Update on the Taiwan household model

02/08/2021

Household/non-household transmission model

- Agent-based model
  - Number of households: 100,000
  - Household size: 3

- Household transmission (within household i)

$$\lambda_{i,hh} = c_{hh} * t_{hh} * I_i$$

number of infectious cases (within a household)

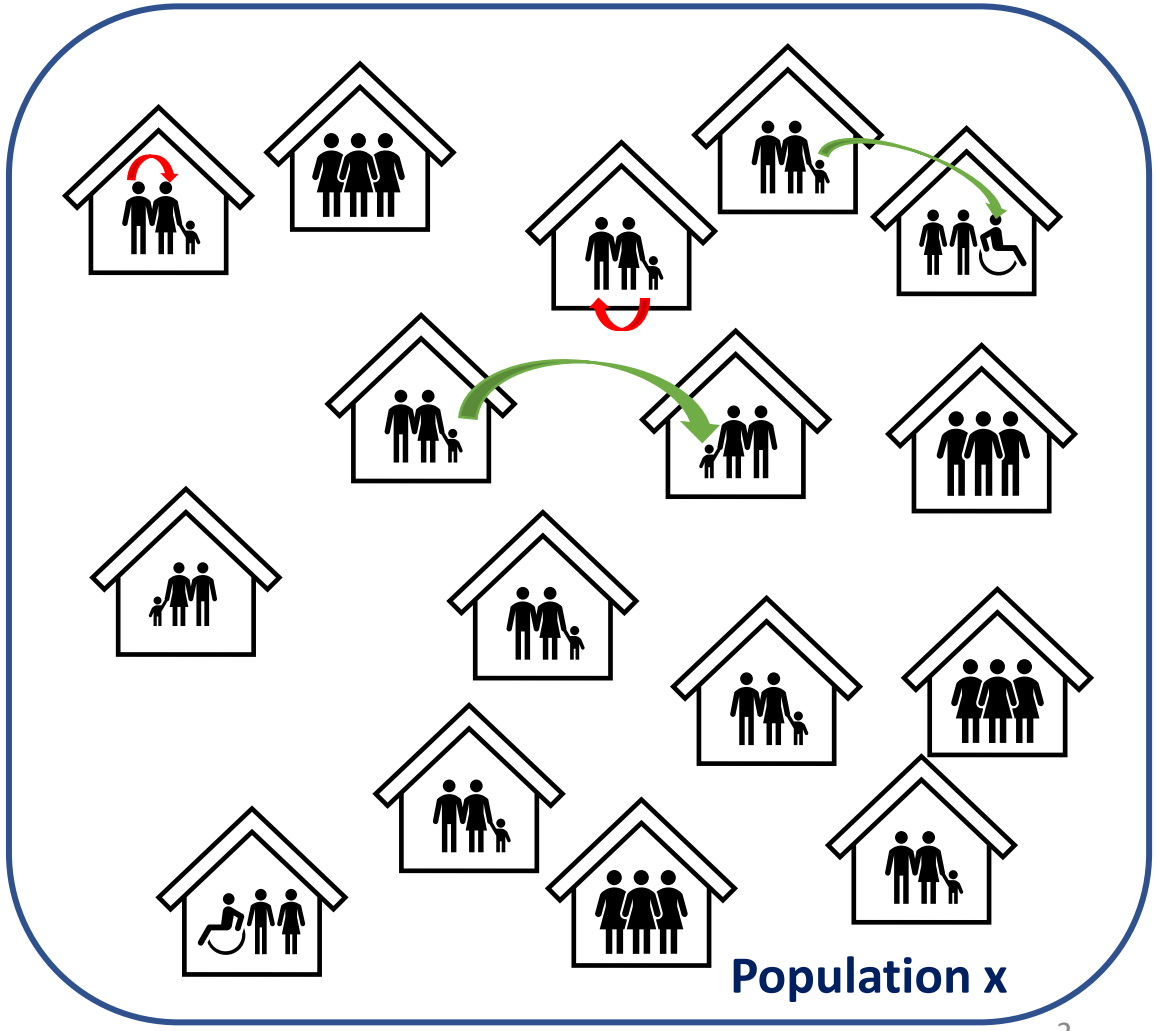
- Non-household transmission

$$\lambda_{nhh} = c_{nhh} * t_{nhh} * \sum I / \sum N$$

number of contact per day

transmission probability

total population



Household/non-household transmission model

- Model setting
  - Initial case in the population: 1
  - Duration of infectiousness: 5 days
  - Total population: 300,000 (number of households*household size)

- Model output
  - 40 stochastic runs (each costs about 4-5 minutes)
  - Reproduction numbers (Rt) for household and non-household cases
  - Number of new infections by household and non-household transmission

Changes in COVID-19 transmissibility

- **Before alert level 3**

(week 1-3)

- Wave 1 survey
  - Total contacts: 9.14
  - Household contacts: 2.26

- Transmission probability
  - Household: 0.21 (Thompson et al.)
  - Non-household: 0.26

- **After alert level 3**

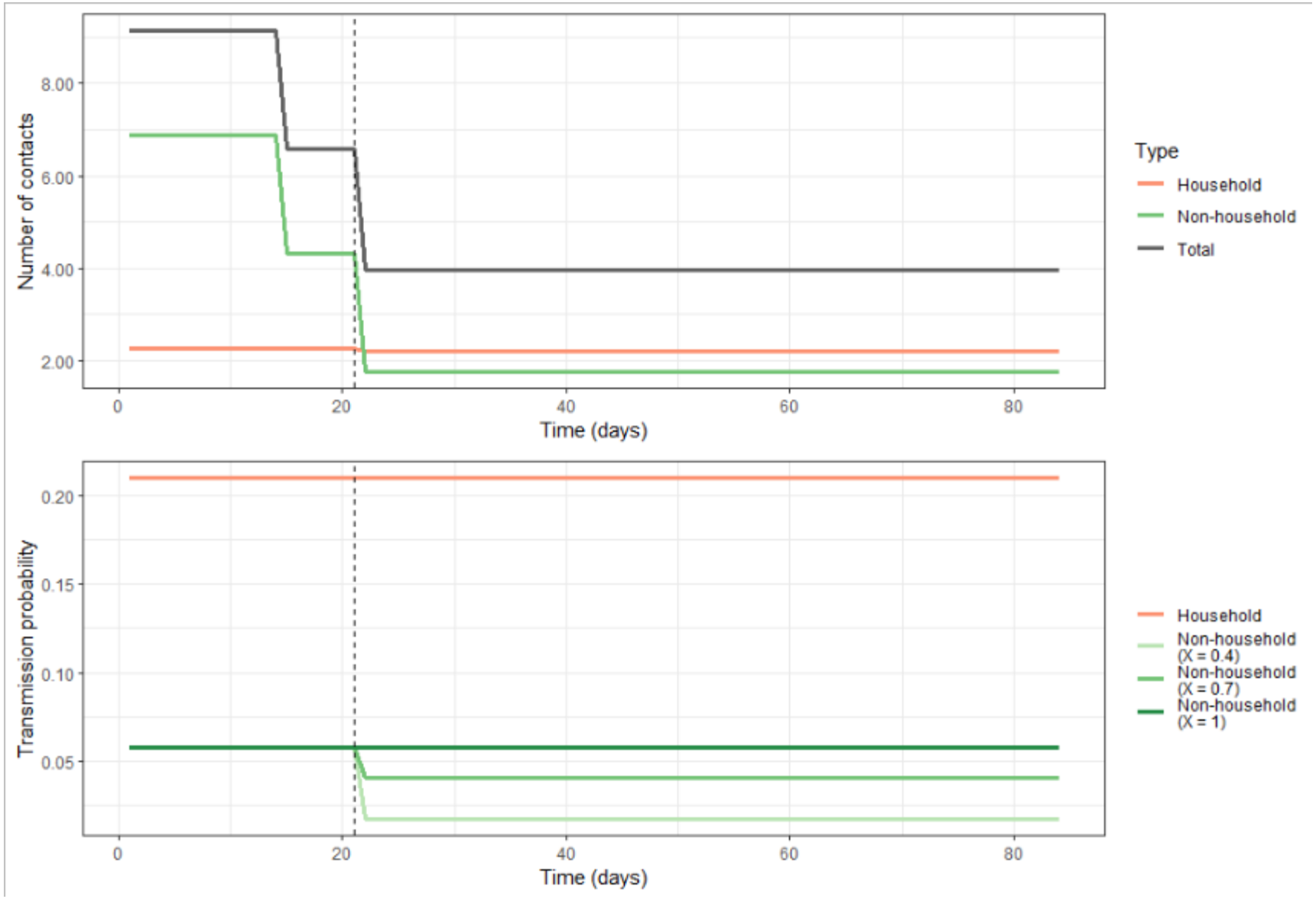
(week 4-12)

- Wave 3 survey
  - Total contacts: 3.97
  - Household contacts: 2.20

- Transmission probability
  - Household: 0.21
  - Non-household: 0.21*0.26*X
  - Multiplicative effect of measures
    - X = 1: no effect
    - X = 0.3: moderate effect
    - X = 0.7: strong effect

Input data

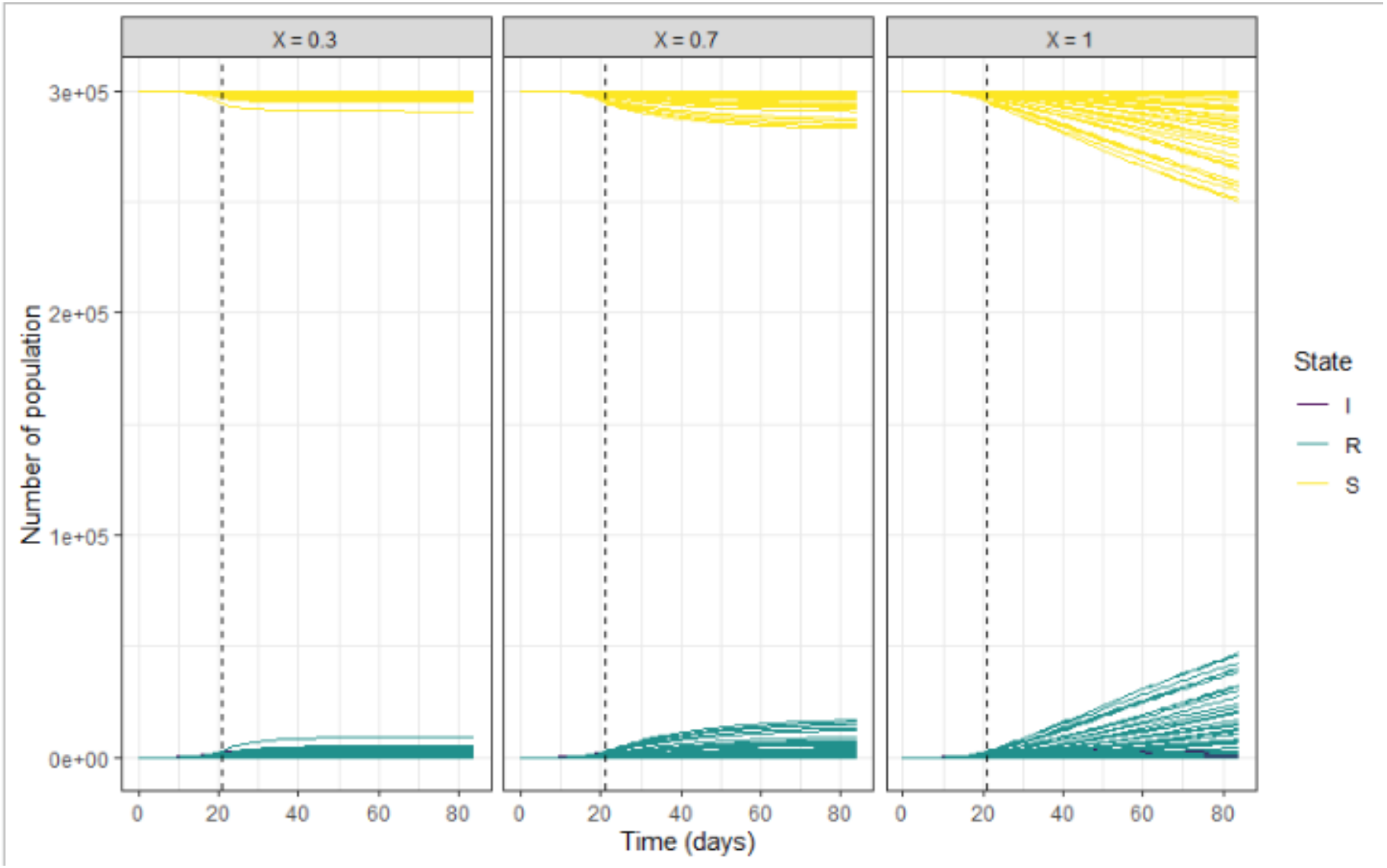
*non-contact rate declines a week before (15-21th day) the implementation of alert level 3 measures, to reflect the effect of alert level 2



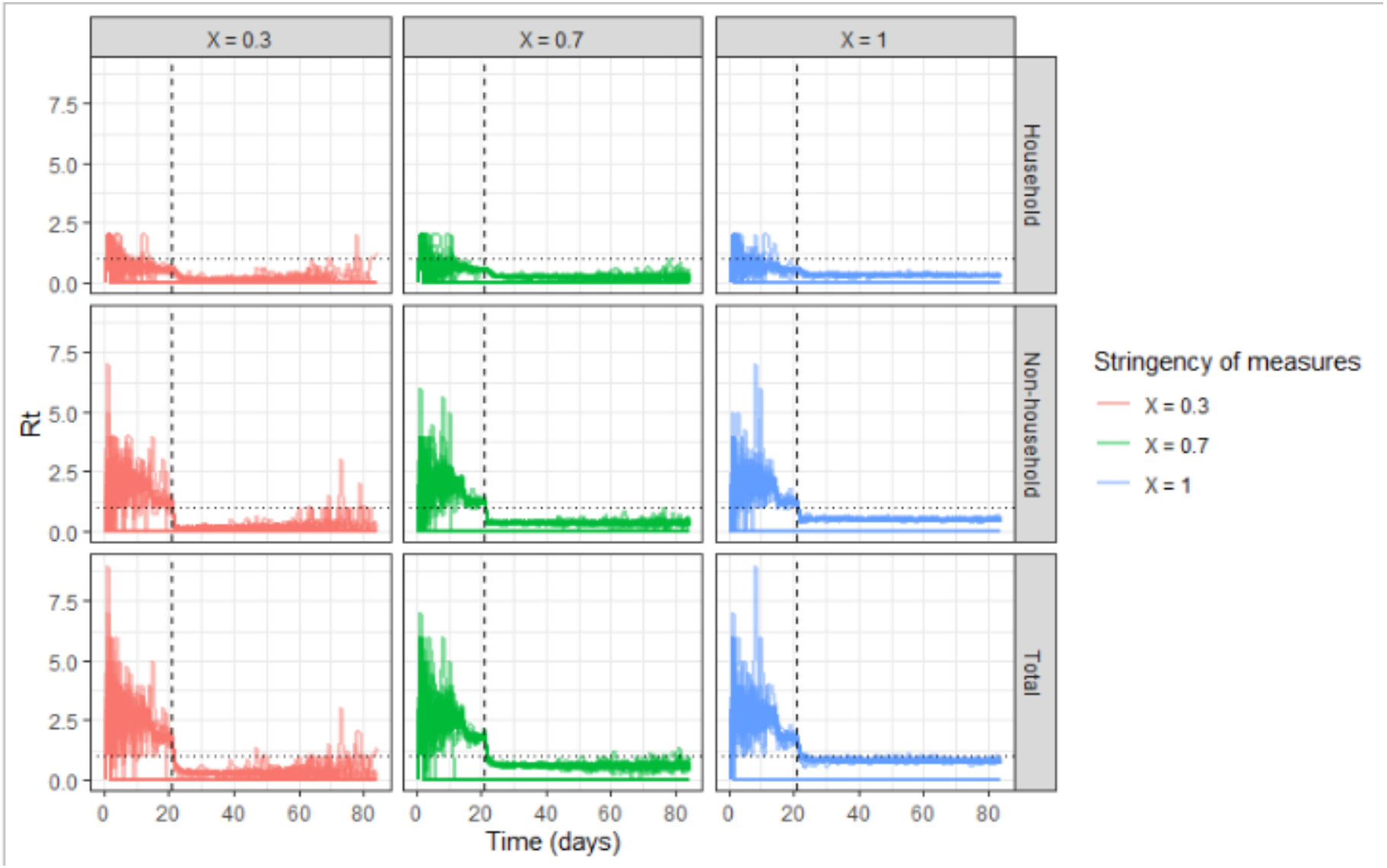
Evaluation of vaccination impact

Scenarios	Initial distribution of state
Fully susceptible (baseline)	S: 300,000 - 1 I: 1 R: 0
20% of vaccine coverage + 1 per household	S: 300,000 - 1 - 60,000 I: 1 R: 60,000 (60,000 household)
20% of vaccine coverage + 2 per household	S: 300,000 - 1 - 60,000 I: 1 R: 60,000 (30,000 household)

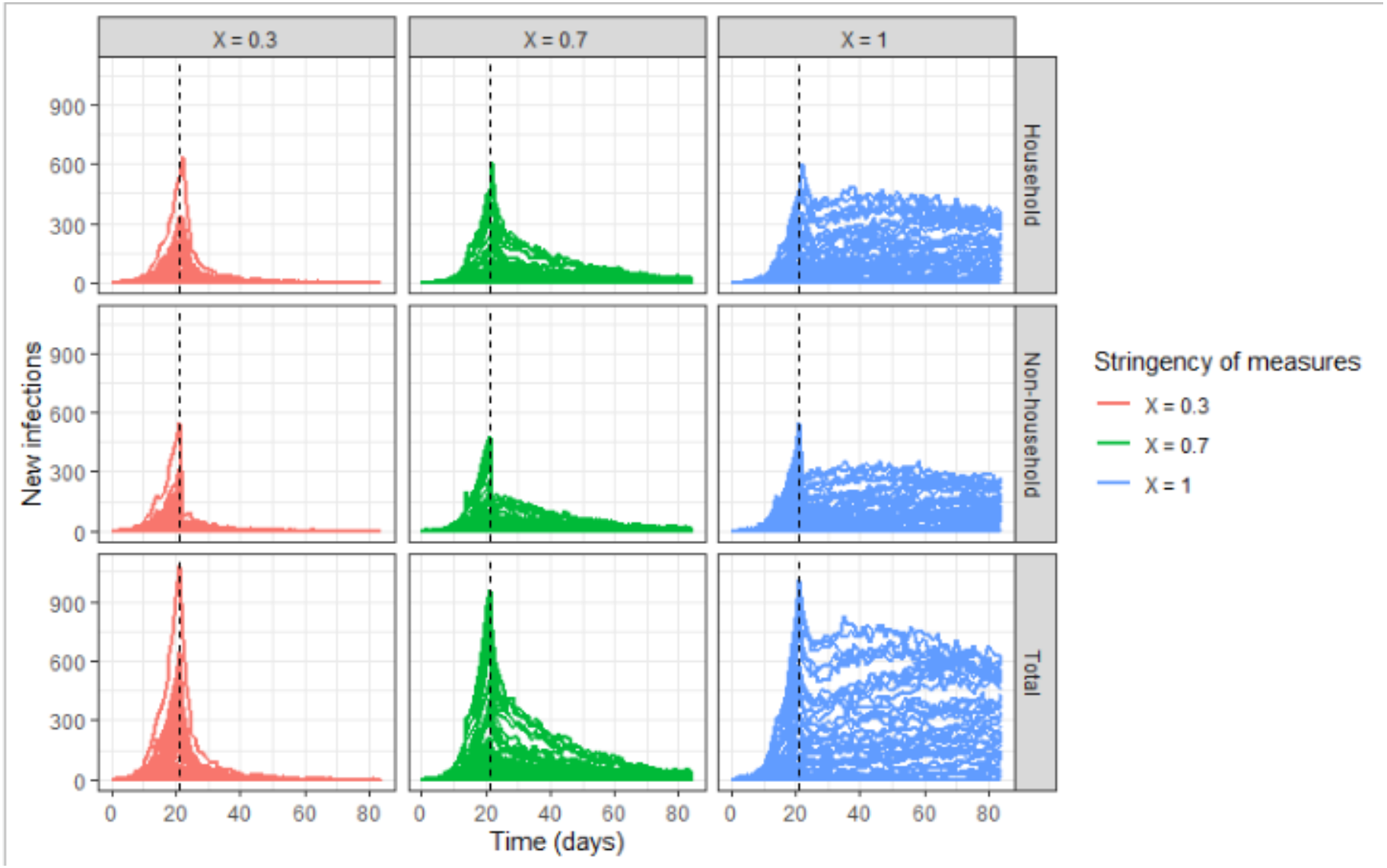
Fully susceptible scenario – **State overview**



Fully susceptible scenario – **Rt estimates**

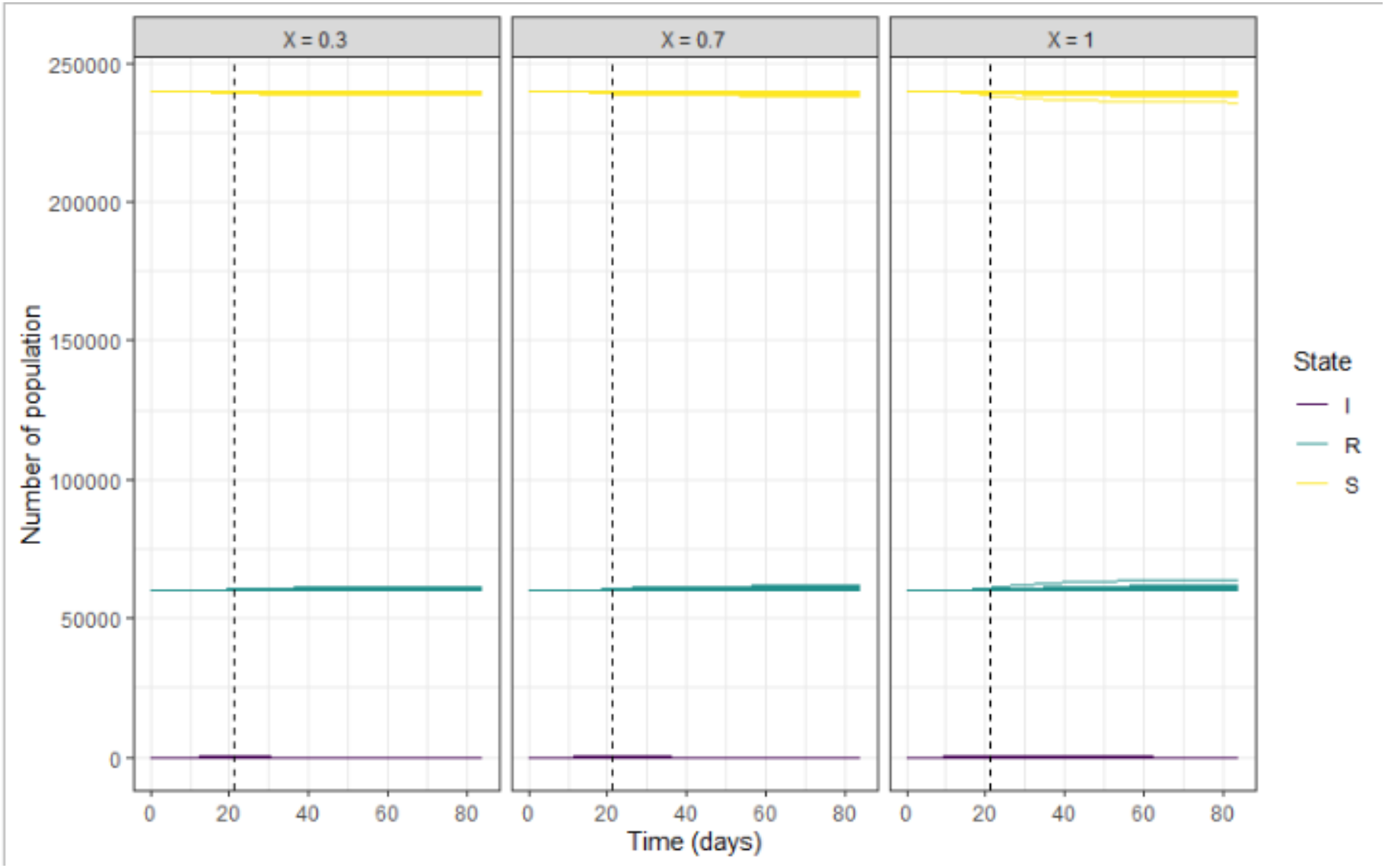


Fully susceptible scenario – **New infections**



Partially vaccinated scenario – **Rt estimates**

Allocation strategy:
(1) 1 person per household



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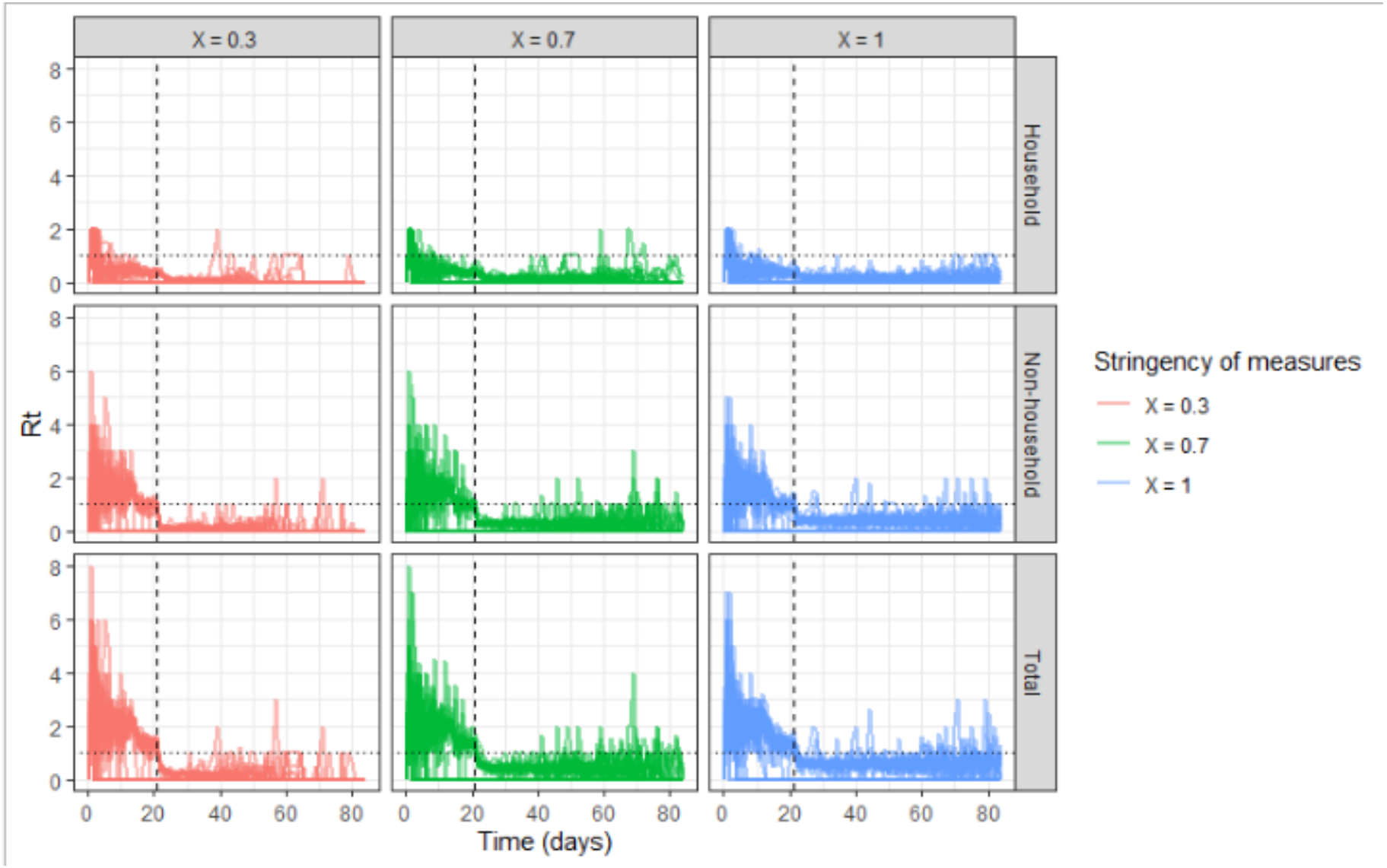
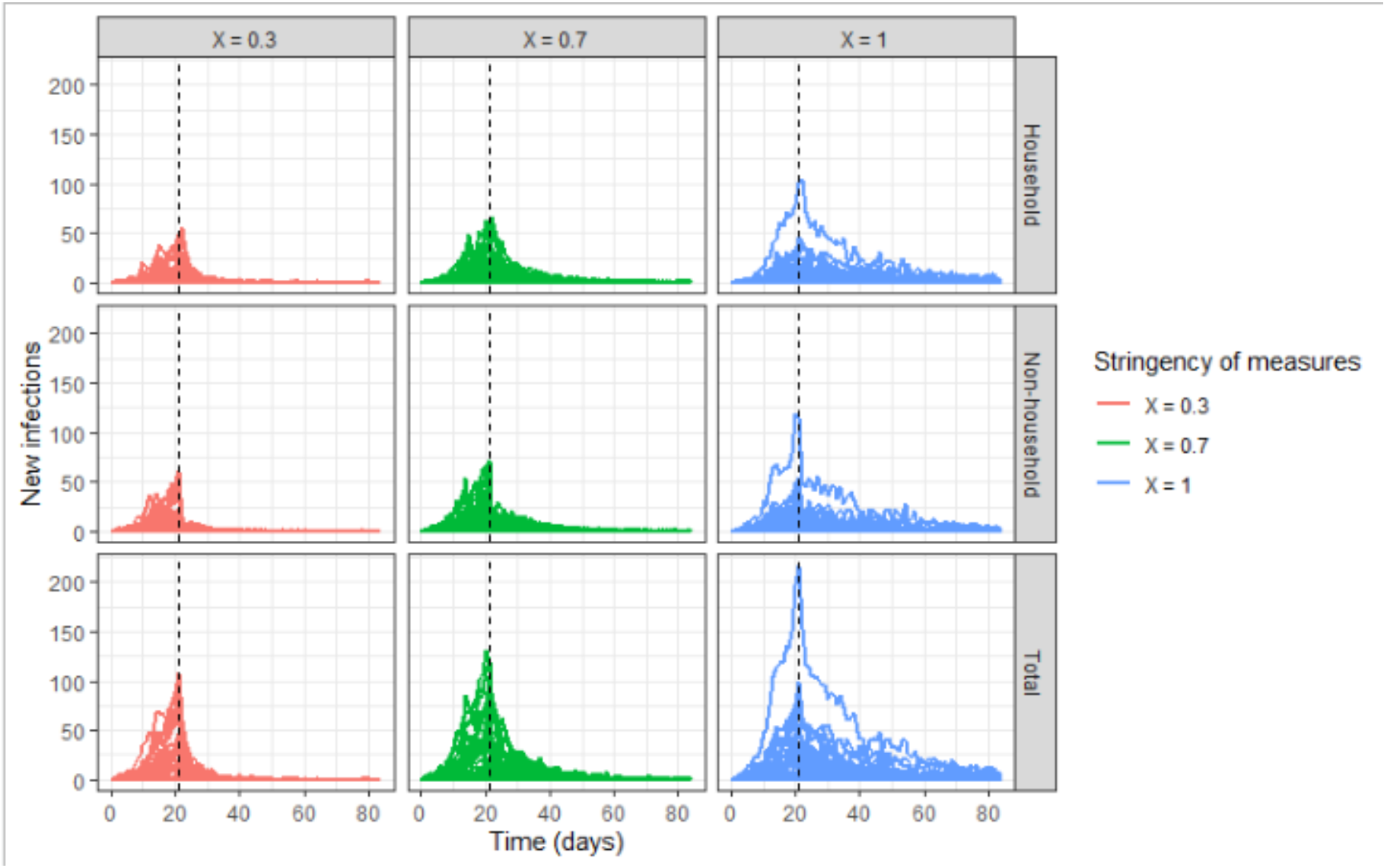


Partially vaccinated scenario – **New infections**

Allocation strategy: (1) 1 person per household

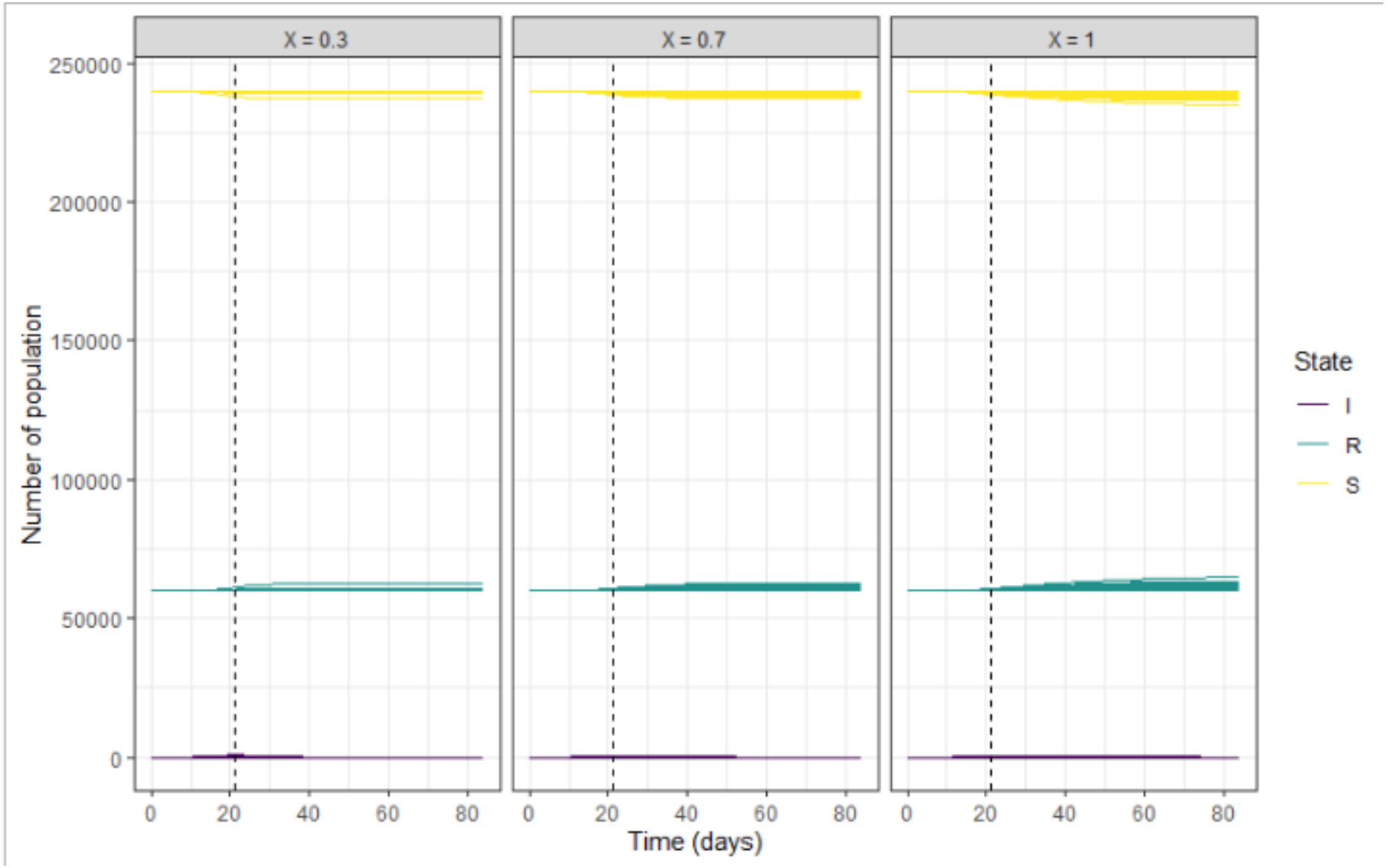
Note:

The stochastic effect of transmission can be seen, where the peak number of infections can be more than 2 times than the average.



Partially vaccinated scenario – **State overview**

Allocation strategy: (2) 2 persons per household



Partially vaccinated scenario – **Rt estimates**

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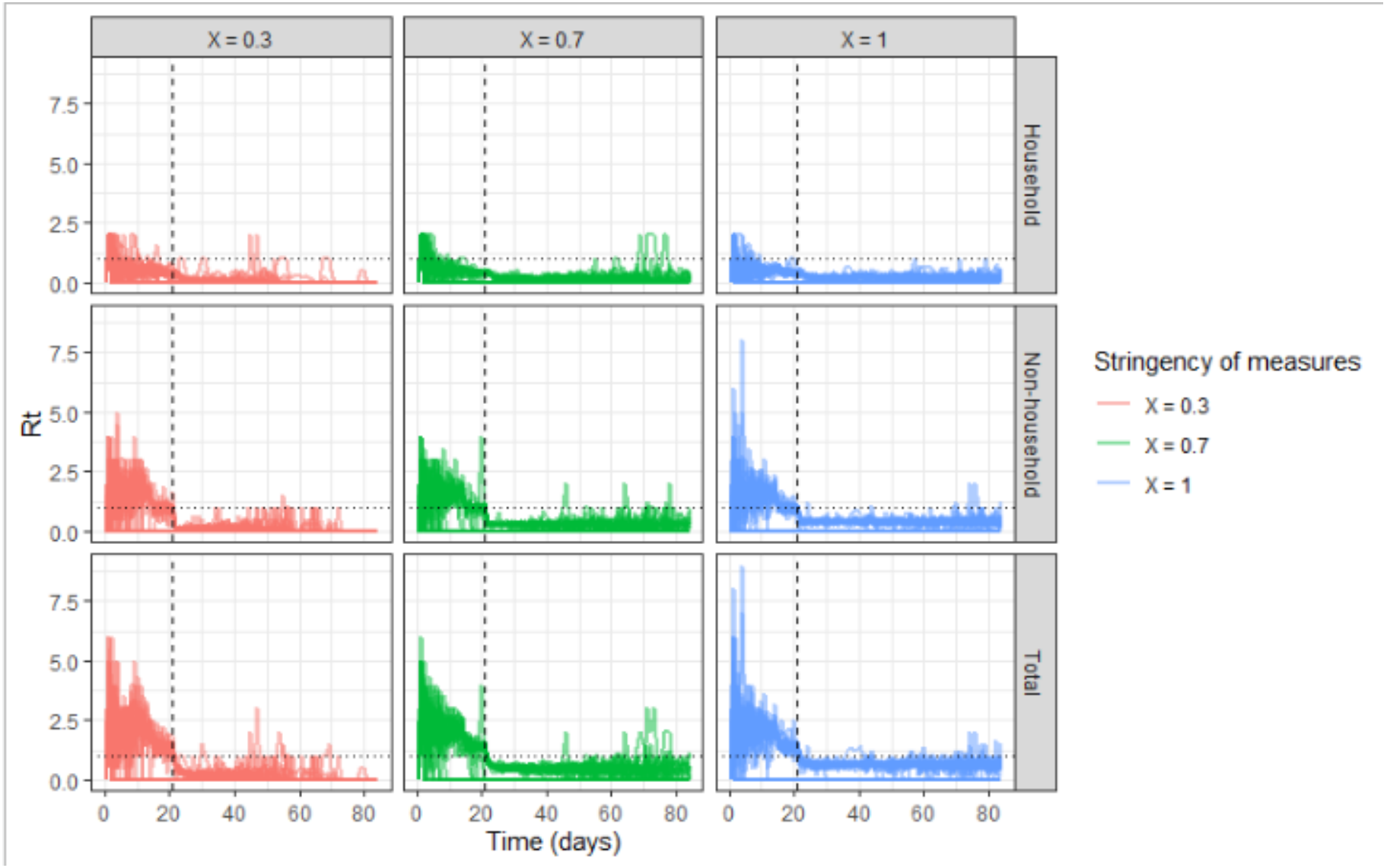

Partially vaccinated scenario – **New infections**

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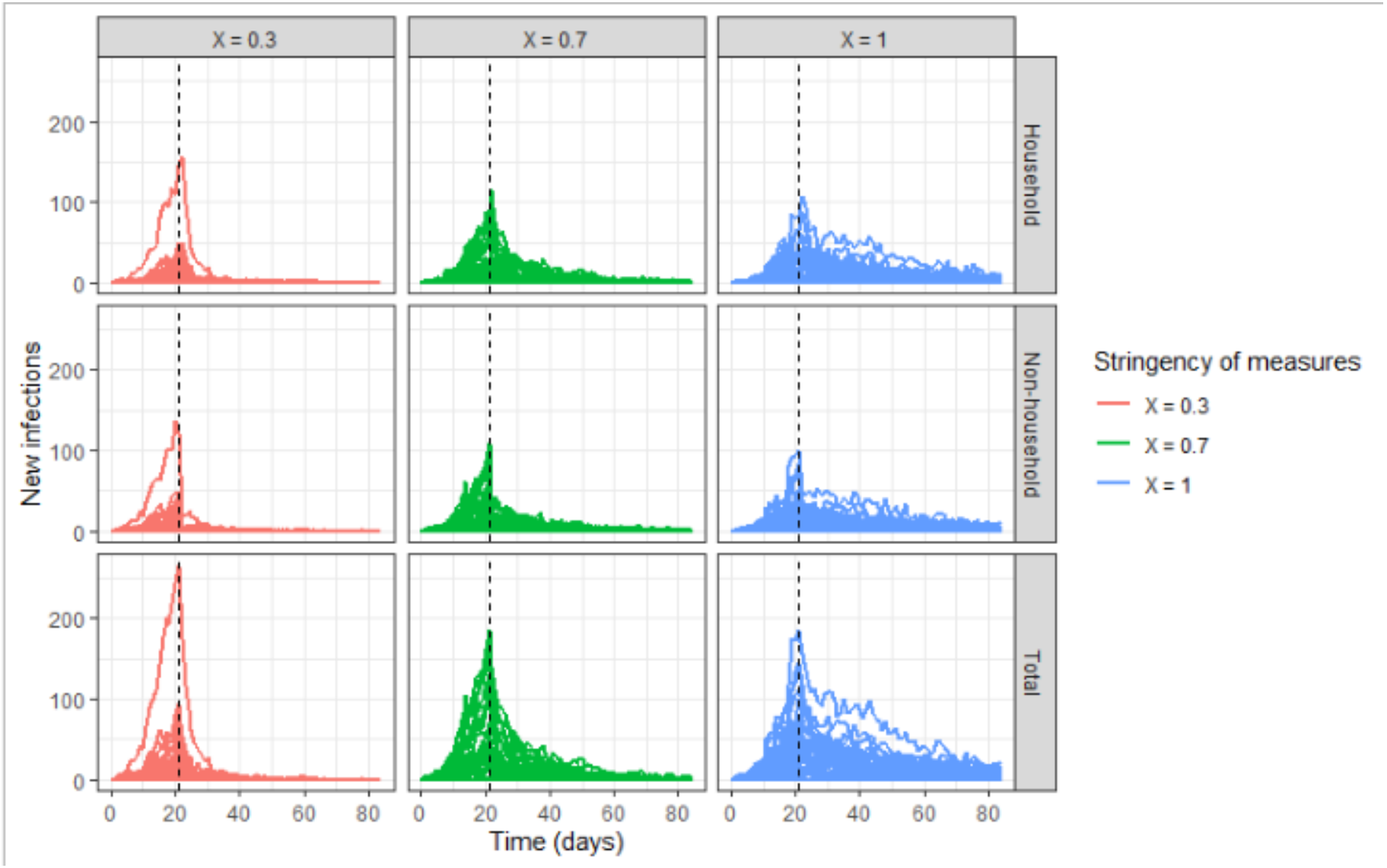
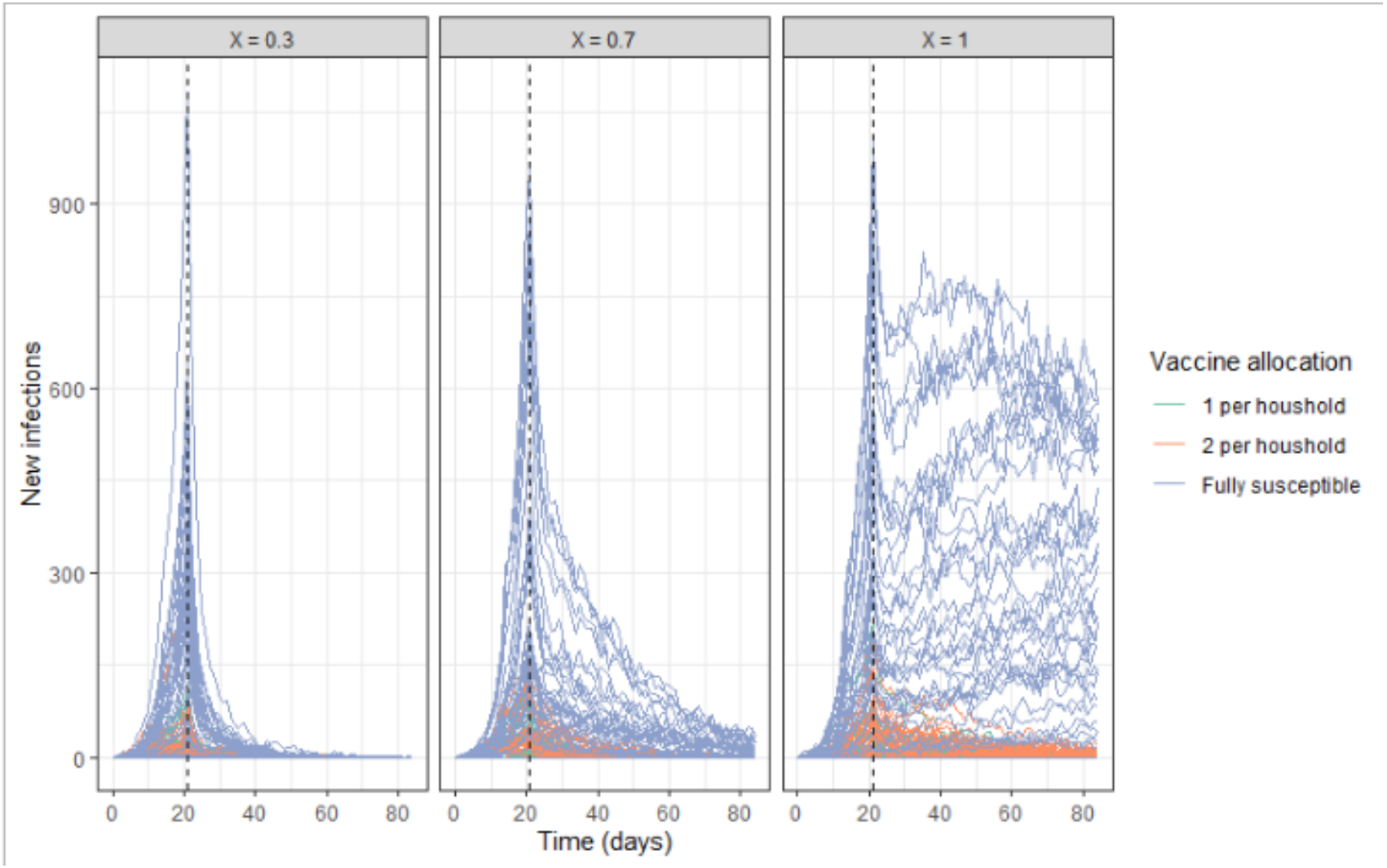


Comparison between fully susceptible and partially vaccinated scenarios



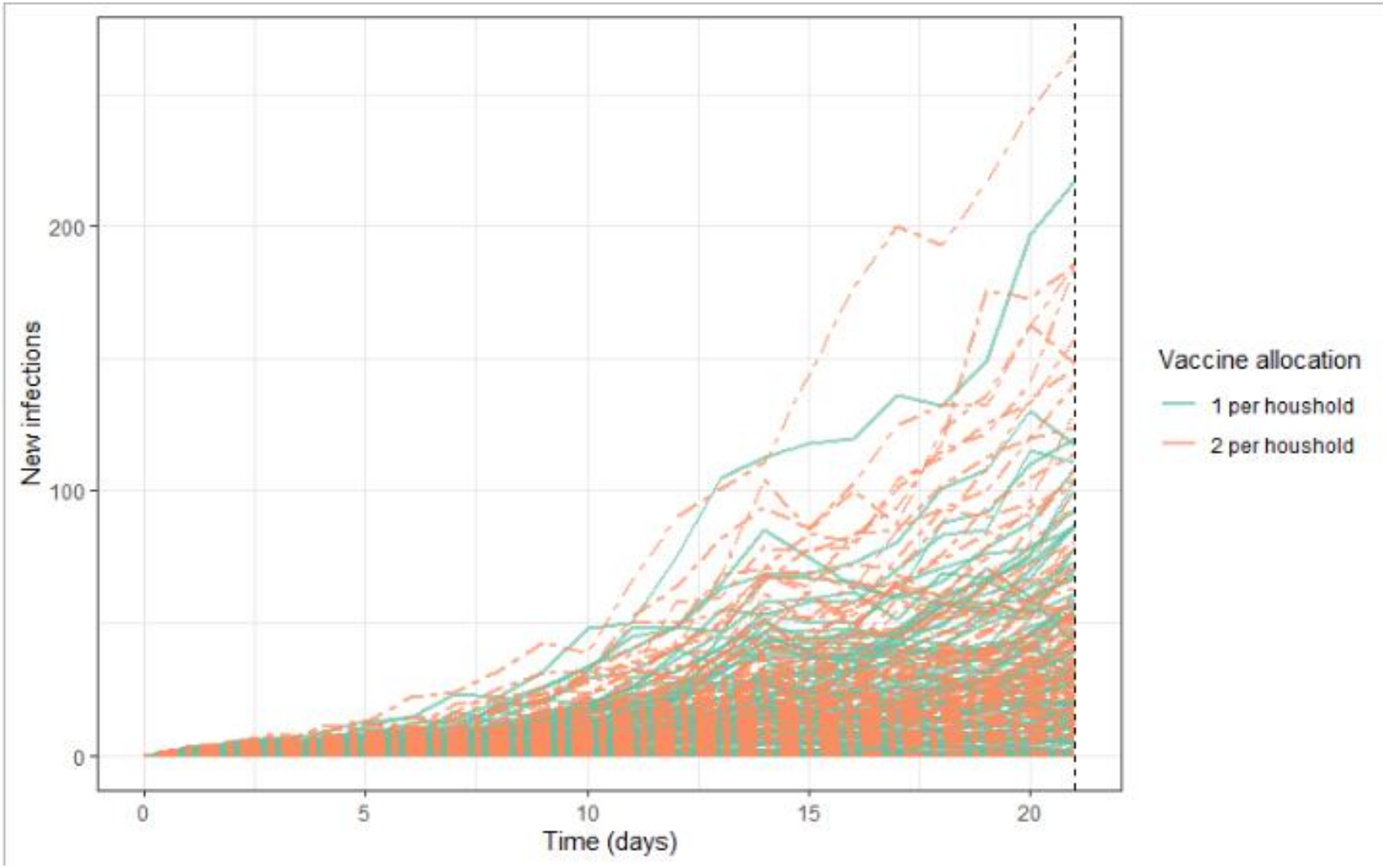
Note:

It is obvious that an outbreak is more likely to occur in the fully susceptible population, compared to the vaccinated population (coverage = 20%).

Comparison between vaccine allocation strategies

Note:

Similar impacts on outbreak prevention are shown between the vaccination allocation strategies of 1 and 2 members per household.



Outbreak potential

Allocation strategy / Indicators	Without vaccination, fully susceptible	20% of total population vaccinated, 1 per household	20% of total population vaccinated, 2 per household
Cumulative infections over the first 2 weeks: median (1^{st} – 3^{rd} quantiles)	273 (63, 368)	58 (4, 121)	62 (16, 122)
<= 10 cumulative infections over the first 2 weeks: number of runs (total runs)	17 (120)	34 (120)	26 (120)