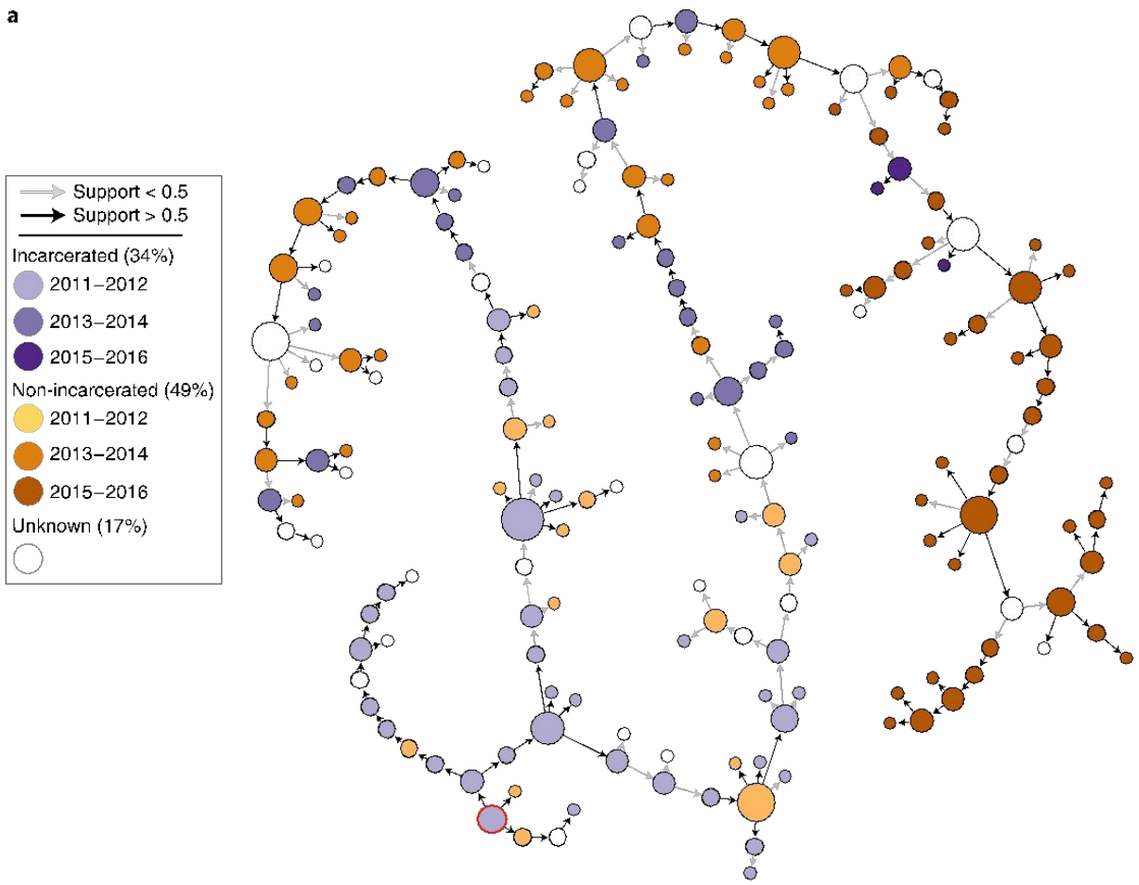
What is the relationship between prison and community TB epidemics?





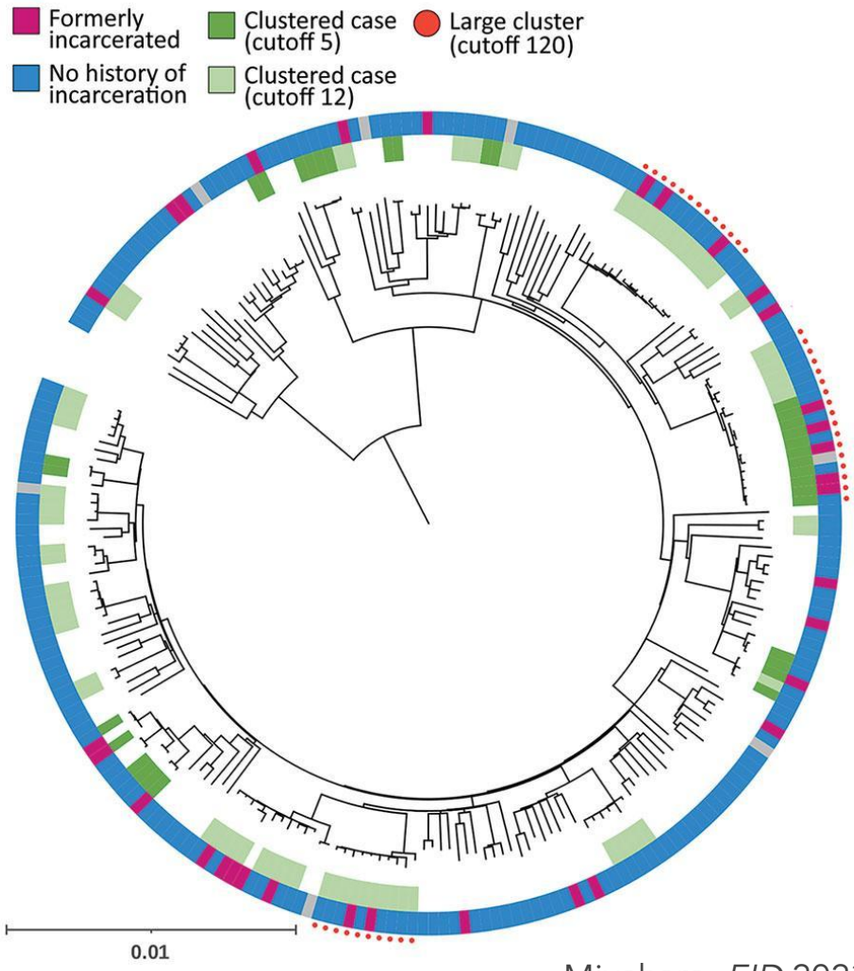
~40% of community TB cases arise directly from cases in incarcerated or formerly incarcerated individuals

Walter et al, *Lancet Reg Am* 2022



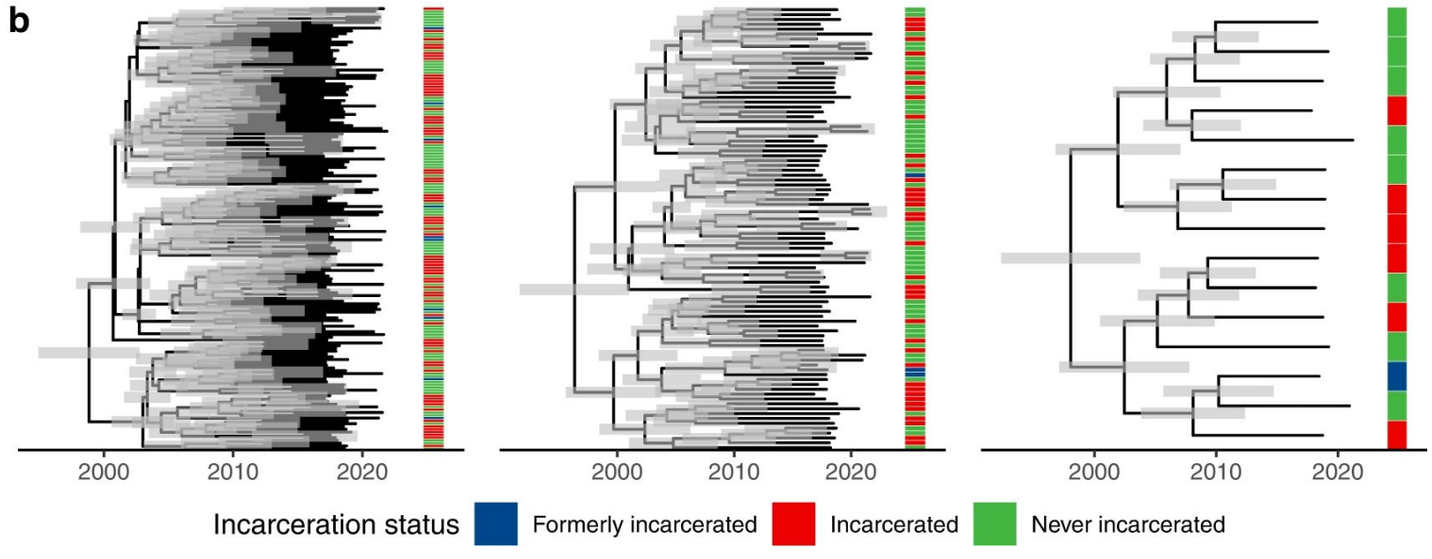
Gygli et al. *Nat Med* 2021

31% of MDR TB in Georgia linked to prisons



Miyahara, *EID* 2023

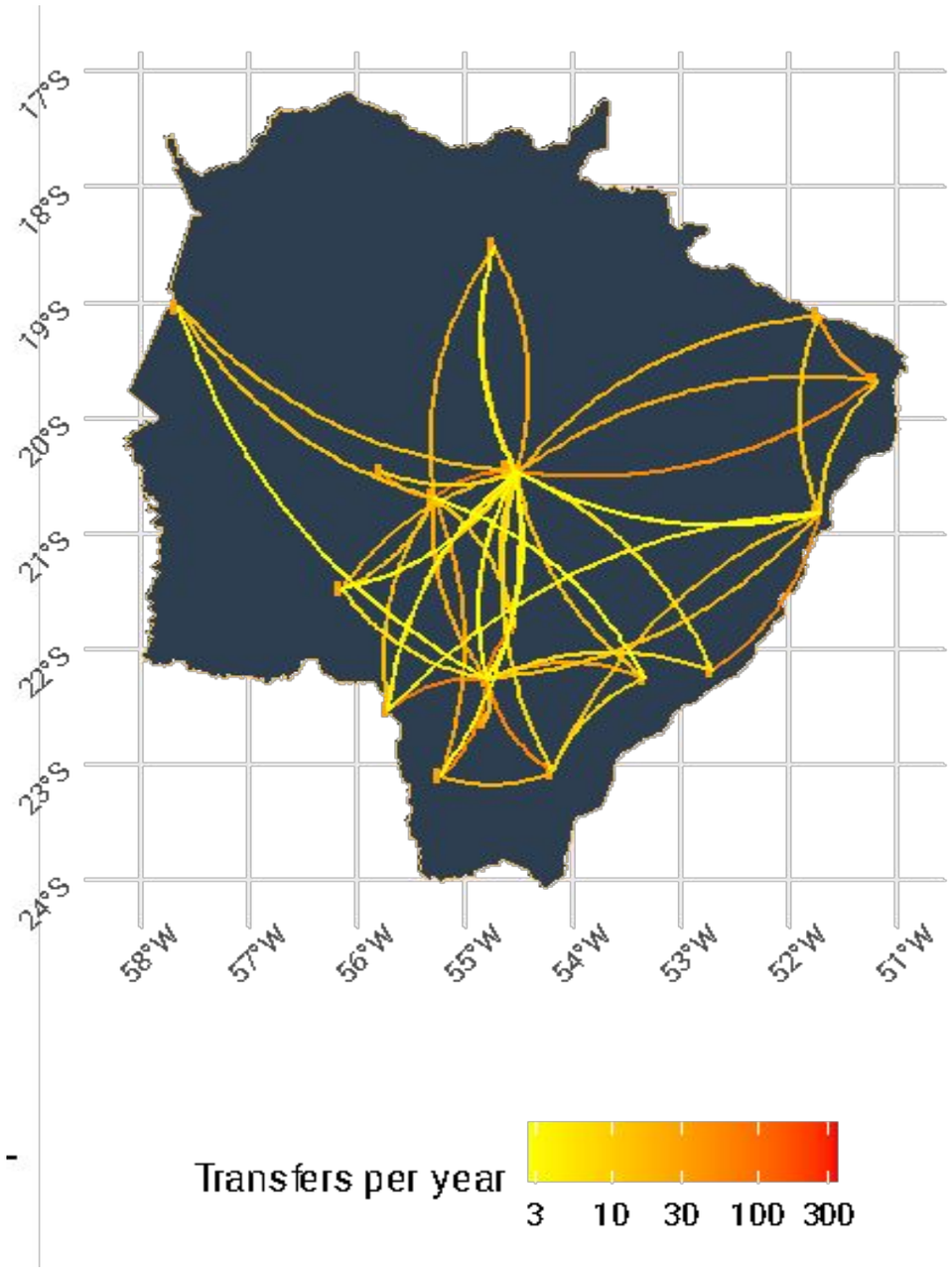
Formerly incarcerated individuals 4.7 times more likely to be in community transmission clusters (Thailand)

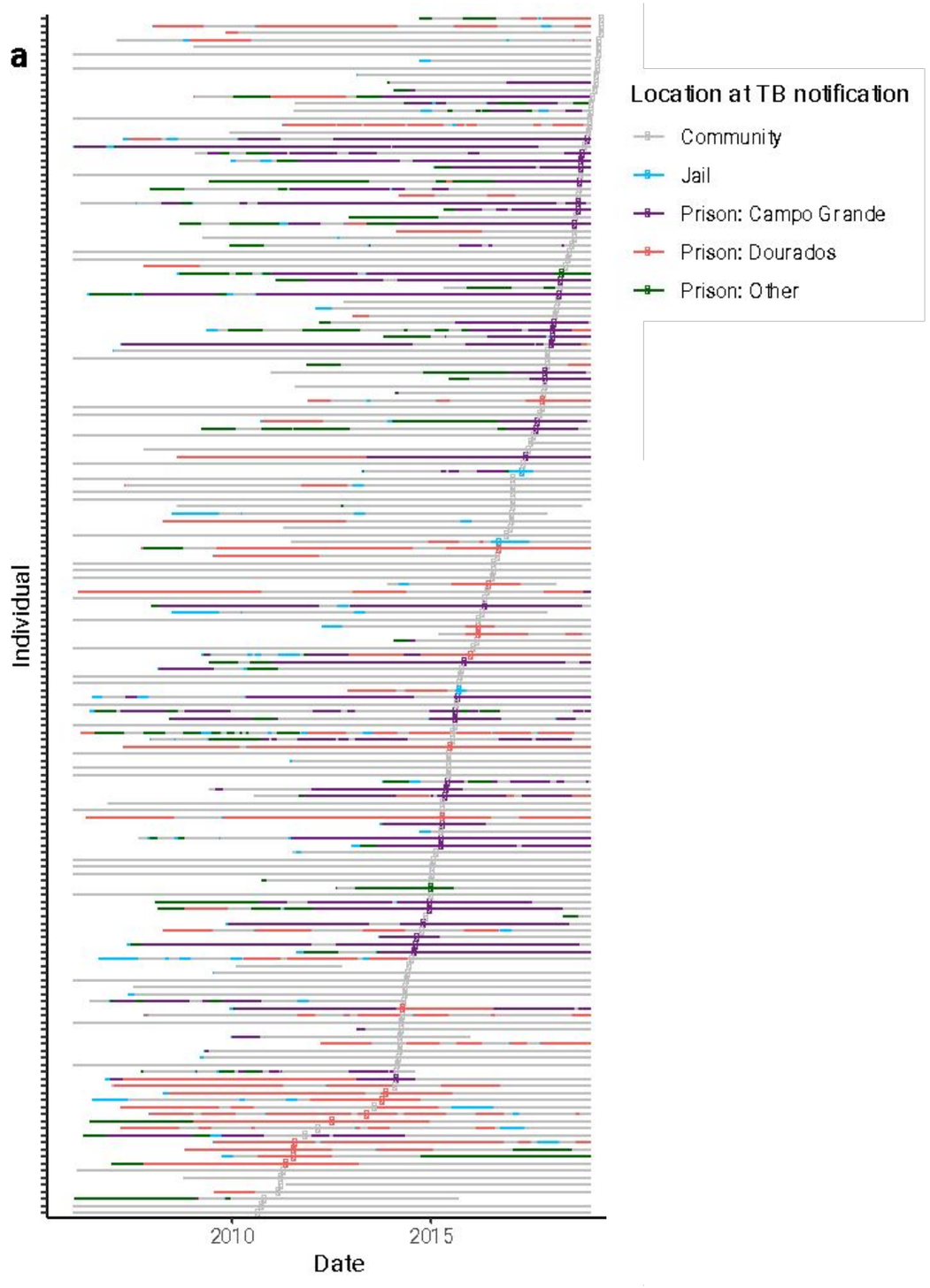


85% of never-incarcerated individuals in Paraguay were in transmission clusters with individuals with incarceration history

Sanabria et al, *Nat Comm*, 2023

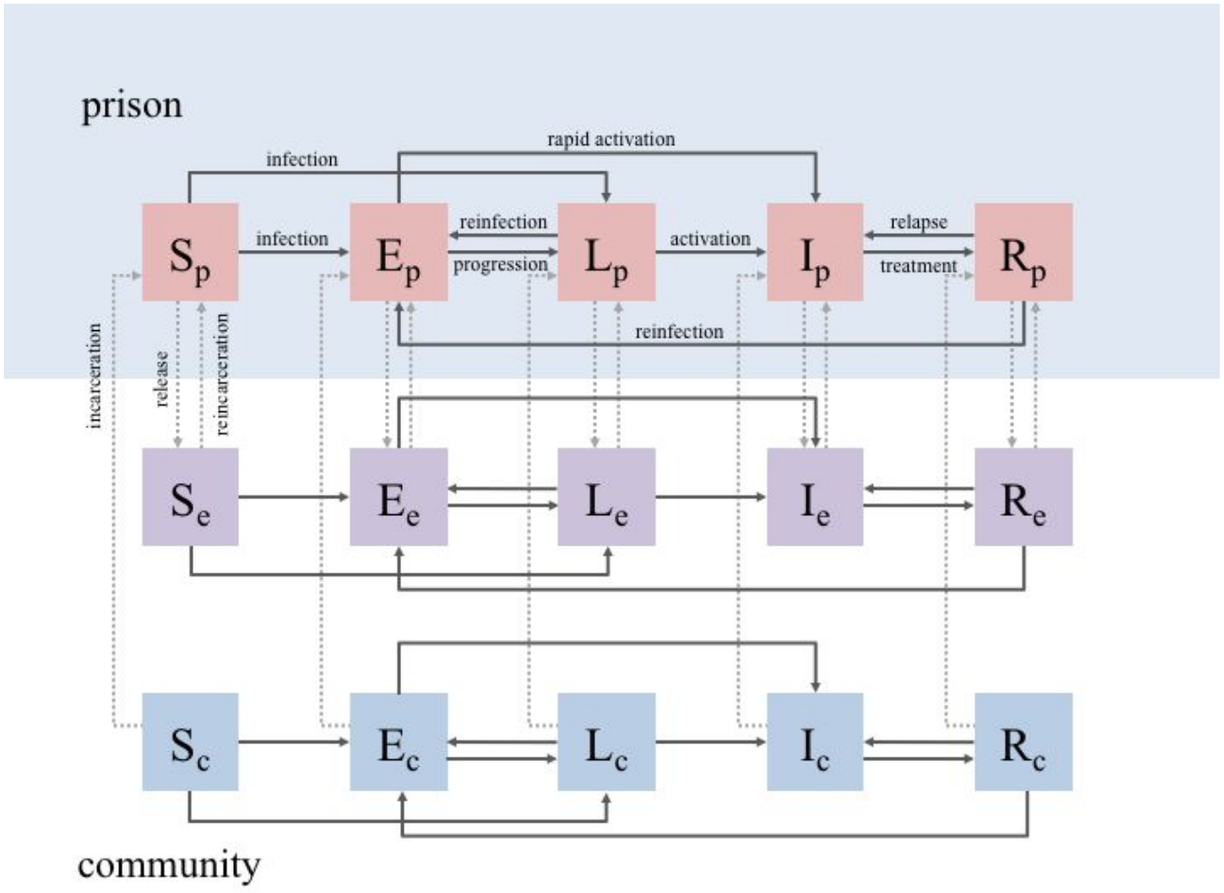
Prisons not only amplify but also spatially disseminate TB

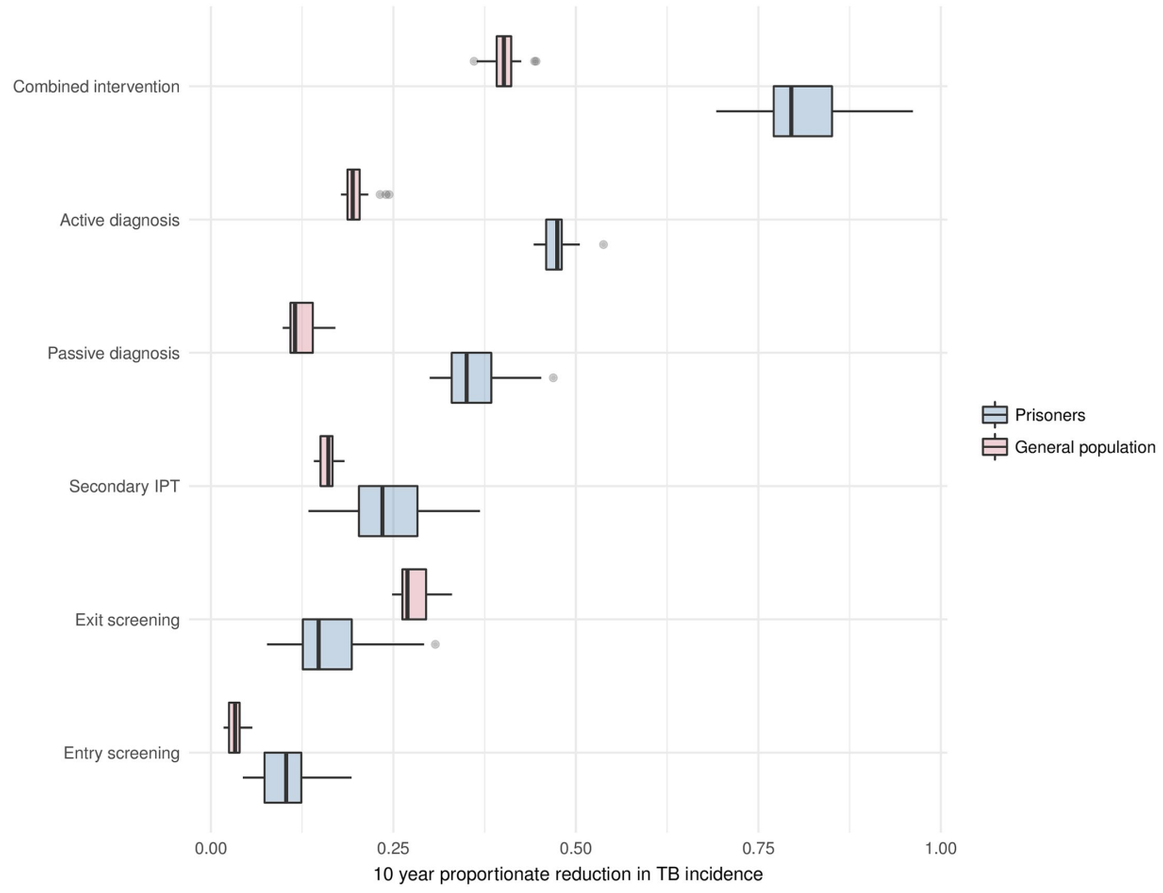




Walter et al, *Lancet Reg Am* 2022

Interventions conducted in prisons could have outsized impact on TB





An effective combination of case detection interventions conducted only in prisons could reduce TB in the community by >30%

Mabud T, *et al. PLoS Medicine*, 2019

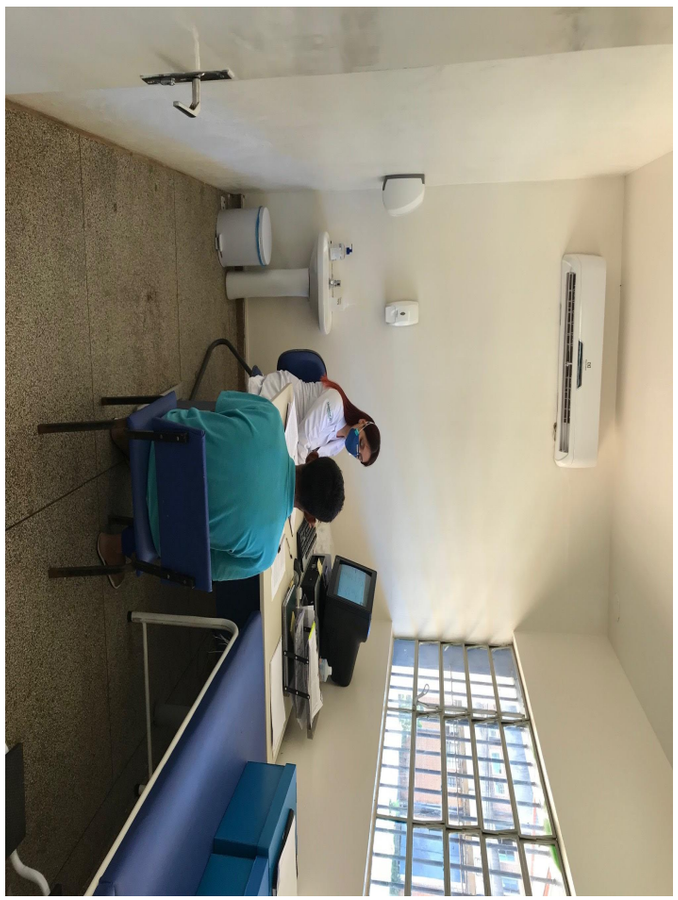
How can we respond effectively to the TB epidemic in prisons?

TB Studies in Prisons in Mato Grosso do Sul

TB incidence in general population: 35 per 100,000

TB incidence prisons: >3,000 per 100,000

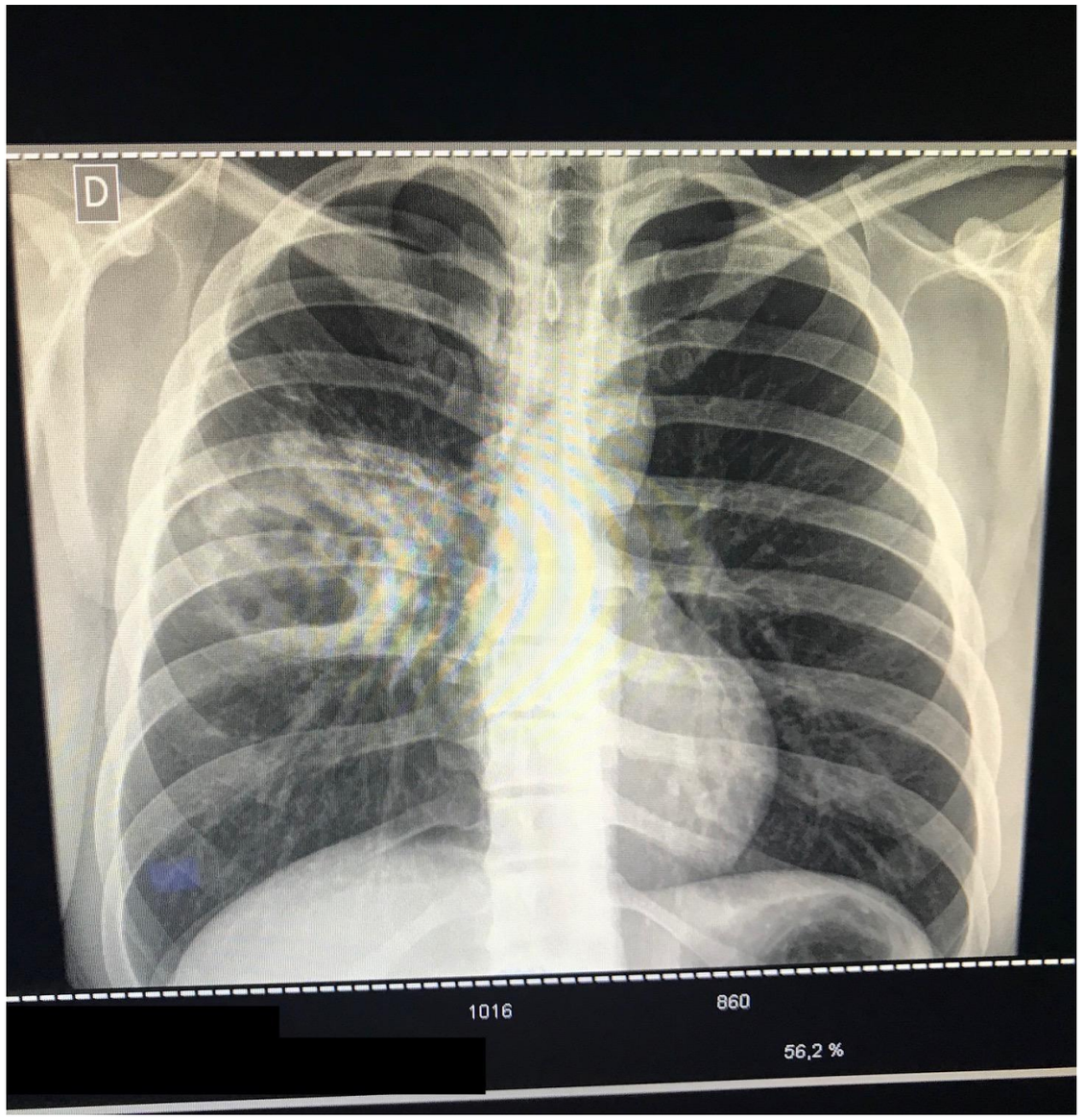
Mass TB Screening



Active case finding

For every participant, irrespective of symptoms:

- Chest x-ray
- Sputum collection for Xpert and culture



Yield, Efficiency, and Costs of Mass Screening Algorithms for Tuberculosis in Brazilian Prisons

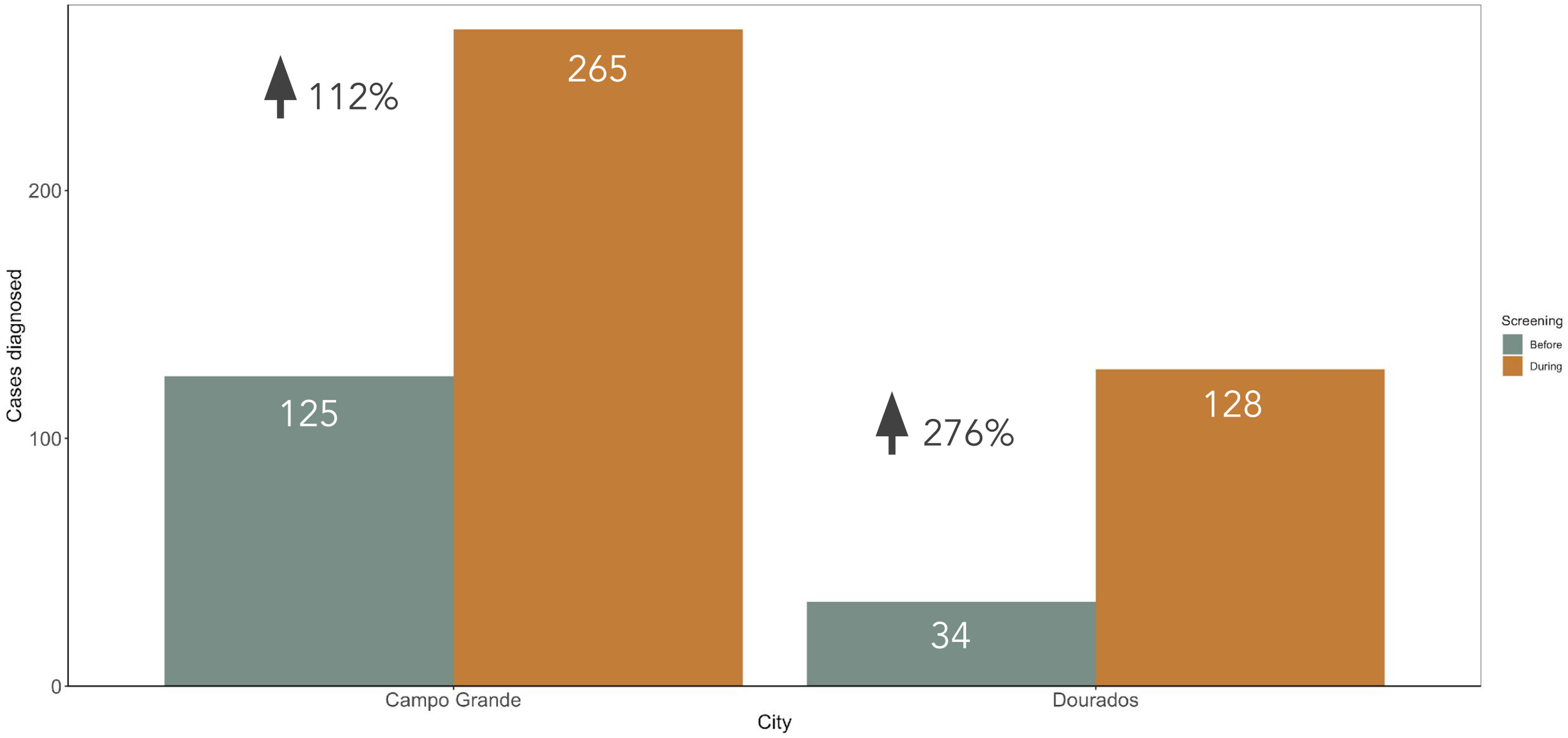
Andrea da Silva Santos,[1] Roberto Dias de Oliveira,[2] Everton Ferreira Lemos,[2] Fabiano Lima,[2] Ted Cohen,[3] Olivia Cords,[4] Leonardo Martinez,[4] Crhistinne Gonçalves,[2] Albert I. Ko,[3] Jason R. Andrews,[4,a] and Julio Croda[2,3,5,a]

[1]Faculty of Health Sciences, Federal University of Grande Dourados, Dourados, Brazil, [2]School of Medicine, Federal University of Mato Grosso do Sul, Campo Grande, Brazil, [3]Department of Epidemiology of Microbial Diseases, Yale University School of Public Health, New Haven, Connecticut, USA, [4]Division of Infectious Diseases and Geographic Medicine, Stanford University School of Medicine, Stanford, California, USA, and [5]Oswaldo Cruz Foundation Mato Grosso do Sul, Campo Grande, Brazil

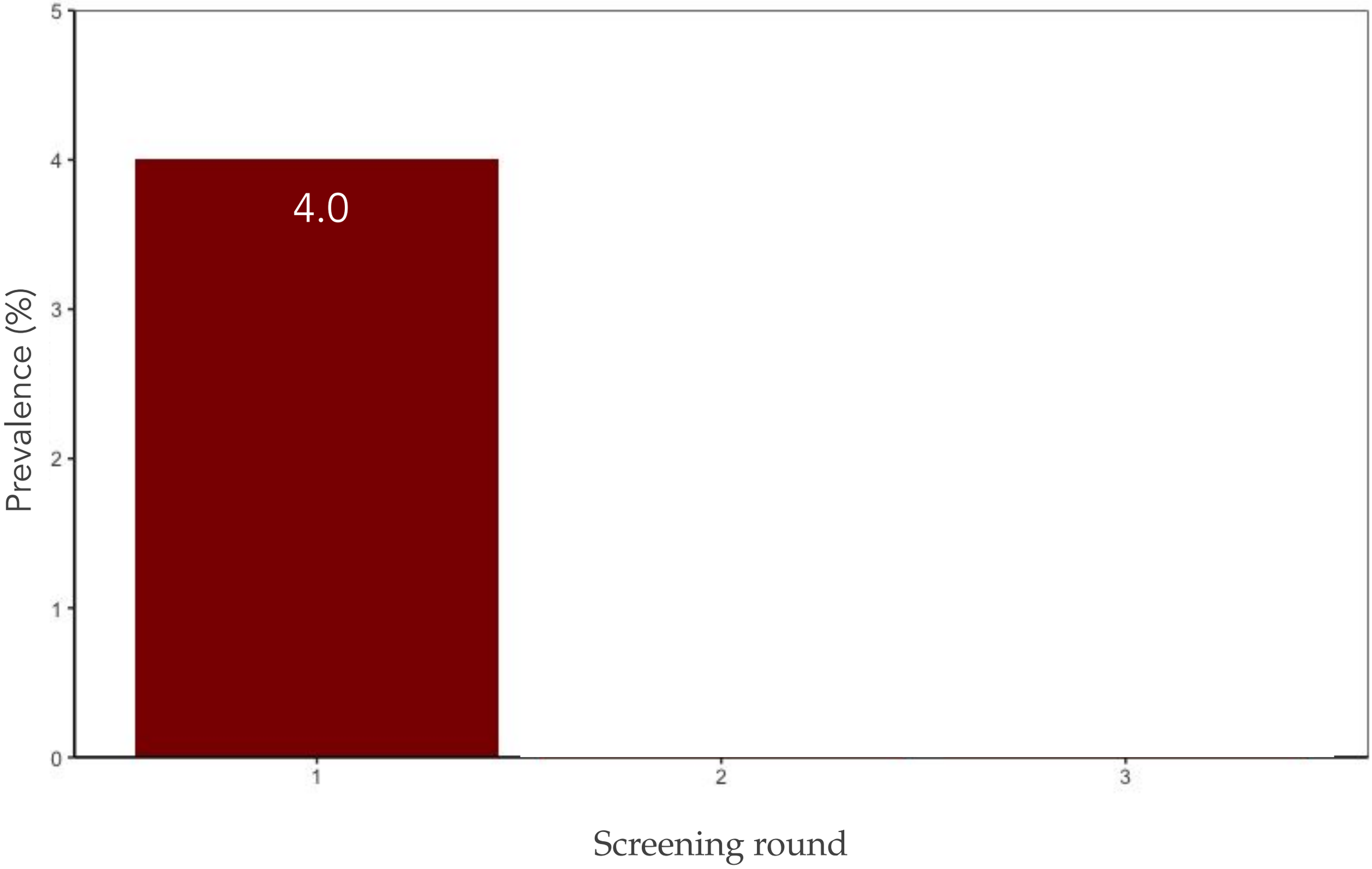
- 5,387 screened
  - 214 active TB (3.9%)
- Symptom screening would miss up to half of cases

da Silva Santos et al, *Clin Inf Dis,* 2020

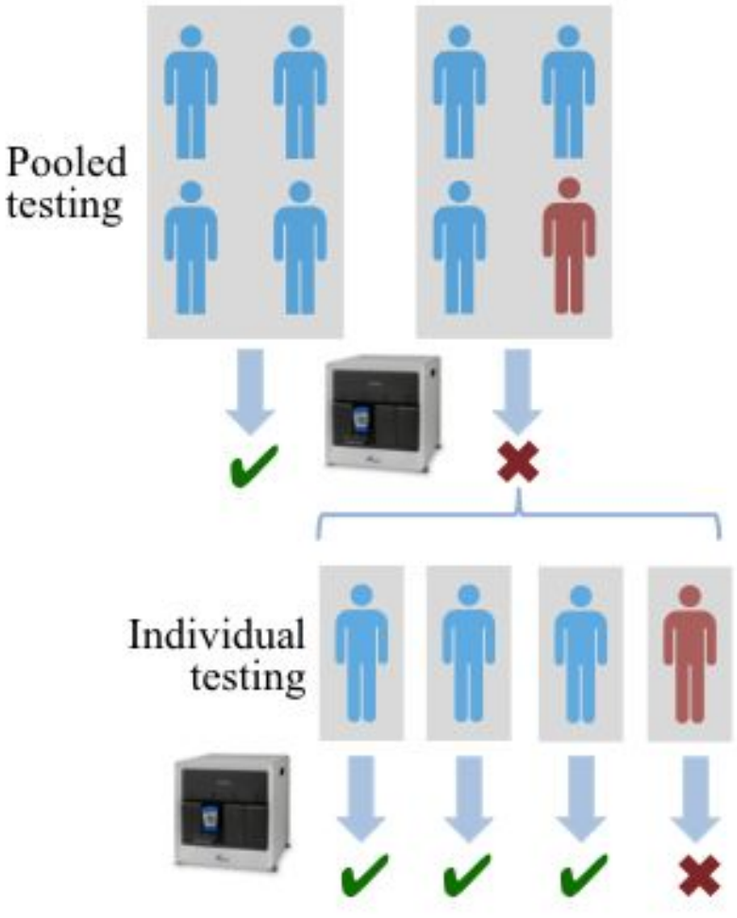
Screening markedly increased case detection



But prevalence remained extremely high



Sputum pooling to improve testing efficiency



Clinical Infectious Diseases

MAJOR ARTICLE

Pooling Sputum Samples for Efficient Mass Tuberculosis Screening in Prisons

Paulo César Pereira dos Santos,[1] Andrea da Silva Santos,[1] Roberto Dias de Oliveira,[2] Bruna Oliveira da Silva,[1] Thiego Ramon Soares,[1] Leonardo Martinez,[3] Renu Verma,[4] Jason R. Andrews,[4,a] and Julio Croda[5,a]

[1]Faculty of Health Sciences, Federal University of Grande Dourados, Dourados, Mato Grosso do Sul, Brazil; [2]School of Nursing, State University of Mato Grosso do Sul, Dourados, Mato Grosso do Sul, Brazil; [3]Department of Epidemiology, School of Public Health, Boston University, Boston, Massachusetts, USA; [4]Division of Infectious Diseases and Geographic Medicine, Stanford University School of Medicine, Stanford, California, USA; and [5]Oswaldo Cruz Foundation, Mato Grosso do Sul, Campo Grande, Mato Grosso do Sul, Brazil

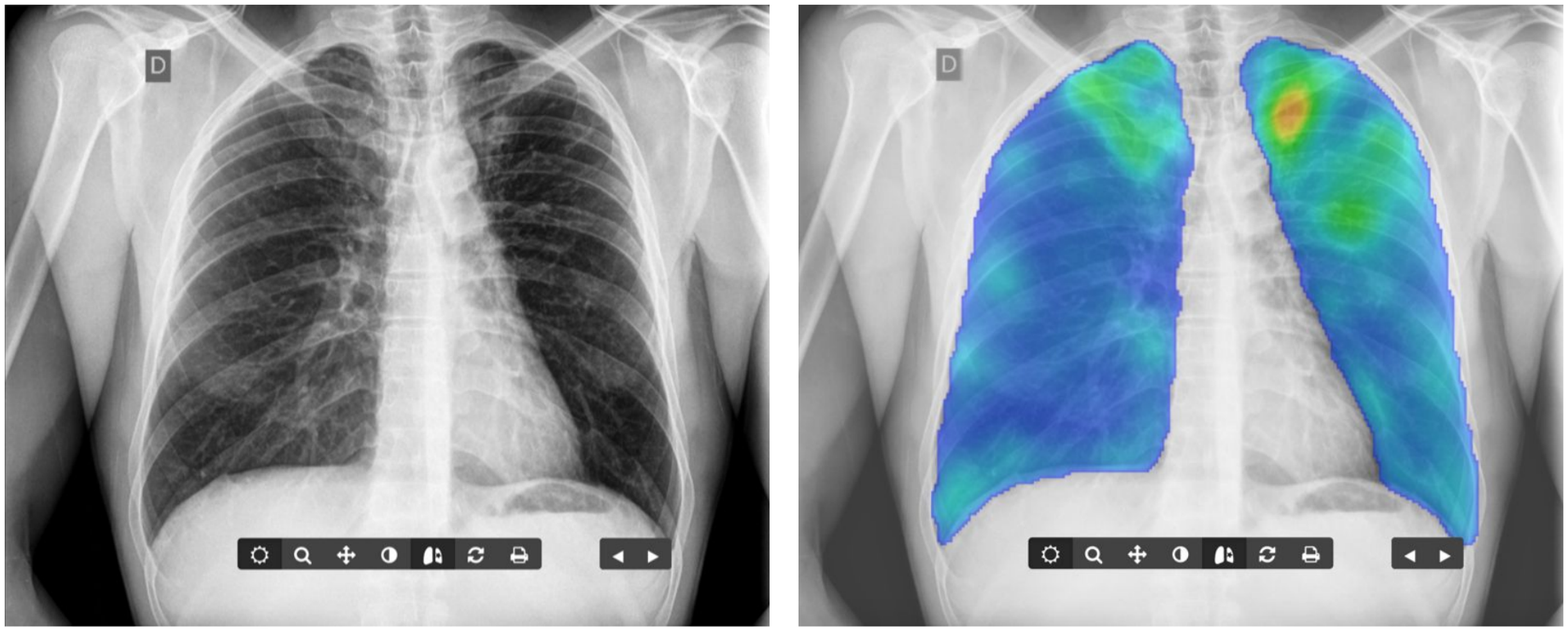
Table 1. Sensitivity of Sputum Pooling by Pool Size Using Xpert® MTB/RIF Ultra, Stratified by Distinct Levels of *Mycobacterium tuberculosis* Semi-Quantitative Load Estimated by Xpert® MTB/RIF G4

	Xpert® MTB/RIF Ultra Semiquantitative				
	Mycobacterium tuberculosis Load of the Positive Sample				
Pool Size	High (%)	Medium (%)	Low (%)	Very Low (%)	Total (%, 95% CI)
4	5/5 (100)	5/5 (100)	5/5 (100)	4/5 (80)	19/20 (95, 75–100)
8	5/5 (100)	5/5 (100)	5/5 (100)	5/5 (100)	20/20 (100, 83–100)
12	5/5 (100)	4/5 (80)	3/5 (60)	4/5 (80)	16/20 (80, 56–94)
16	10/10 (100)	10/10 (100)	10/10 (100)	9/10 (90)	39/40 (97, 87–100)
Total (%)	25/25 (100)	24/25 (96)	23/25 (92)	22/25 (88)	94/100 (94, 87–98)

Abbreviation: CI, confidence interval.

Reduced costs by >50% per case dected

Automated interpretation of x-rays



- Screening of 2,075 individuals with sputum Xpert/culture
- 259 confirmed TB cases
- Compared CAD4TB v6, Lunit TB and qXR

Evaluation of chest X-ray with automated interpretation algorithms for mass tuberculosis screening in prisons: A cross-sectional study

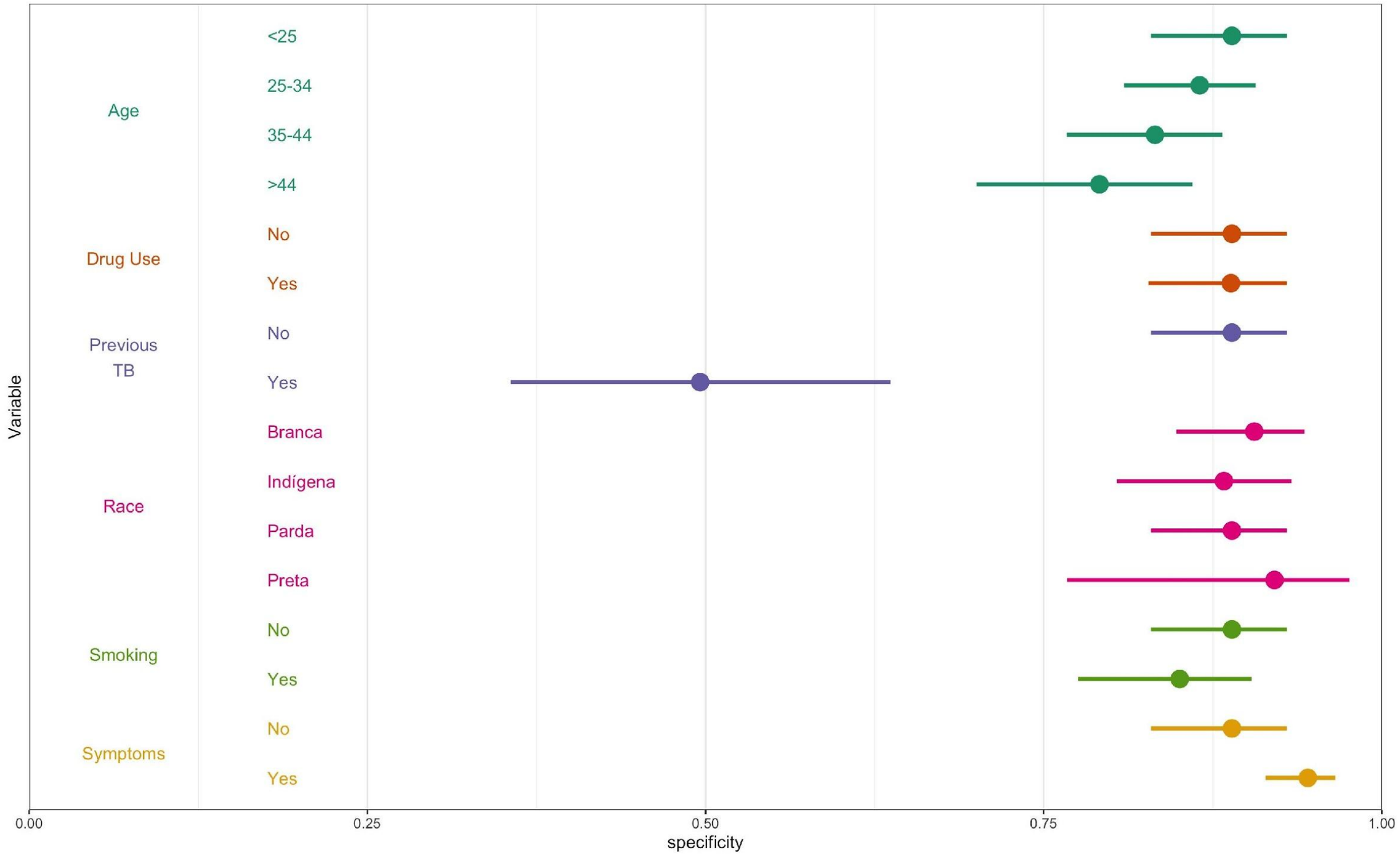
Thiego Ramon Soares,[a] Roberto Dias de Oliveira,[a,b] Yiran E. Liu,[c] Andrea da Silva Santos,[a] Paulo Cesar Pereira dos Santos,[a] Luma Ravena Soares Monte,[b] Lissandra Maia de Oliveira,[d] Chang Min Park,[e,f] Eui Jin Hwang,[e,f] Jason R. Andrews,[c,i] and Julio Croda[d,g,h,i,]*

System	AUC (95% CI)	At pre-defined thresholds		At 90% sensitivity, 4% prevalence		
		Sensitivity % (95% CI)	Specificity % (95% CI)	Specificity % (95% CI)	PPV %	NPV %
CAD4v6	0.88 (0.85–0.90)	80.7 (75.4–85.3)	82.7 (80.8–84.4)	62.3 (52.0–73.1)	9.0	99.3
LunitTB	0.91 (0.89–0.93)	79.9 (74.5–84.6)	89.8 (88.3–91.2)	83.7 (72.4–87.3)	18.7	99.5
qXR	0.90 (0.88–0.92)	74.5 (68.8–79.7)	89.4 (87.9–90.8)	74.2 (60.2–81.3)	12.7	99.4

Table 2: **Sensitivity, Specificity, Area Under the Curve (AUC), Positive Predictive Value (PPV) and Negative Predictive Value (NPV) of each algorithm at pre-defined thresholds or with thresholds adjusted to 90% sensitivity as specified by the WHO Target Product Profile minimum target.**

Soares et al, *Lancet Reg Americas*, 2022

Factors influencing specificity of CXR abnormalities



Soares et al, *Lancet Reg Americas*, 2022

Obstacles to implementing x-ray screening in prisons

- Many prisons lack x-ray machines
- Screening requires transportation of individuals outside of their cell block

We could use better diagnostics, but we have tools that work and shouldn't delay their implementation while this crisis continues

Scaling up evidence-based approaches to tuberculosis screening in prisons

Salome Charalambous, Kavindhran Velen, Zulma Rueda, Julio Croda, Michael E Herce, Sheela V Shenoi, Frederick L Altice, Monde Muyoyeta, Lily Telisinghe, Louis Grandjean, Salmaan Keshavjee, Jason R Andrews

People deprived of liberty have among the highest rates of tuberculosis globally. The incidence of tuberculosis is ten times greater than the incidence of tuberculosis in the general population. In 2021, WHO updated its guidance to strongly recommend systematic screening for tuberculosis in prisons and penitentiary systems. Which case-finding strategies should be adopted, and how to effectively implement these strategies in these settings, will be crucial questions facing ministries of health and justice. In this Viewpoint, we review the evidence base for tuberculosis screening and diagnostic strategies in prisons, highlighting promising approaches and knowledge gaps. Drawing upon past experiences of implementing active case-finding and care programmes in settings with a high tuberculosis burden, we discuss challenges and opportunities for improving the tuberculosis diagnosis and treatment cascade in these settings. We argue that improved transparency in reporting of tuberculosis notifications and outcomes in prisons and renewed focus and resourcing from WHO and other stakeholders will be crucial for building the commitment and investments needed from countries to address the continued crisis of tuberculosis in prisons.

Lancet Public Health 2023

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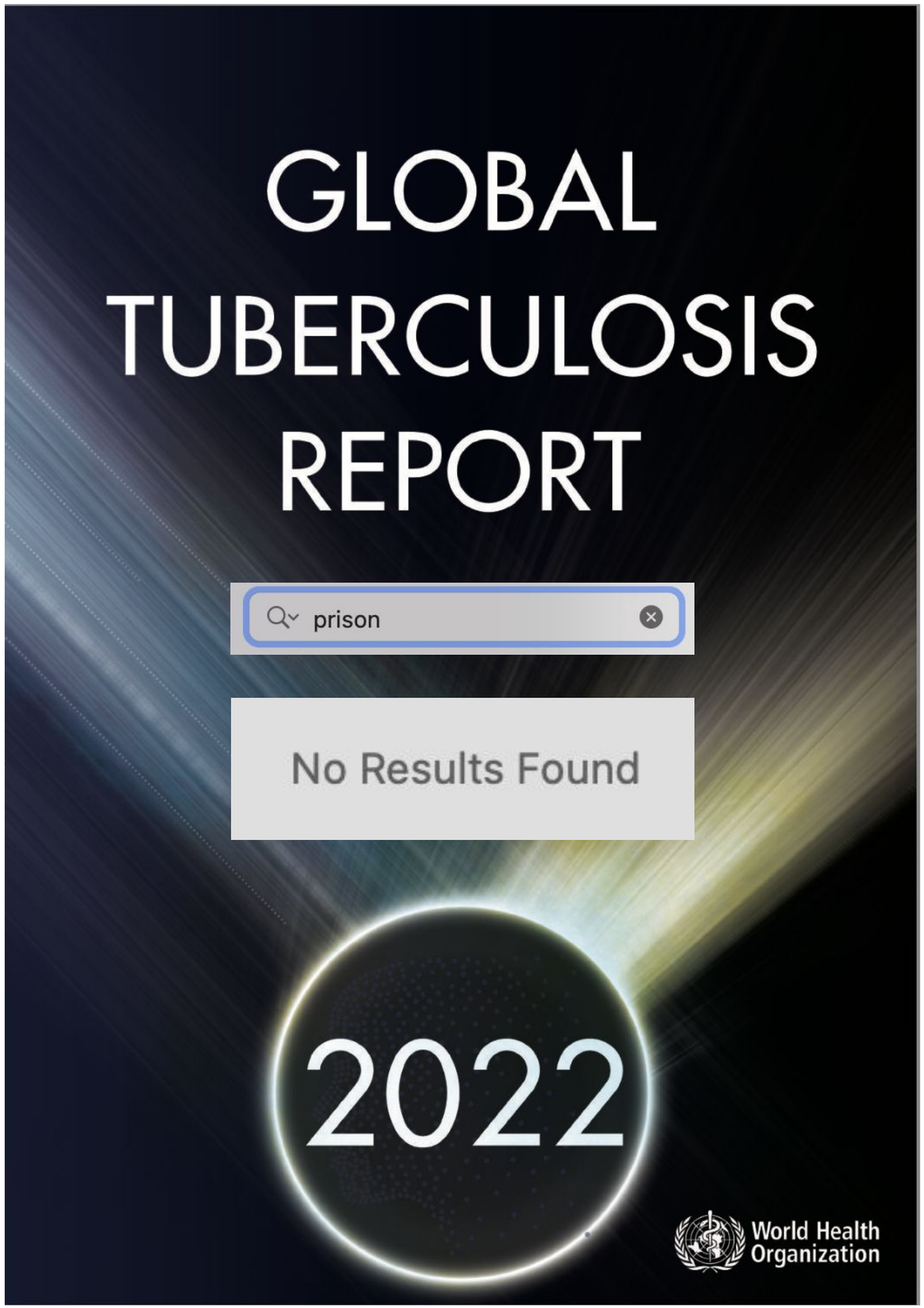
The Aurum Institute, Johannesburg, South Africa (S Charalambous PhD, K Velen PhD); **School of Public Health, Wits University, Johannesburg, South Africa** (S Charalambous); **Division of Epidemiology of Microbial Diseases, School of Public**

Remaining Challenges and Opportunities for Responding to TB in Prisons


GLOBAL
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REPORT
prison
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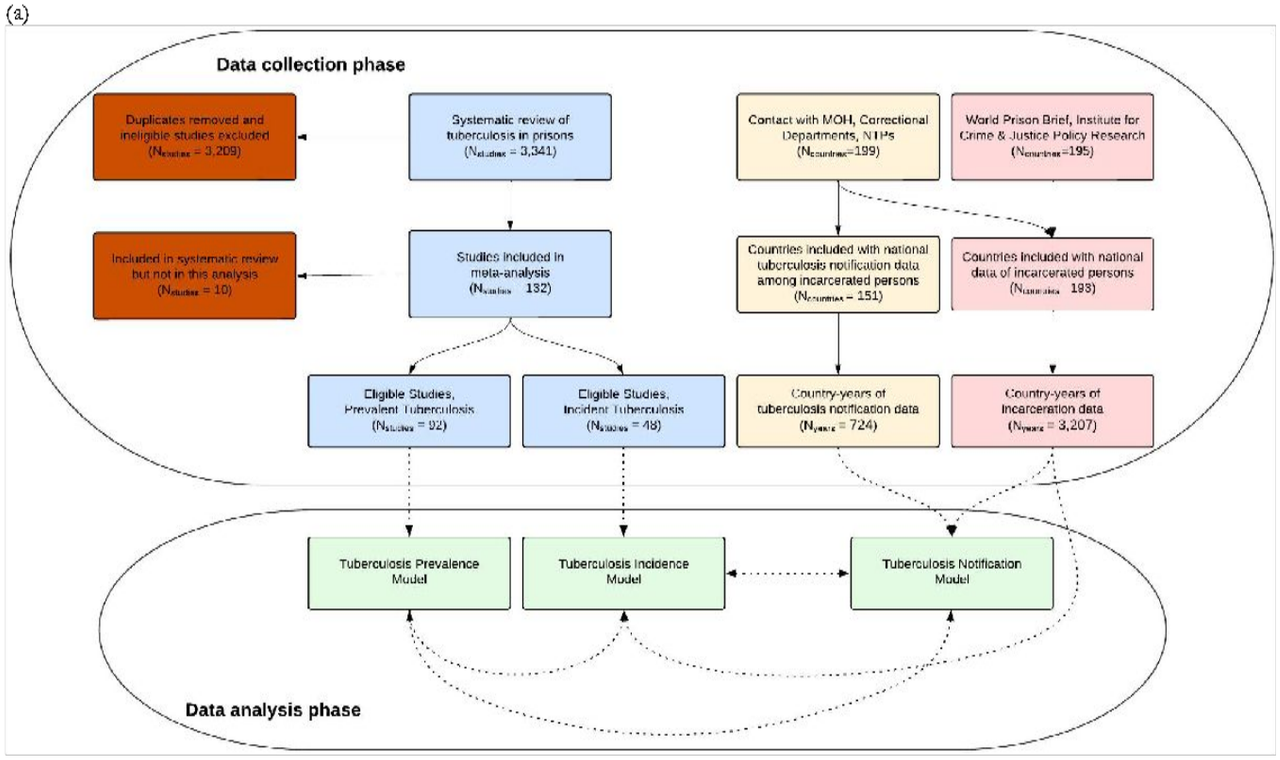
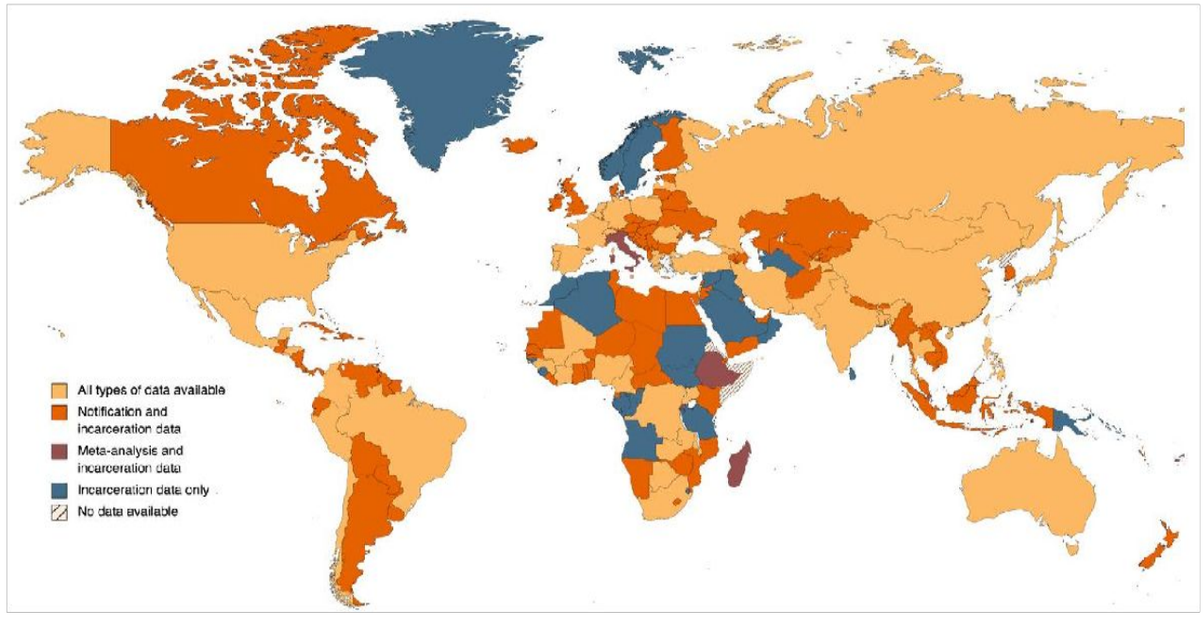
PARE

Assembling global data on TB in prisons

(a)

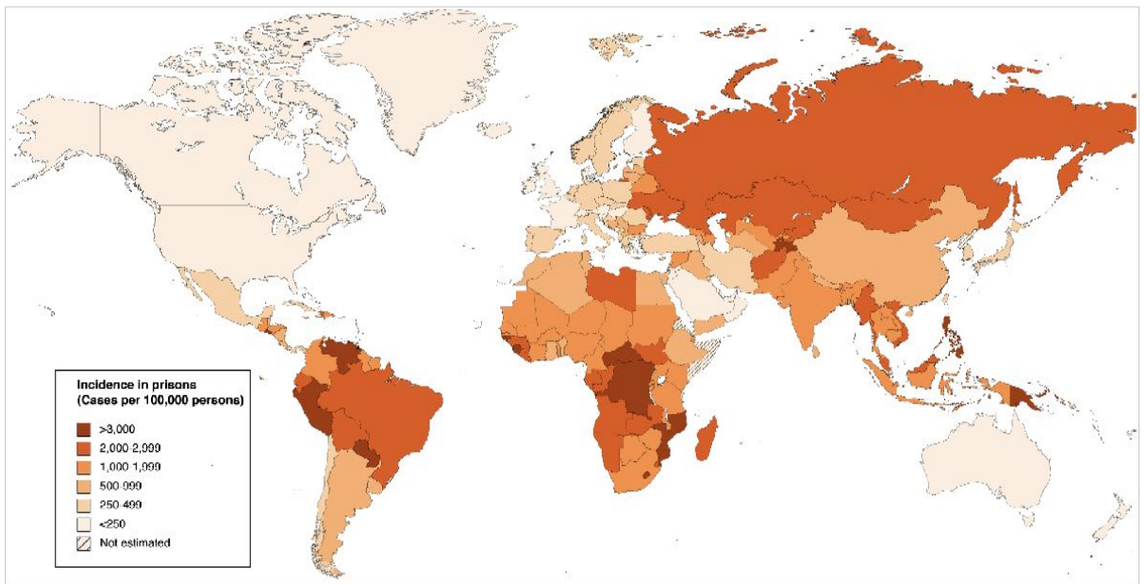


(b)



Bayesian hierarchical modeling to estimate country-specific TB incidence in prisons

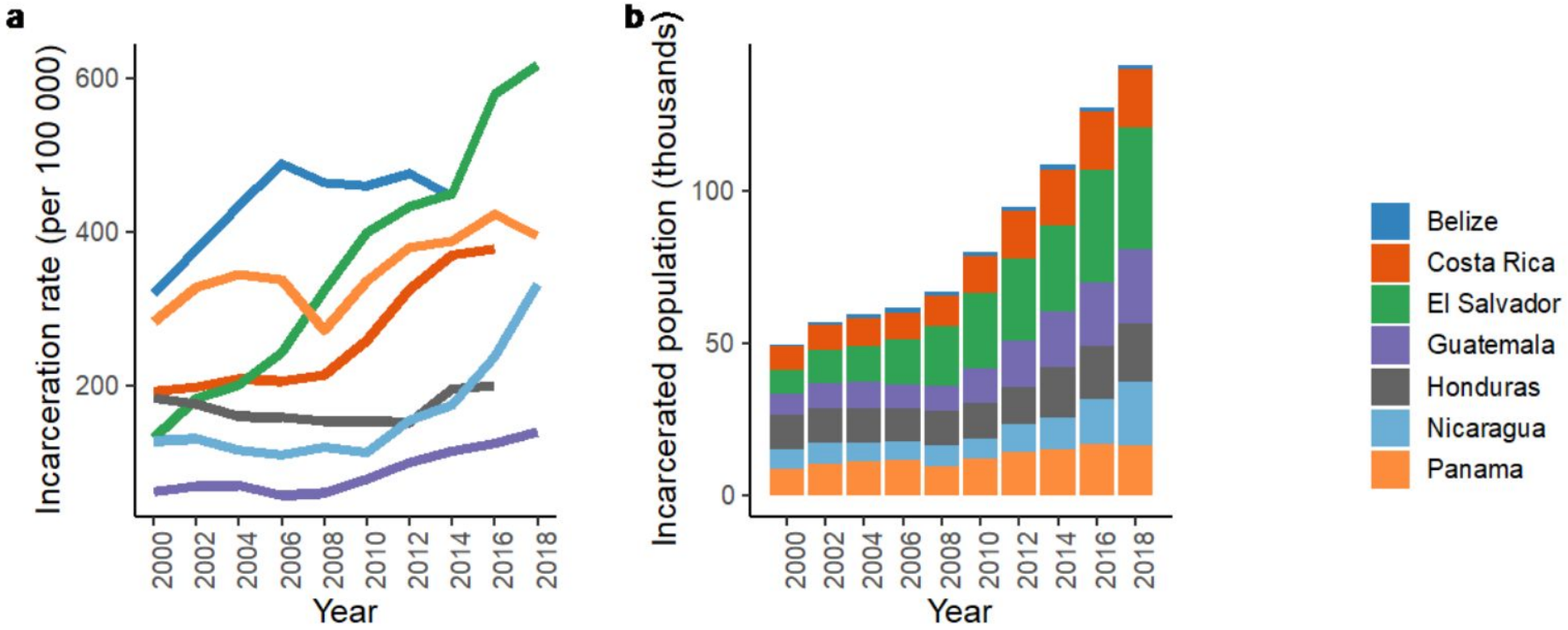
Figure 3. Estimated tuberculosis incidence in prisons (cases per 100,000 person-years) by country, 2019.



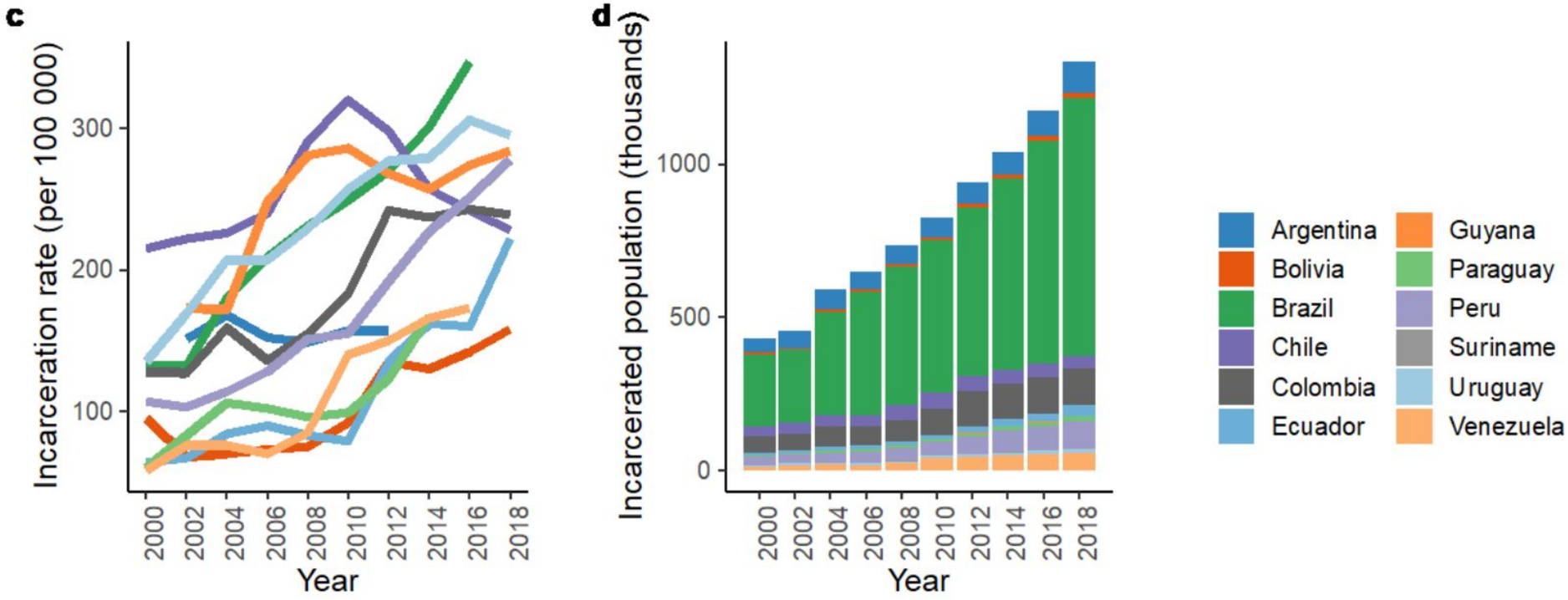
Martinez, Warren, et al, *Under Review*

Incarceration trends

Central America

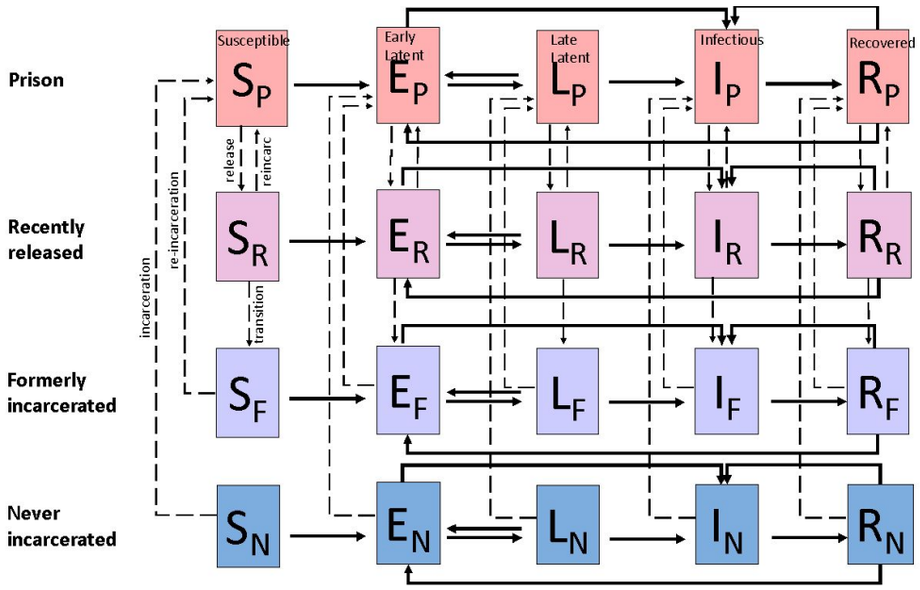


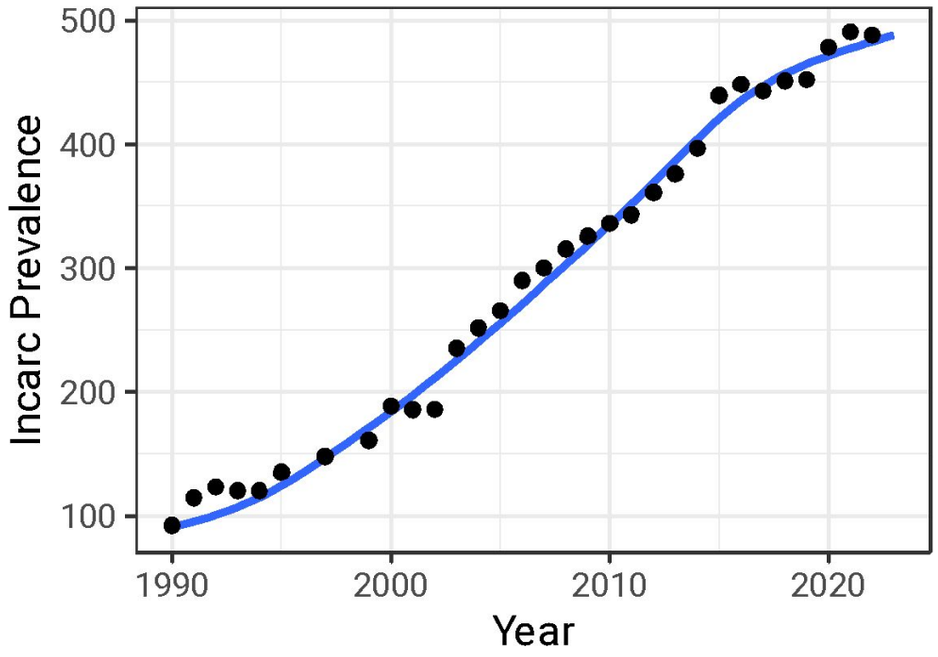
South America

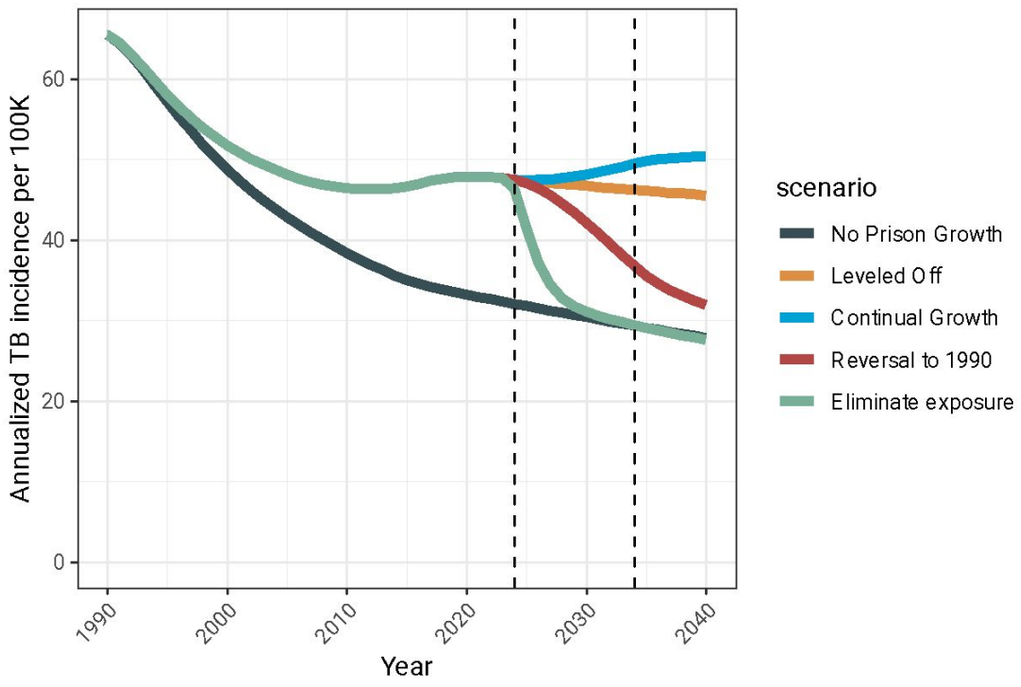


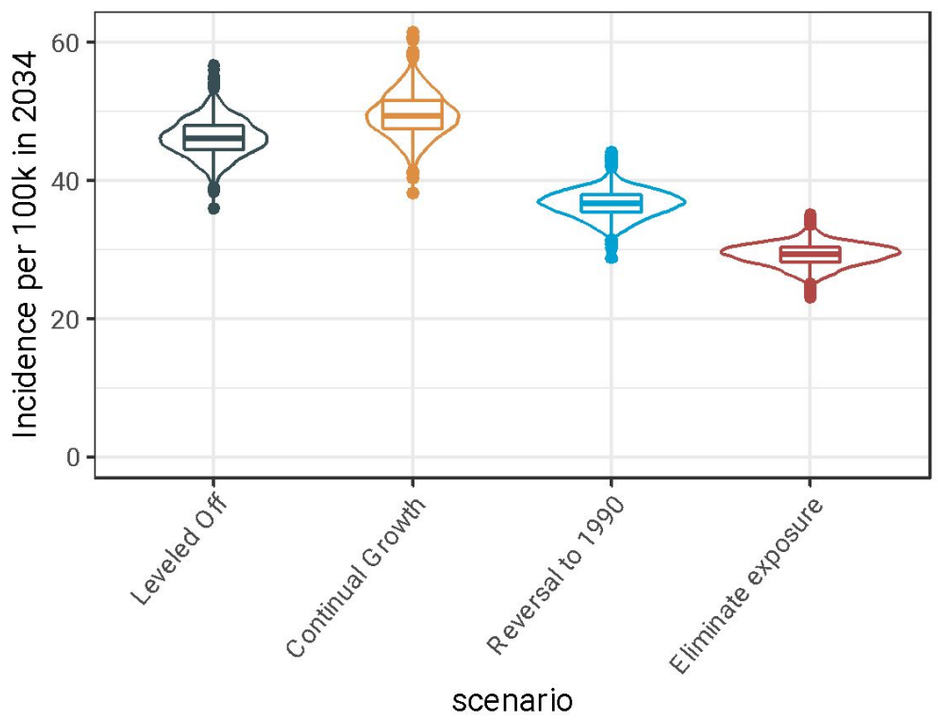
Walter, Martinez et al, *Lancet*, 2021

Modeling the role of incarceration on population TB incidence









Liu et al, *Under Preparation*

If incarceration rates remained 1990 level:
National TB incidence 37% ↓

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