Outside the biomedical – modelling the socio-economic drivers and consequences of TB

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MODELLING GROUP

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&TROPICAL
MEDICINE

Overview

- Context
- Modelling socio-economic drivers of TB
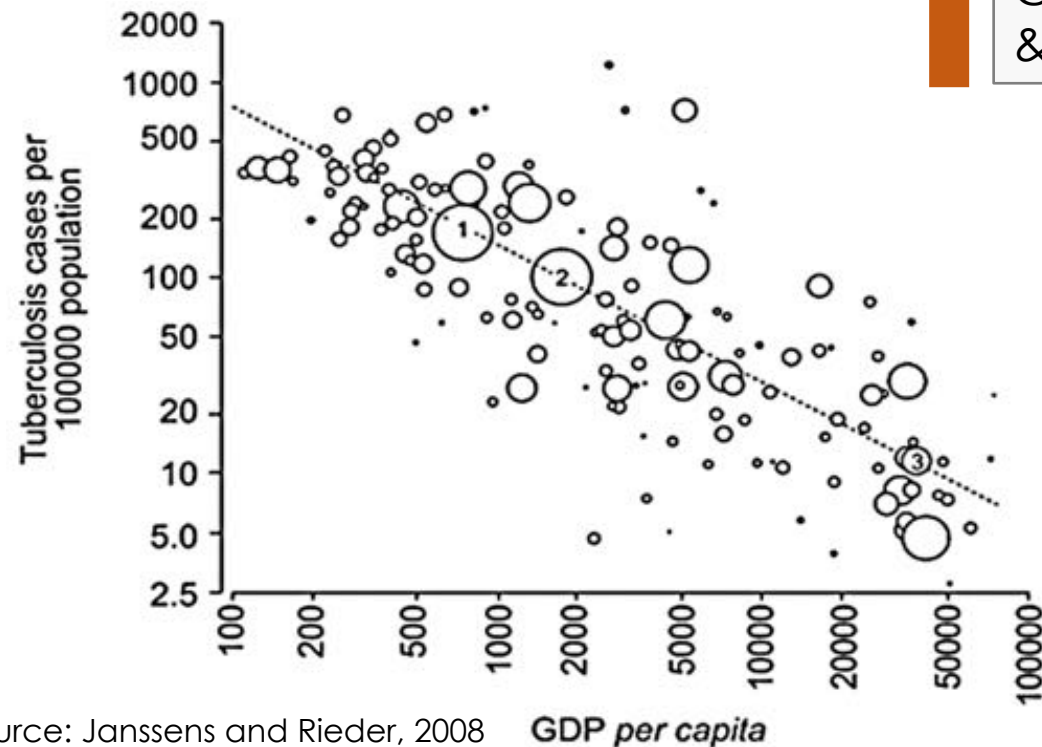- Modelling socio-economic consequences of TB
- Where next

Key issues in TB control

?

1.7 Billion Exposed (?reservoir?)

Houben et al. PLOS Medicine

?

10 million Disease (?symptomatic and infectious?)

1.4 million deaths

Case finding & treatment

Source: Janssens and Rieder, 2008

Policy context

THE END TB STRATEGY

No TB-affected household facing catastrophic costs in 2020

PILLAR 2: BOLD POLICIES AND SUPPORTIVE SYSTEMS

A. Political commitment with adequate resources for TB care and prevention

B. Engagement of communities, civil society organizations, and all public and private care providers

D. Social protection, poverty alleviation and actions on other determinants of TB

C. Universal health coverage policy, and regulatory frameworks for case notification, vital registration, quality and rational use of medicines, and infection control

SDGs and TB

Review of TB modelling of SE determinants

- Little work done – though papers hard to find

Modelling the social and structural determinants of tuberculosis: opportunities and challenges

D. Pedrazzoli,*† D. Boccia,† P. J. Dodd,‡ K. Lönnroth,§¶ D. W. Dowdy,# A. Siroka,§ M. E. Kimerling,**
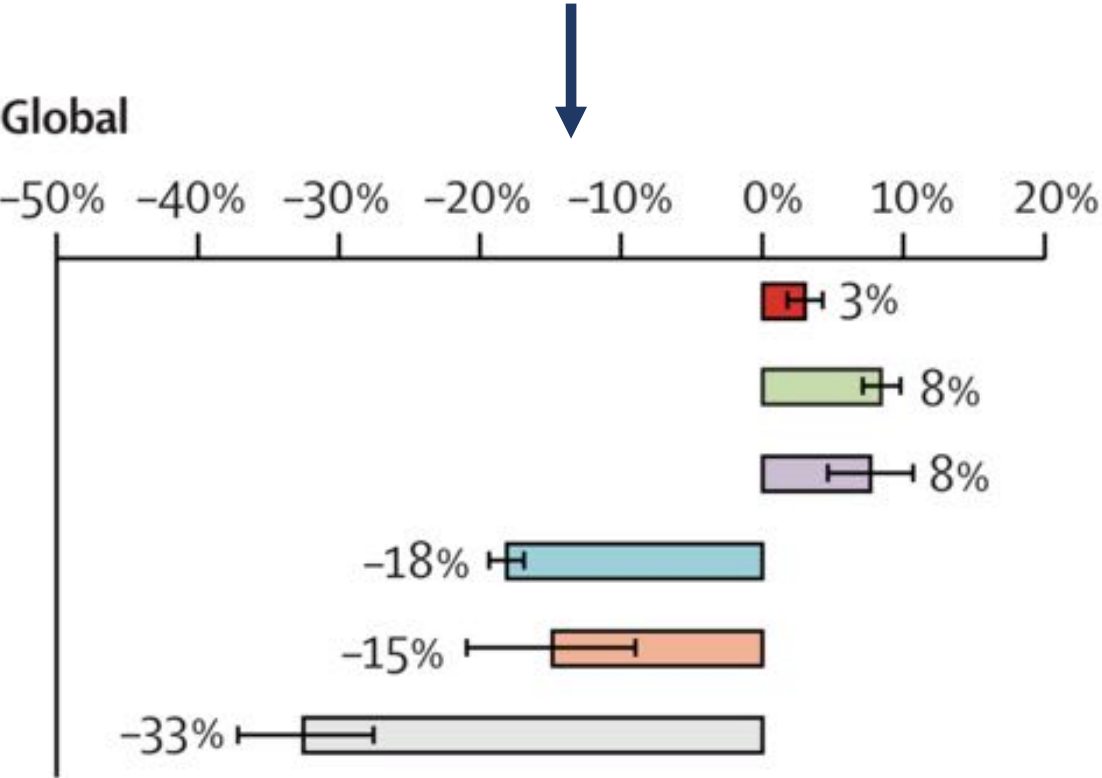R. G. White,*† R. M. G. J. Houben*†

- 8 papers found, 6 transmission models, 2 analytical models
  - Oxlade 2011 Med Dec Making, perhaps erroneously omitted

Drivers of TB

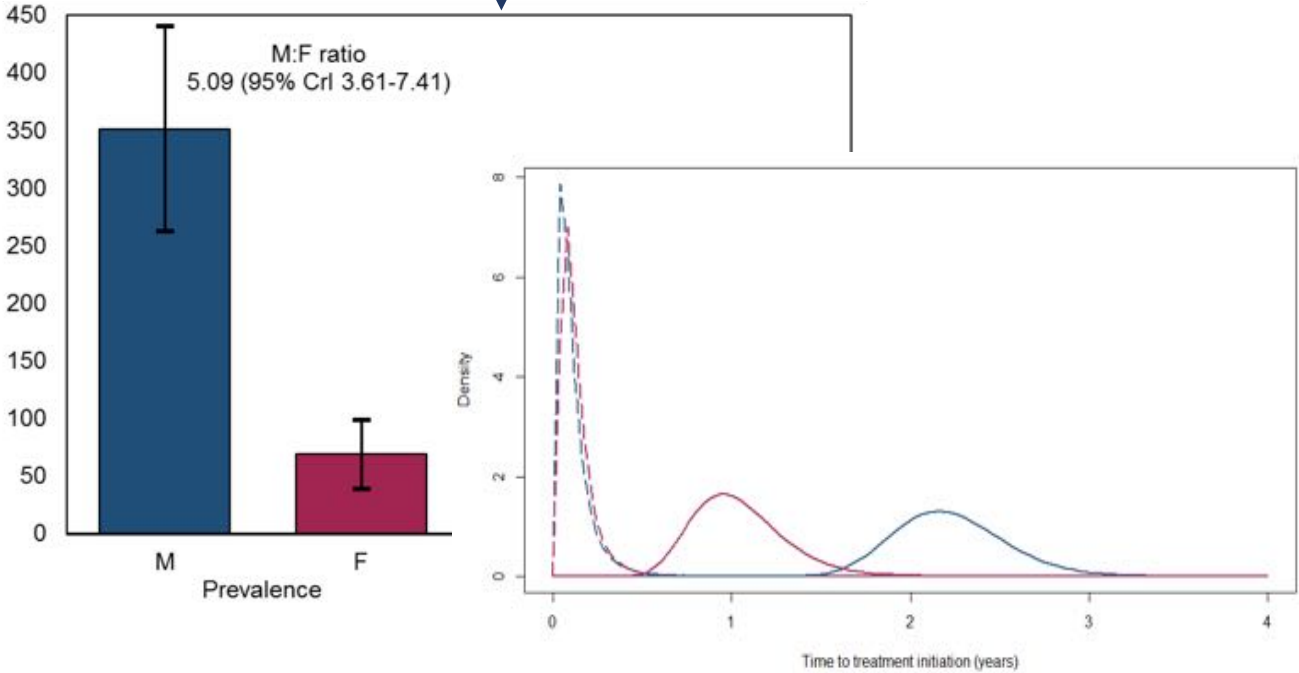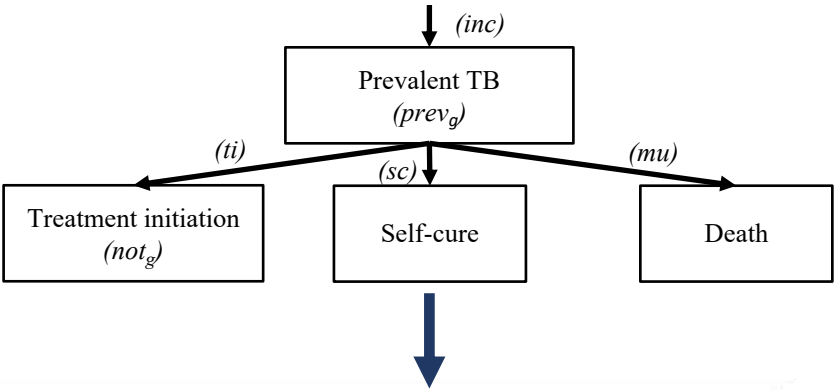Statistical and Mechanistic modelling

Nutrition+diabetes (SDG-2), Gender (SDG-5)

$$I_{(a,r,t)} = I_{0(r)}e^{-z(r)t}[1 + U_{(r,t)}(R_u - 1)][1 + D_{(a,r,t)}(R_d - 1)]$$

Global

−50% −40% −30% −20% −10% 0% 10% 20%

3%
8%
8%
−18%
−15%
−33%

Source: Odone et al 2014 Lancet Diab Endo

(inc)

Prevalent TB
(prev_g)

(ti) *(sc)* *(mu)*

Treatment initiation *(not_g)* Self-cure Death

M:F ratio
5.09 (95% CrI 3.61-7.41)

M   F
Prevalence

Density

Time to treatment initiation (years)

Source: Horton et al 2018 AJE

Poverty (SDG-1)
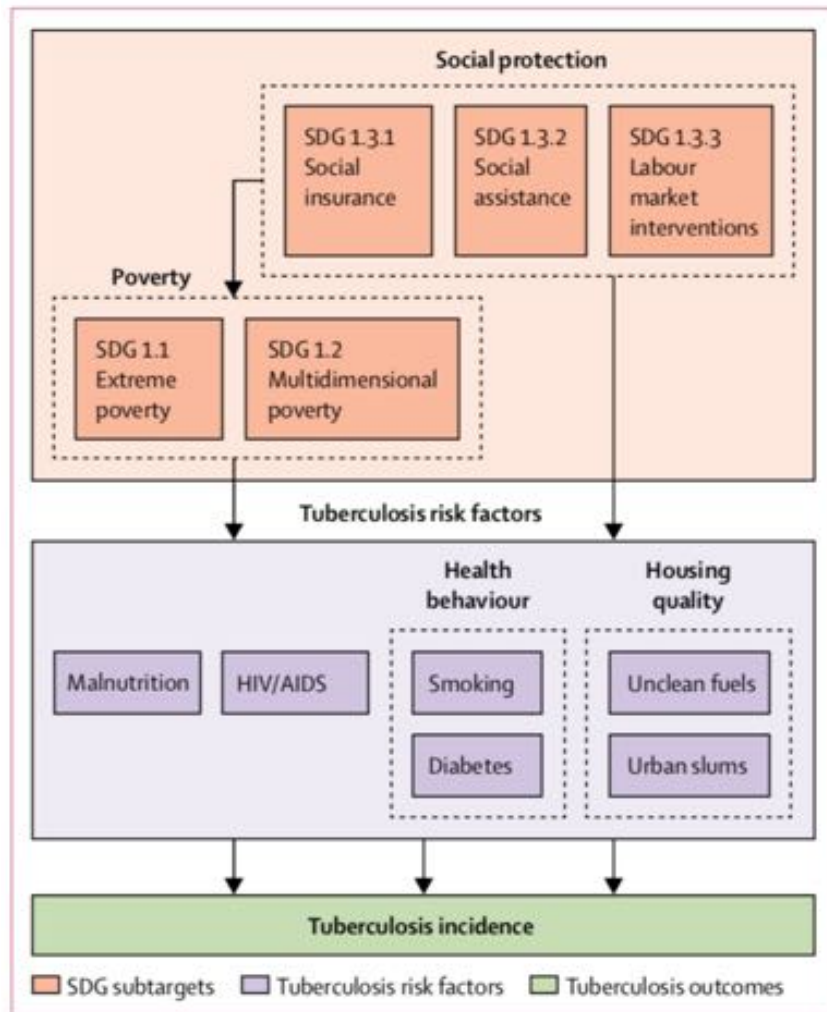

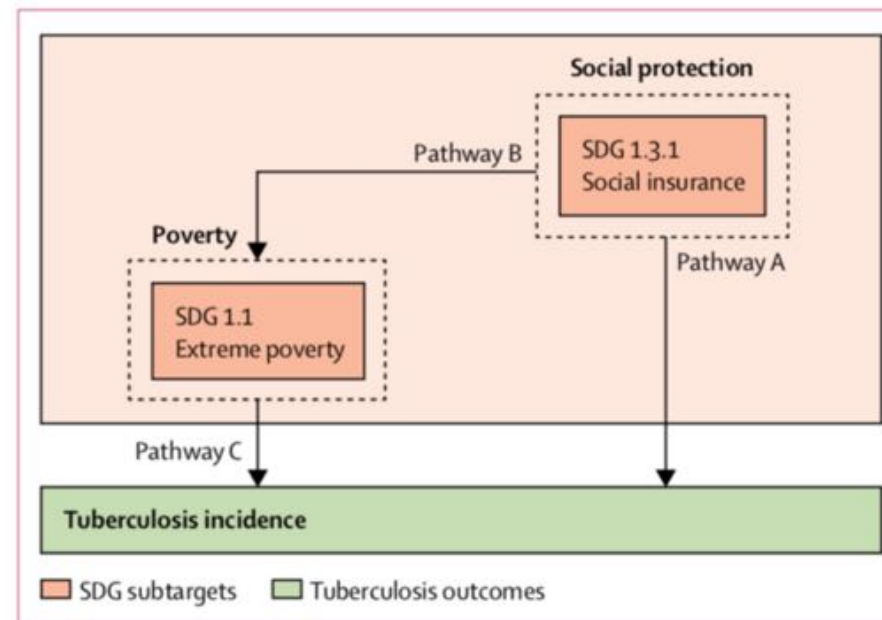Figure 1: Conceptual framework linking SDG 1 indicators to tuberculosis incidence

Figure 2: Reduced conceptual framework

Figure 3: Examples of causal pathways
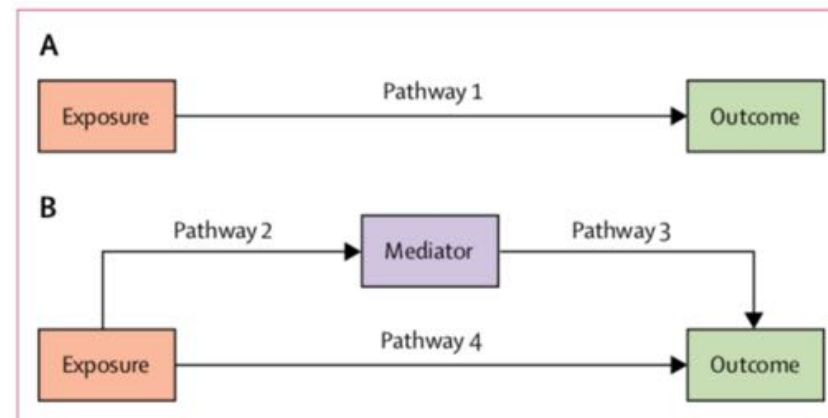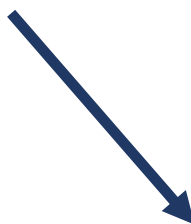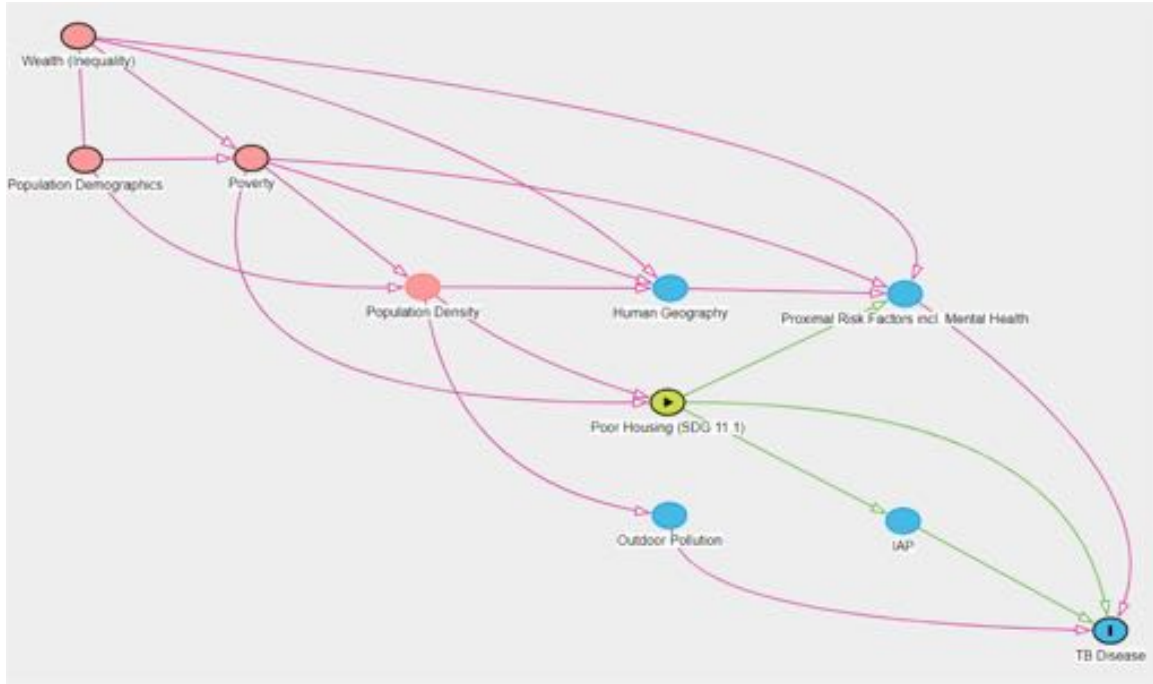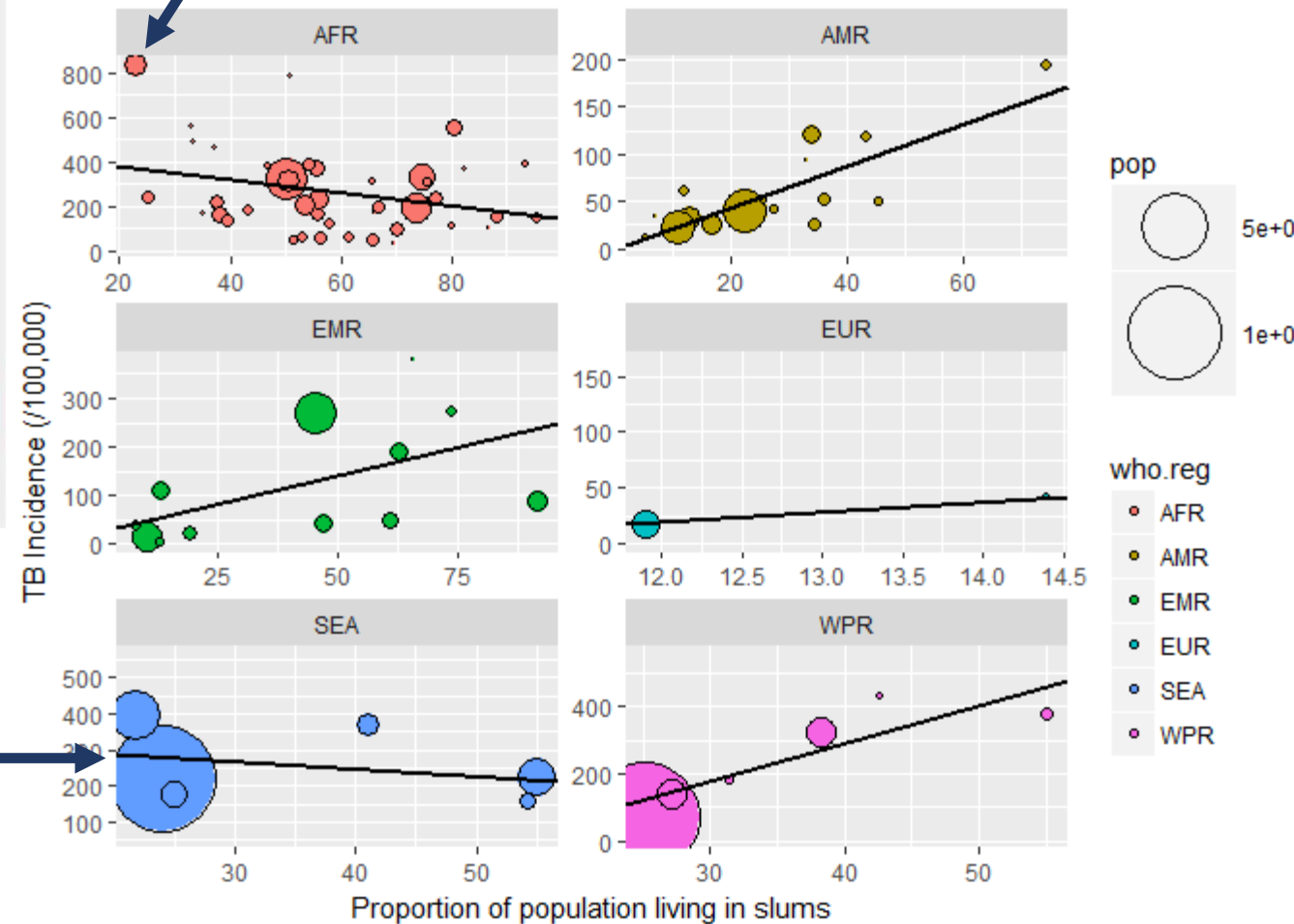
	Expected annual proportional decrease
Pathway A: social protection for all (100% coverage)	8·7%
Pathway C: poverty elimination (100% eliminated)	2·0%
Pathway A and Pathway C: social protection and poverty elimination	11·1%
Pathways B + C: social protection via poverty elimination	1·8%
Pathway A and Pathways B + C: total effect of social protection	9·1%

Source: Carter et al 2018 Lancet GH

SDG-11: Urbanisation

Figures courtesy of Daniel Carter – work in progress
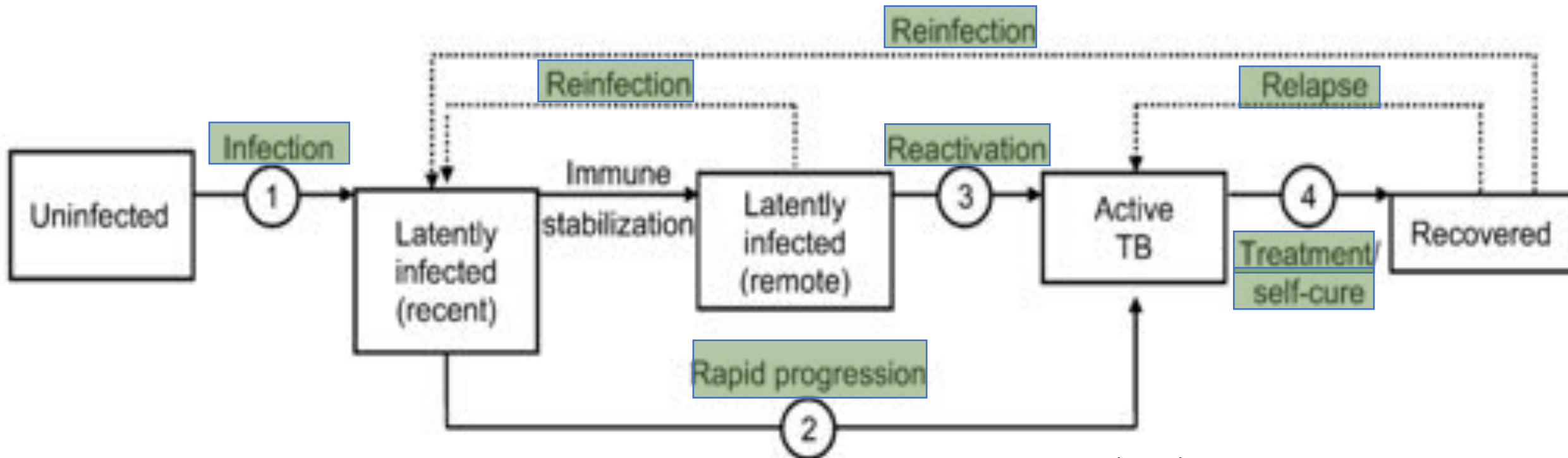
Mechanistic Modelling – the challenge

- What is exact mechanism of socio-economic determinants?
  - Change in <u>progression</u> from infection to disease?
  - Change in mixing/Effective Contact Rate
  - Change in relapse after treatment and/or self-cure?
  - Change in case detection, treatment success

Dowdy et al, 2013 IJTLD

Mechanistic modelling of SE determinants
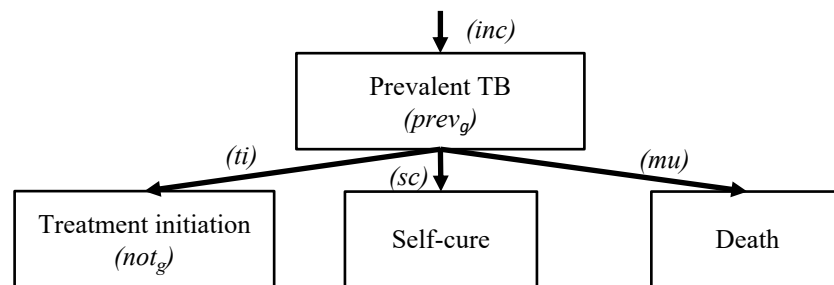
BMC Public Health

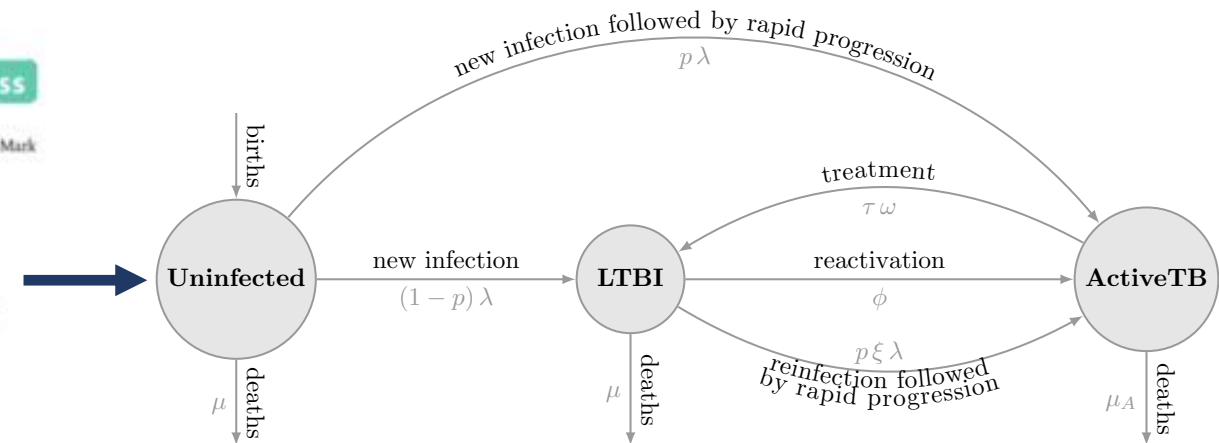RESEARCH ARTICLE   Open Access

Modelling the impact of social protection on tuberculosis: the S-PROTECT project

D. Boccia[1*], W. Rudgard[1], S. Shrestha[2], K. Lönnroth[3], P. Eckhoff[4], J. Golub[5], M. Sanchez[6], E. Maciel[7], D. Rasella[8], P. Shete[9,10], D. Pedrazzoli[1], R. Houben[11], S. Chang[4] and D. Dowdy[2]

Source: Horton et al 2018 AJE

- Full dynamic model
  - Mixing, Progression
  - Care pathway
  - Risk behavior (smoking)

Consequences of TB

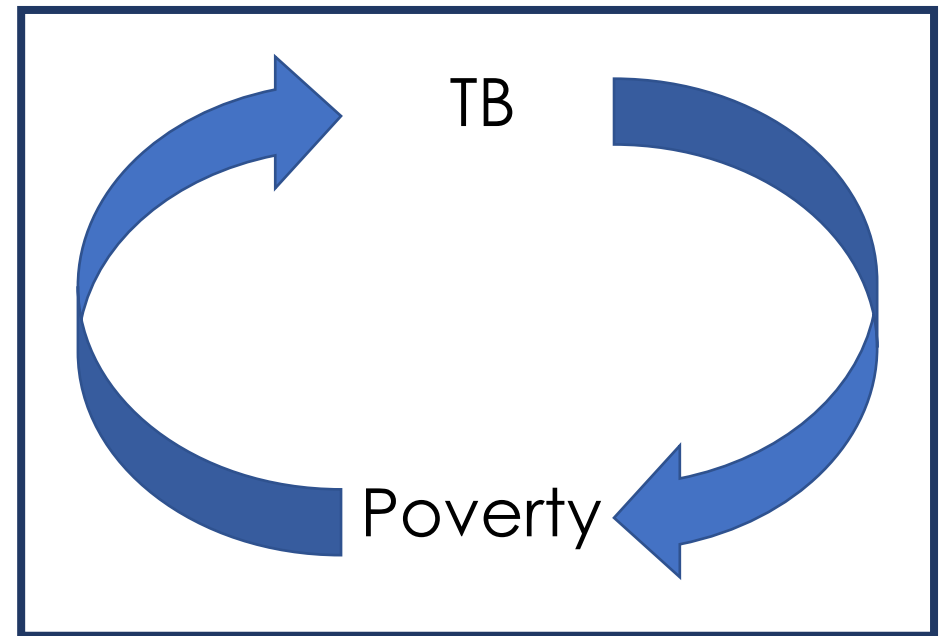Statistical and Mechanistic modelling

Modelling consequences of TB

Well-covered in *many* TB models

- Biomedical: Death, Recurrence, lung damage ('sequalae')

THE END TB STRATEGY

No TB-affected household facing catastrophic costs in 2020

TB

Poverty

Seldom/never covered in TB models

Catastrophic costs

- Definition of total catastrophic costs due to TB
  - *WHO-GTB: sum of direct medical costs, direct* non-medical costs and indirect costs to the patient exceeding 20% of total annual household income

- Data from survey(s):
  - Range: **35% to 83%**
  - Usually higher in MDR patients
  - No <u>detected</u> difference in TB outcomes

Completed
Ongoing
Planned
Not planned
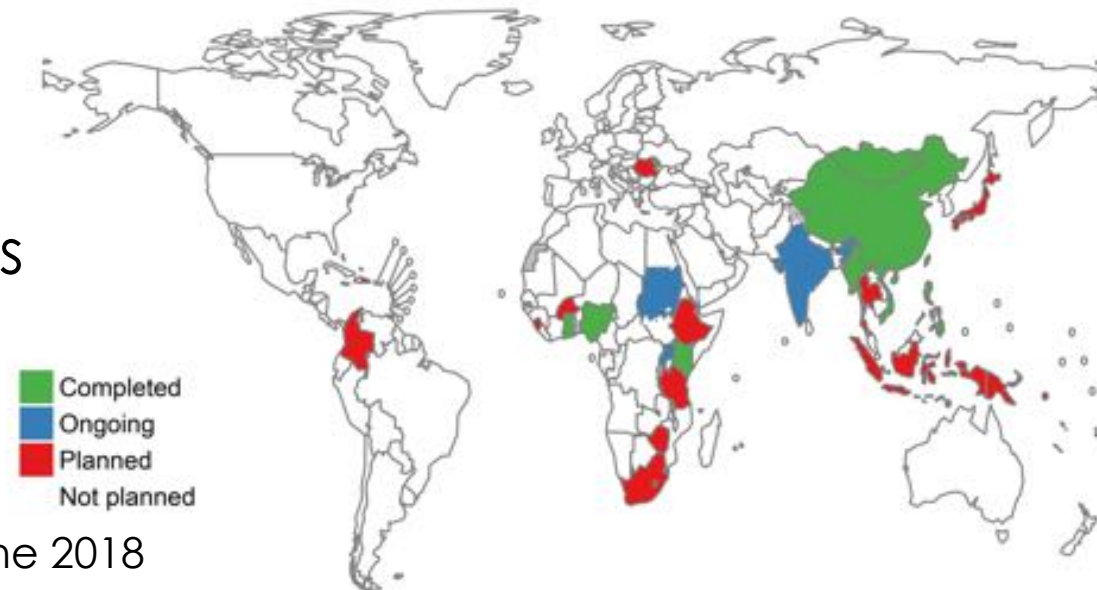
Source: WHO/Global TB Programme: Status of surveys as of June 2018

Modelling catastrophic costs

- Include Catastrophic costs as outcome in models

- Can be little doubt of impact of catastrophic costs on <u>individuals</u> and <u>household</u>

- Challenge --> relate/value catastrophic costs averted against death or case averted
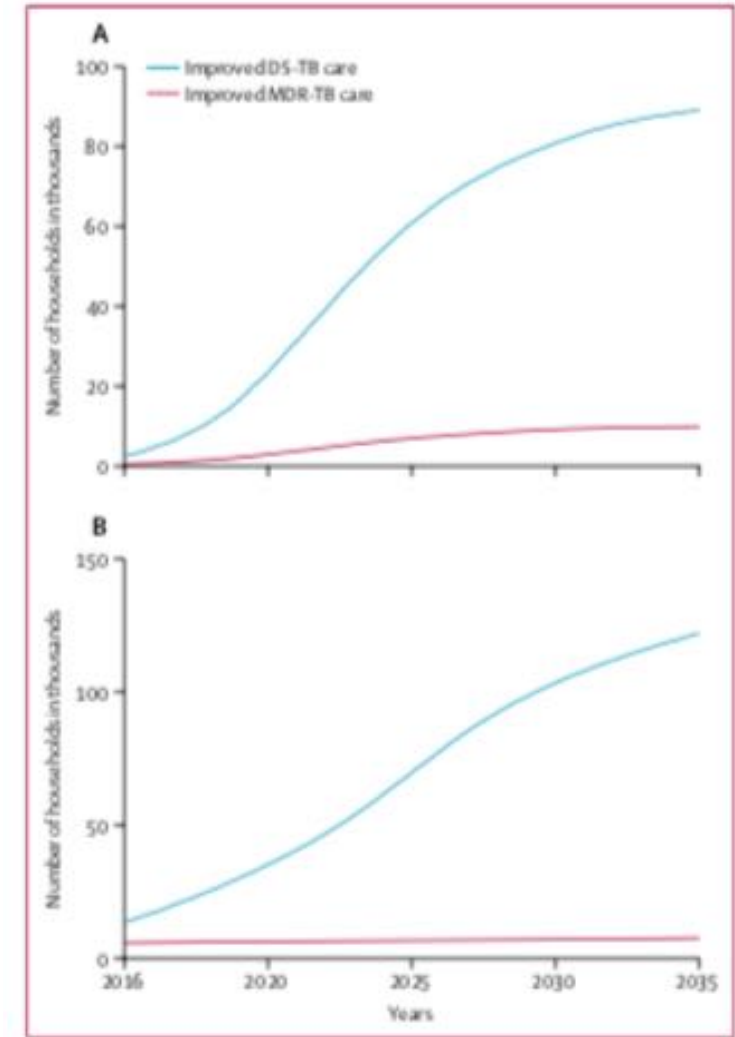 - Different interventions, different distribution of impact.

Figure 2: Number of households in India per year with catastrophic costs averted by improved tuberculosis care over the period 2016–35

Source: Verguet et al. Lancet GH 2017

Long-term consequences

- Not clear if/how TB exacerbates poverty cycle

- Seems intuitive that it does

- Draw on life-course epidemiology methods?
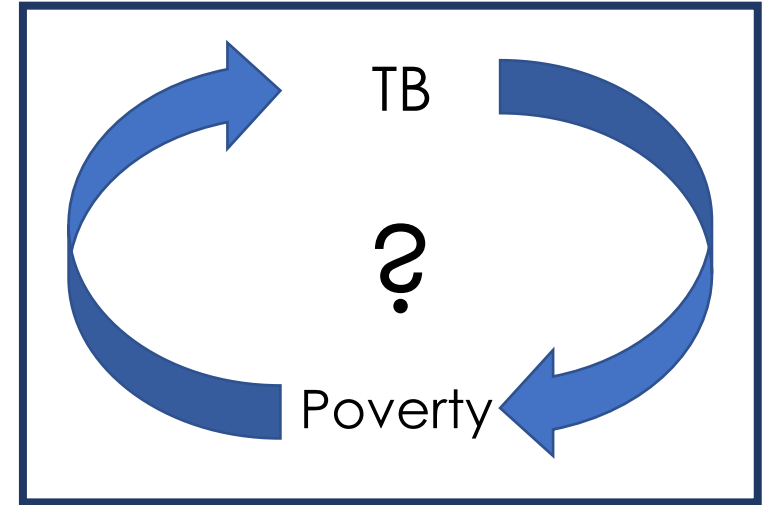
Conclusions/messages

- Limited modelling work done.

- Diverse and complex field, not easy to collate data.

- Important to understand pathways before mechanistic modelling.

- Socio-economic determinants matter for prevention, on population and individual level.

- Opportunities to emphasize the need for intersectorial action.

- Interesting and necessary

How should models consider the role of social determinants, comorbidities, nutrition, and the environment in prevention of TB?

- Progressively and urgently

- Strengthen data

- Consider catastrophic costs as a valid outcome of 'prevention'?

Acknowledgements

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- Delia Boccia
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- Katherine Horton
- William Rudgard