Estimating the optimal measles vaccination age

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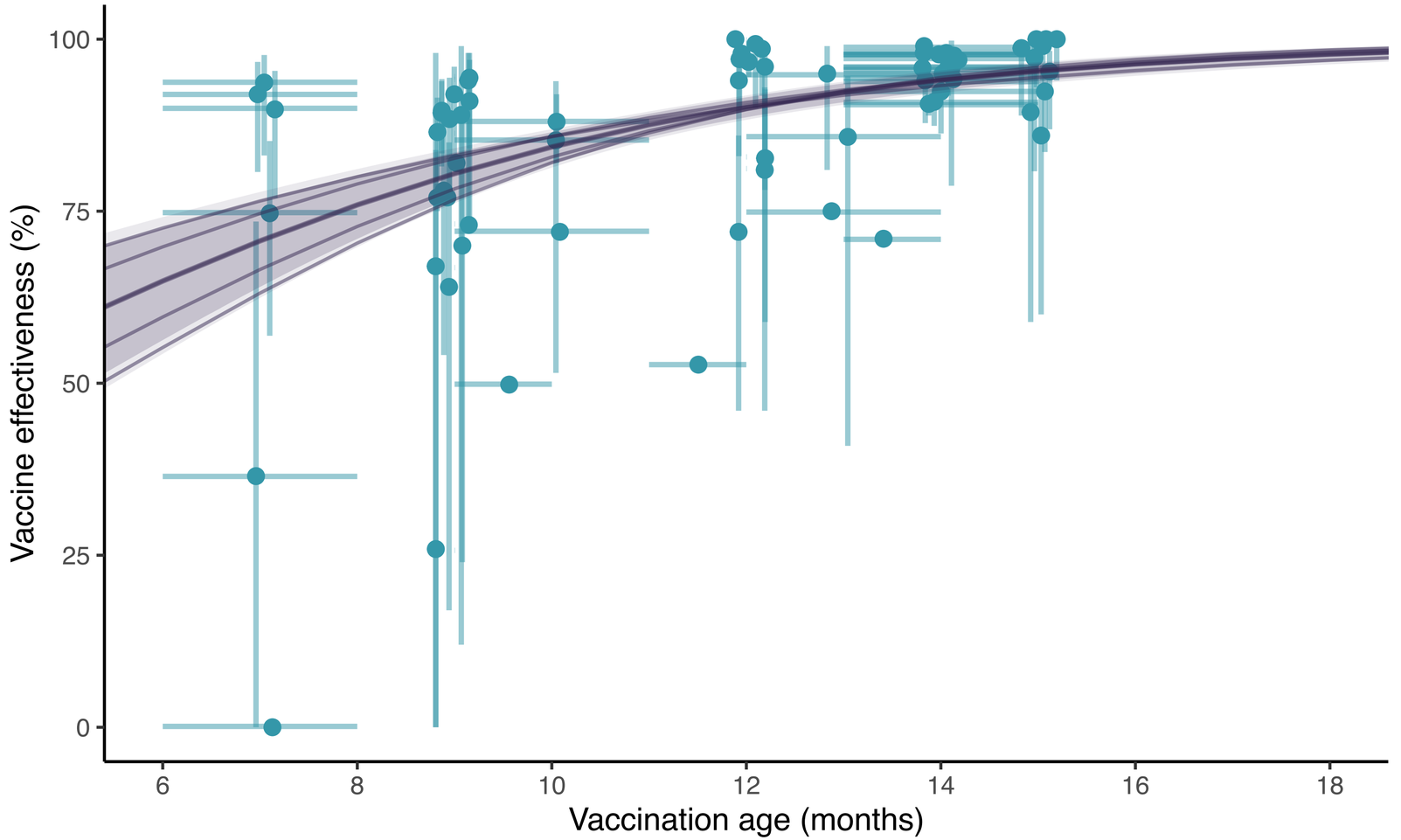
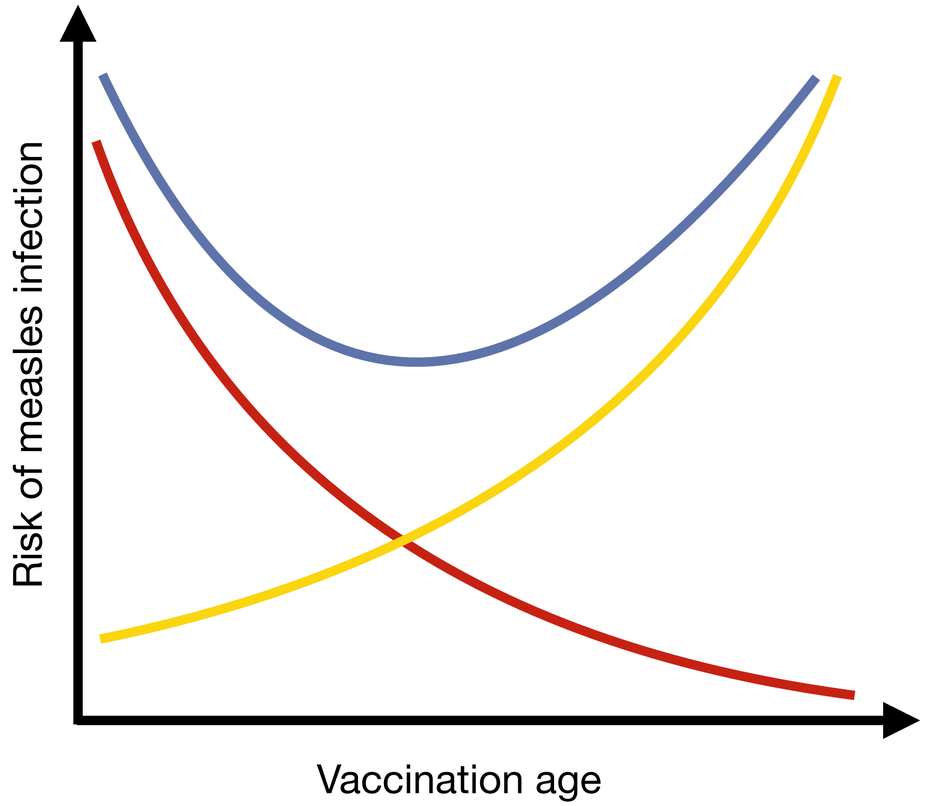
Measles vaccine effectiveness increases with age



Data from Hughes, S. L. *et al.*(2020).

Vaccination age trades-off risks



Risk of vaccine failure

Risk of infection prior to vaccination

Risk of measles infection

Agenda

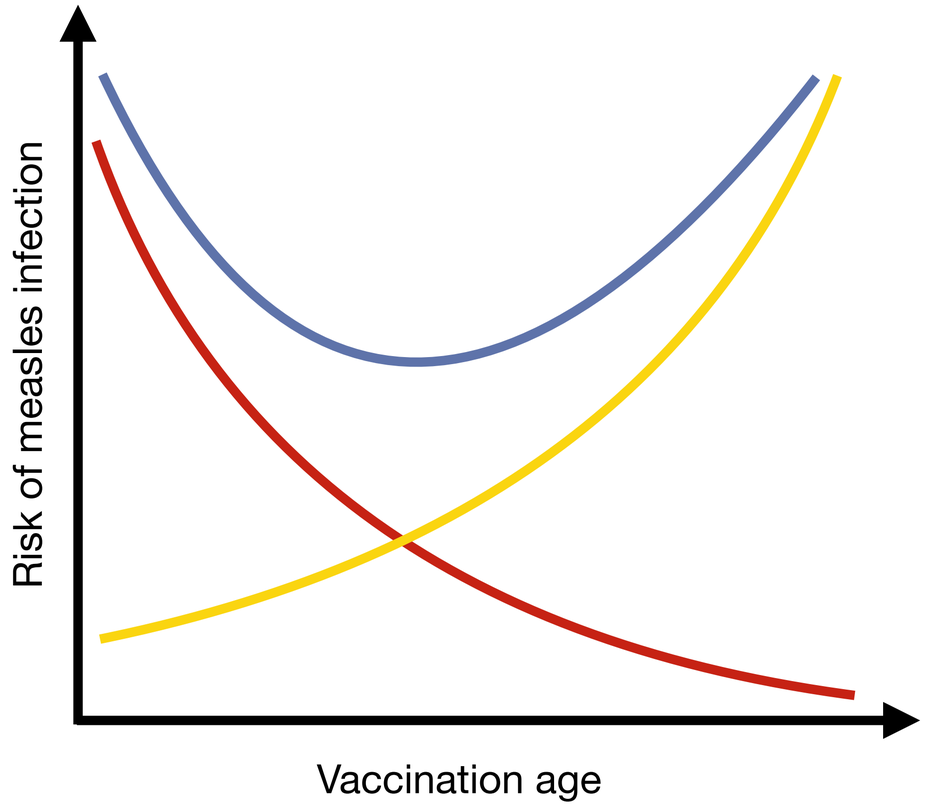
Previously presented:

- Method for calculating the optimal measles vaccination age
- Applied the method to synthetic populations
  - The optimal age is population-specific

New:

- Limited matrices from low- and lower-middle income countries
  - Applied the method to 4 matrices from sub-saharen Africa
  - Tested different demographic forms

Vaccination age trades-off risks



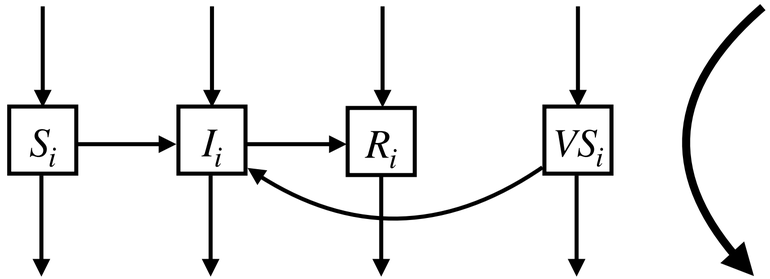
Risk of vaccine failure

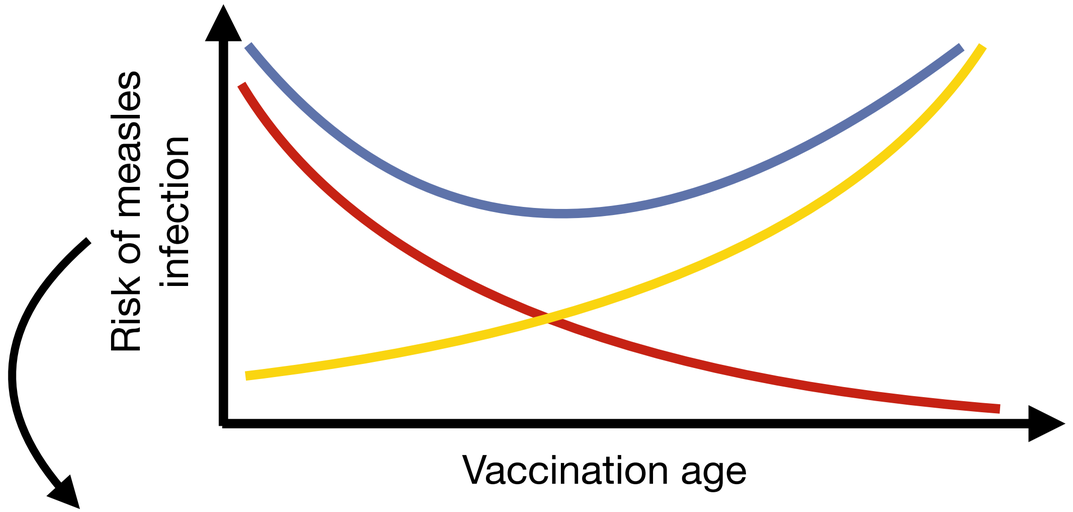
Risk of infection prior to vaccination

Risk of measles infection

Calculating the optimal age

Quantifying the risk trade off





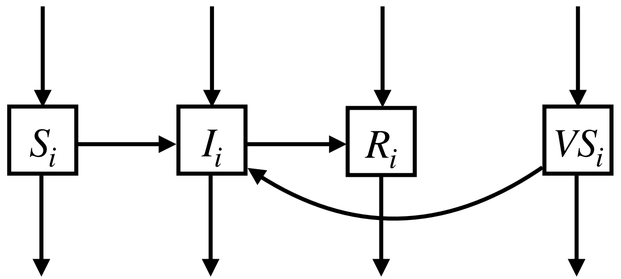
Risk of vaccine failure

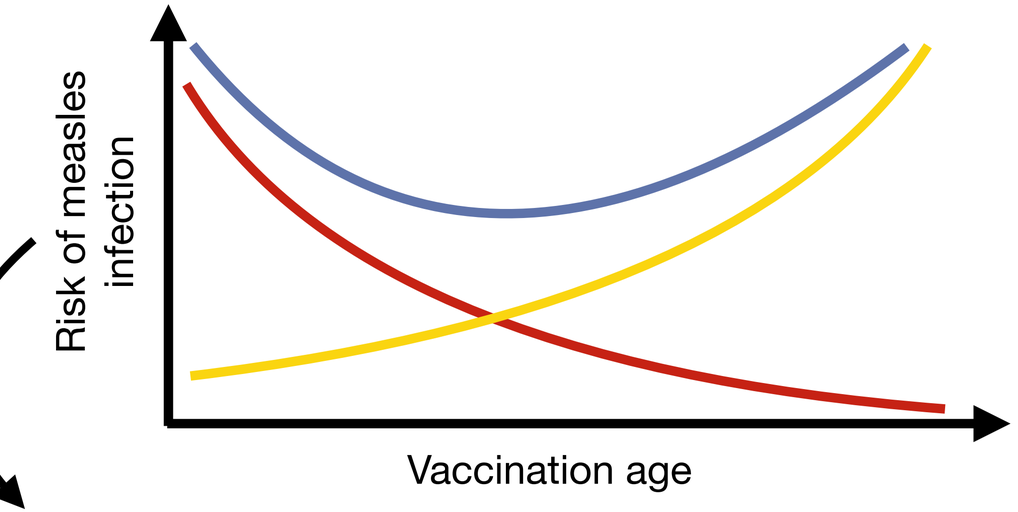
Risk of infection prior to vaccination

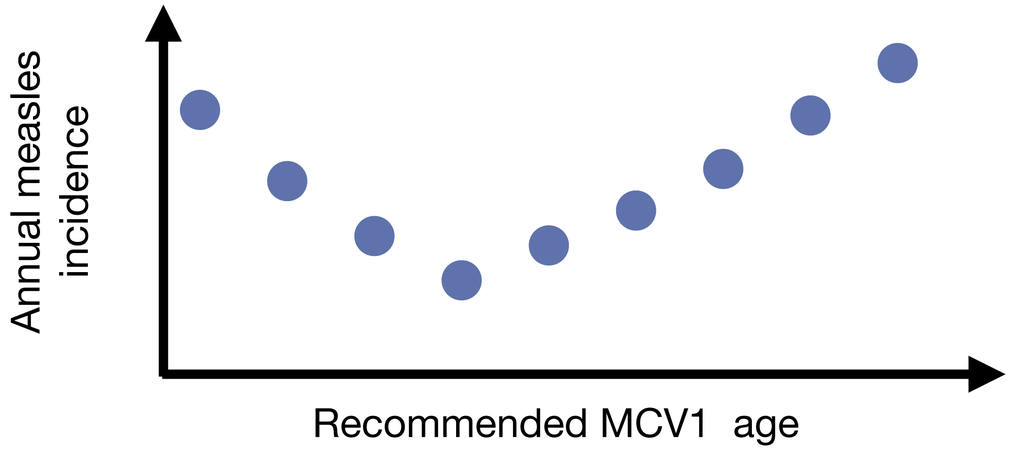
Risk of measles infection

Calculating the optimal age

Quantifying the risk trade off







Risk of vaccine failure

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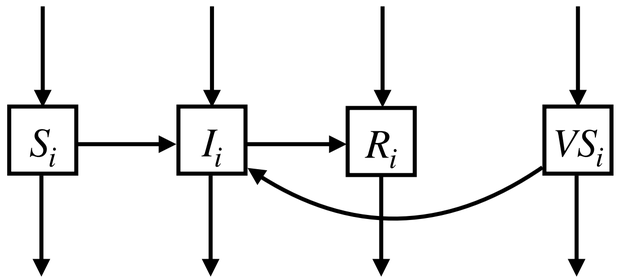
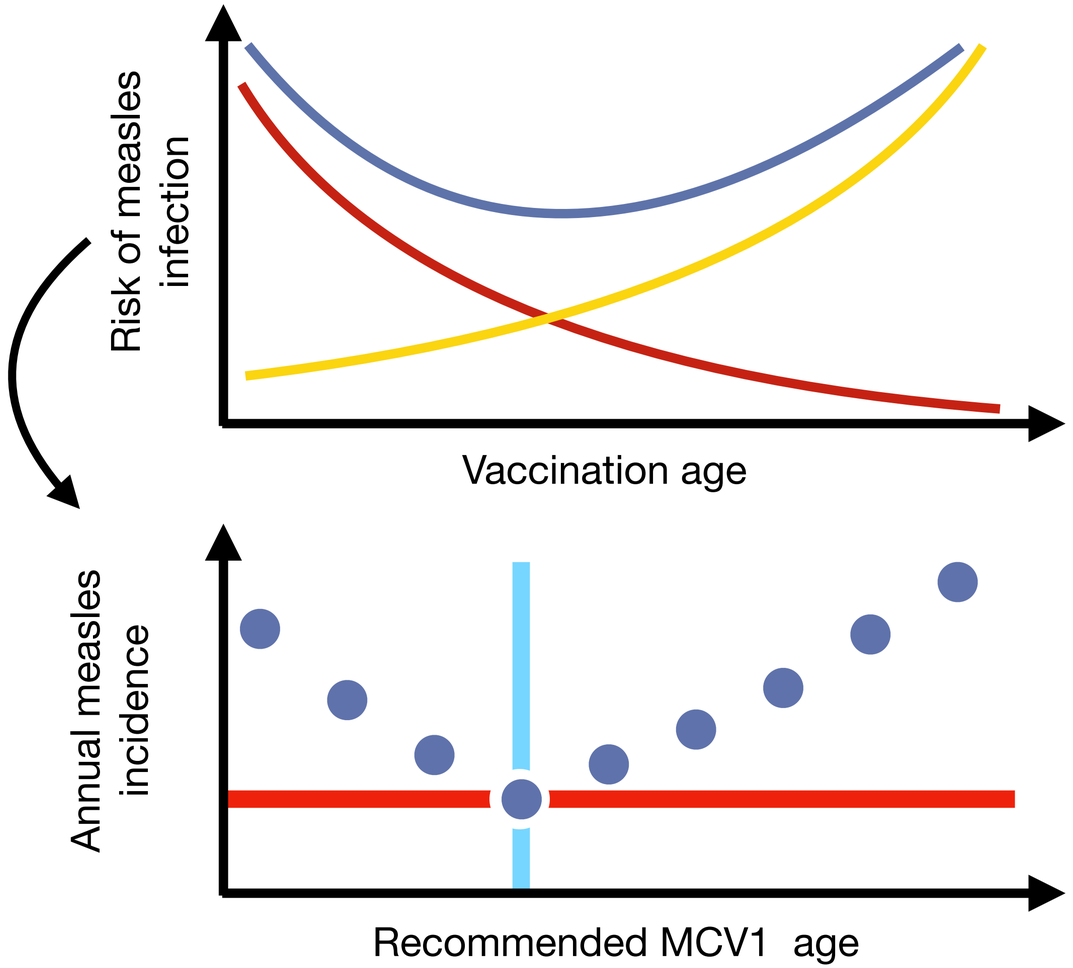




Risk of vaccine failure

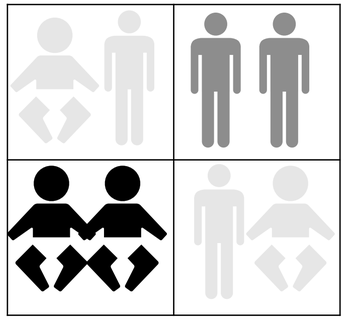
Risk of infection prior to vaccination

Risk of measles infection

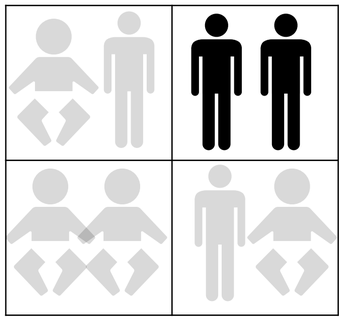
Factors that affect the optimal age

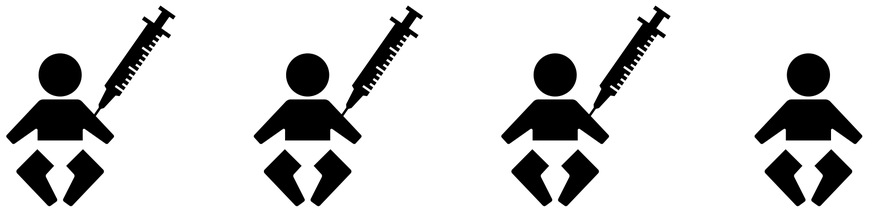
- Social contact matrices
  - China, India, Japan, Moscow, South Africa, UK, USA
- MCV1 coverage
  - 45%, 55%, 65%, 75%, 85%
- Transmission level
  - Low, medium, high

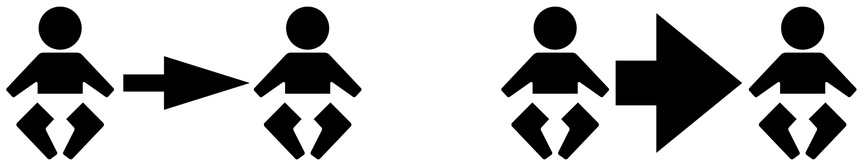
South Africa



China

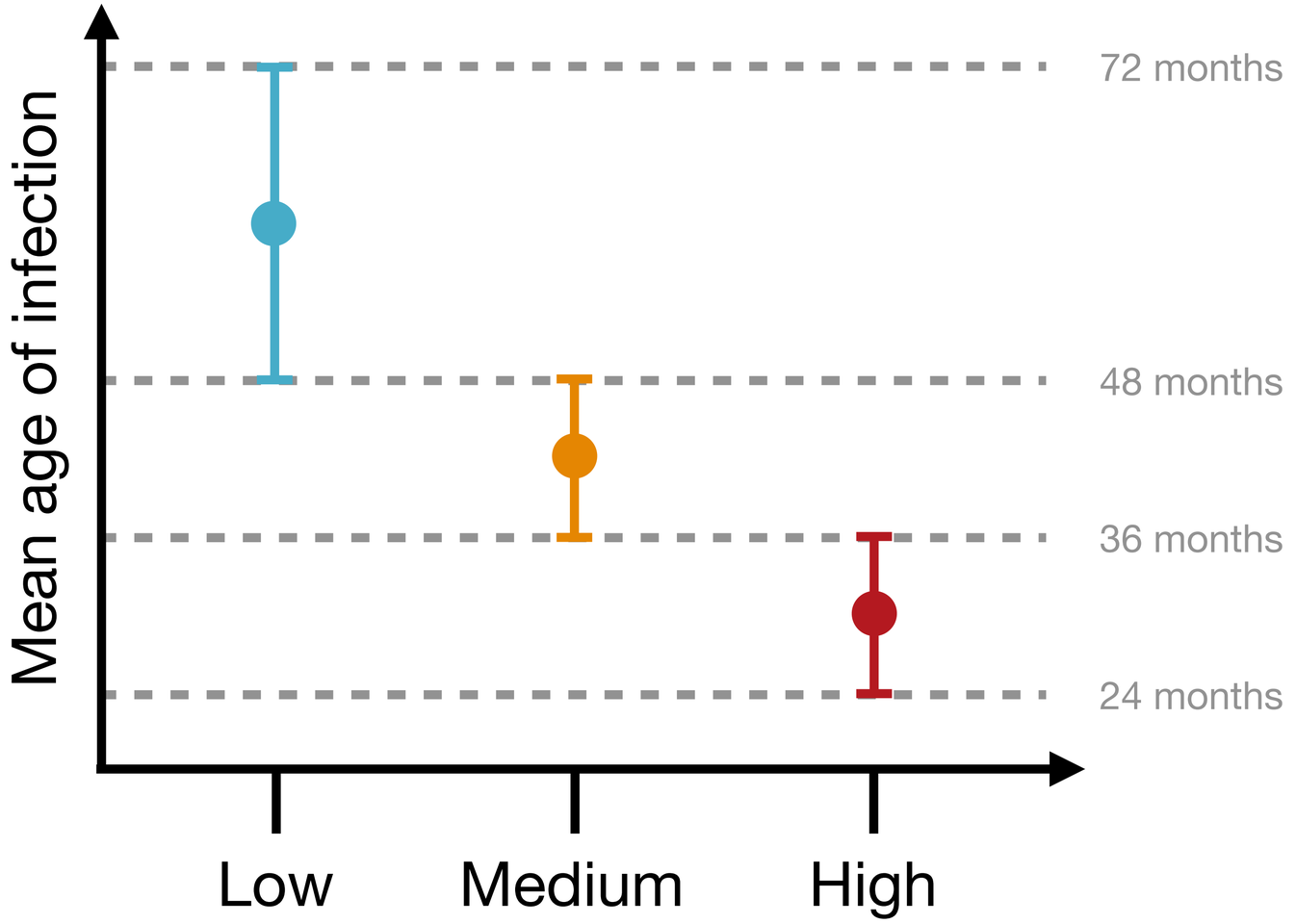






Factors that affect the optimal age

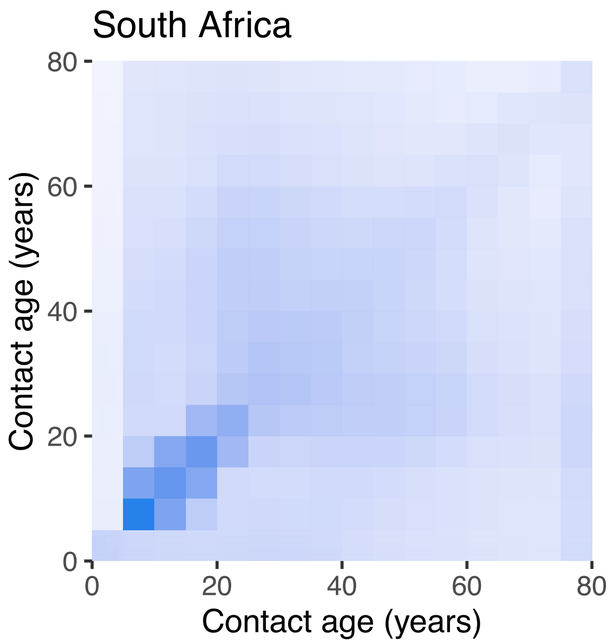
Transmission level

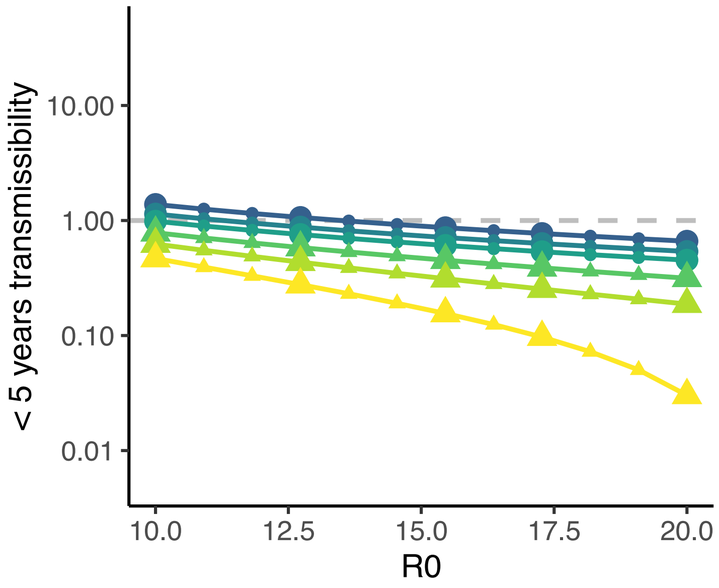


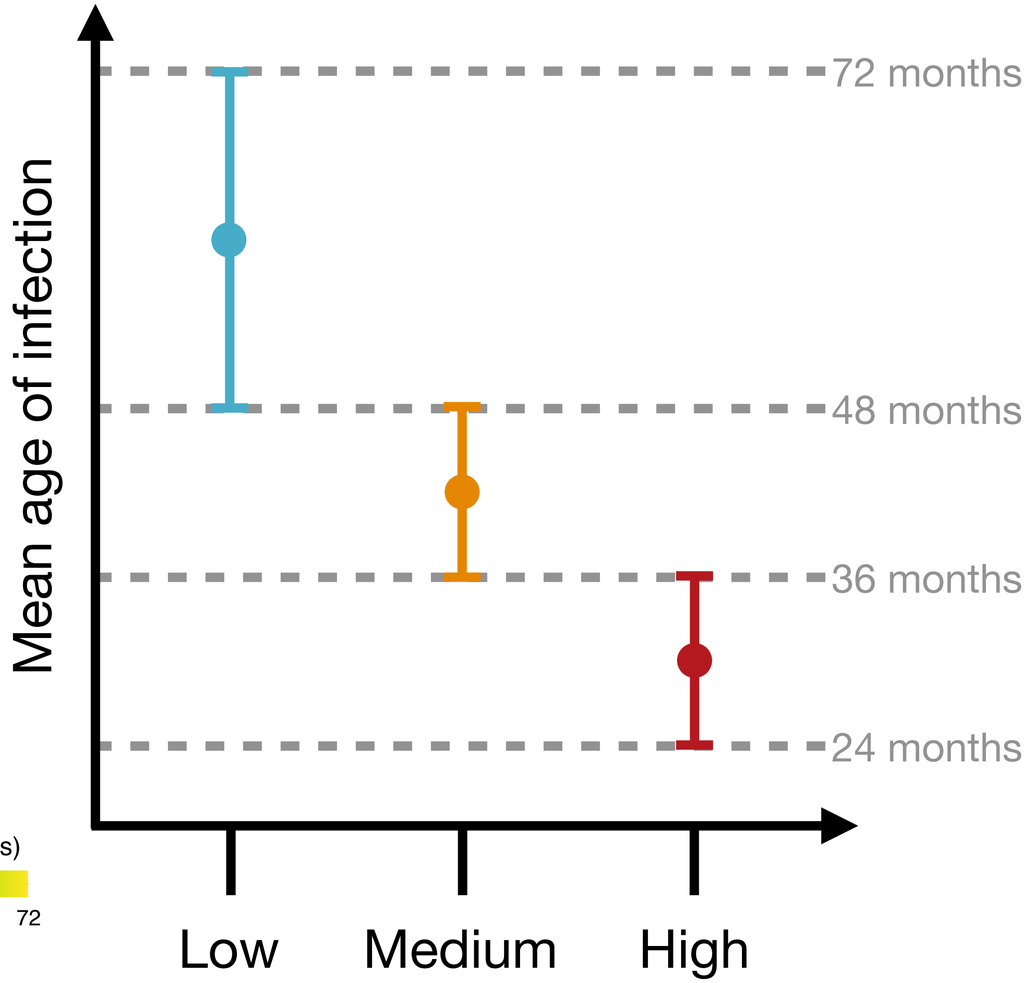
Data from Anderson, R. & May, R. (1983).

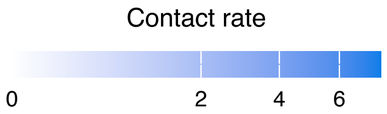
Factors that affect the optimal age

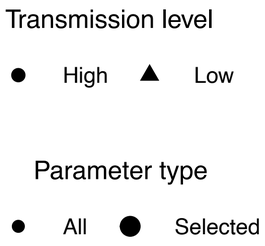
Transmission level

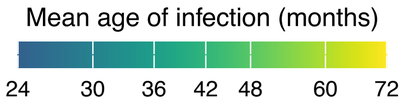






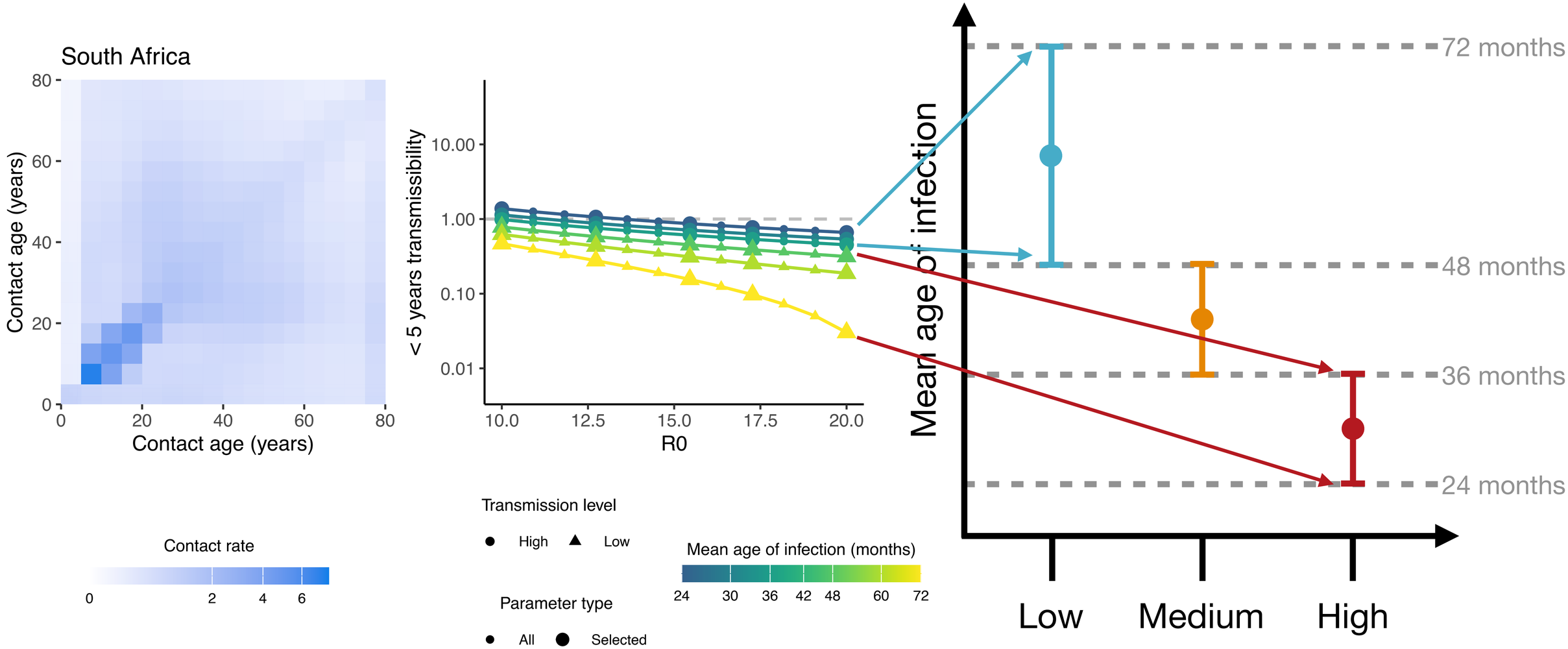






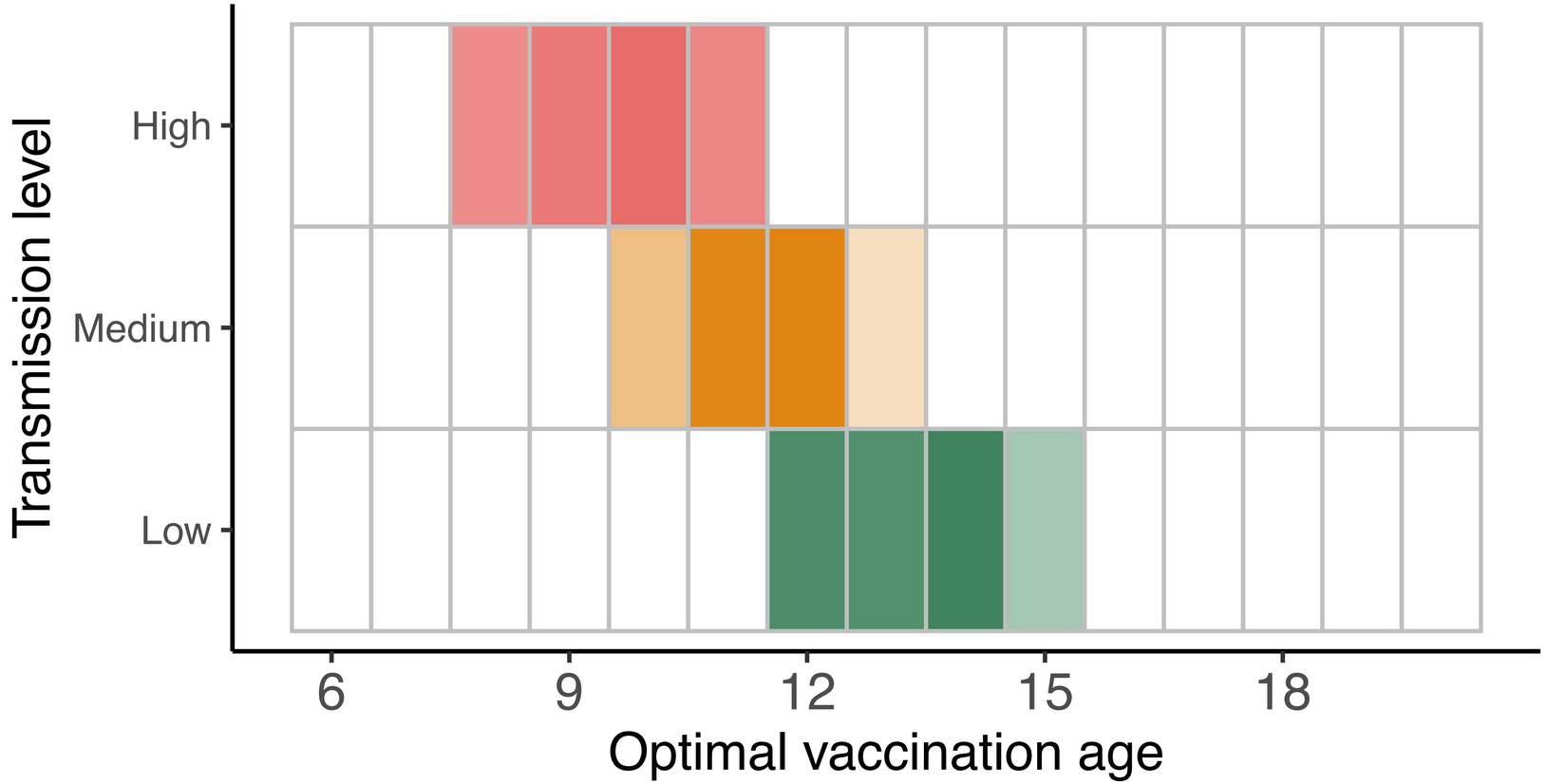
Factors that affect the optimal age

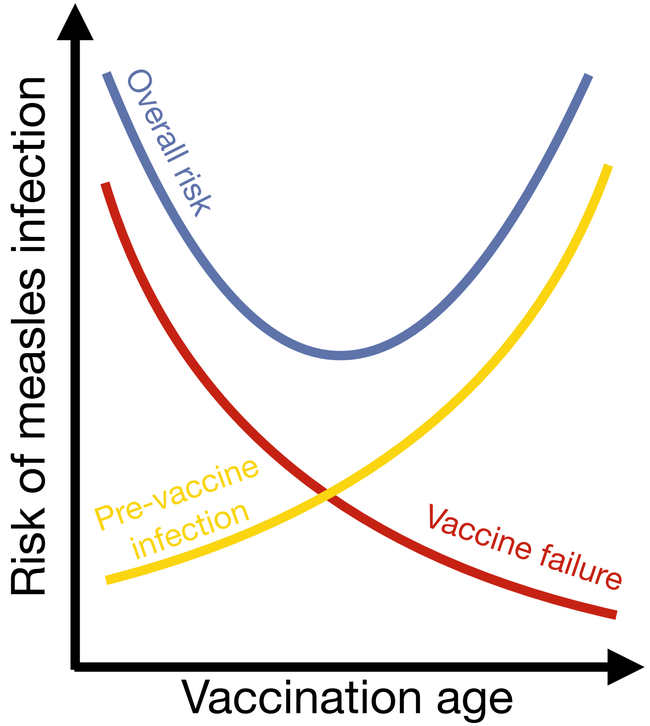
Transmission level

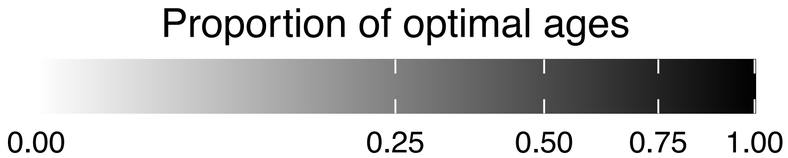


Results: Transmission level

Increased transmission level leads to decreased MCV1 age







USA, 45%

Results: Transmission level

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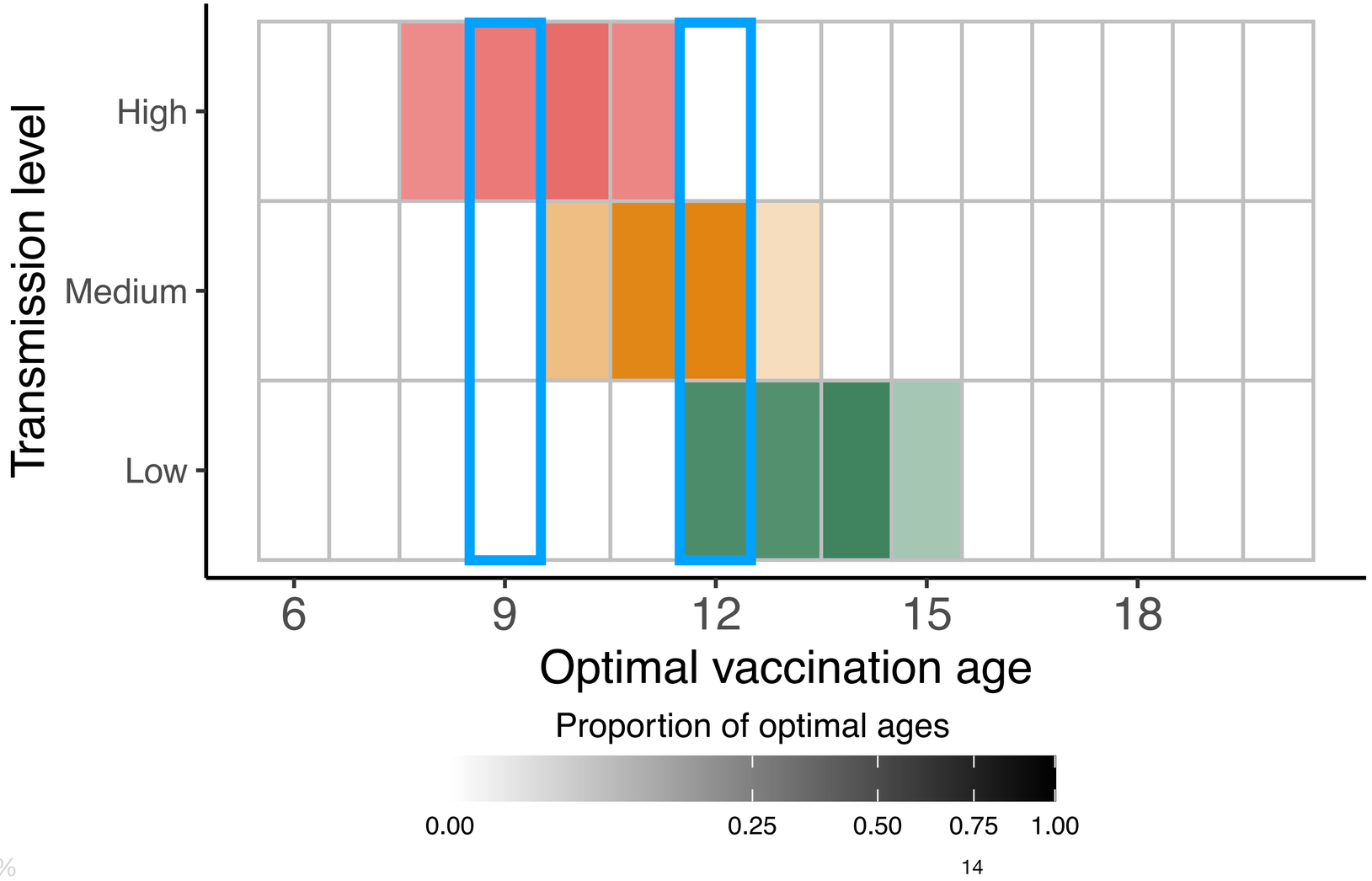
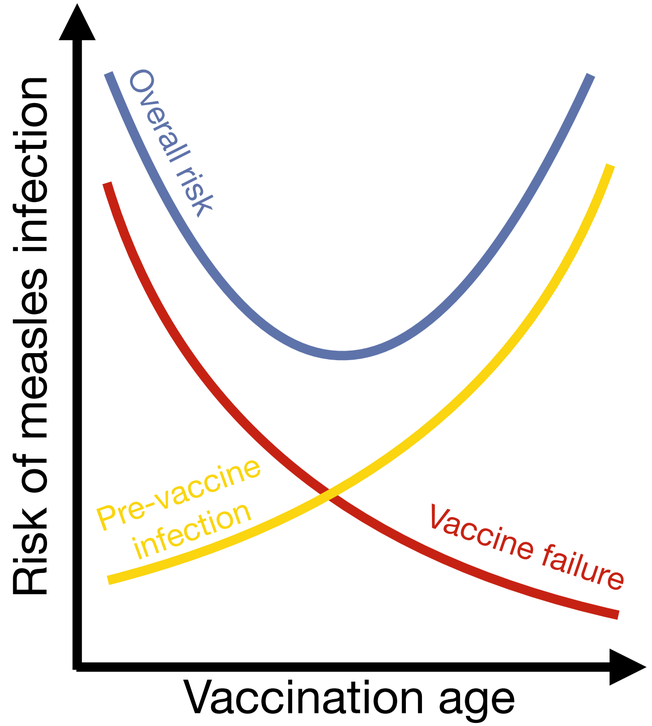


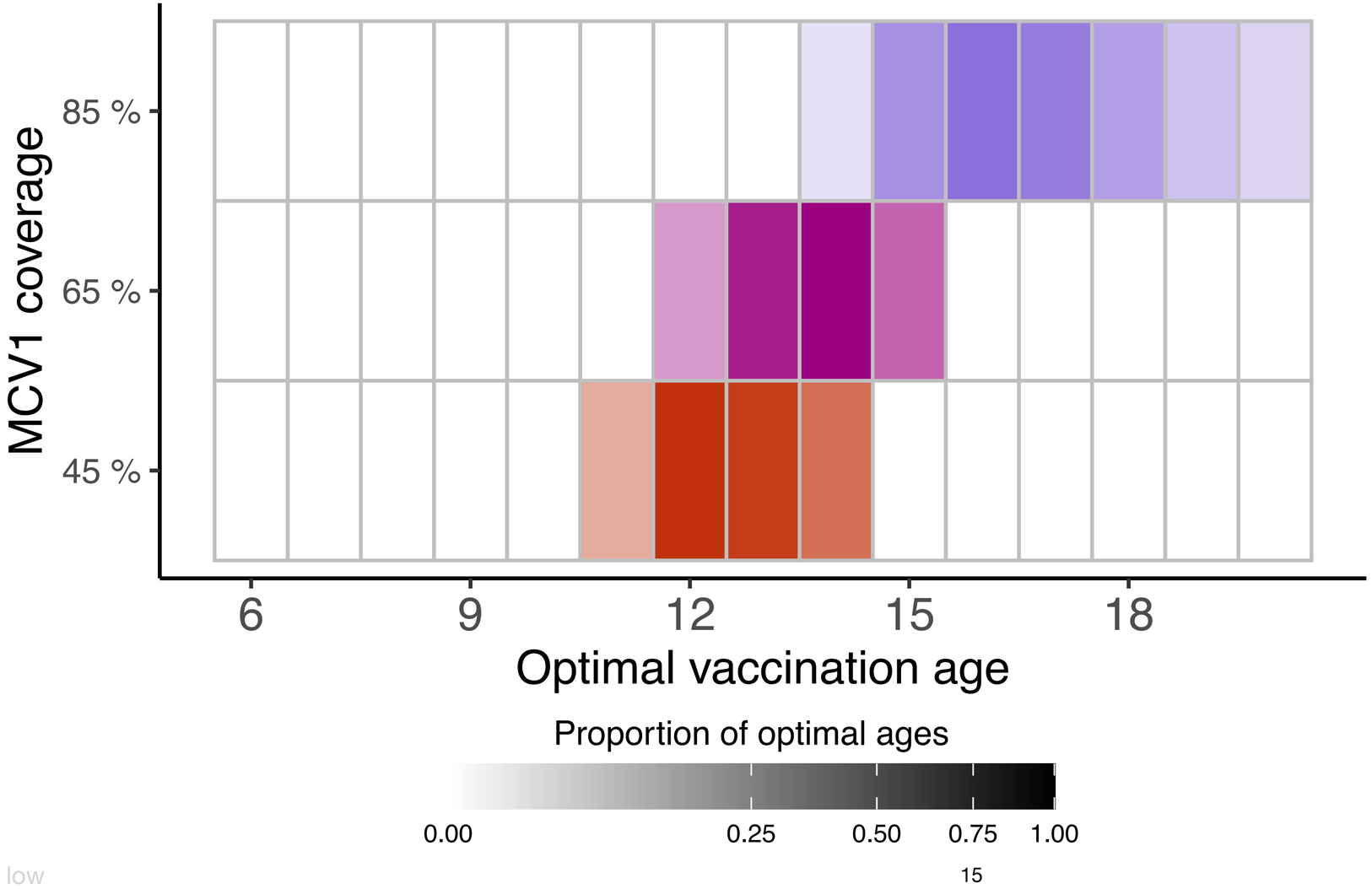


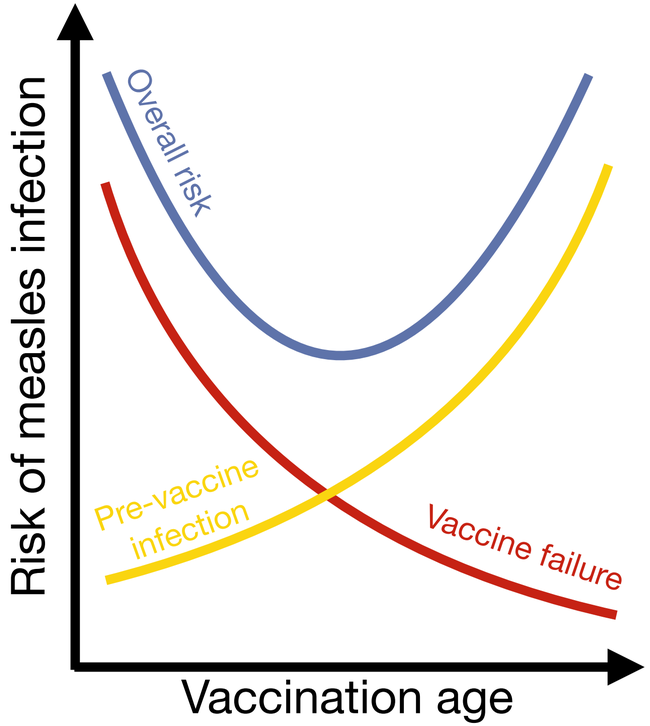
WHO ages

USA, 45%

Results: MCV1 coverage

Increased vaccine coverage leads to increased MCV1 age

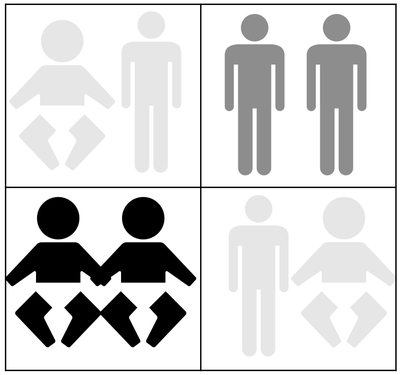




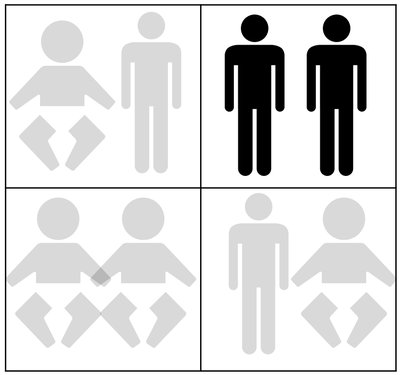
Results: Social Contact Matrices

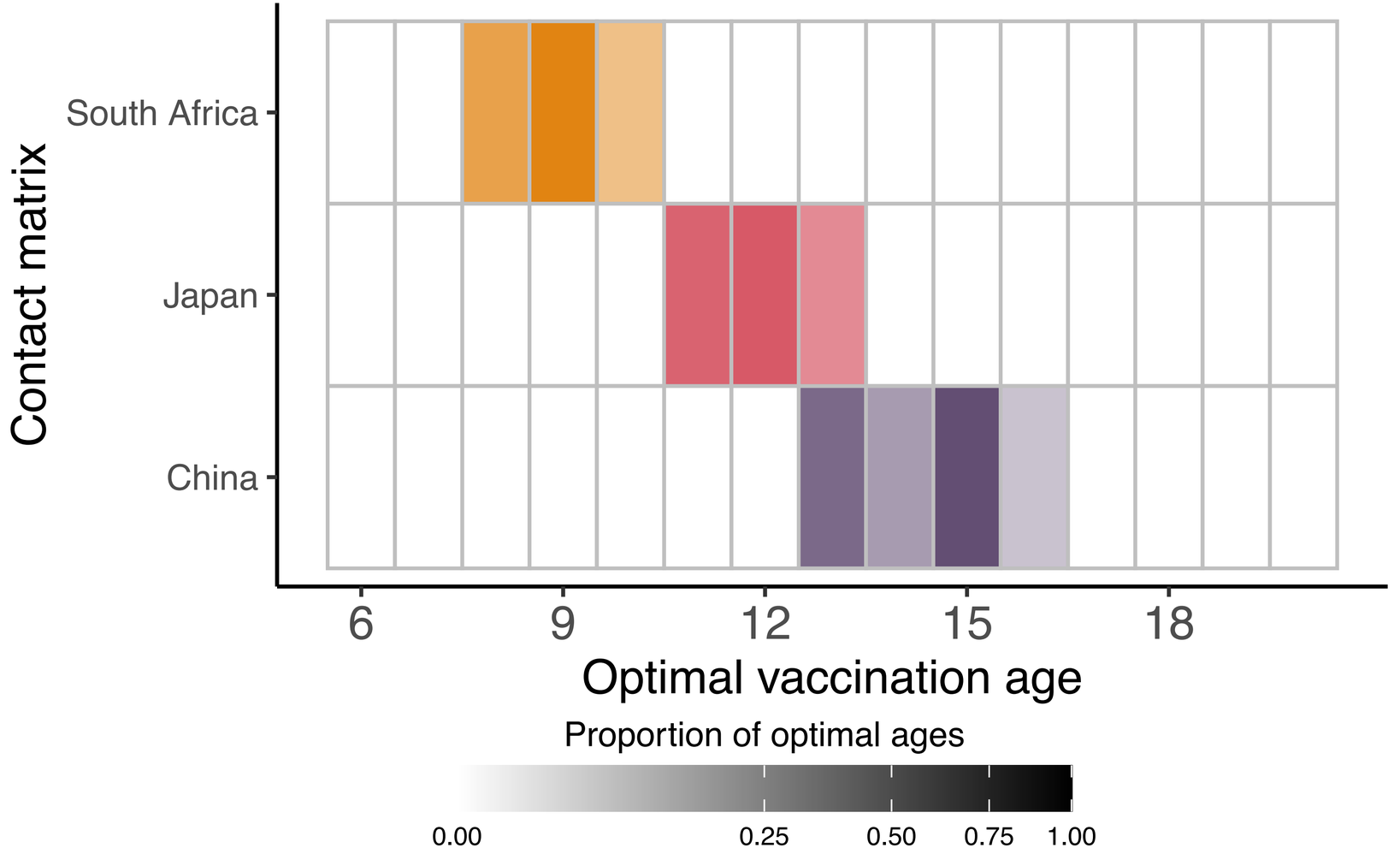
Different social contact matrices result in different optimal ages

South Africa

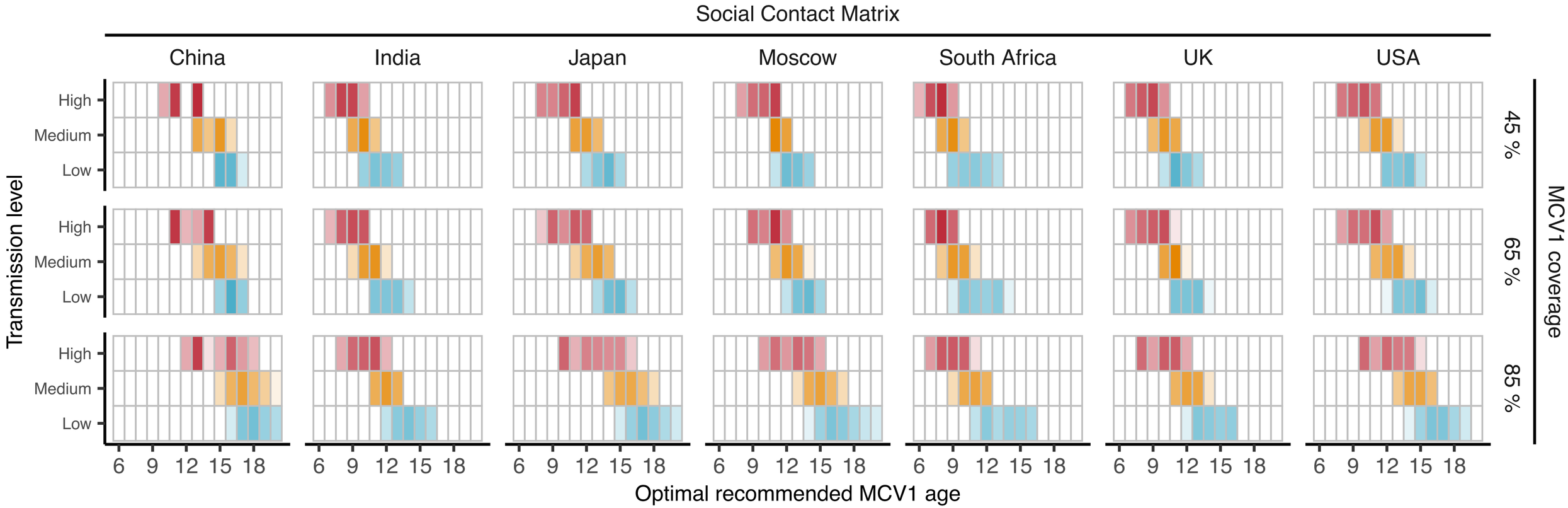


China





Results

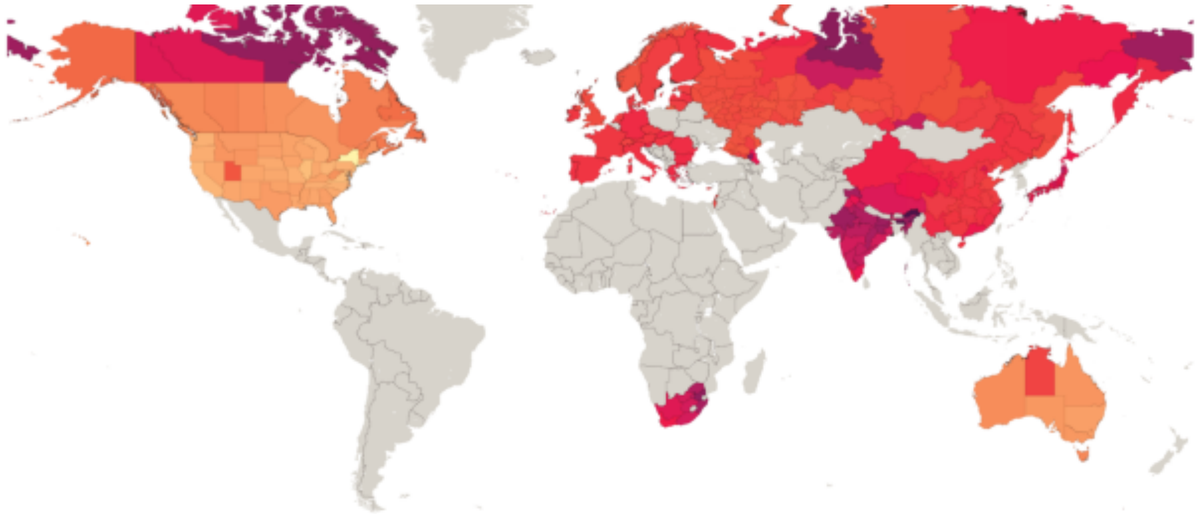

Social Contact Matrix
China
India
Japan
Moscow
South Africa
UK
USA
Transmission level
High
Medium
Low
45 %
65 %
85 %
MCV1 coverage
6 9 12 15 18
Optimal recommended MCV1 age

Part 1: summary

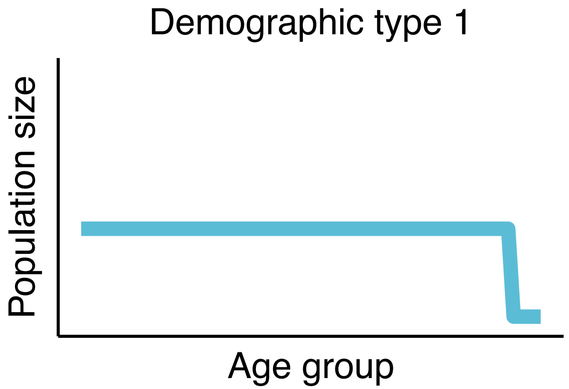
- The **optimal age varies** between populations
  - Increases in the **transmission level** lead to **decreases** in the optimal age
  - Increases in the **vaccine coverage** lead to **increases** in the optimal age
  - Different **Social Contact Matrices** result in **different optimal ages**

Limited applications to lower income countries

Limited social contact matrices



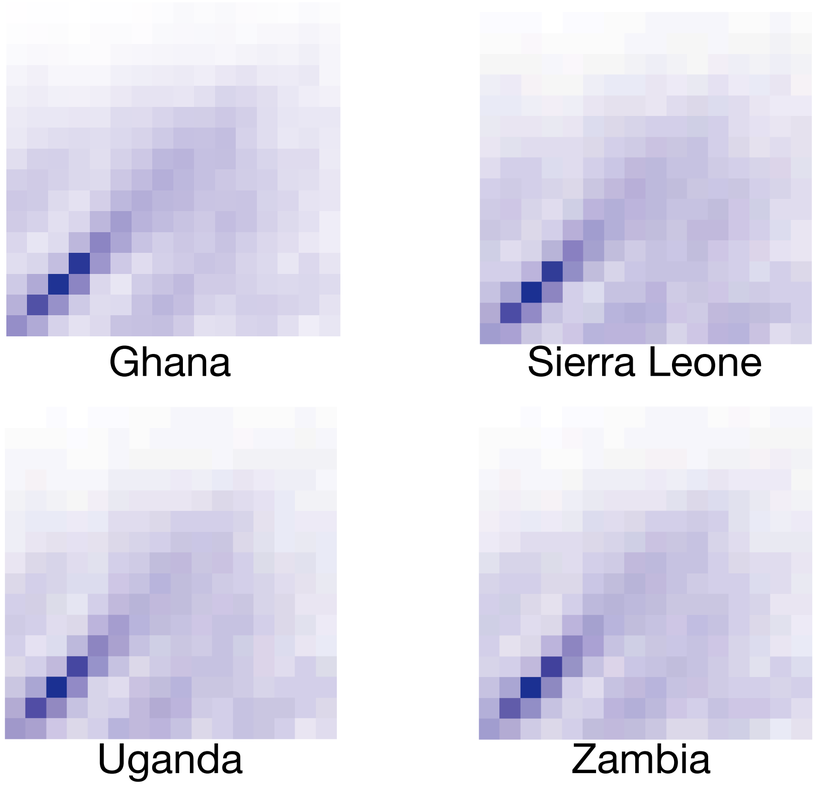
Demographic structure



SCM included in Mistry, D. *et al.* (2021)

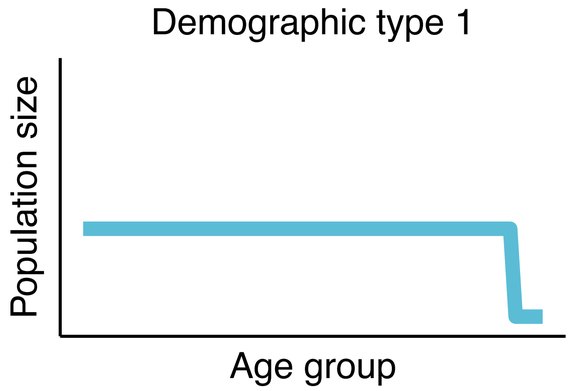
Extension: Low- and lower-middle-income countries

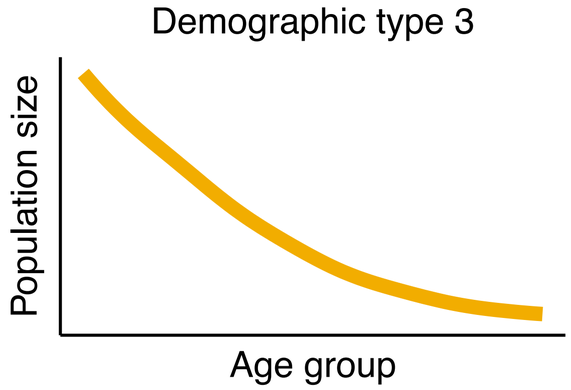
4 social contact matrices from sub-Saharan Africa



Social contact matrices from Prem *et al.* (2021)

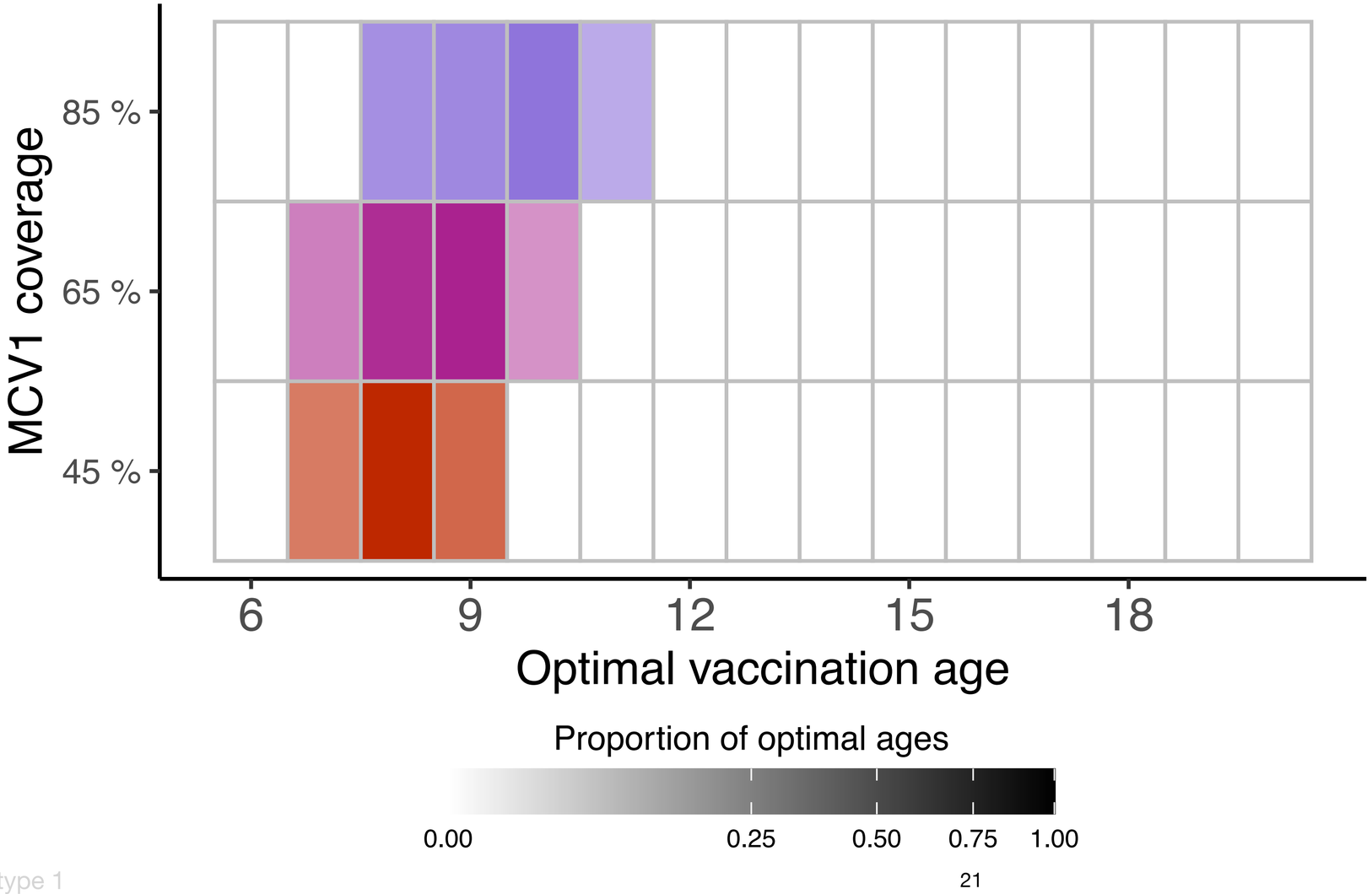
Yearly age group population sizes





Results: Low- and lower-middle-income countries

The impact of MCV1 coverage is reduced



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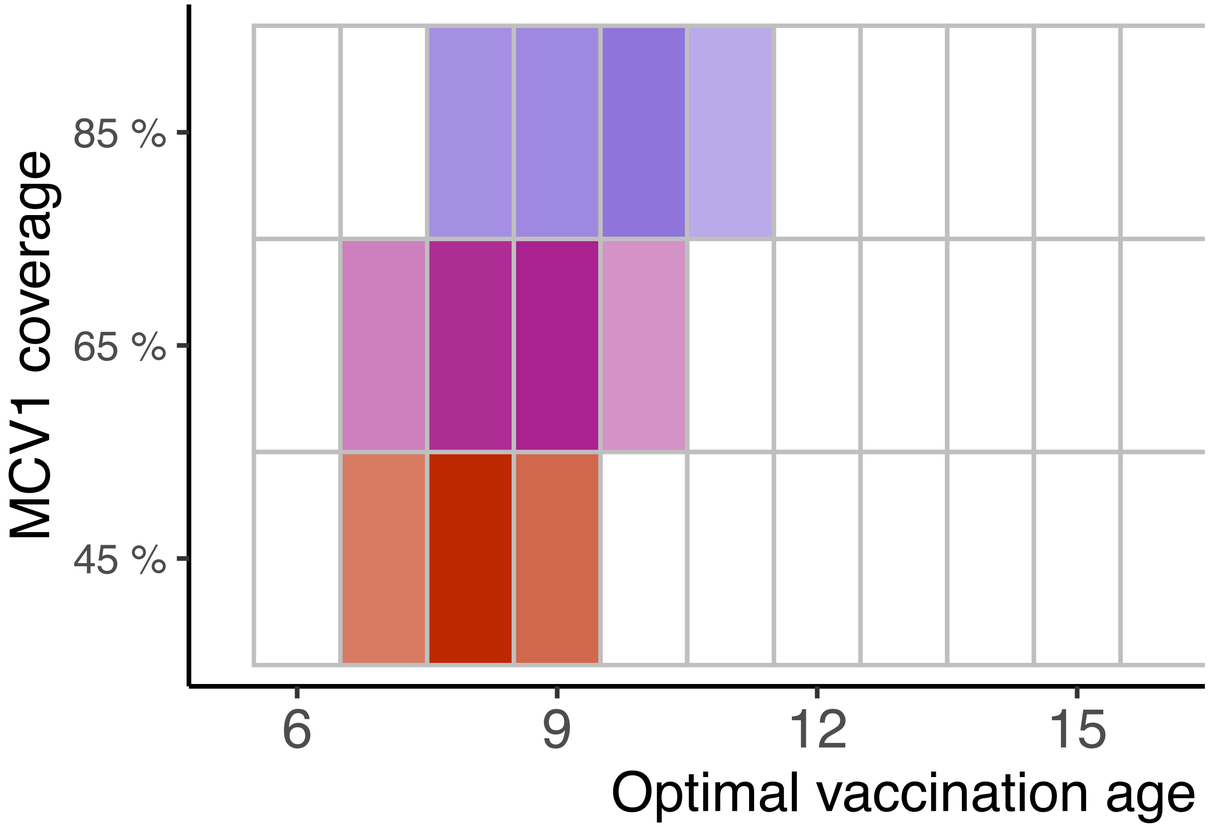
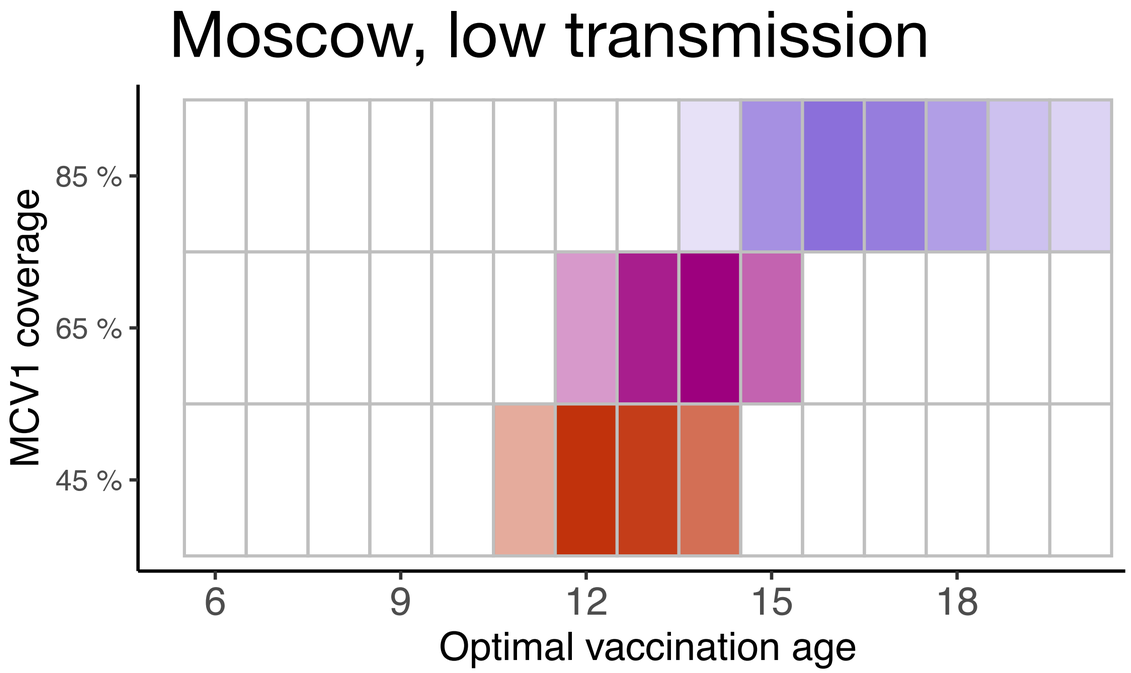
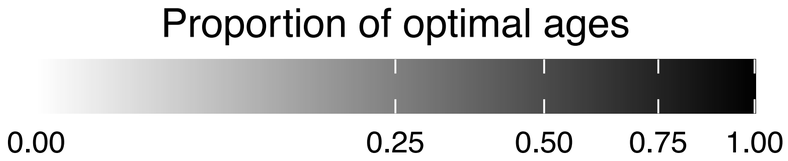


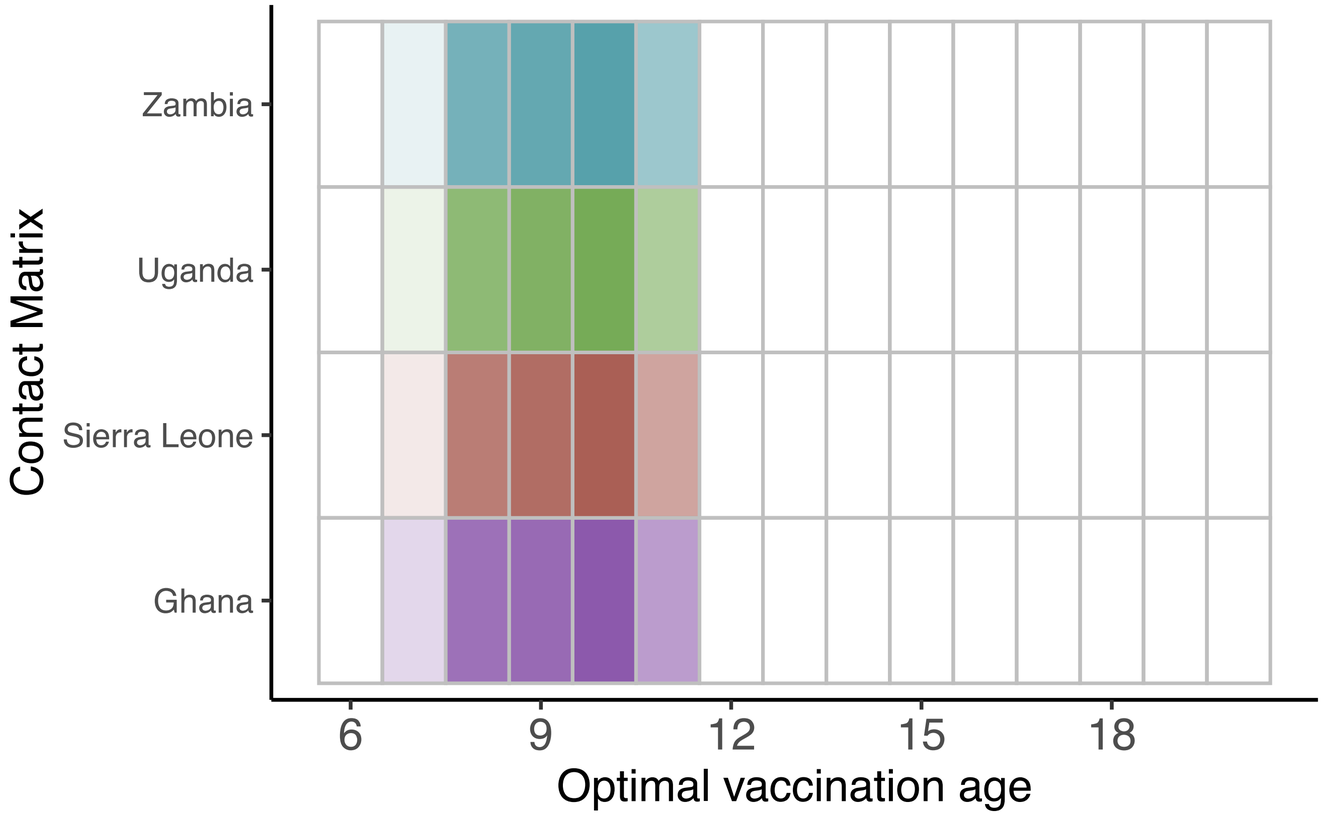


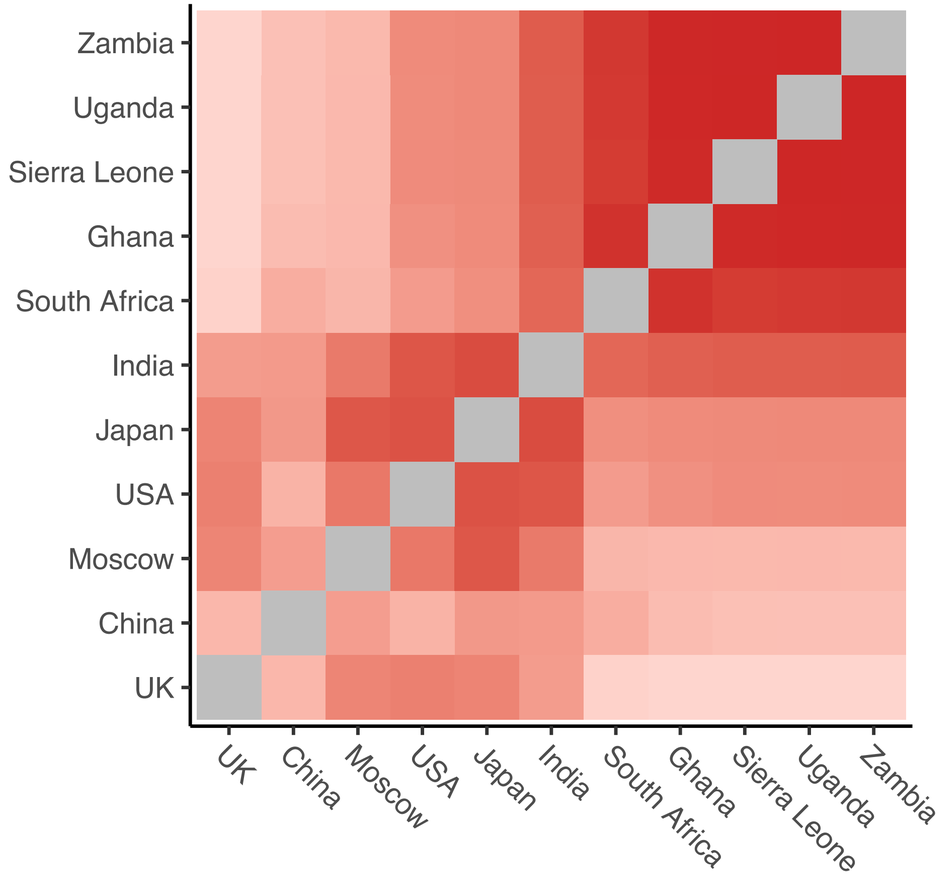


Zambia, type 1

Results: Low- and lower-middle-income countries

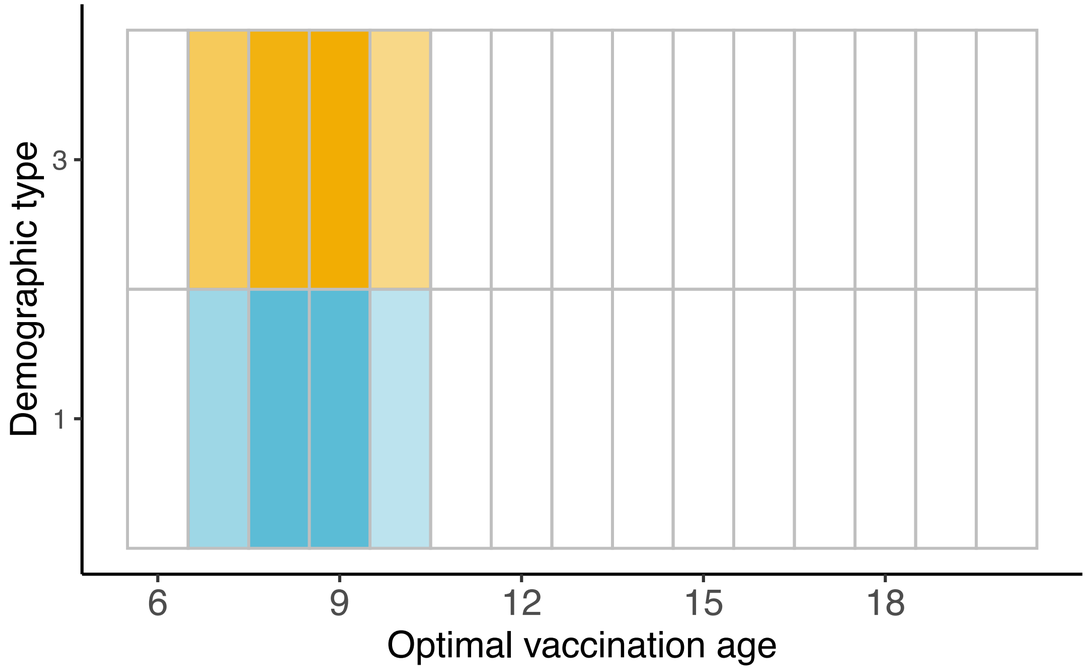
No significant differences between SCM

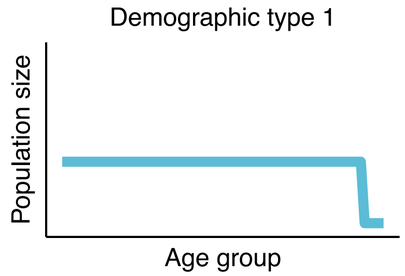


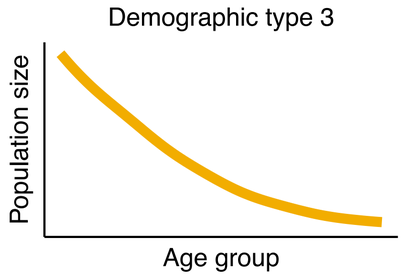


Results: Low- and lower-middle-income countries

No significant differences between demographic types



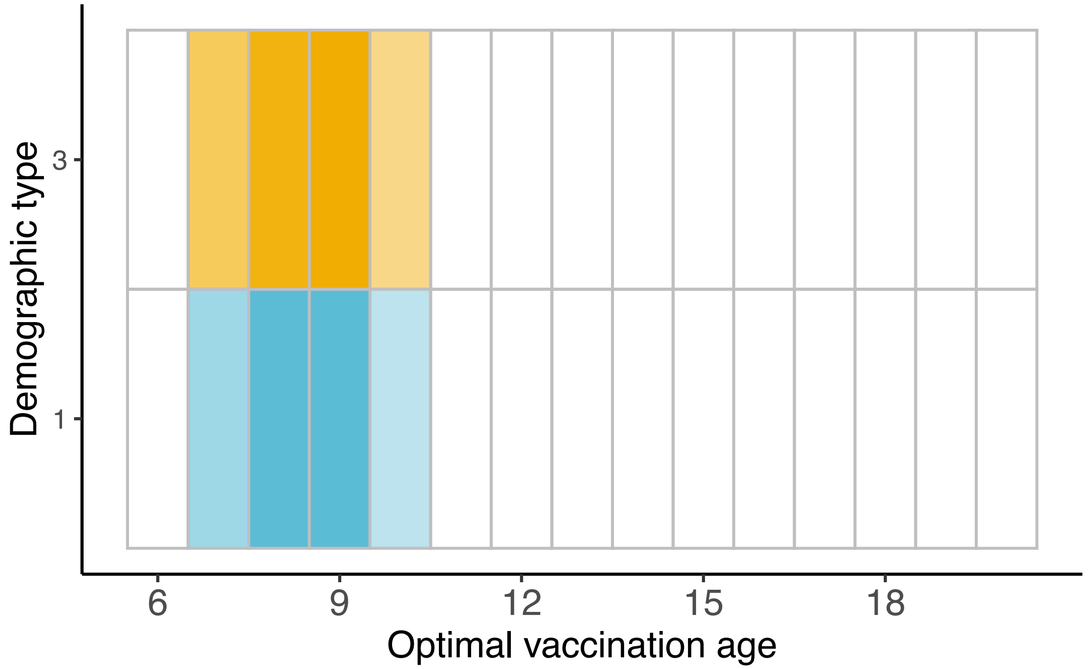


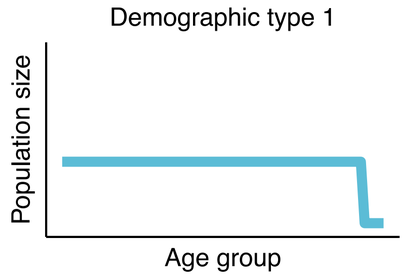


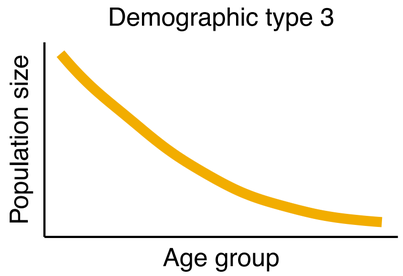
Ghana, 65%

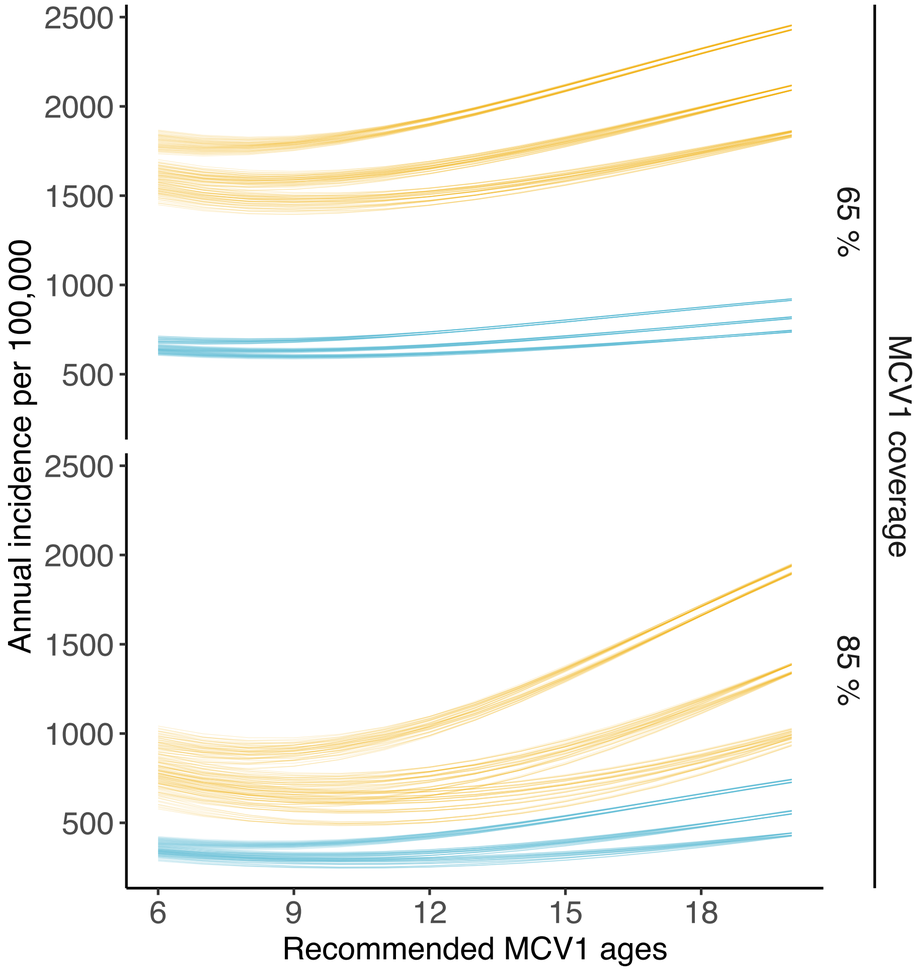
Results: Low- and lower-middle-income countries

Differences in incidence between demographic types

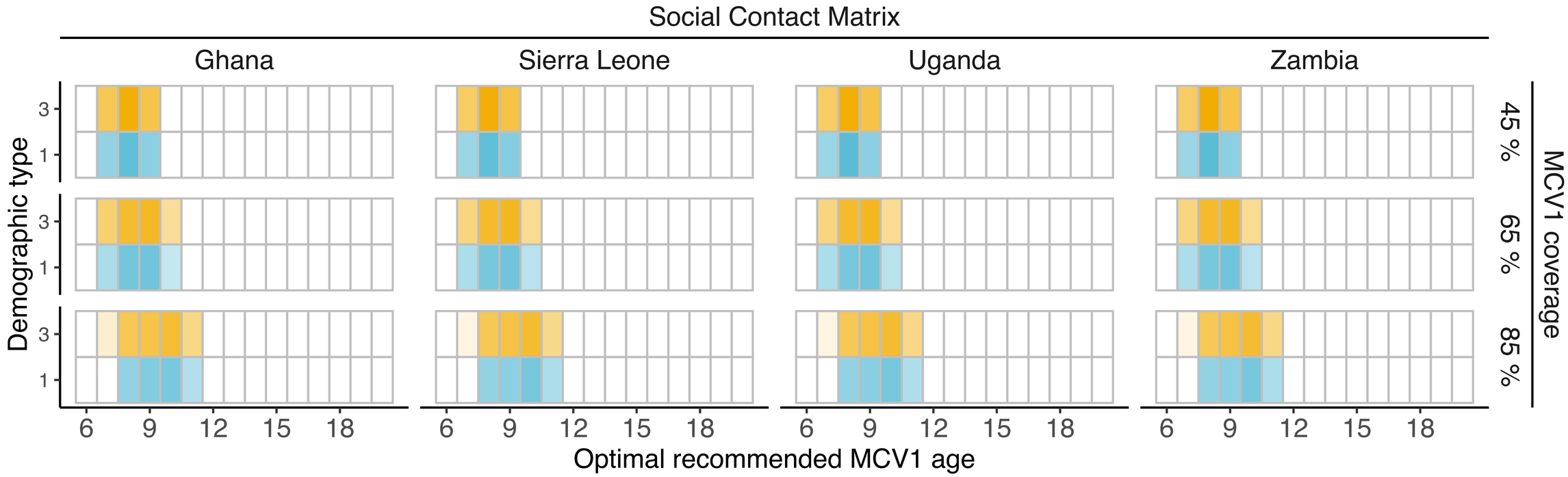


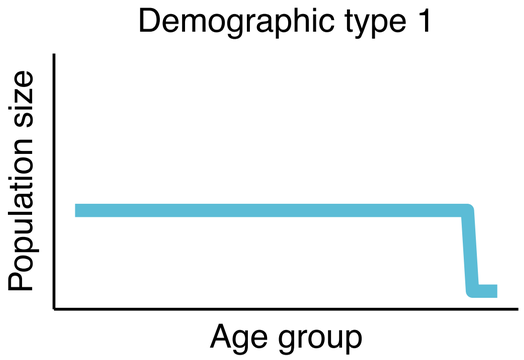


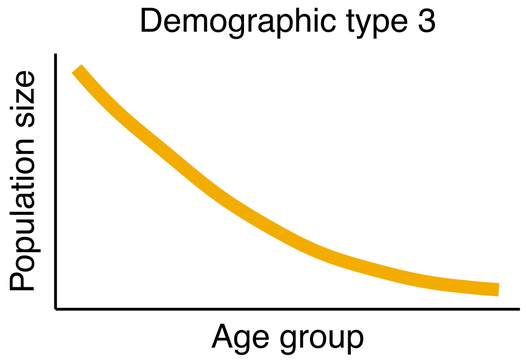


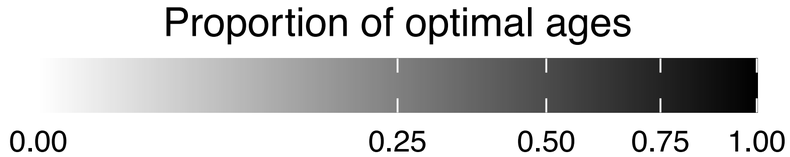


Results: Low- and lower-middle-income countries







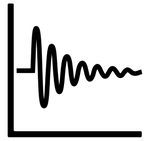


Part 2: summary

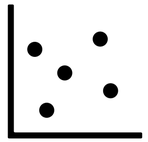
- The **optimal age varies less** between populations
  - The impact of **vaccine coverage** was **reduced**
  - The **demographic type** had **no impact** on the optimal age
  - Different **social contact matrices** result in **fewer differences** in optimal ages
    - The social contact **matrices** are **very similar**
    - Are the similarities **artificial**?

Limitations and Prospectives

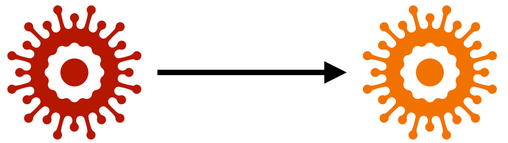
- Endpoint



- Model fitting

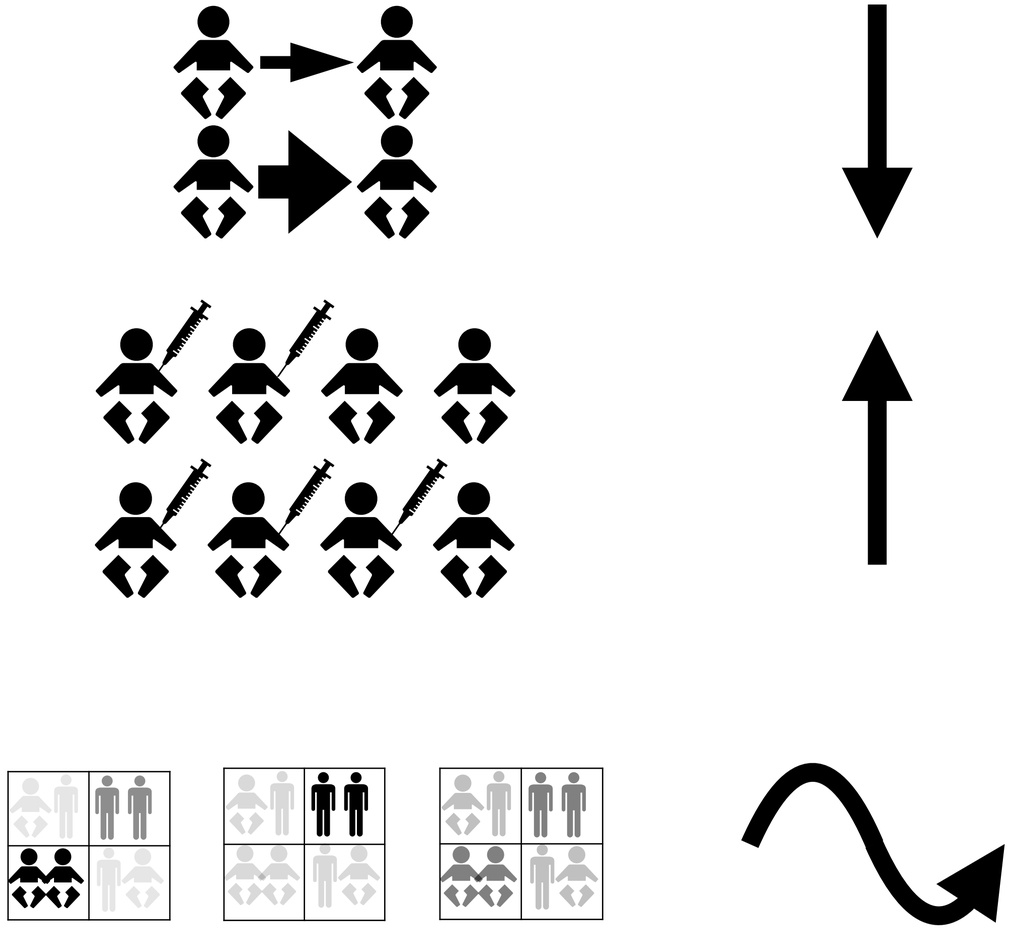


- Extensions to other pathogens



Summary

- **MCV1 age** can impact measles **incidence**
- The **optimal MCV1 age** is context-dependent
  - **Transmission level**
  - **MCV1 coverage**
  - **Social Contact Matrix**
- The optimal age **varied less** in **low-income country** examples
- Better distribution of **high-quality** social contact matrices in the **global south**



Summary

Max Planck Institute for Infection Biology

IMPRS for Infectious Diseases and Immunology
INTERNATIONAL MAX PLANCK RESEARCH SCHOOL

- **MCV1 age** can impact measles **incidence**
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Preprint!

Thank you!

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Pietro Gemo

Sarah Kramer

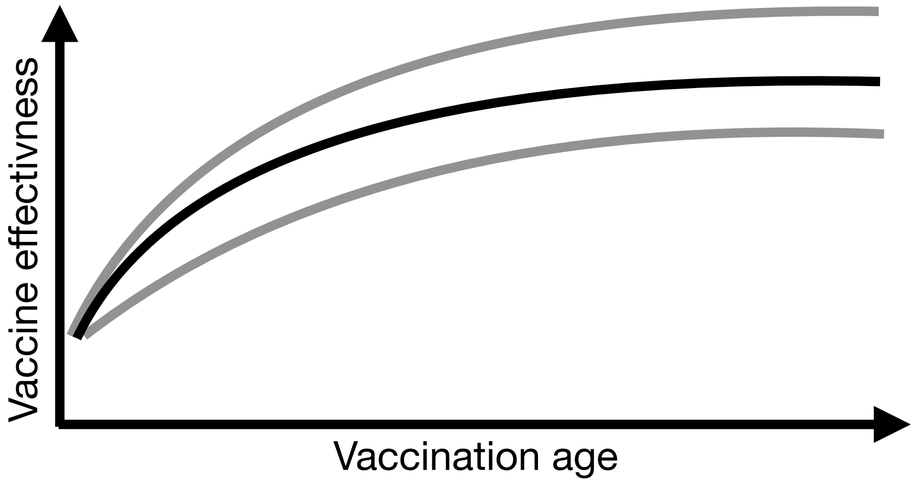
Former members

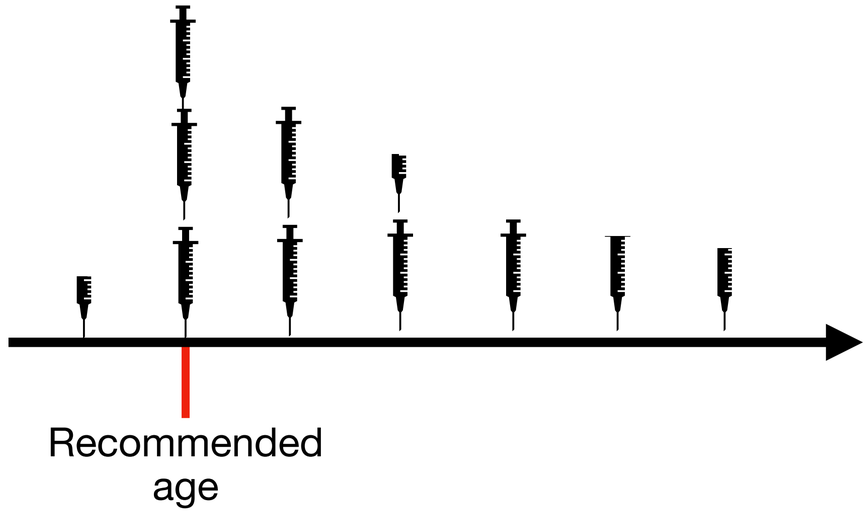
Michael Briga

Sarah Pirikahu

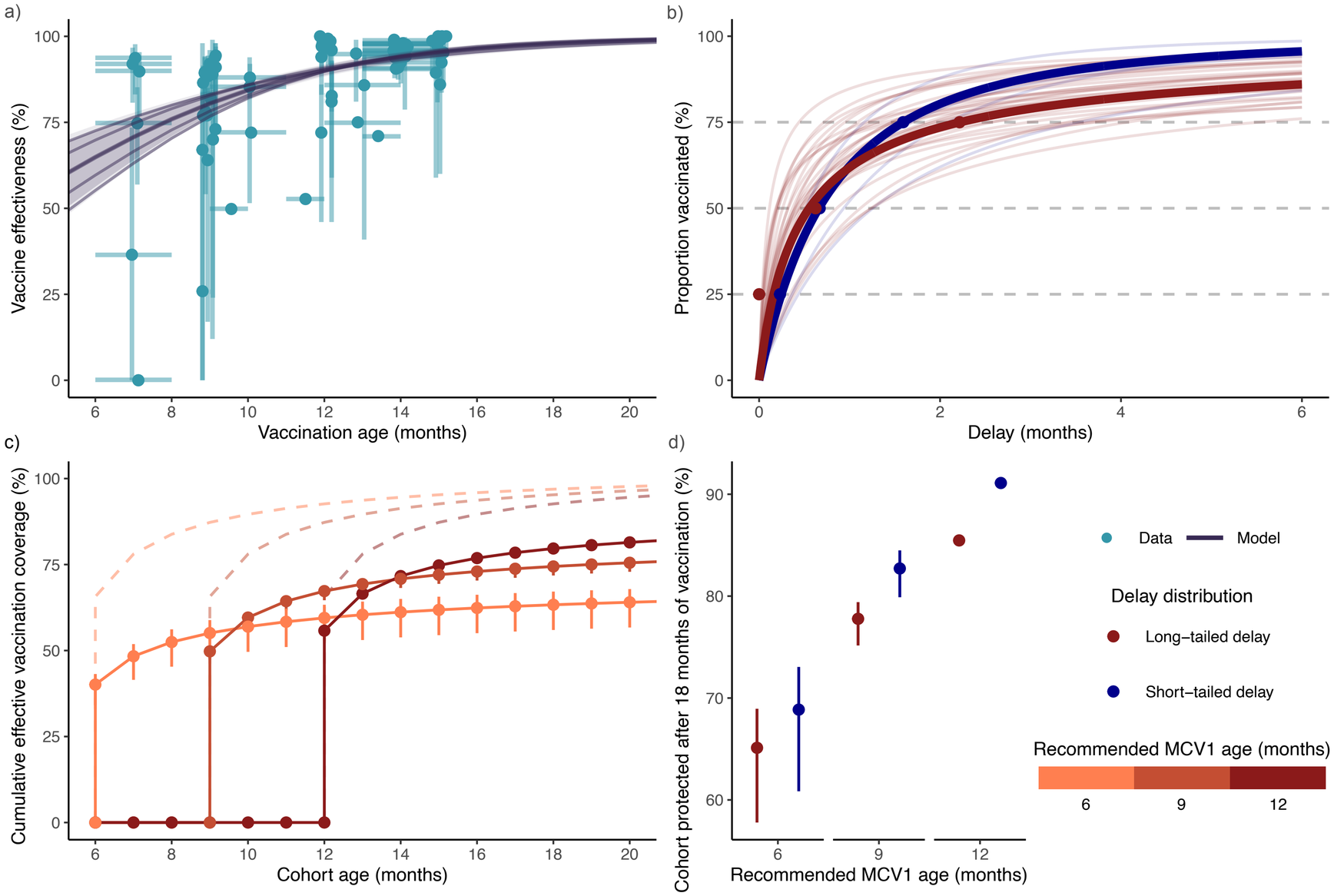
Factors that don’t affect the optimal age

- Vaccine effectiveness curve
- Vaccination delay

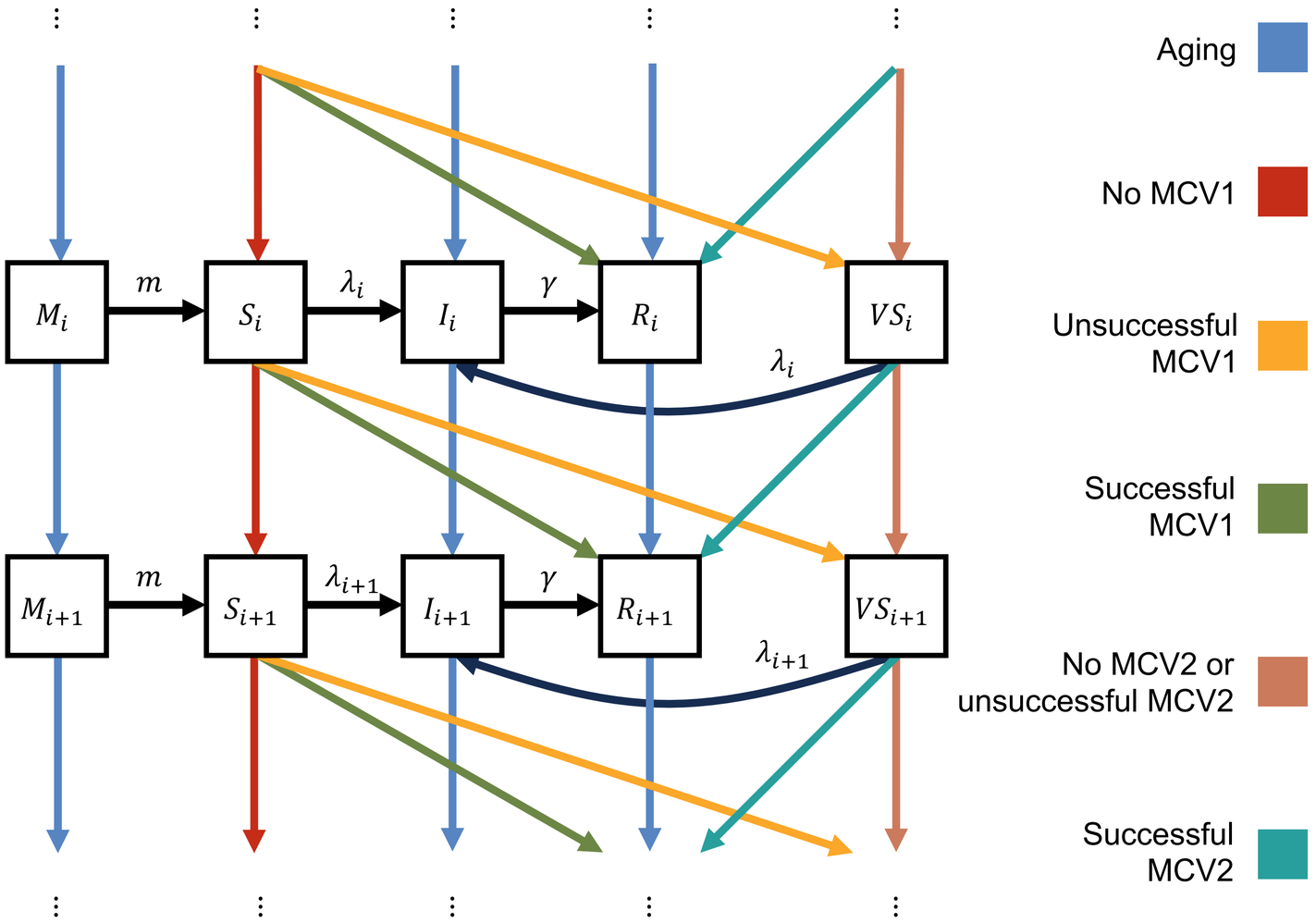




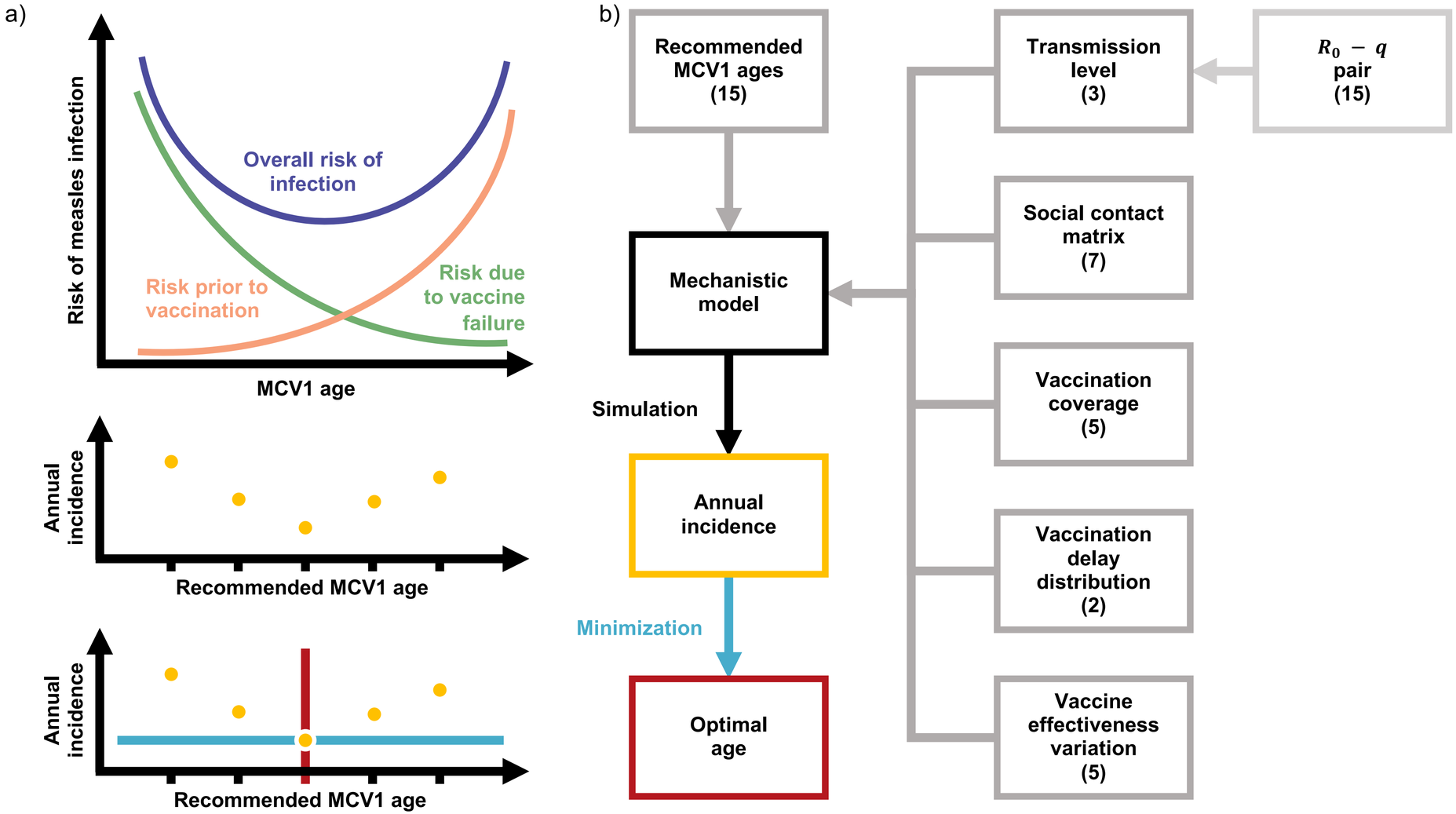
Vaccination in the model



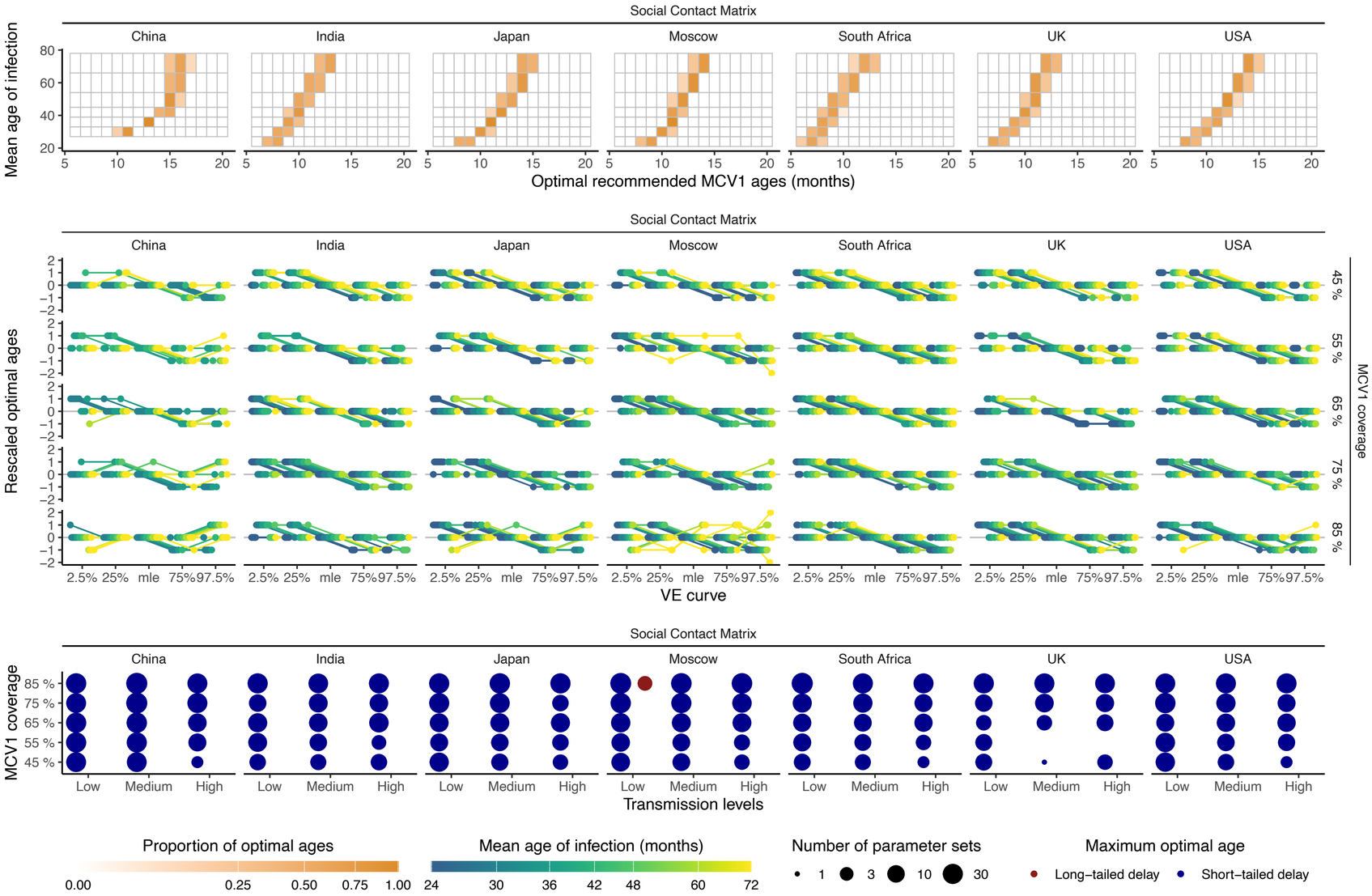
Model structure

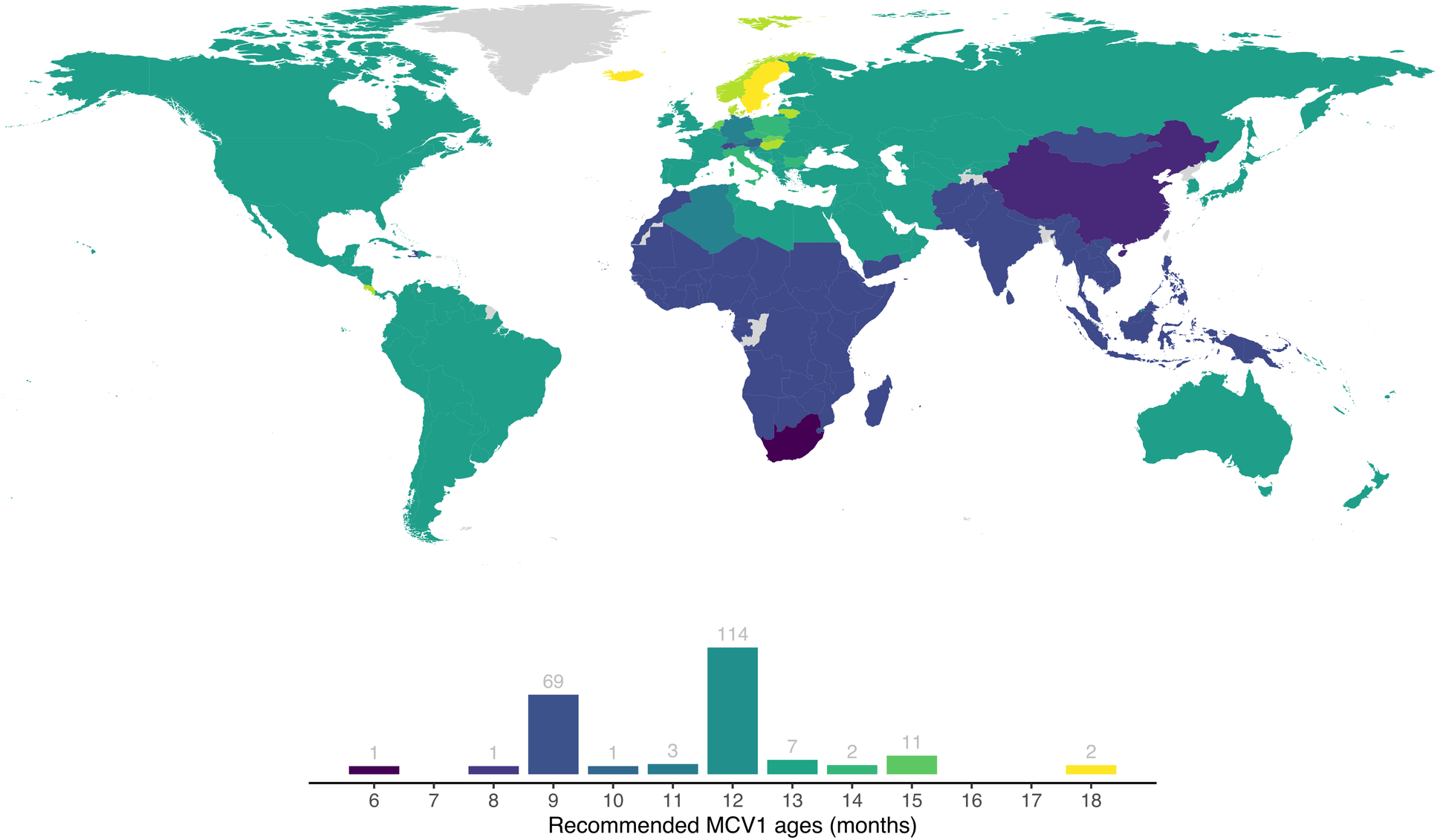


Simulation procedure



Other factor results




114
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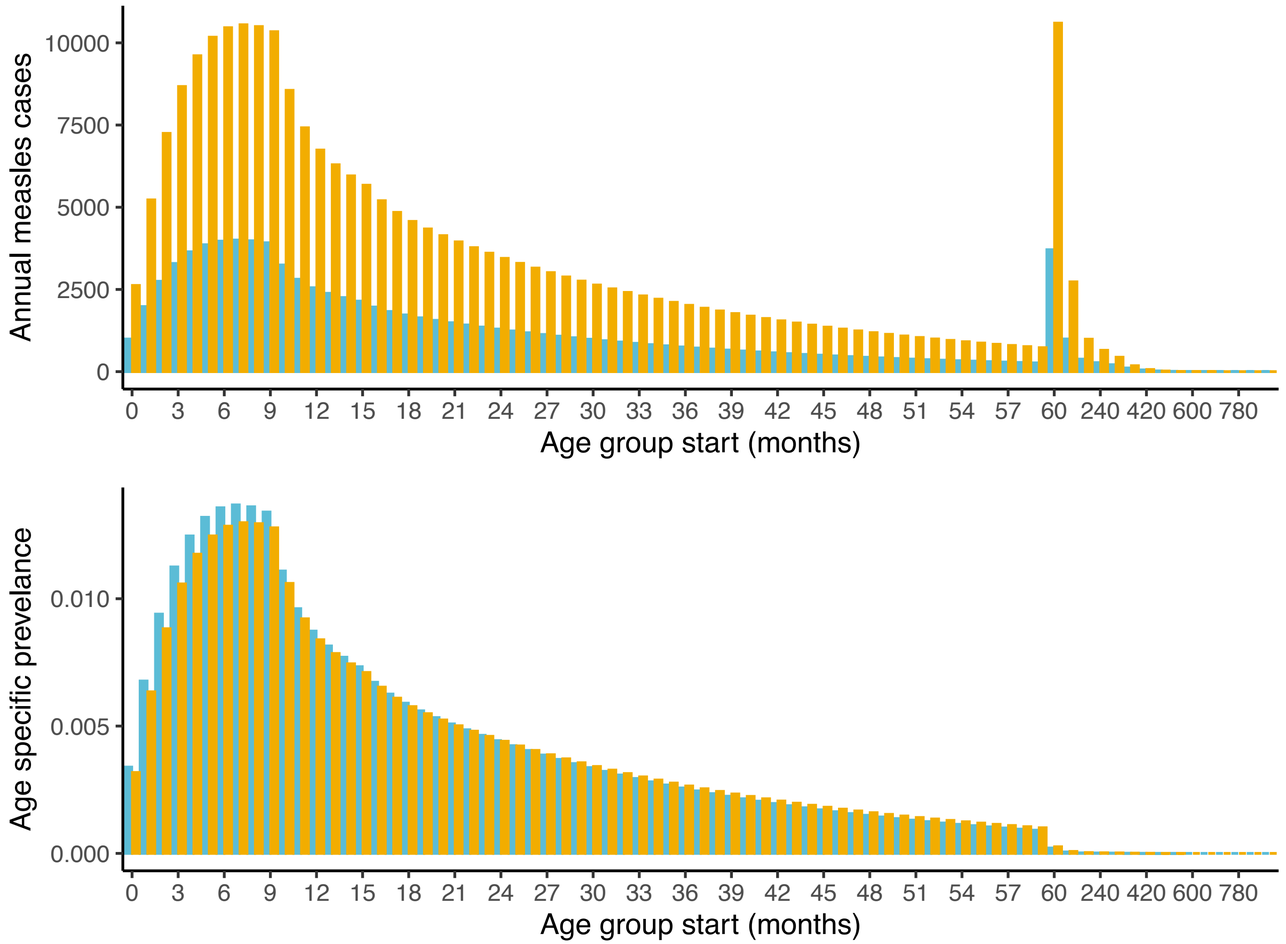
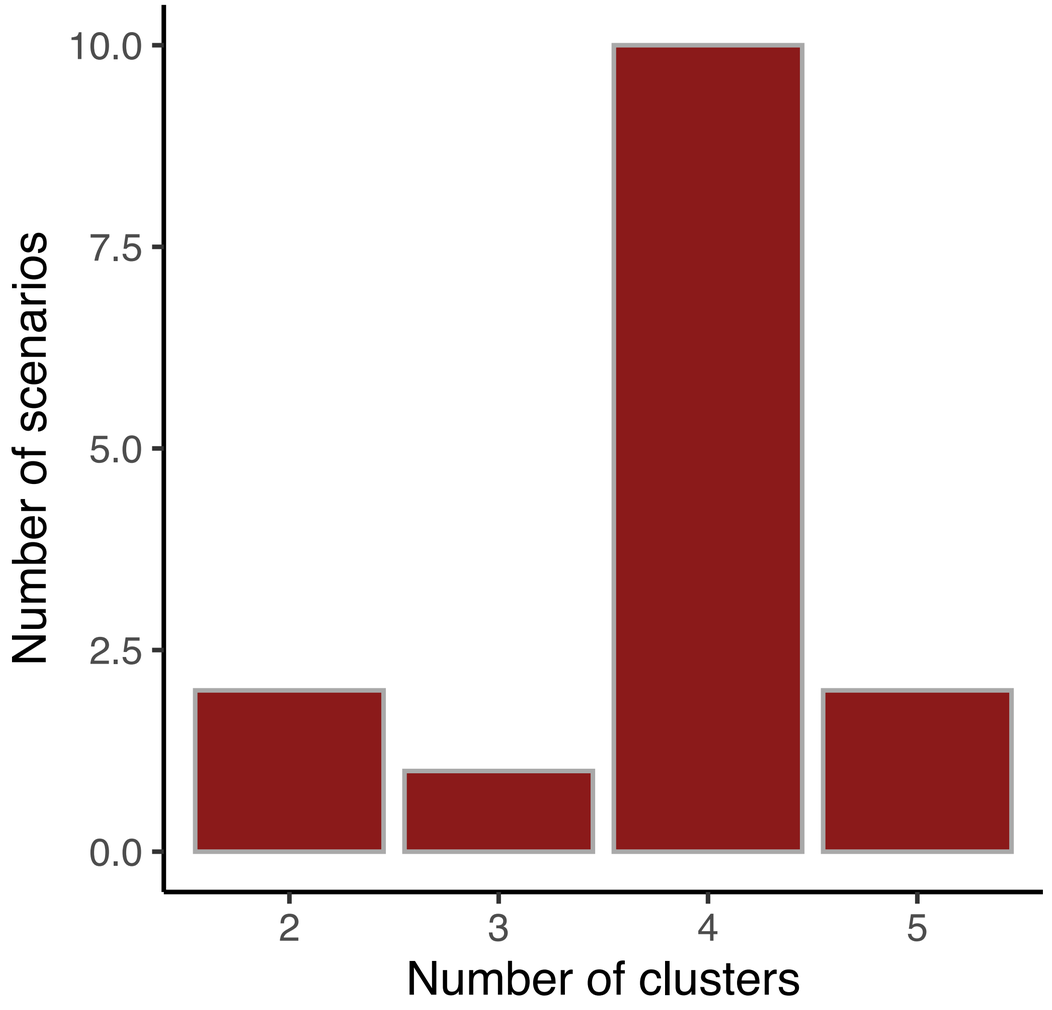
Recommended MCV1 ages (months)

Demography age differences



SCM clustering



Only varying R0