The Tuberculogenic Environment

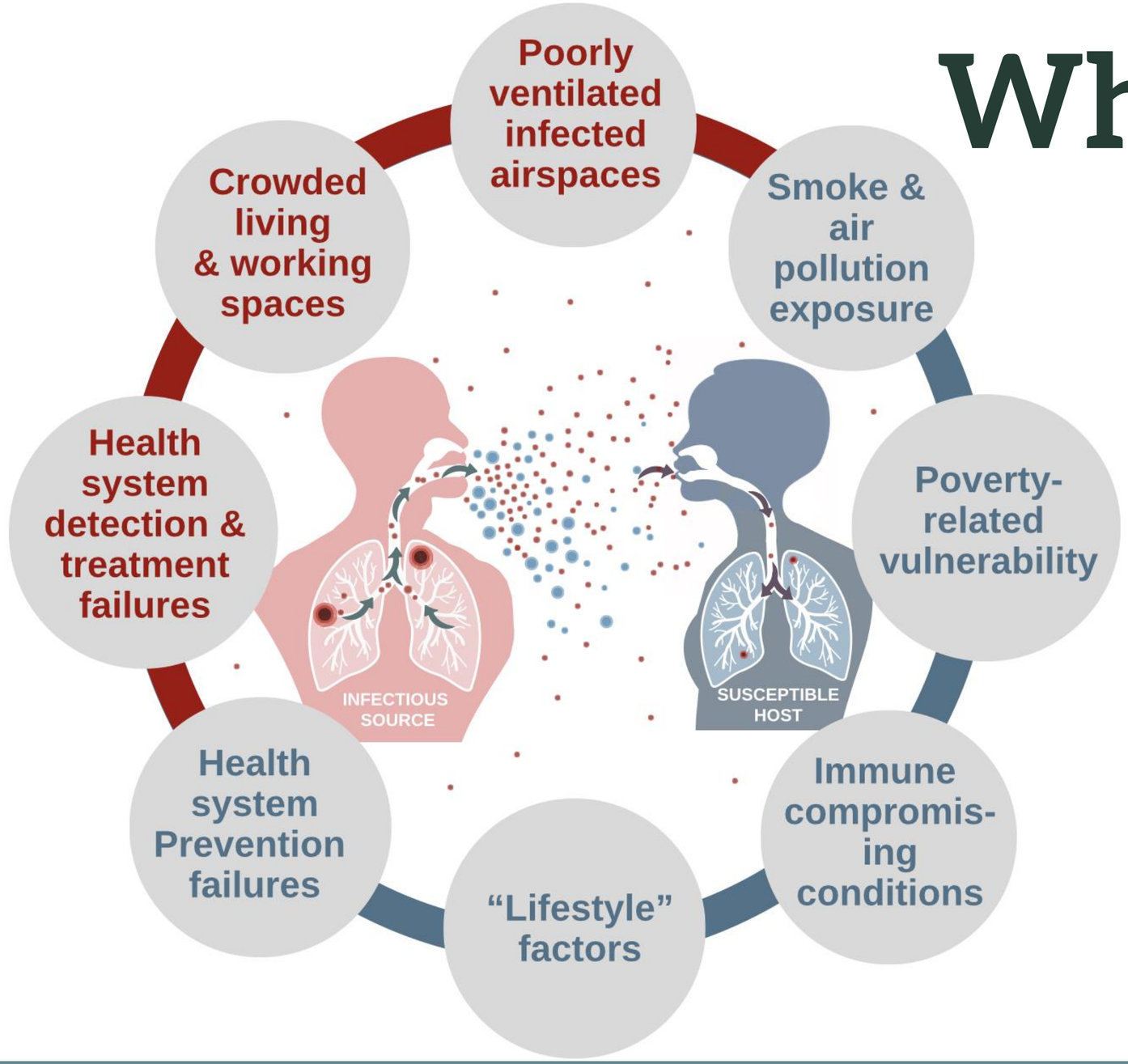
Drs Collins Timire & Mikaela Coleman

LMU KLINIKUM

THRU ZIM
THE HEALTH RESEARCH UNIT ZIMBABWE

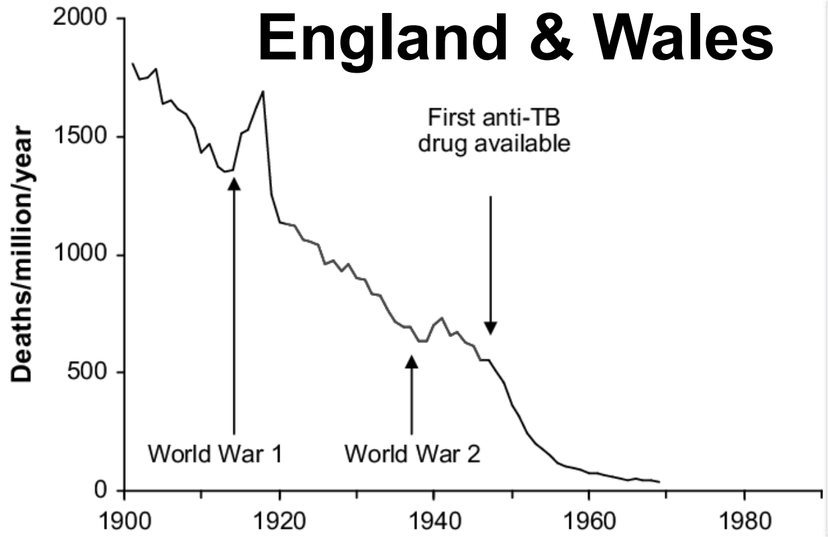
THE UNIVERSITY OF SYDNEY

What causes TB?

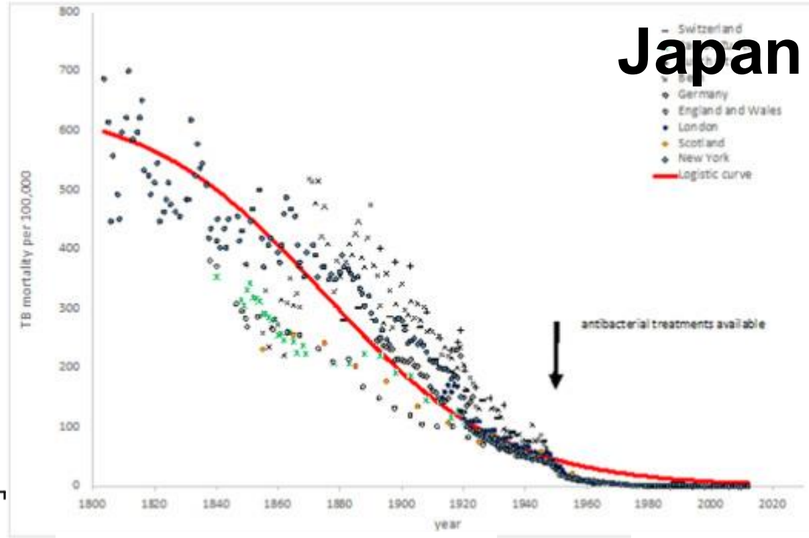


What "eliminated" TB?

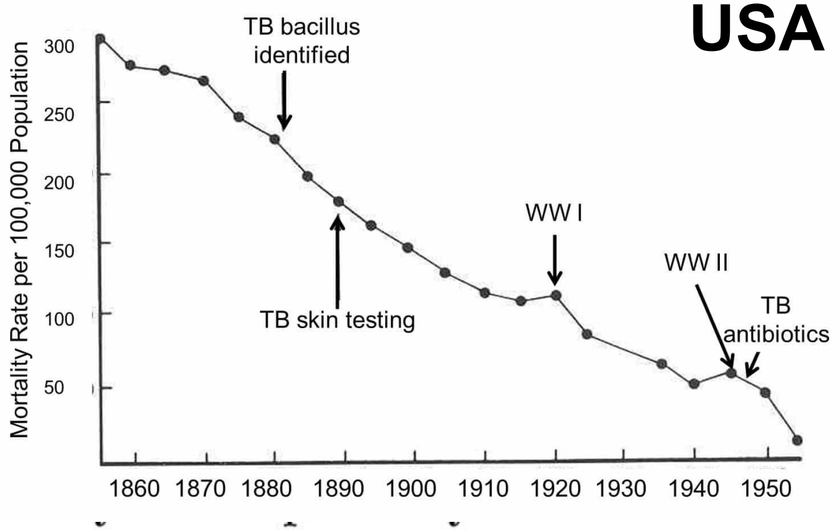
England & Wales



Japan



USA



Switzerland

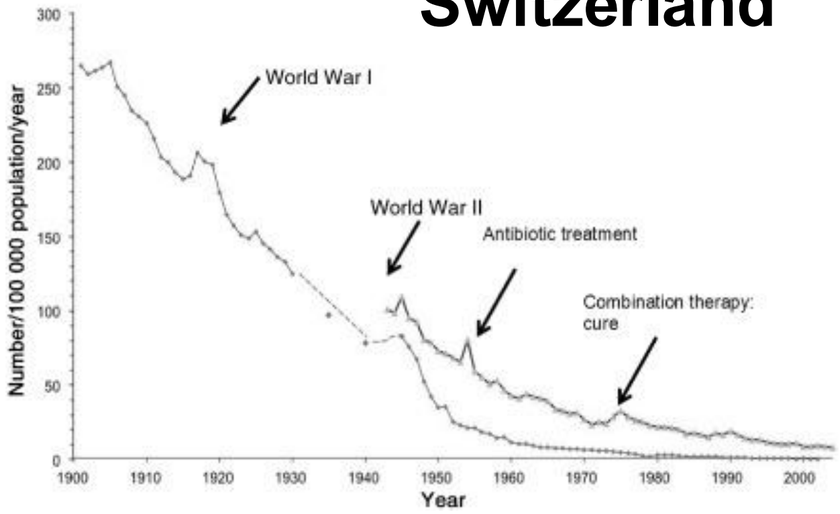
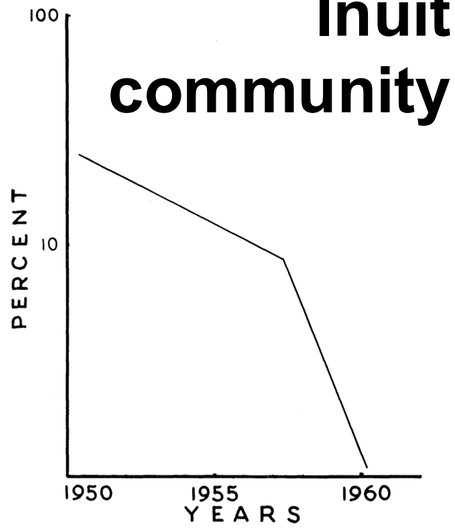


Figure 3. Average rate of decline in tuberculosis infection rates among Eskimo children 0–3 years of age in two periods: 1949–57 and 1957–60

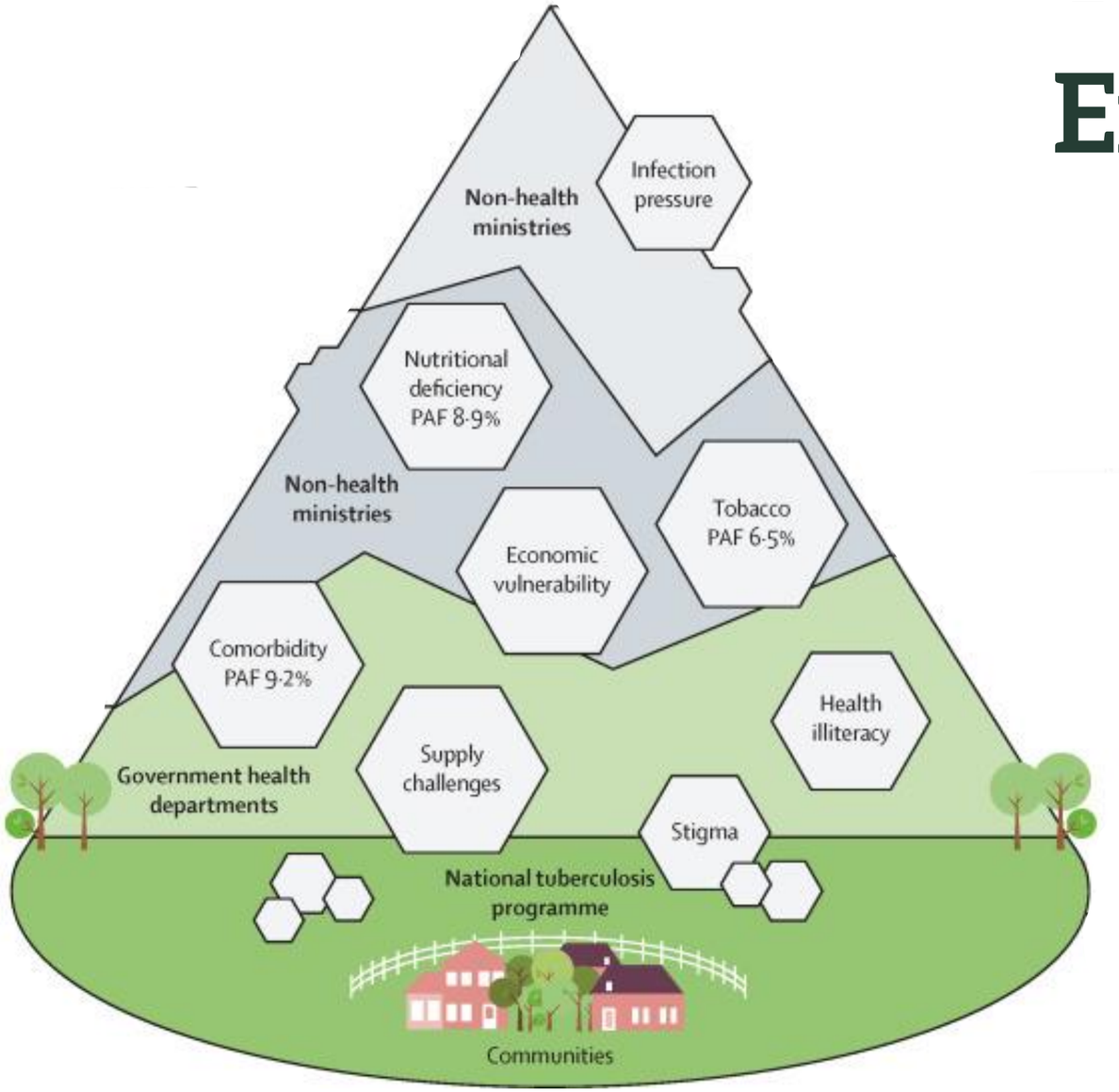
Inuit community



Nevertheless, conditions are better than they were 10 years ago, and as a result, the control of tuberculosis has become less difficult. For without the facilities brought by an improved standard of living, without the increased understanding afforded by education, and without the high degree of cooperation of the people in all phases of the tuberculosis control program, it is unlikely that the efforts of public health personnel, dedicated as they have been, could have accomplished so much so quickly.

Comstock & Phillip 1961 Public Health Reports

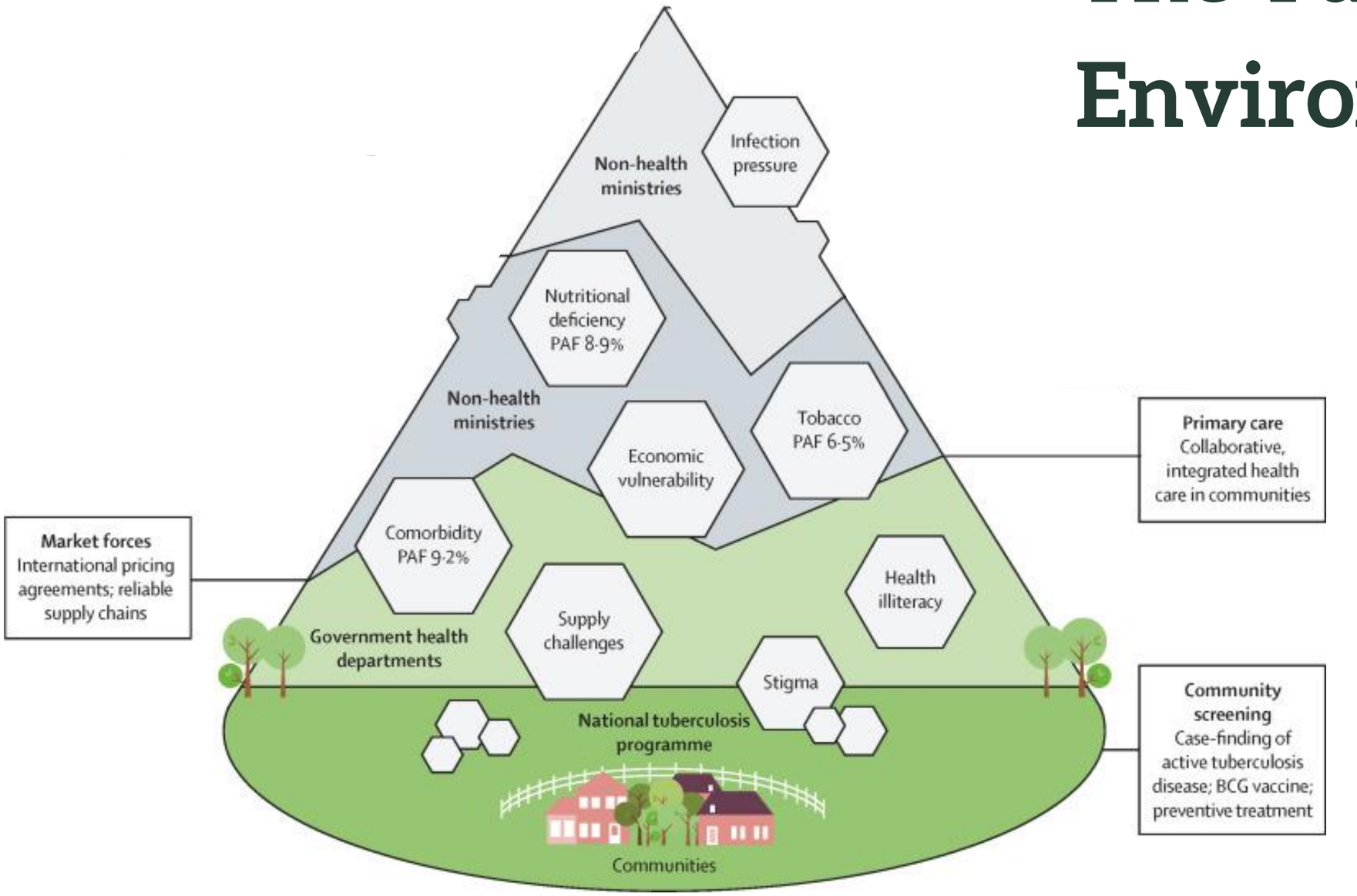
The Tuberculogenic Environment



The tuberculogenic environment

Mikaela Coleman, Claire J Calderwood*, Sian Magee, Frank Underwood, Tenzin Kunor, Collins Timire, Kavindhran Velen, Emily L MacLean, Madhukar Pai, Palwasha Y Khan, Anurag Bhargava, Madhavi Bhargava, Leonardo Martinez, Katharina Kranzer, Sarah Bernays, Ben J Marais*

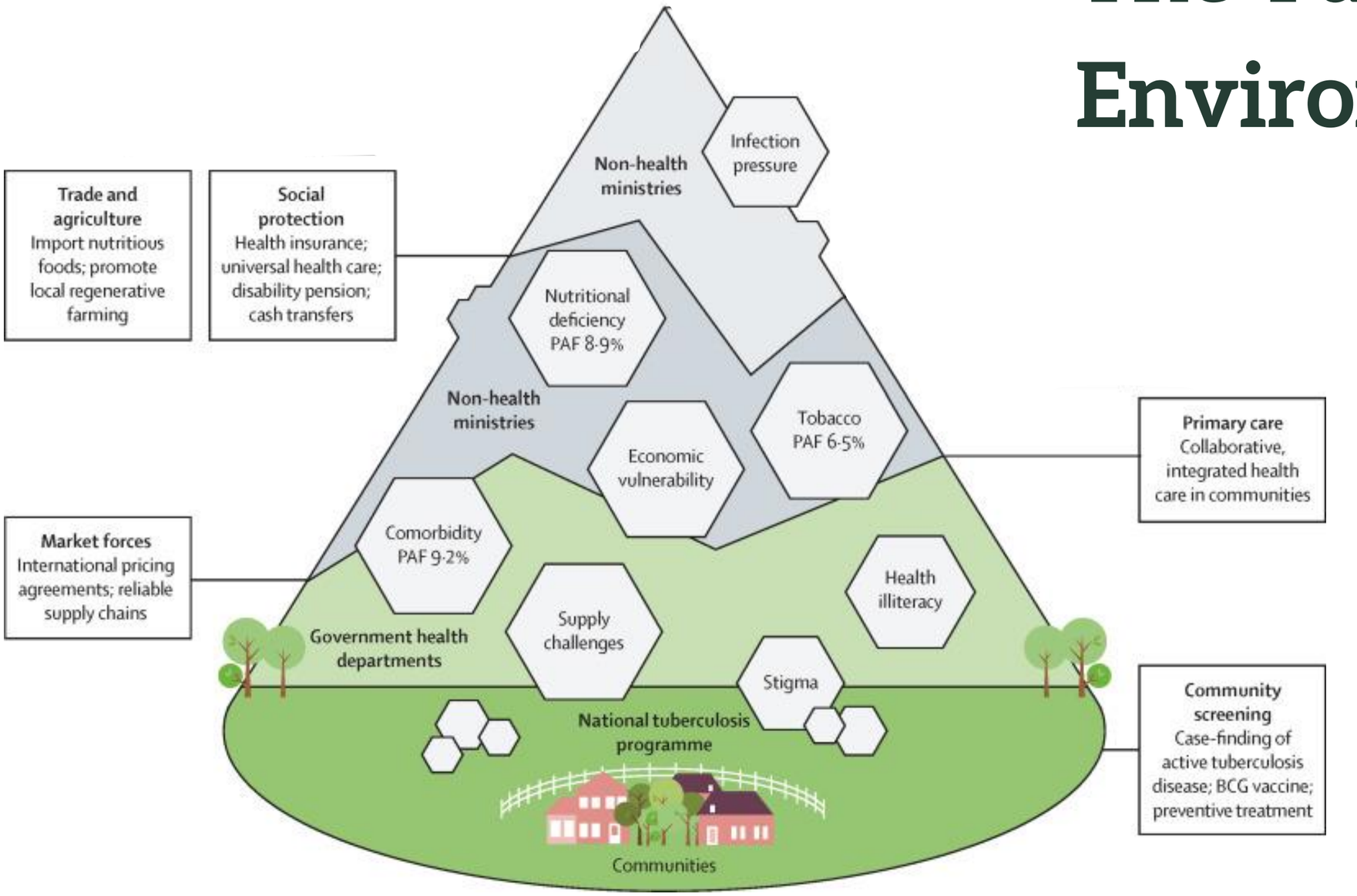
The Tuberculogenic Environment



The tuberculogenic environment

Mikaela Coleman, Claire J Calderwood*, Sian Magee, Frank Underwood, Tenzin Kunor, Collins Timire, Kavindhran Velen, Emily L MacLean, Madhukar Pai, Palwasha Y Khan, Anurag Bhargava, Madhavi Bhargava, Leonardo Martinez, Katharina Kranzer, Sarah Bernays, Ben J Marais*

The Tuberculogenic Environment



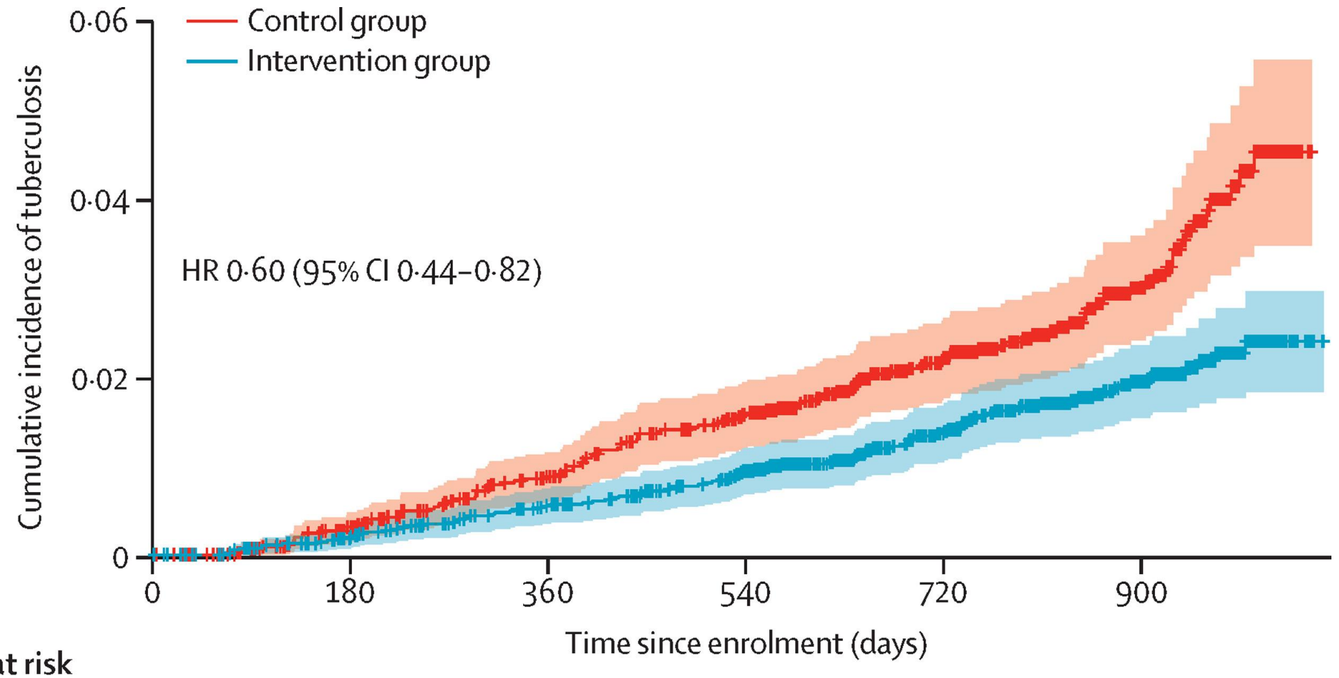
The tuberculogenic environment

Mikaela Coleman, Claire J Calderwood*, Sian Magee, Frank Underwood, Tenzin Kunor, Collins Timire, Kavindhran Velen, Emily L MacLean, Madhukar Pai, Palwasha Y Khan, Anurag Bhargava, Madhavi Bhargava, Leonardo Martinez, Katharina Kranzer, Sarah Bernays, Ben J Marais*

RATIONS study

Nutritional supplementation to prevent tuberculosis incidence in household contacts of patients with pulmonary tuberculosis in India (RATIONS): a field-based, open-label, cluster-randomised, controlled trial

Anurag Bhargava, Madhavi Bhargava, Ajay Meher, Andrea Benedetti, Banurekha Velayutham, G Sai Teja, Basilea Watson, Ganesh Barik, Rajeev Ranjan Pathak, Ranjit Prasad, Rakesh Dayal, Adarsh Kibballi Madhukeshwar, Vineet Chadha, Madhukar Pai, Rajendra Joshi, Dick Menzies, Soumya Swaminathan



Number at risk (number censored)						
Control group	4631 (0)	4445 (174)	4309 (283)	4125 (437)	3152 (1387)	1426 (3100)
Intervention group	5542 (0)	5450 (88)	5345 (167)	5199 (296)	4076 (1400)	2405 (3058)

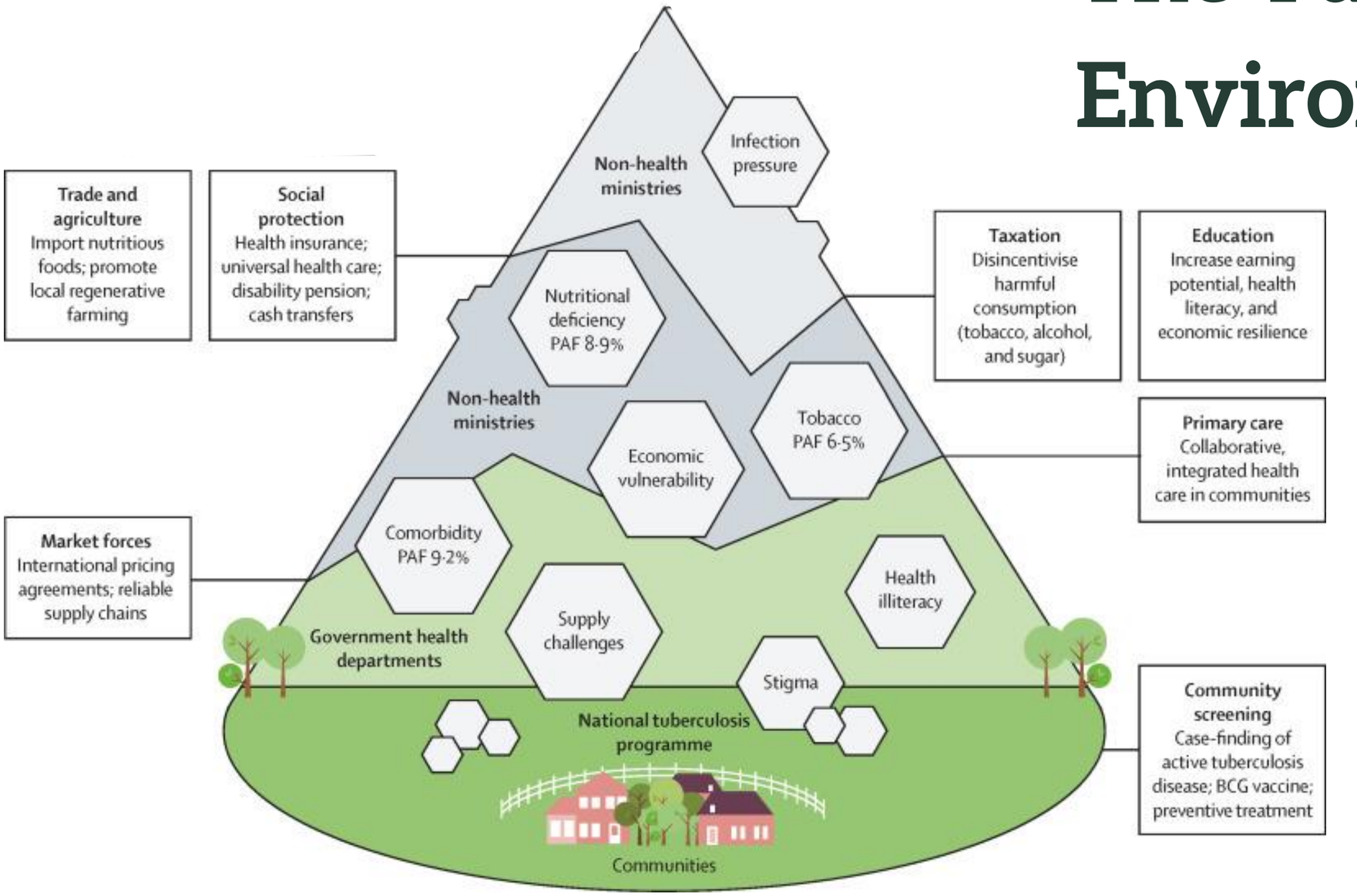
TRADE AGREEMENTS SANCTION JUNK FOOD IMPORTATION

- Lobby for healthy food importation from trade partners; protect communities against predatory corporate advertising.

AGRICULTURE PRIORITISES LOCAL REGENERATIVE FARMING

- High nutrition, high protein farming promoted; including schemes reducing monocropping and cash-cropping.

The Tuberculogenic Environment



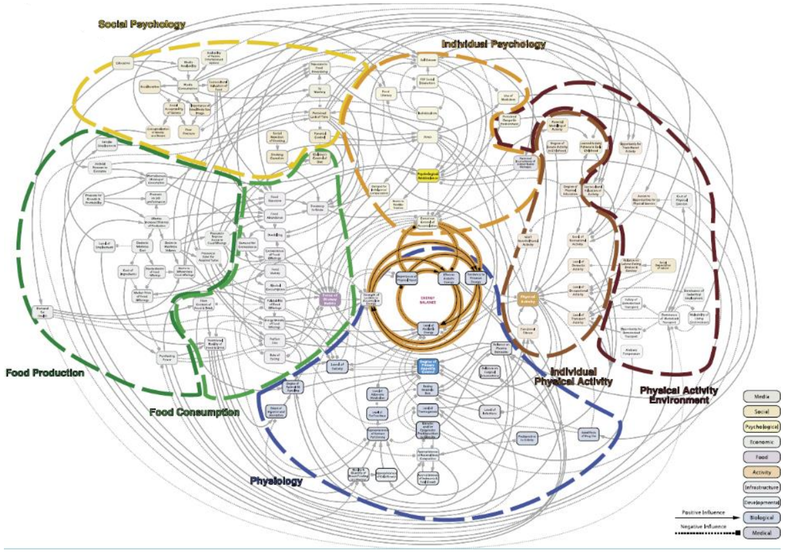
The tuberculogenic environment

Mikaela Coleman, Claire J Calderwood*, Sian Magee, Frank Underwood, Tenzin Kunor, Collins Timire, Kavindhran Velen, Emily L MacLean, Madhukar Pai, Palwasha Y Khan, Anurag Bhargava, Madhavi Bhargava, Leonardo Martinez, Katharina Kranzer, Sarah Bernays, Ben J Marais*

The Obesogenic Environment

Soft Drinks Industry Levy (SDIL) was implemented in April 2018

- Soft drink companies rapidly reformulated to reduce sugar
- Reduction in obesity among girls aged 10 and 11
- Modelling over a 10-year time horizon estimates that the levy adds 200,000 quality-adjusted life-years across the UK population



Taxes for Tuberculosis

SUSTAINABLE FUNDING FOR TUBERCULOSIS ELIMINATION

- Elimination of tuberculosis requires significant long-term funding

PRECARIOUS INTERNATIONAL FUNDING

- International sources of funding are increasingly precarious for countries with high-tuberculosis incidence

DOMESTIC REVENUE FROM HEALTH TAXES

- Tobacco and sugar taxes generate domestic revenue and simultaneously reduce tuberculosis vulnerability (eg, lung damage, diabetes, undernutrition)

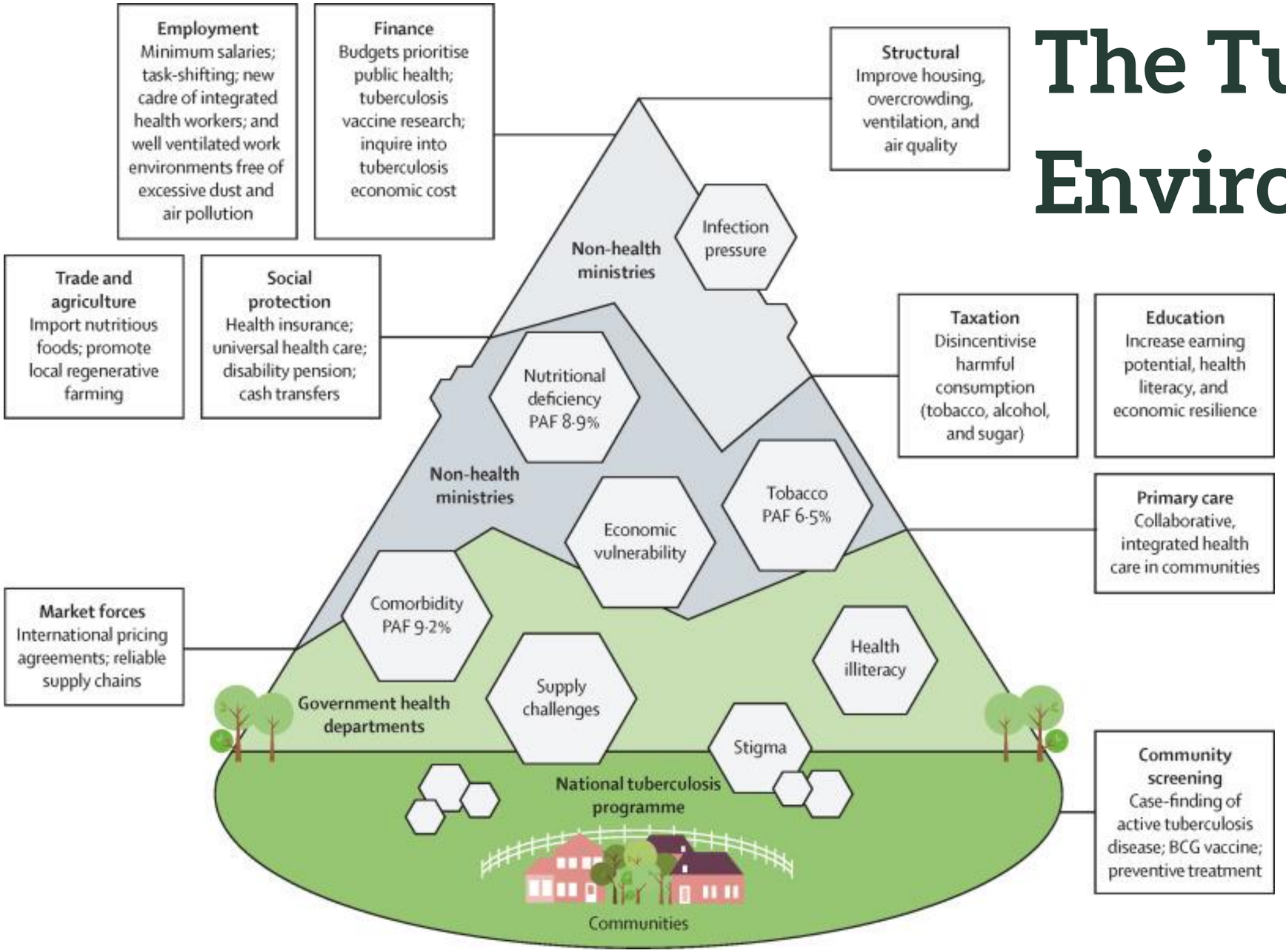
SUSTAINABLE TB & NUTRITION INTERVENTIONS

- With advocacy, revenue from tobacco and sugar taxes could fund sustainable community-wide tuberculosis and nutrition interventions

Taxes for tuberculosis: could tobacco and sugar tax revenue fund tuberculosis control interventions?

Mikaela Coleman [1,2] Anna K Coussens,[3,4,5] Claire Jacqueline Calderwood [6,7] Ingrid Schoeman,[8] Madhavi Bhargava,[9] Pranay Sinha,[10,11] Ben J Marais,[2,12] Katharina Kranzer[1,6,7]

The Tuberculogenic Environment

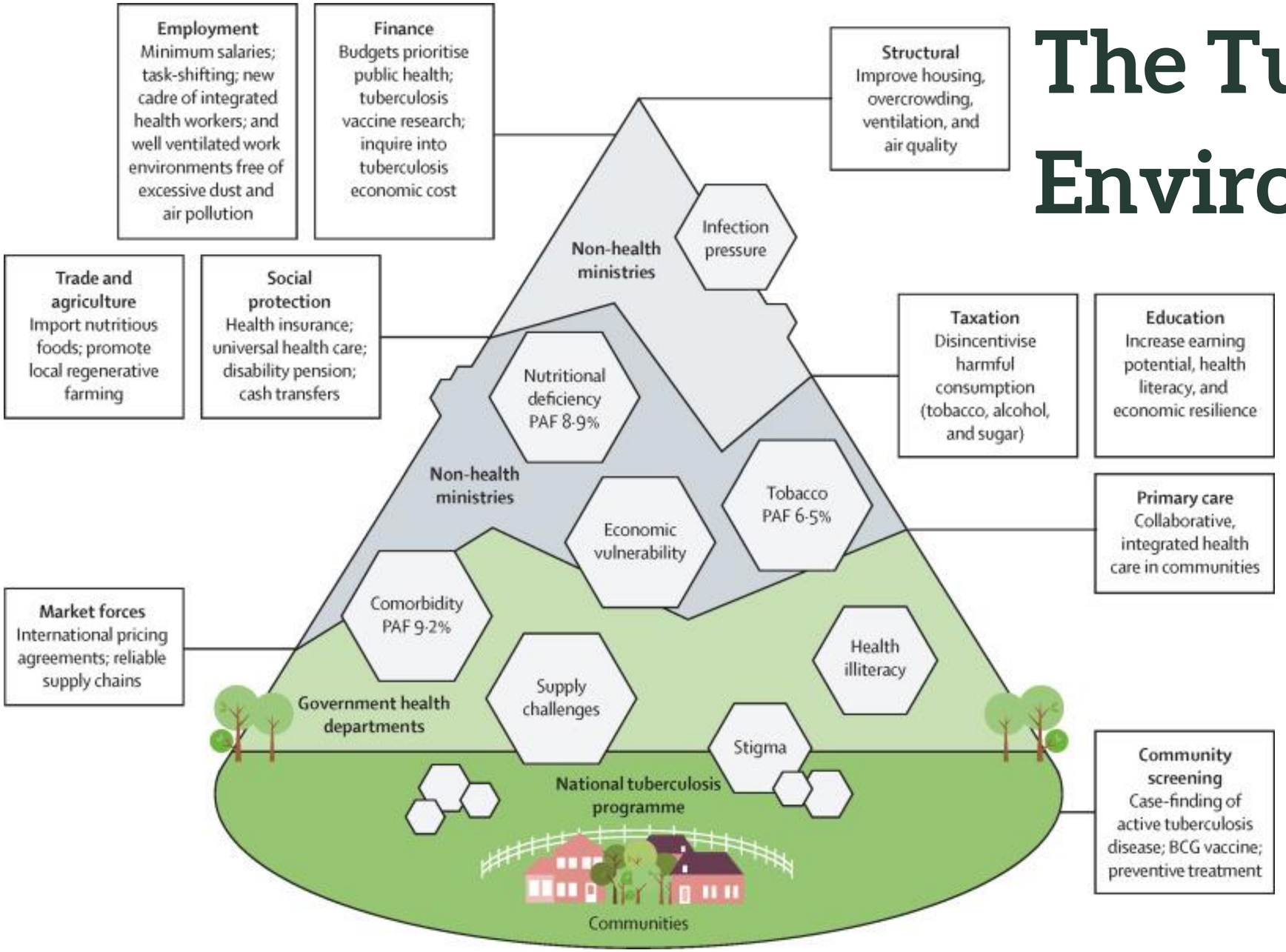


The tuberculogenic environment

Mikaela Coleman, Claire J Calderwood*, Sian Magee, Frank Underwood, Tenzin Kunor, Collins Timire, Kavindhran Velen, Emily L MacLean, Madhukar Pai, Palwasha Y Khan, Anurag Bhargava, Madhavi Bhargava, Leonardo Martinez, Katharina Kranzer, Sarah Bernays, Ben J Marais*

Papworth Village

The Tuberculogenic Environment



What forces that shape tuberculogenic environments are missing?

Climate change

Racism

Global geopolitics

War

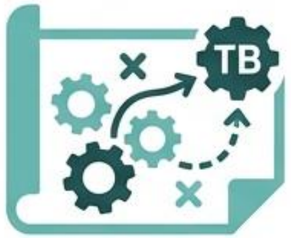
One health

The tuberculogenic environment

Mikaela Coleman, Claire J Calderwood*, Sian Magee, Frank Underwood, Tenzin Kunor, Collins Timire, Kavindhran Velen, Emily L MacLean, Madhukar Pai, Palwasha Y Khan, Anurag Bhargava, Madhavi Bhargava, Leonardo Martinez, Katharina Kranzer, Sarah Bernays, Ben J Marais*

Reshaping Knowledge Flows

How can other sectors take responsibility for TB when they don't know about TB?



INTERSECTORAL GOALS

TB STRATEGIC PLANS HAVE INTERSECTORAL GOALS

- Unemployment, minimum wage/sick leave, health system ventilation and undernutrition targets

CROSS-SECTOR TB DASHBOARDS

- Data collection relevant to intersectoral action and TB outcomes, with progress towards milestones, available to relevant sectors with roles/responsibility always clear in data

INTERSECTORAL TB TASKFORCE

- A regular platform for joint-accountability, goal alignment and solution workshopping for TB and poverty-associated disease

PATIENT/COMMUNITY RIGHTS & ADVOCACY TRAINING

- Seed and nurture grassroots movements amongst community groups to continue lobbying, awareness raising and pressure on intersectoral actors

Centring Affected Community

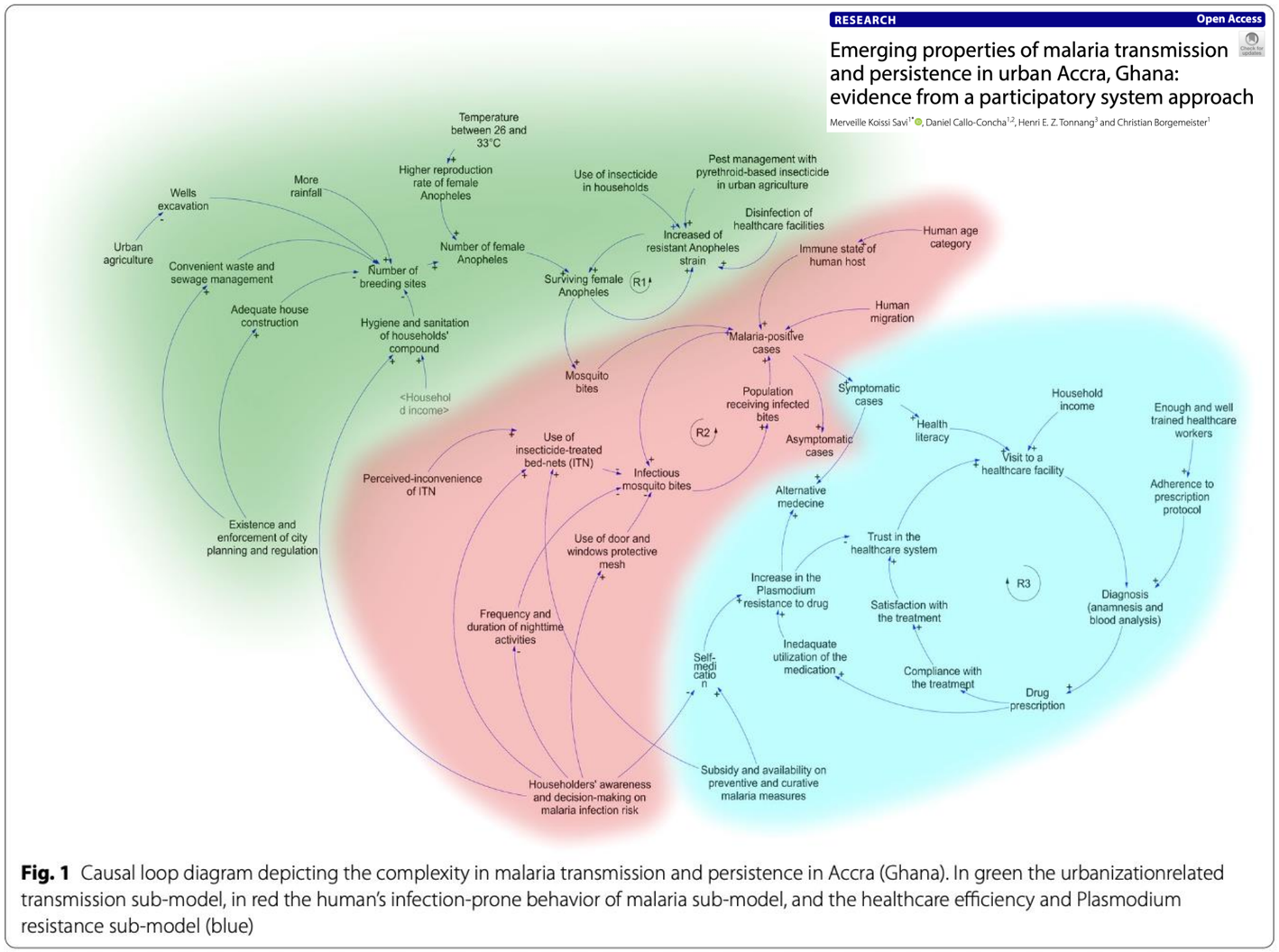


Fig. 1 Causal loop diagram depicting the complexity in malaria transmission and persistence in Accra (Ghana). In green the urbanizationrelated transmission sub-model, in red the human's infection-prone behavior of malaria sub-model, and the healthcare efficiency and Plasmodium resistance sub-model (blue)

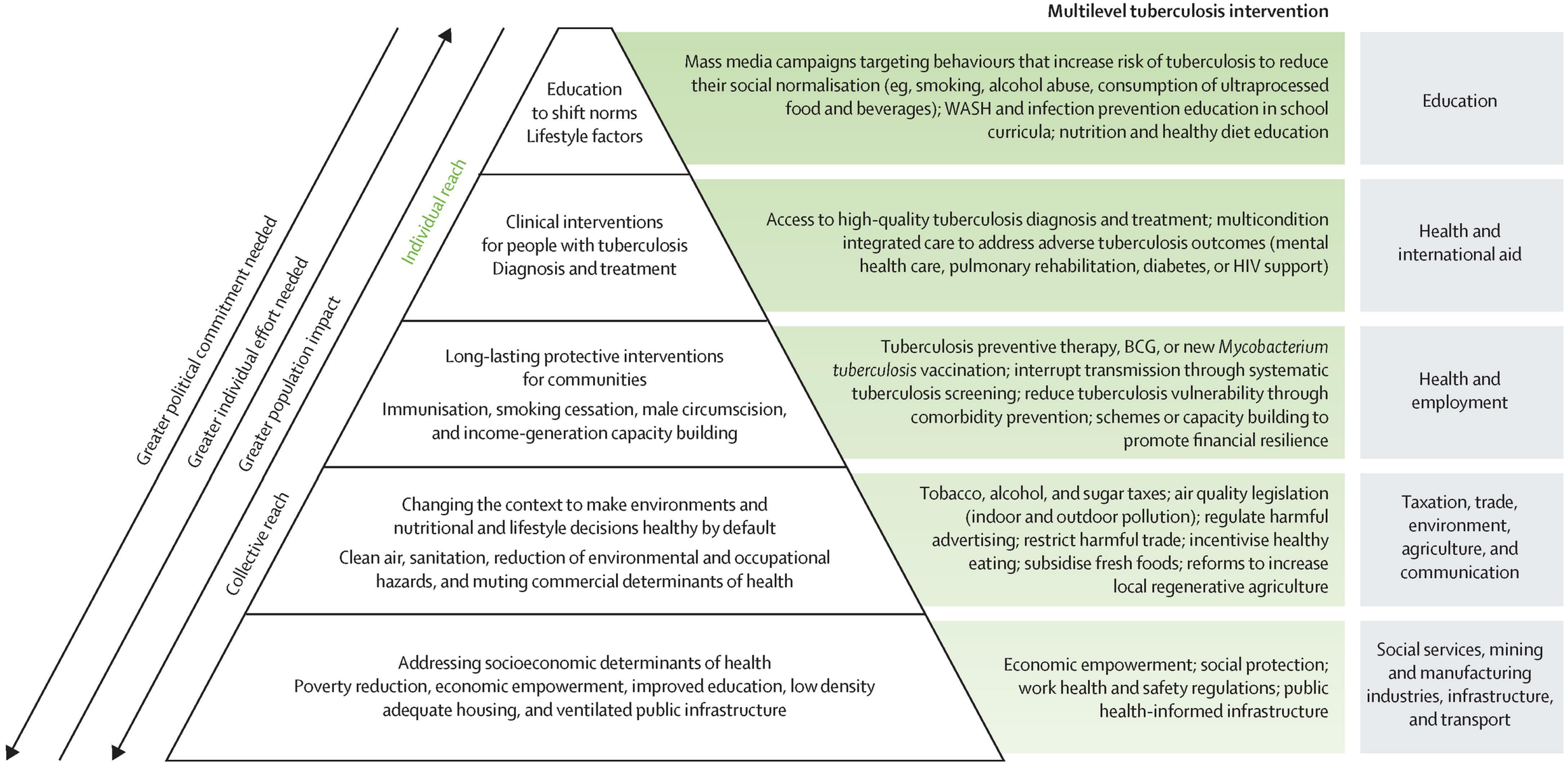
Assumptions

1. Insecticide treated nets (ITNs) are not as available as needed
2. Increasing ITN availability and making them free will prevent Malaria outbreaks

Discovery

1. Poor sewerage systems, potholes and garbage create mosquito breeding grounds
2. Young people who party at night in these environments are most at risk
3. Improved road infrastructure, garbage collection and sewerage systems + targeted ITN provision

Frieden's Impact Pyramid



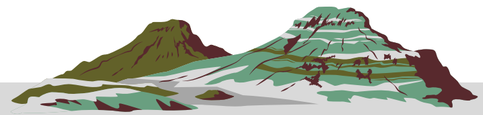
A Paradigm Shift is Needed

Does your health system aim to
treat TB cases

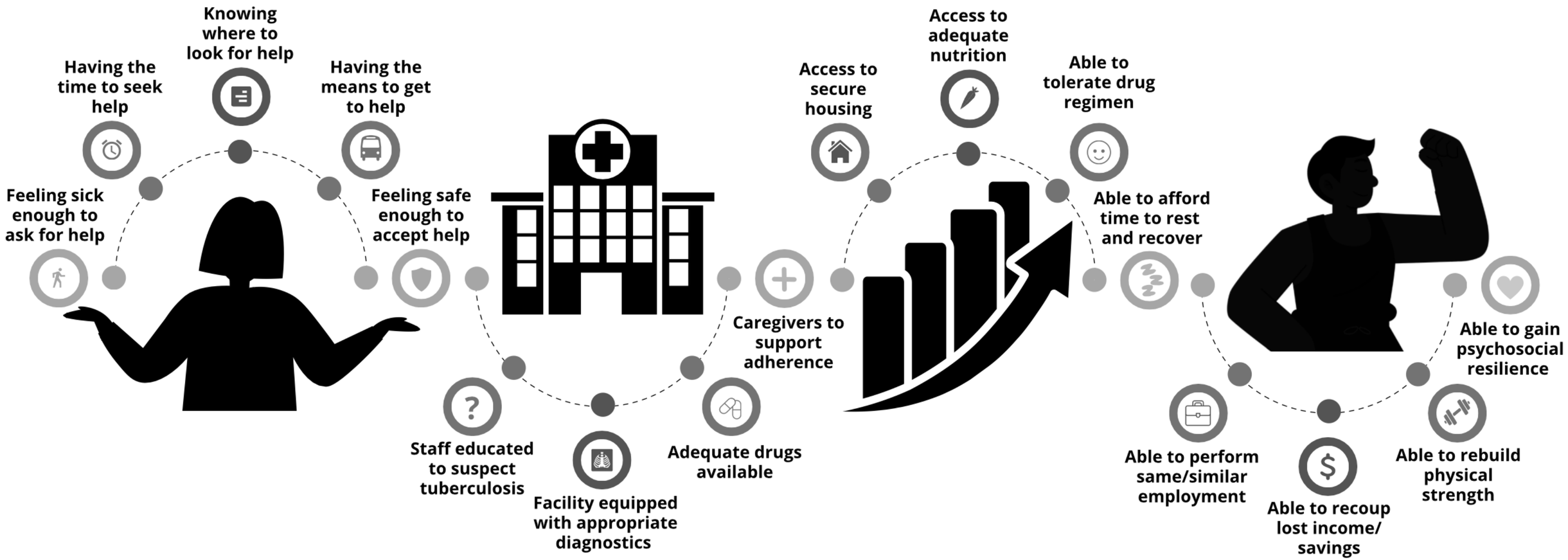
or

Does it aim to eliminate the
conditions that produce cases

Why not both?



What is needed to survive TB?



1. Intergrated screenings

IJTLD OPEN

IJTLD Open. 2025 May 12;2(5):291–298. doi: 10.5588/ijtldopen.25.0171

TB disability and multimorbidity at the onset of treatment in Kenya, Uganda, Zambia and Zimbabwe

Sample size 1683

- 1305 (78%) had at leased one comorbidity
  - 567 (34%) had HIV co-infection
  - 141 (8%) had high blood pressure.
  - 101 (6%) had mental health disorders.
  - 65 (4%) had diabetes mellitus
  - 622 (37%) were undernourished.
  - 311 (18%) had probable alcohol dependence

IJTLD OPEN

IJTLD Open. 2024 May 1;1(5):197–205. doi: 10.5588/ijtldopen.24.0082

Show available content in: English | French

Disability, comorbidities and risk determinants at end of TB treatment in Kenya, Uganda, Zambia and Zimbabwe

Sample size 1063

- 763 (72%) had at leased one comorbidity
  - 476 (44%) had HIV co-infection
  - 172 (16%) had high BP, newly detected in 124.
  - 36 (3%) had diabetes mellitus
  - 14% were undernourished
  - 15% had alcohol dependence

PLOS Global Public Health

About Browse Publish

OPEN ACCESS PEER-REVIEWED

RESEARCH ARTICLE

Tuberculosis comorbidities, multimorbidity and mortality amongst adults in South Africa: A prospective cohort study nested in a trial

Greta K. Wood, Rachel L. Byrne, Limakatso Lebina, Eve Worrall, Pattamukkil Abraham, Emily L. Webb, Peter MacPherson, Neil A. Martinson, Tom Wingfield

Published: August 5, 2026 • https://doi.org/10.1371/journal.pgph.0006720

1721/1997 (86%) had at least one morbidity.

- 948/1997 (48%) multi-morbidity.
- 45% were undernourished.
- 20% had severe undernutrition.
- 3.7% had diabetes mellitus.
- 55% had HIV infection.
- 28% reported use of alcohol.

https://doi.org/10.1371/journal.pgph.0006720

- TB comorbidities & multi-morbidity: increase risk of TB incidence and mortality. (Wood et al 2026)
- Multi-morbidity (MM) is presence of ≥2 concurrent diseases or health conditions. e.g. HIV infection, diabetes, smoking, undernutrition, alcohol use disorders (AUD).
- Most MM occurs around 40-49 years and >60 years (Reis Santos, 2013)
- Aging population is associated with polypharmacy.

2. Early diagnosis and treatment of TB

- **Reduces frailty, income loss due to reduced productive capacity and hospitalization.**
- **Use of WHO approved rapid molecular diagnostic tests including nPOC NAAT and non sputum-based testing methods (tongue swabs).**

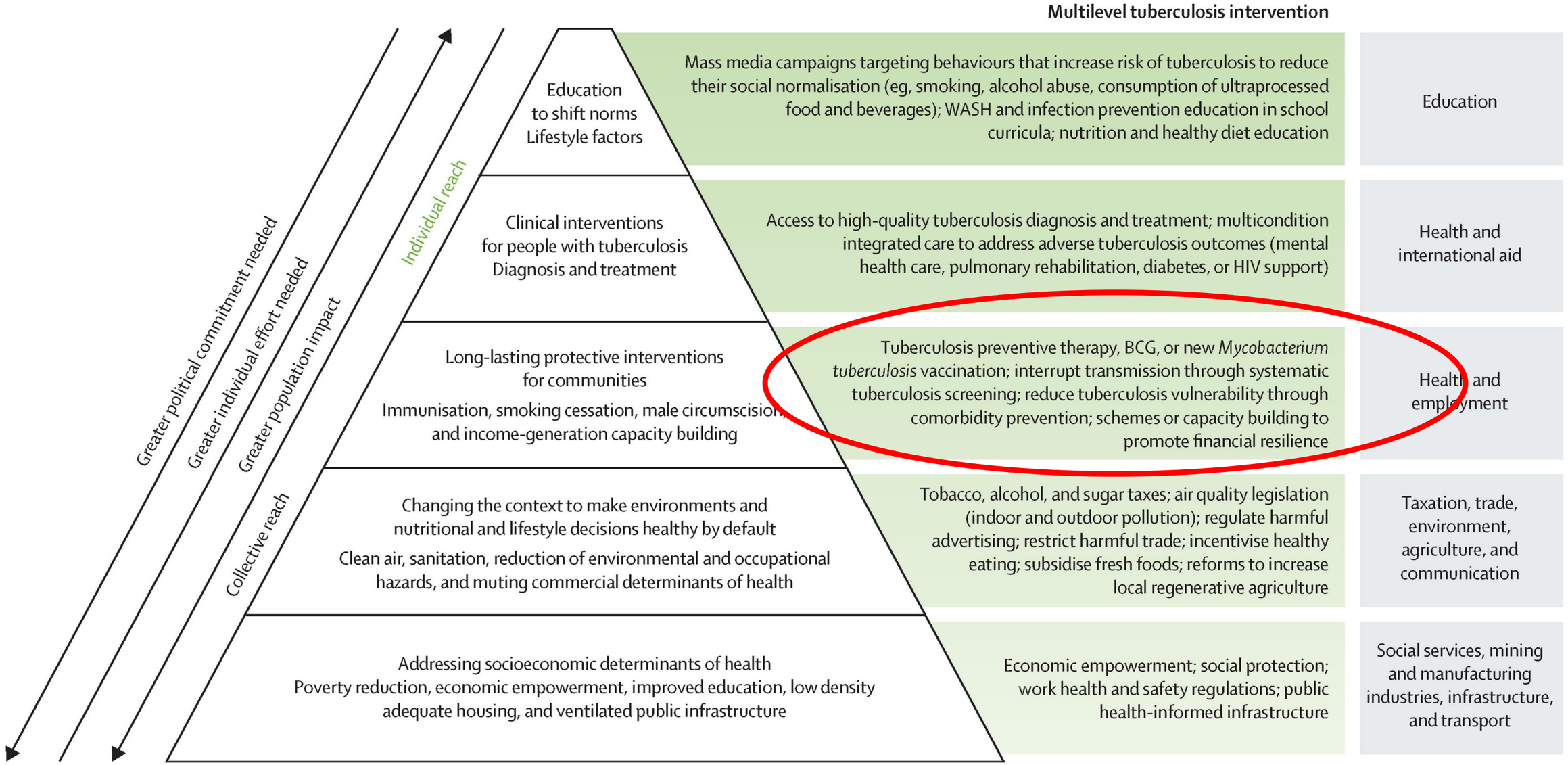
The Journal of Infectious Diseases

BRIEF REPORT

People With Prior Tuberculosis Have Accelerated Frailty and Differential Survival into Older Age: A Cross-sectional Analysis in Southern Africa

M. Coleman,[1,2] A. Manyara,[3] C. J. Calderwood,[4,5,6] A. de Wilton,[3] E. I. Y. Madela,[7] H. Wilson,[3] A. Burton,[3] L. Gates,[8] B. Cassim,[7] C. Pearse,[8] T. Madanhire,[3] R. A. Ferrand,[4,5] K. A. Ward,[8,9] K. Kranzer,[2,4,5] and C. L. Gregson[3,5]

Frieden's Impact Pyramid



3. TB preventive therapy

- 25% of the global population has TBI. (Houben, 2016)
- Has 10-15% lifetime risk of developing TB disease. (WHO, 2018)
- PLHIV (52% of targeted 30million) and HHCs (25% of the targeted 30 million received TPT during the period 2018-2022) (WHO, 2024)
- TB preventive therapy reduces the risk but faces several barriers.
  - Lack of incentives to take TPT, stock-outs, side effects, pill burden.
- Ensuring uninterrupted stocks of TPT medicines, especially shorter regimens and pediatric formulations.
- Addressing knowledge deficits among HCWs, PLHIV and caregivers of CLHIV about the benefits and risks of TPT formulations.

Tropical Medicine and Infectious Disease

MDPI

Article

Evaluation of Tuberculosis Preventive Treatment Uptake Among People Living with HIV in PEPFAR-Supported Facilities in Zimbabwe

Collins Timire [1,2,*,†], Tawanda Mapuranga [3,†], Ronald T. Ncube [3], Talent Maphosa [4], Sithabiso Dube [3], Nqobile Mlilo [3], Cynthia Chiteve [3], Selma Dar Berger [1], Owen Mugurungi [2], Fungai Kavenga [2], Tsitsi Mutasa-Apollo [2], Manners Ncube [2], Clorata Gwanzura [2], Macarthur Charles [4], Riitta A. Dlodlo [1] and Julia Ershova [4]

Tropical Medicine and Infectious Disease

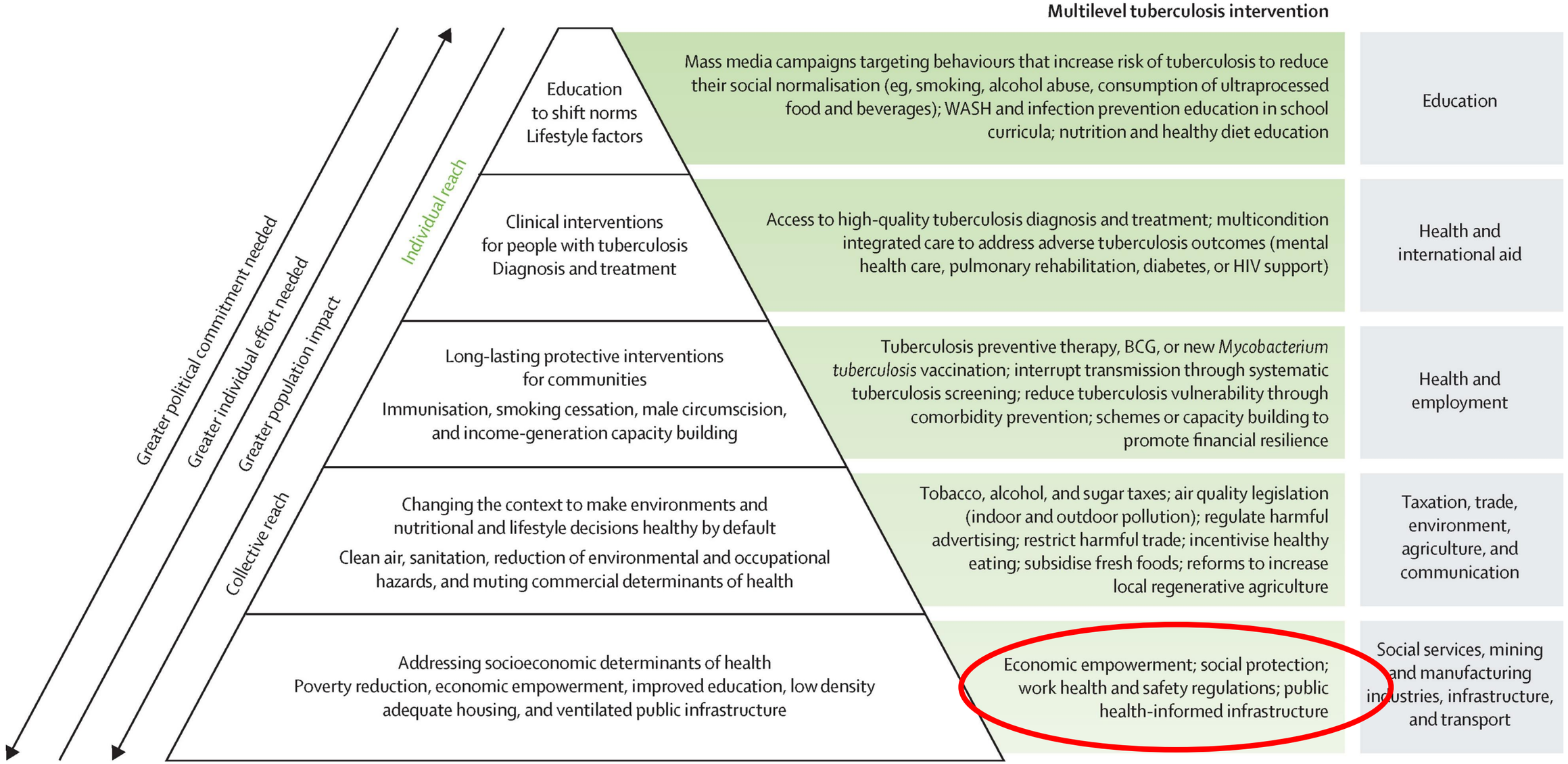
MDPI

Article

Optimization of Case Finding and Preventive Treatment Among Household Contacts of People with Tuberculosis in Zimbabwe

Tawanda Mapuranga [1,*,†], Collins Timire [2,3,†], Ronald T. Ncube [1], Sithabiso Dube [1], Nqobile Mlilo [1], Cynthia Chiteve [1], Owen Mugurungi [2], Fungai Kavenga [2], Manners Ncube [2], Nicholas Siziba [2], Selma Dar Berger [3], Talent Maphosa [4,5], Macarthur Charles [5], Julia Ershova [5] and Riitta A. Dlodlo [3]

Frieden's Impact Pyramid



4. Social protection/nutritional interventions

Scope of social protection determines its impact the epidemiology of TB.

- TB specific: TB affected households.
- TB sensitive: Households at risk of TB.
- TB inclusive:

TB specific social protection

- Aim is to improve outcomes; mitigate socioeconomic impacts of TB
- Usually provided as cash, cash vouchers and food.
- RATIONS study: 39% reductions in incidence of TB.
- Food is the vaccine we have against TB. (Sinha, 2023)
- Food is logistically difficult to distribute and is prone to spoilage and pilferage.

Effectiveness of social protection: coverage, comprehensiveness and shock responsiveness.

- Multisectoral collaborations to enhance comprehensiveness of social protection.
  - Educational assistance, food and disability grants, hospitalization costs.
- Integrating social workers within NTPs. They can link PwTB to available social protection.
- Need to lobby against policies that exclude PwTB from insurance or disability support.
- NTPs to lobby for TB to be one of eligibility criteria for social grants.

Coverage and effectiveness of conditional cash transfer for people with drug resistant tuberculosis in Zimbabwe: A mixed methods study

Collins Timire[1,2,3]*, Charles Sandy[2], Rashida A. Ferrand[1,3], Regina Mubau[2], Peter Shiri[2], Obert Mbiriyawanda[2], Fredrick Mbiba[3], Rein M. G. J. Houben[4], Debora Pedrazzoli[4], Virginia Bond[5,6], Nicola Foster[4], Katharina Kranzer[1,3,7]

Challenge	Recommendation
Suboptimal coverage	• Revise DR-TB registers to capture data on CCT (registration status and receipt). • Sensitise health care workers on availability and importance of registering people on CCT. • Engage social workers to assess welfare of people on DR-TB treatment. • Implement electronic health records to track coverage and access to CCT in real or near real-time.

We cure TB and return people to the environments that first made them sick.

Systems interventions reshape environments from settings of vulnerability into resilience.