Modelling of COVID-19 epidemic and interventions within IDP camps

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PaxSyriana Foundation

crowdfight COVID-19

Motivation

Between December 2019 and March 2020, 1M new IDP → Informal settlements

HIGH DENSITY and no management

~700 camps with 600 person per camp on average (log-normal)

80% family-sized tents (~7 people)

Most of the informal camps have no management.

Source: UN- REACH report, January-March 2020

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NO POSSIBLE lockdown

50% no access to electricity

External water, with 25% not have enough drinking water

External letrines, and 10% households have 1 member disable/elderly.

360% drop of Syrian pound (no access to goods) → high motility to work

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HIGH comorbidity

10% population has chronic diseases, 17% of them have no access to medicines.

Source: UN- REACH report, January-March 2020

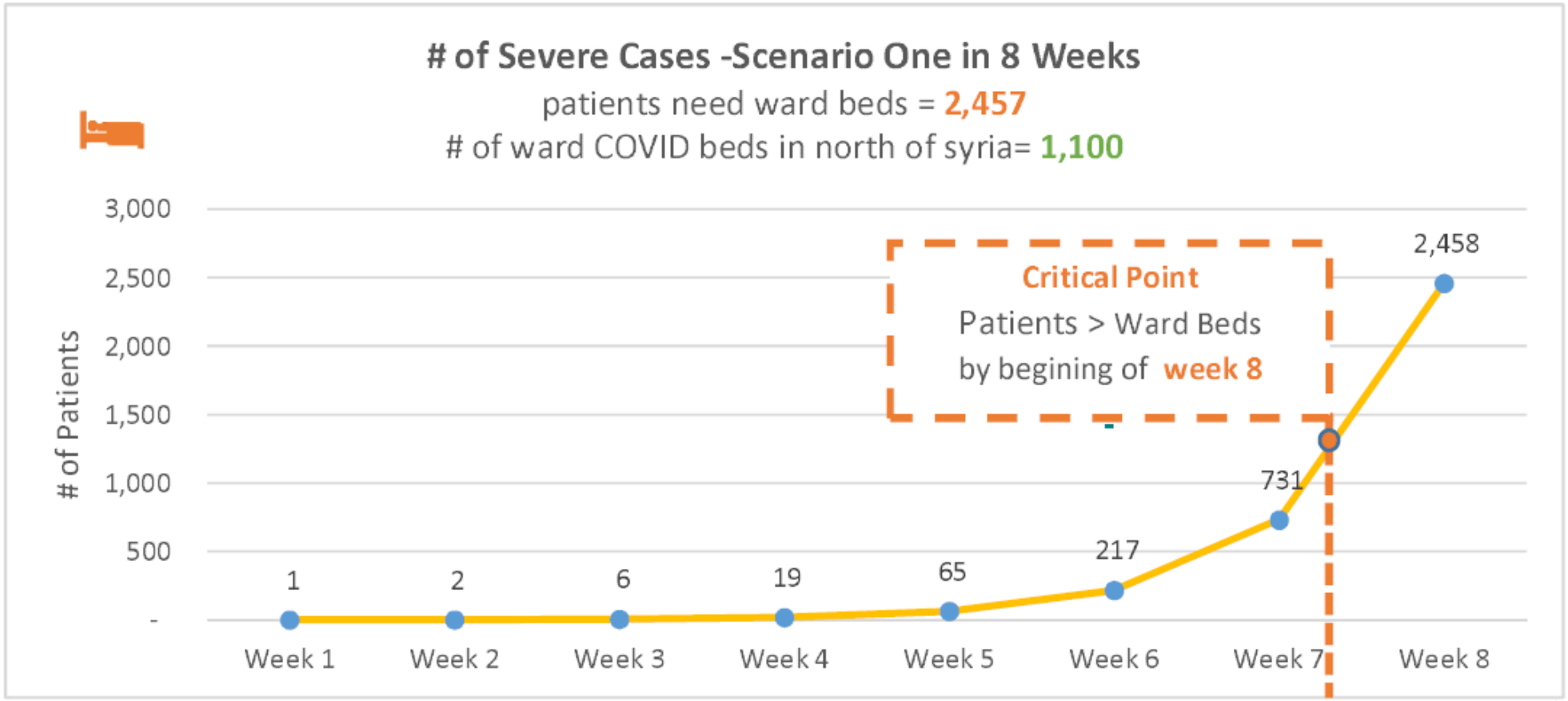


Figure 6 Scenario One predicted severe cases

The health system in NW Syria would be unable to cope by the beginning of week 8; as such, severe cases could become critical and mortality could increase

Hariri et al. The COVID-19 forecast in NW Syria. *MedRxiv* (2020)

Highlights

Modelling

- Comparmental models.
- Age-structured.
- Deterministic, stochastic.
- Parameters estimated for IDPCs.

Strategies

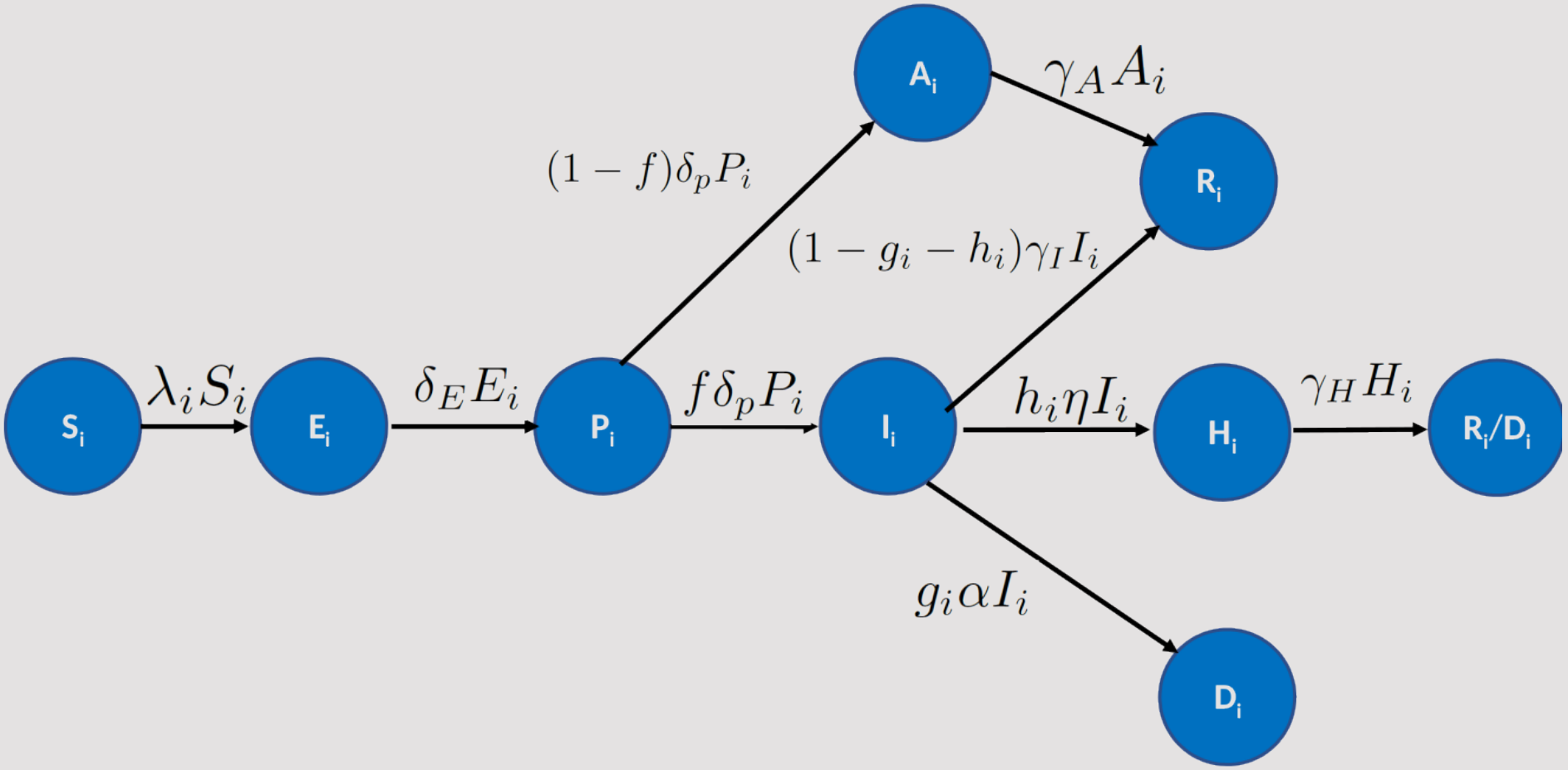
- Self-distancing
- Shielding, lockdown
- Isolation
- Combined strategies

Main conclusions

- Remark 1
- Remark 2
- Combined strategies have a greater effect.

The model

Model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R_i
$(1-g_i-h_i)\gamma_I I_i$
S_i
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E_i
$\delta_E E_i$
P_i
$f\delta_p P_i$
I_i
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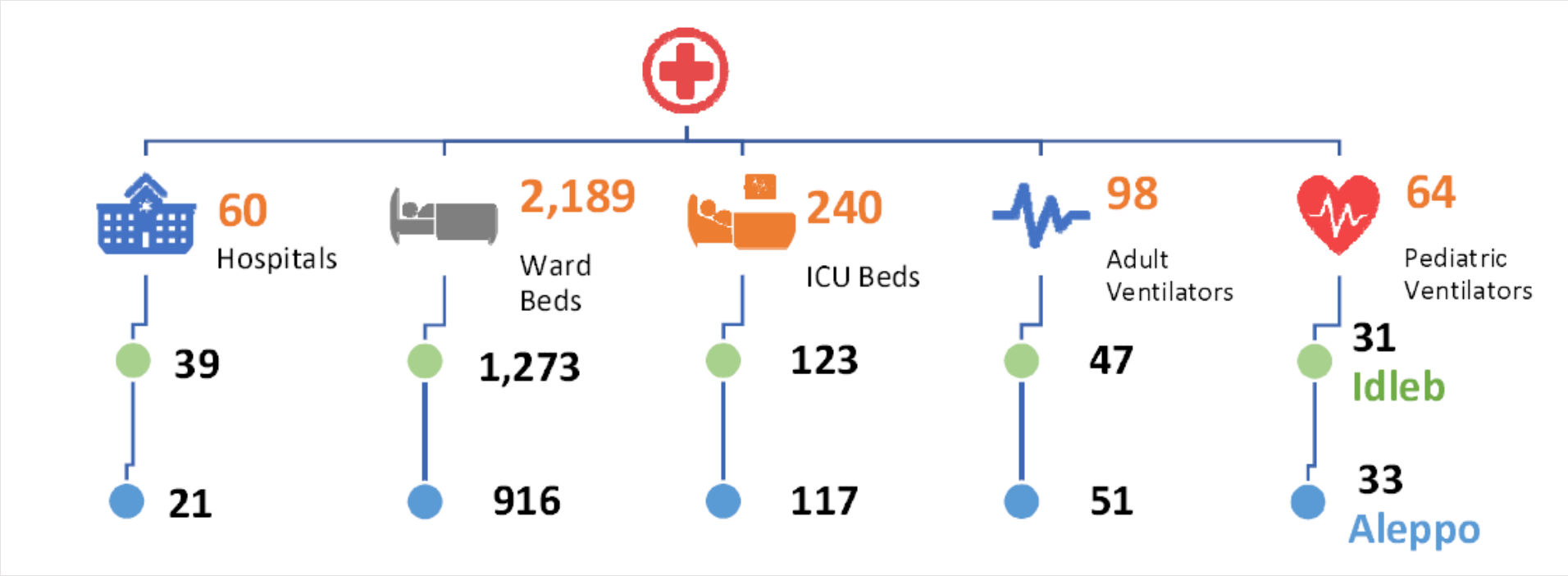
R_i/D_i
$g_i \alpha I_i$
D_i



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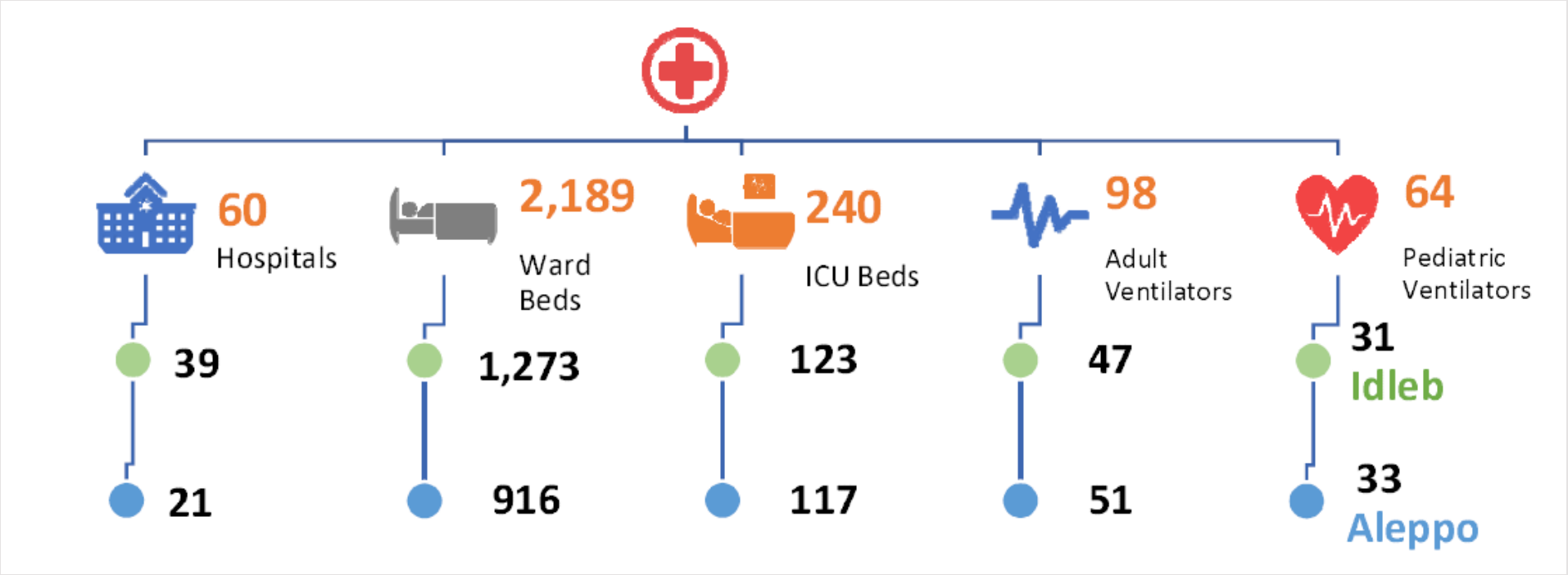

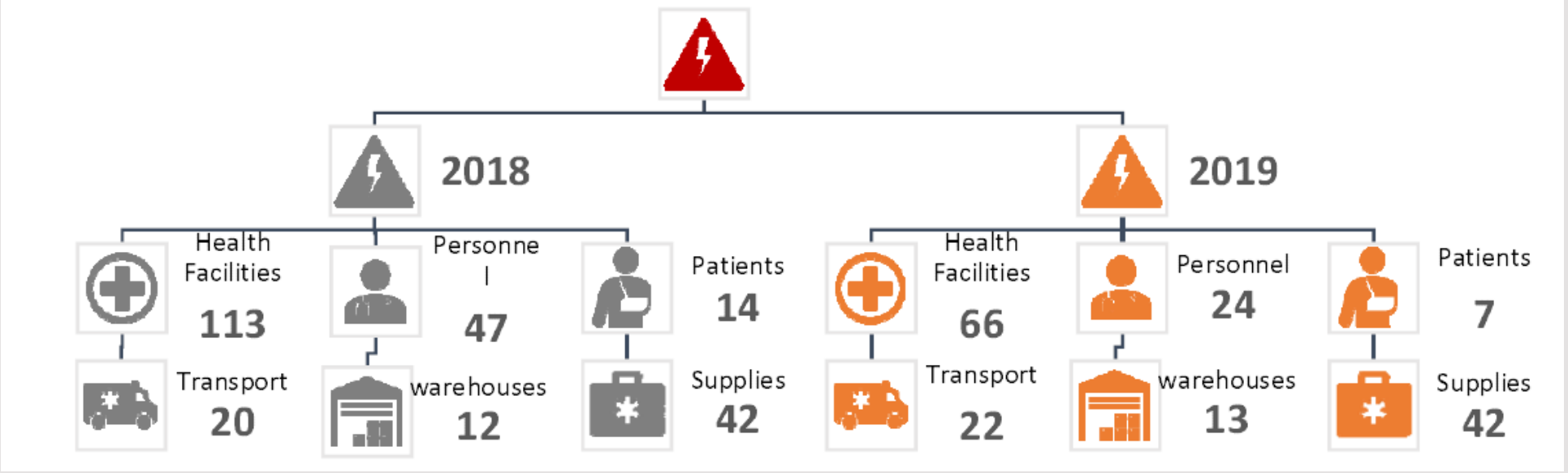

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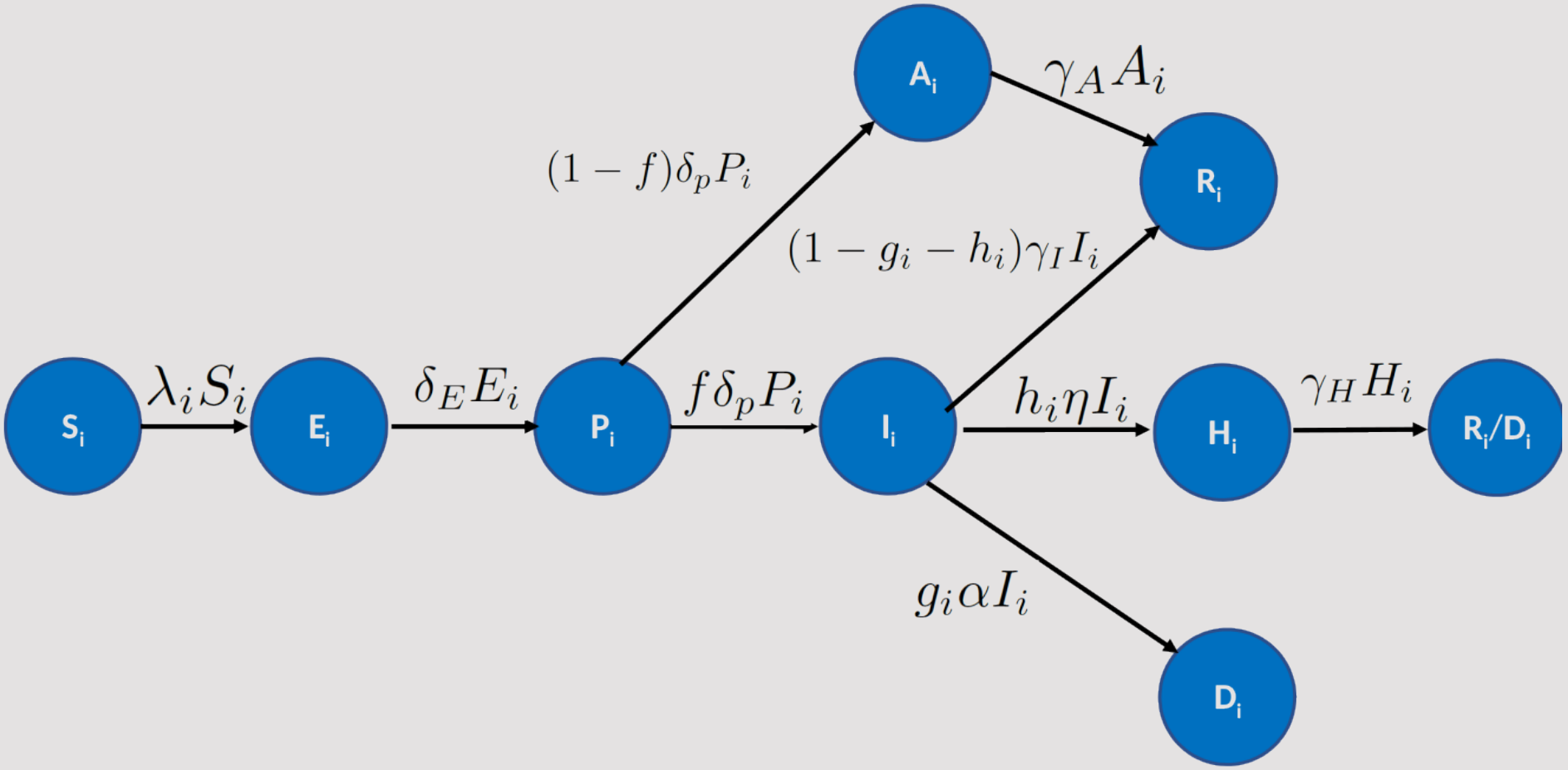
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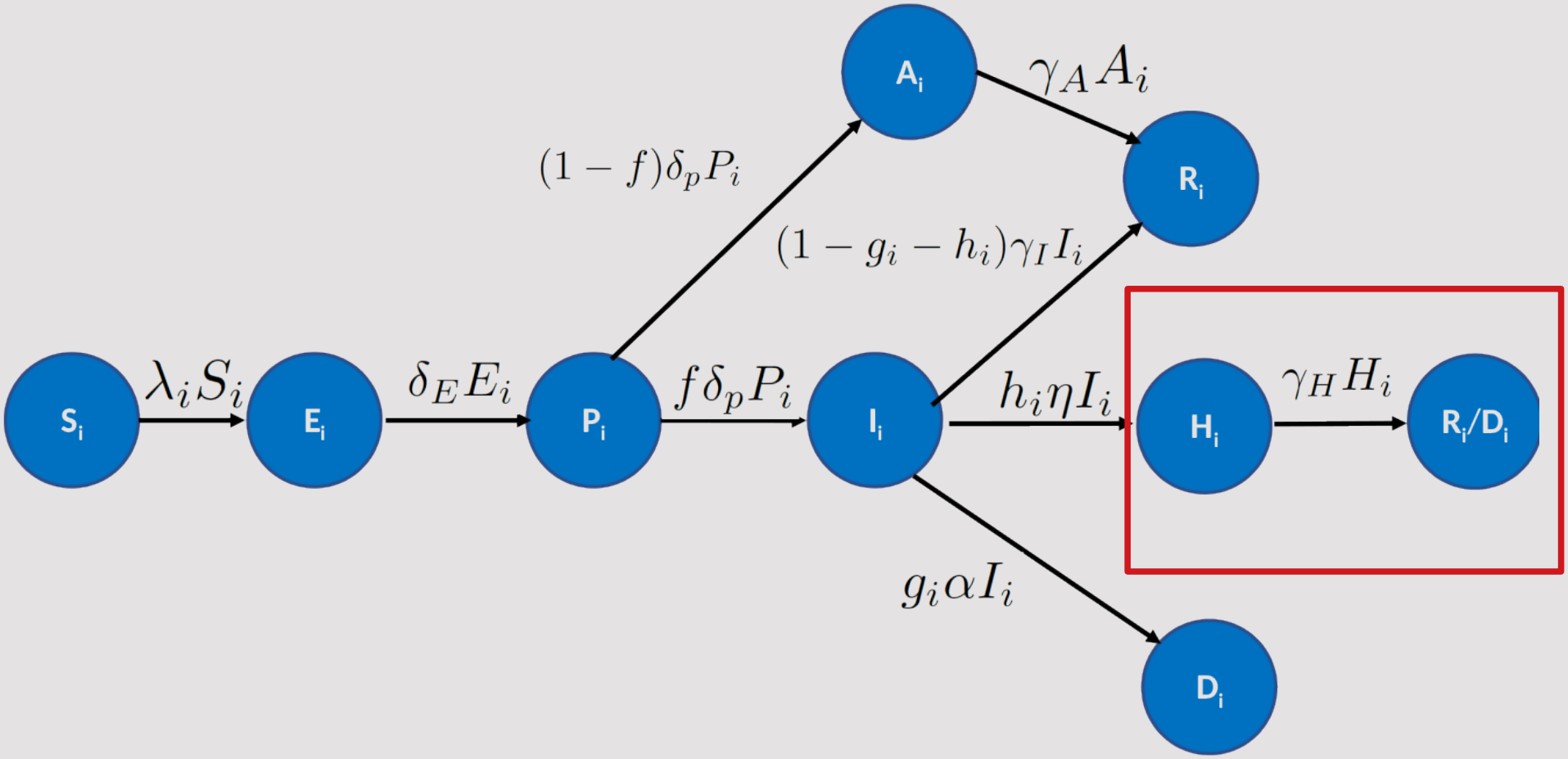
Model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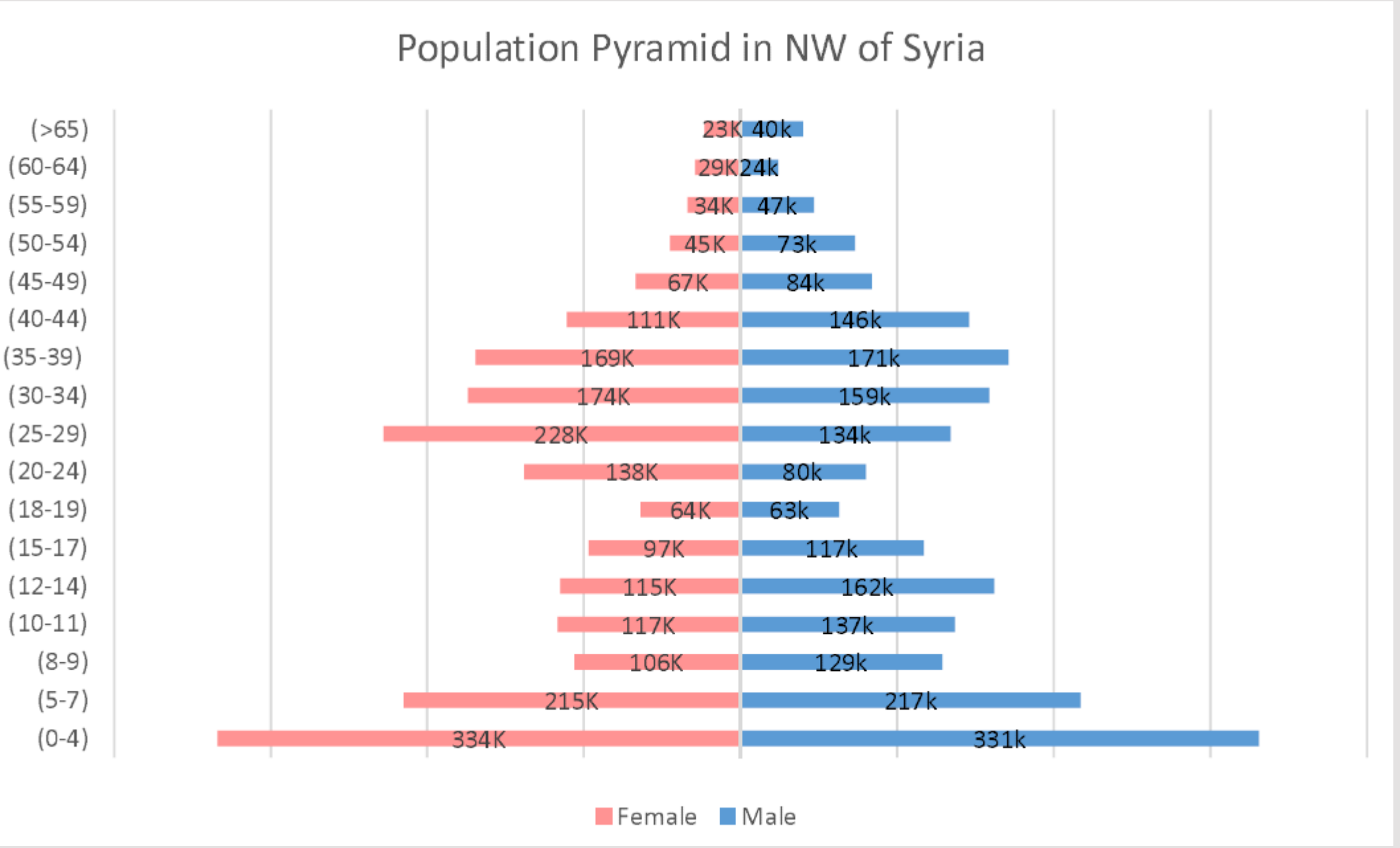
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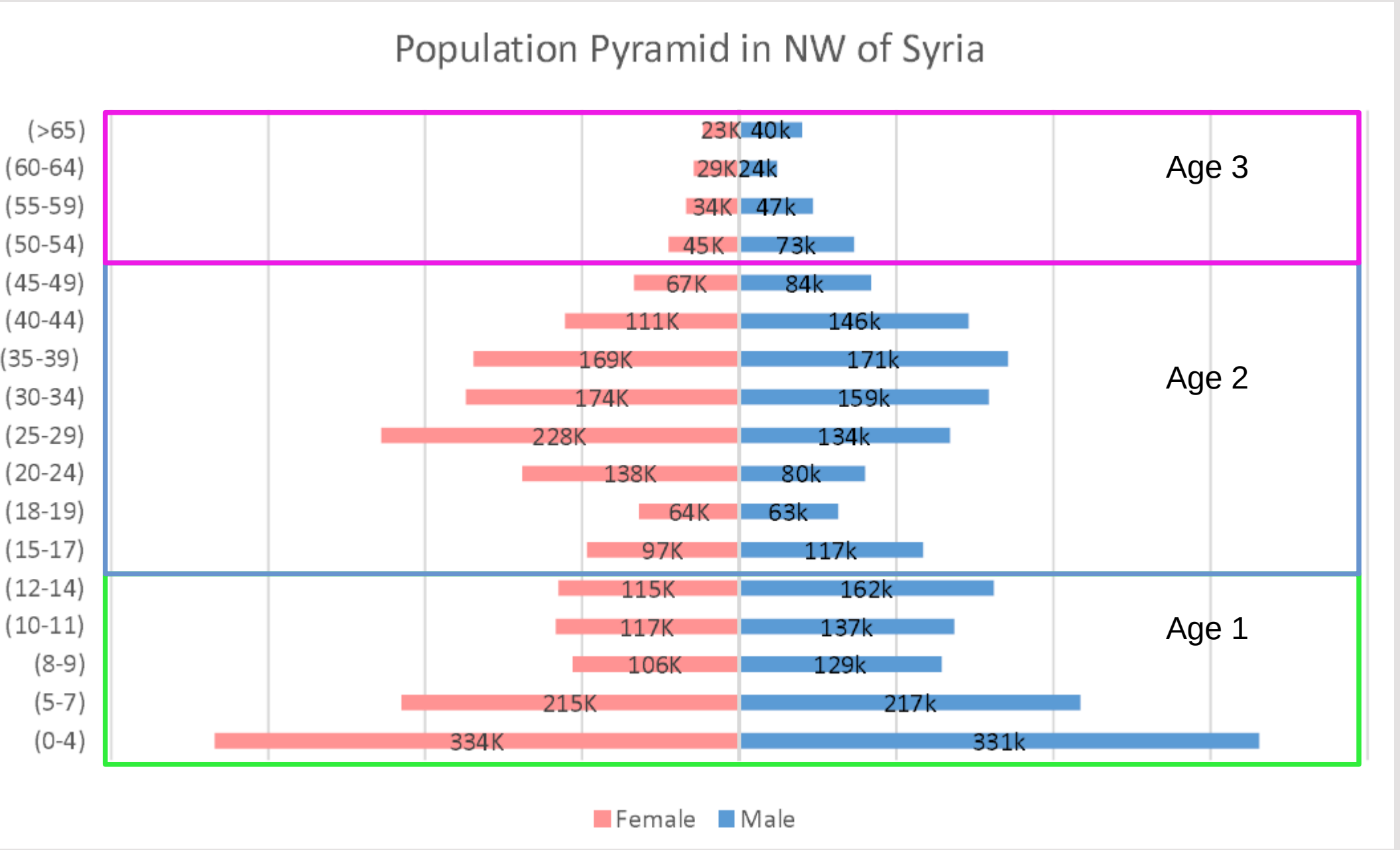
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Age 3
Age 2
Age 1
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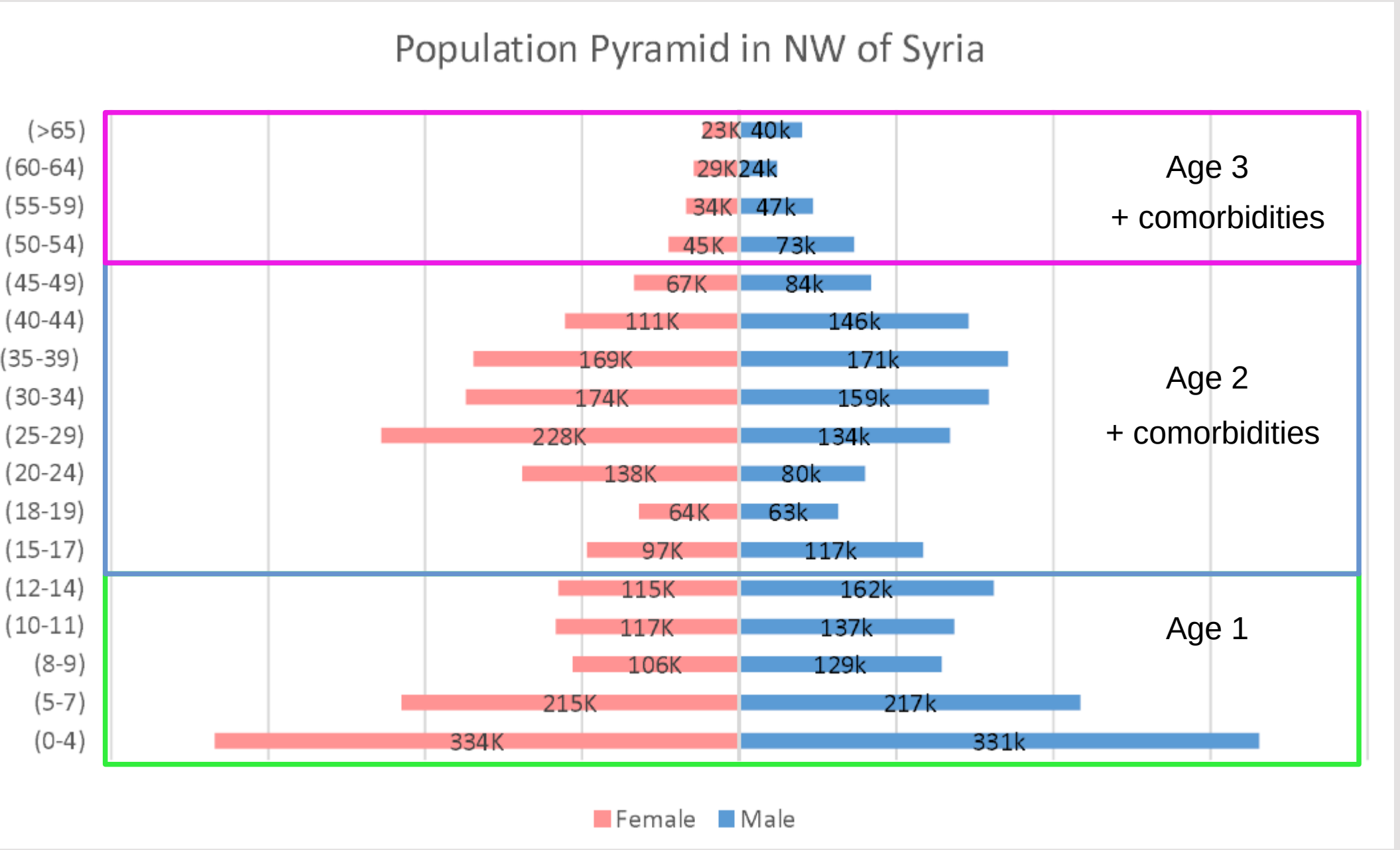
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Age 3
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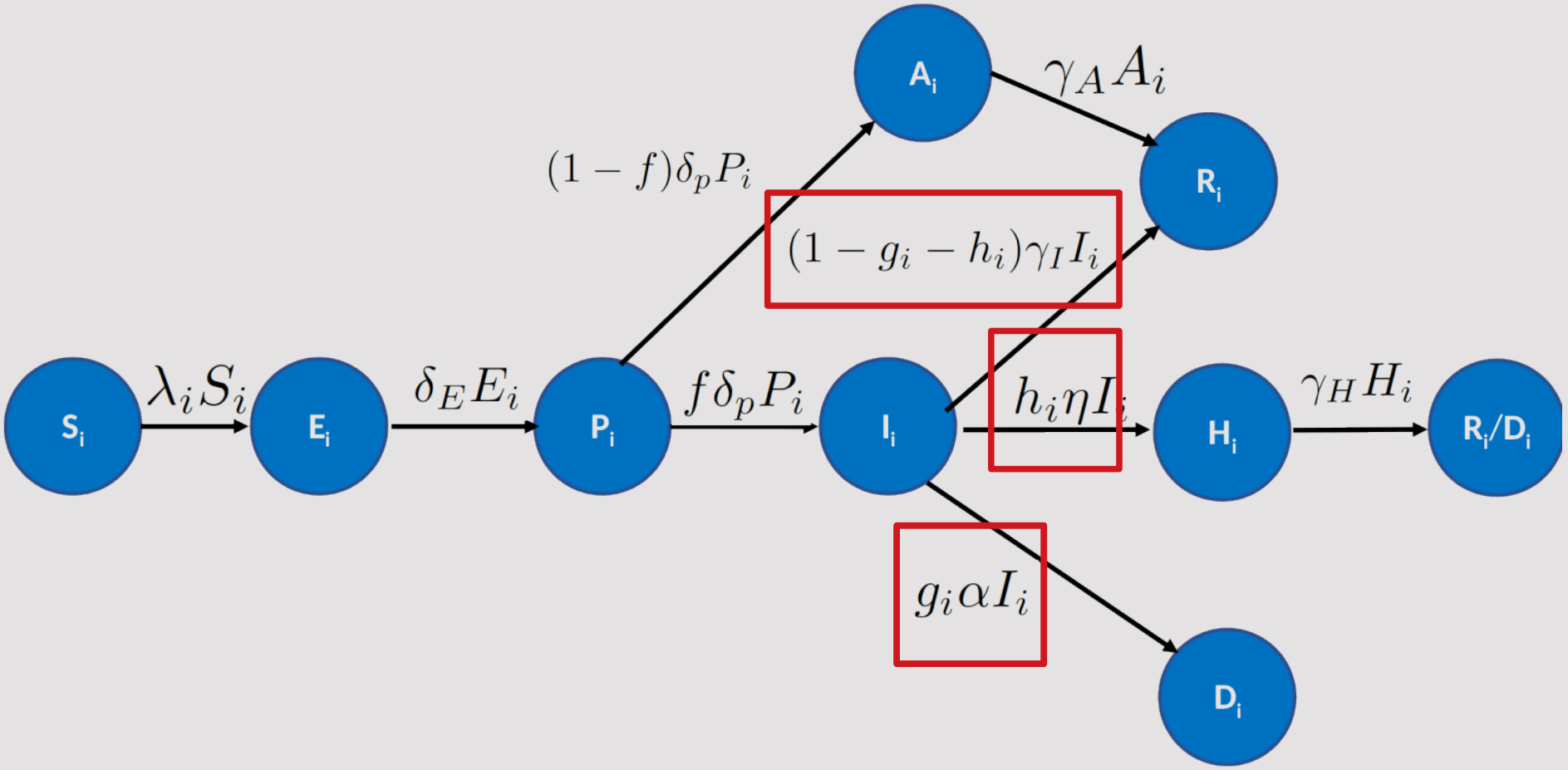
Age 2
+ comorbidities
Age 1
Female
Male

Model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Parameter	Description	Value	Distribution	Reference
$1/\delta_E + 1/\delta_P$	Duration of incubation period in days	5.2 (95% CI: 4.1-7.0)	Lognormal	[1]
$1/\delta_E$	Duration of latency in days	$1/\delta_E + 1/\delta_P - 1/\delta_P$		[2]
$1/\delta_P$	Duration of preclinical infectiousness in days	2.3 (95% CI: 0.8-3.0)	Gompertz	[2]
$1/\gamma_A = 1/\gamma_I$	Duration of clinical ($1/\gamma_I$) and subclinical ($1/\gamma_A$) infectiousness in days	7		[2, 3]
$1/\eta$	Delay from symptoms onset to hospitalization in days	7 (IQR: 4-8)	Gamma	[4]
$1/\alpha$	Delay from symptoms onset to ICU (here death) in days	10 (IQR: 6-12)	Gamma	[4]
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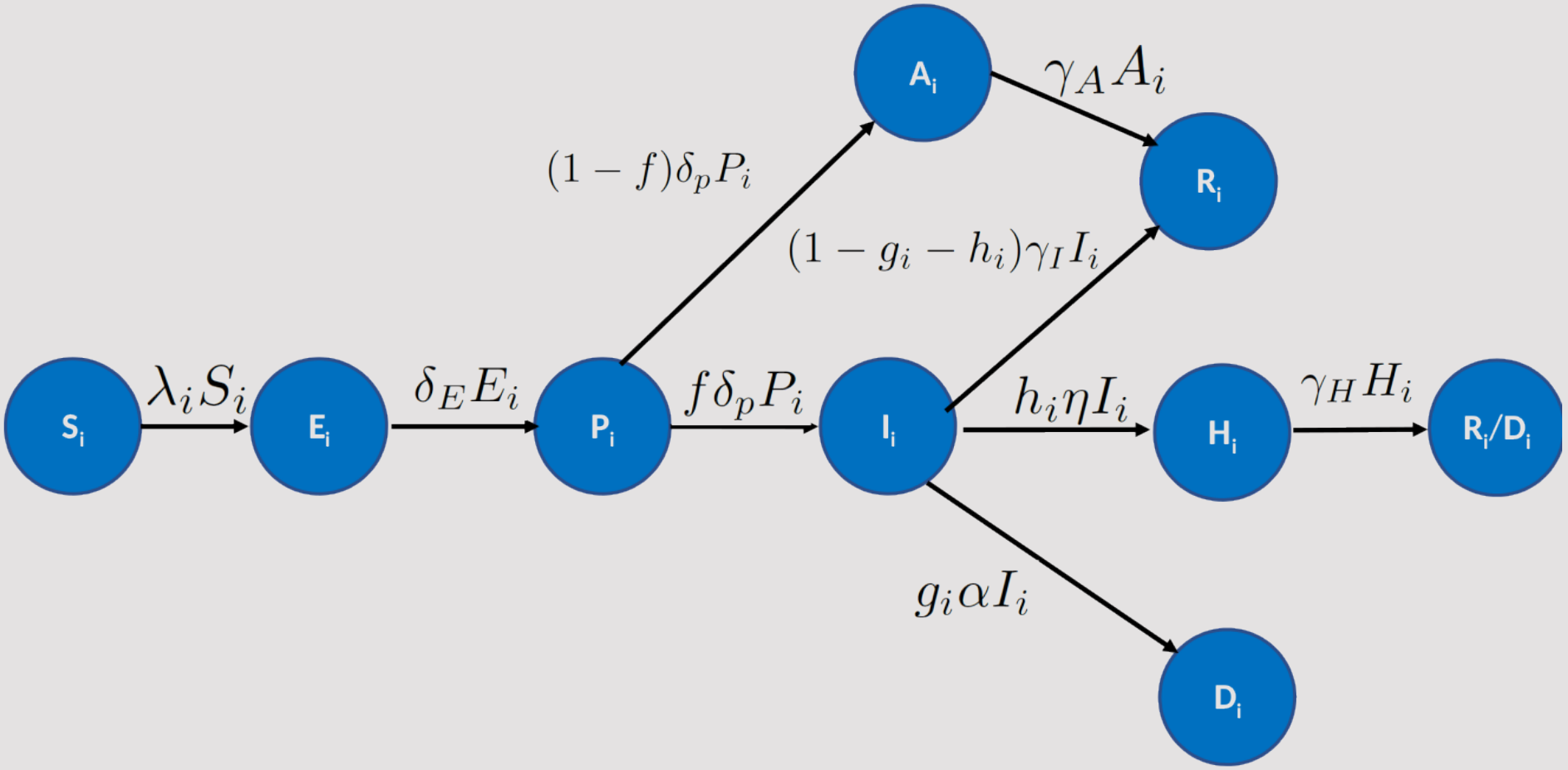
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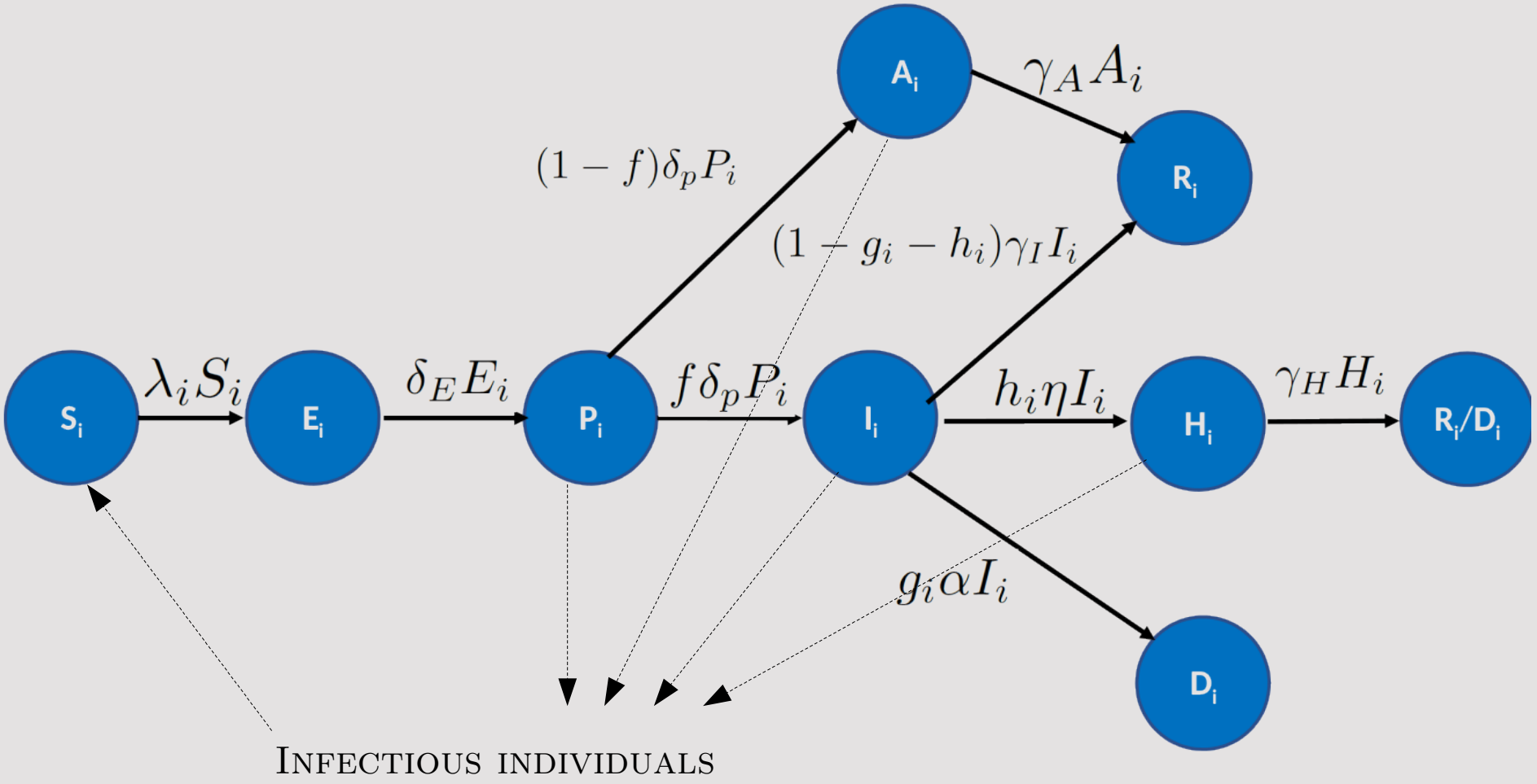
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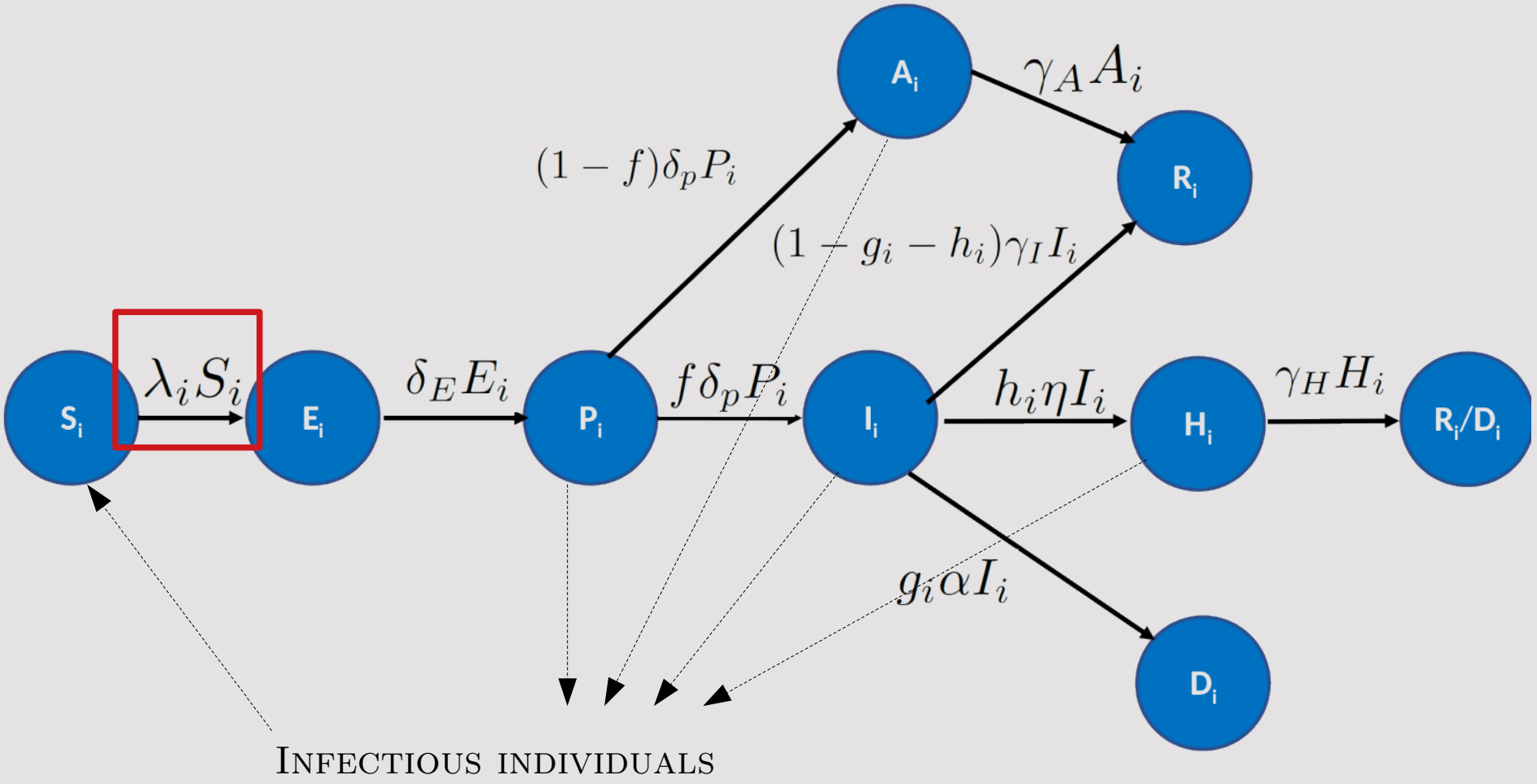
Infectious individuals

Model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Infectious individuals

$$\lambda_i = \sum_{j=1}^{n} \beta_{ij} \frac{P_j + A_j + I_j + H_j}{N_j}$$

With: $\beta_{ij} = \tau C_{ij}$

τ is the probability of infection if there is a contact

C is the number of contacts between population classes i and j

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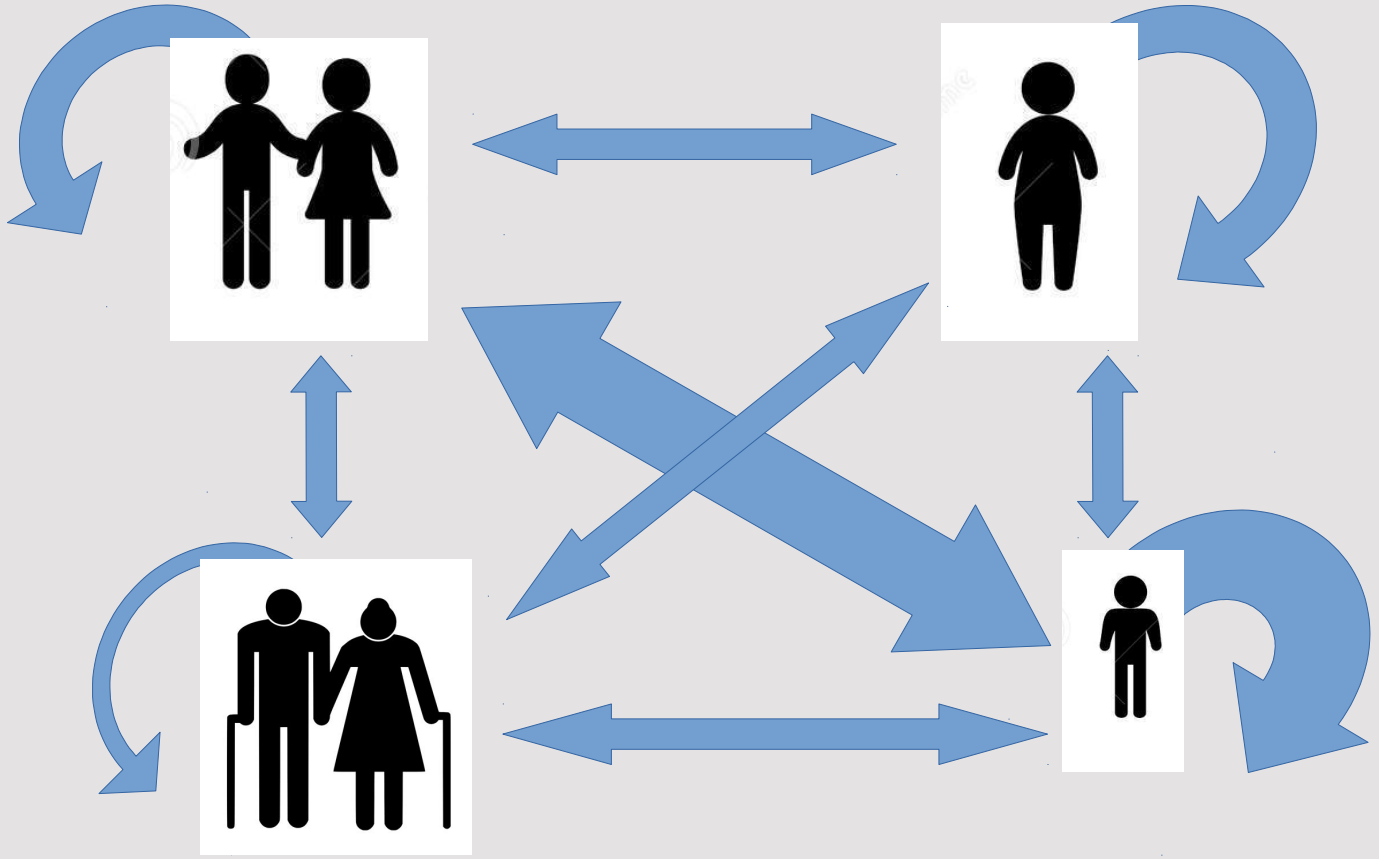

The results

Strategy 1: Self-distancing

Description

- Reduction of contacts between individuals.

Key-points

- Simple and rapid implementation.
- Educational-based, long-term benefit
- Starting investment

  then mouth-to-word

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Kids	25	20	12.5
Adults	15	11	7.5
Elderly	10	8	5

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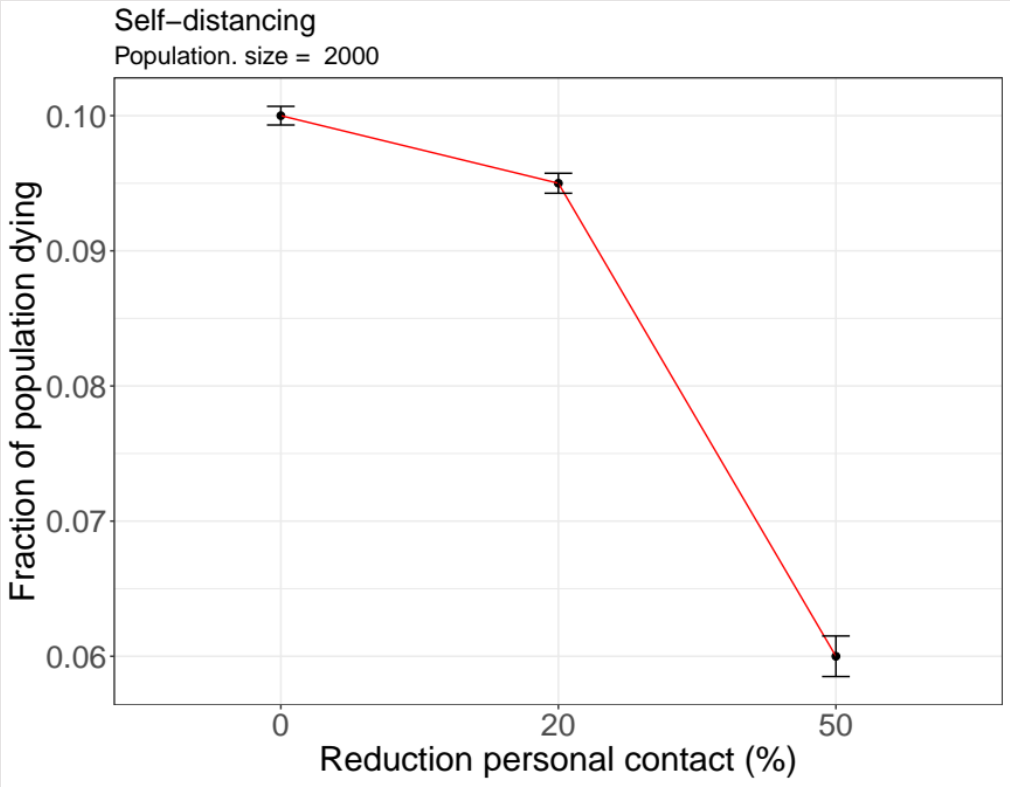

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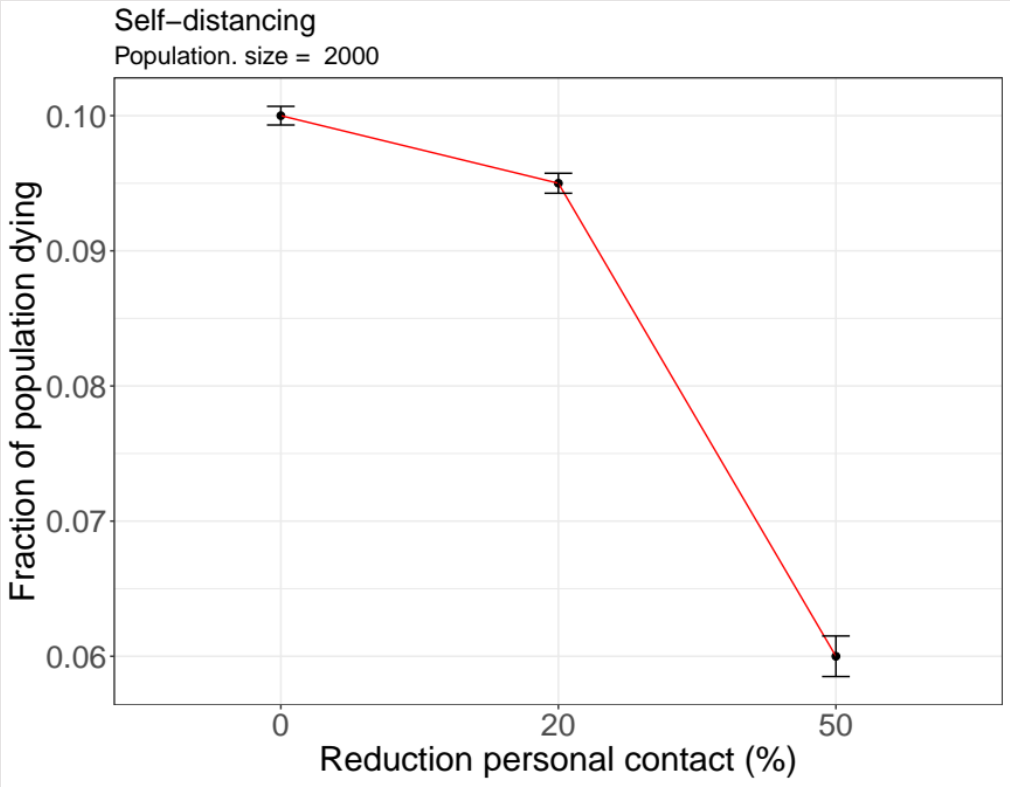

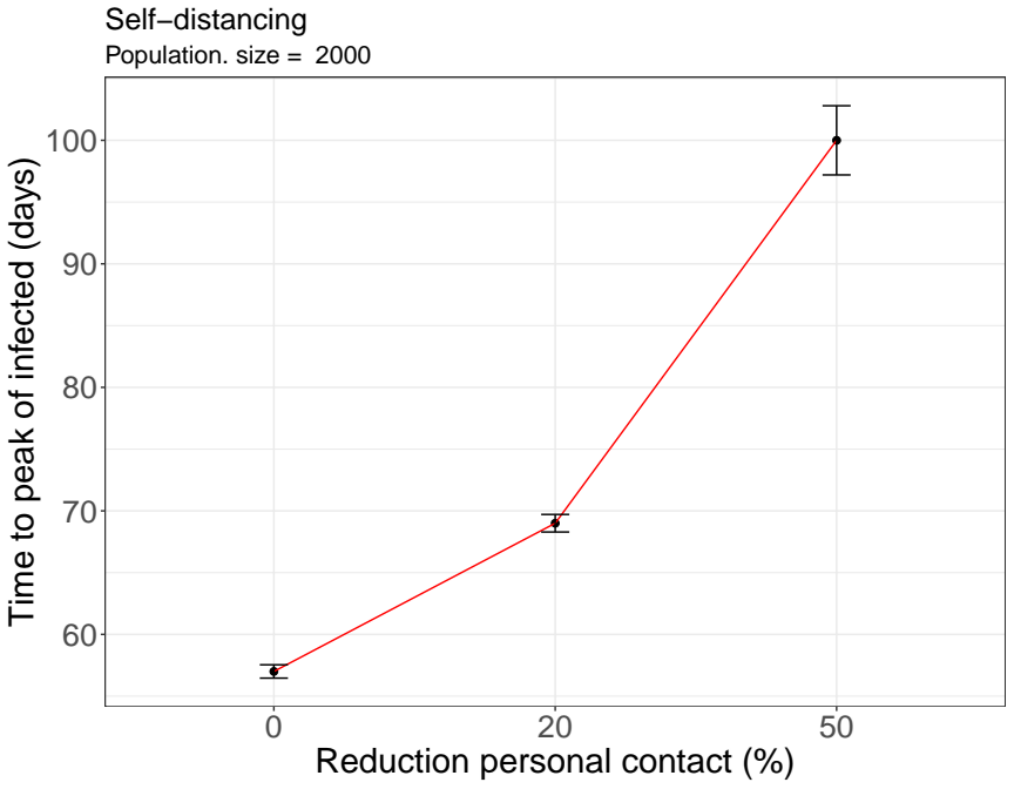

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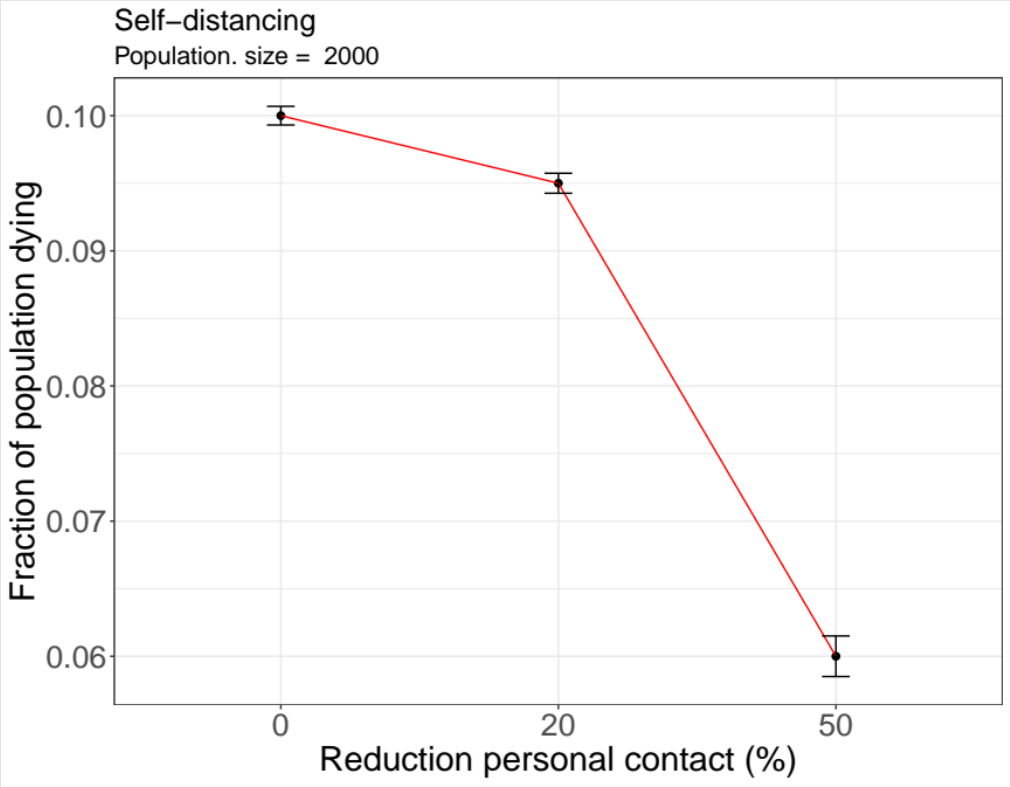
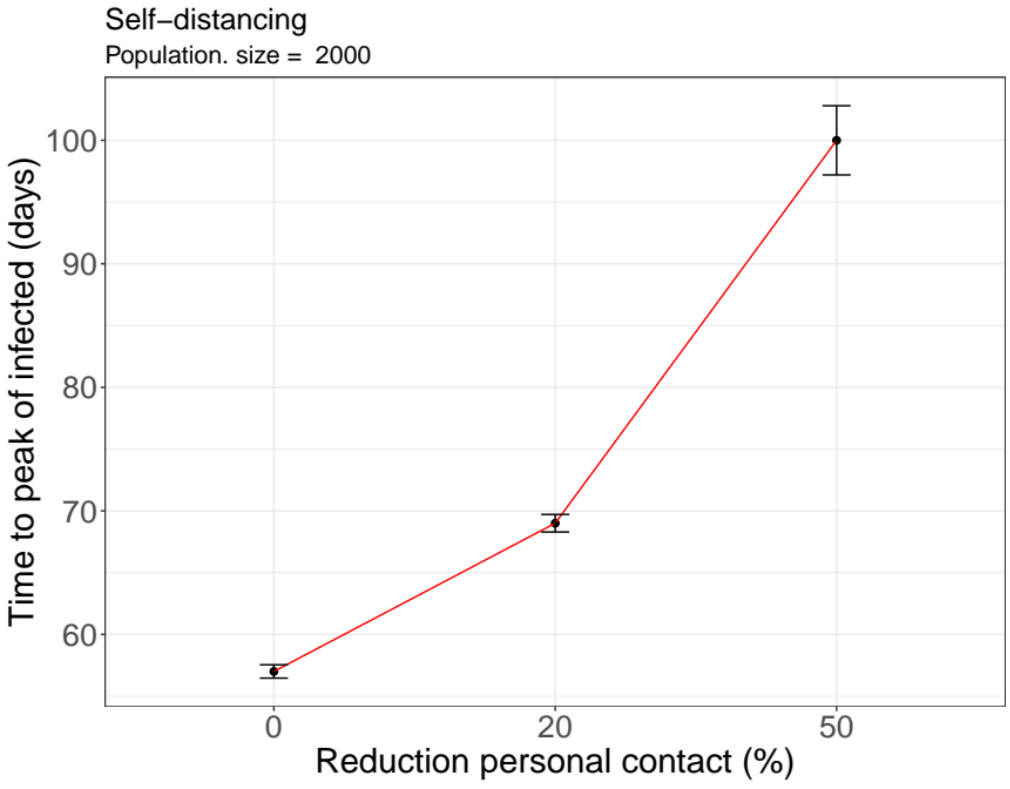




Up to 40% reduction in the the death tolls

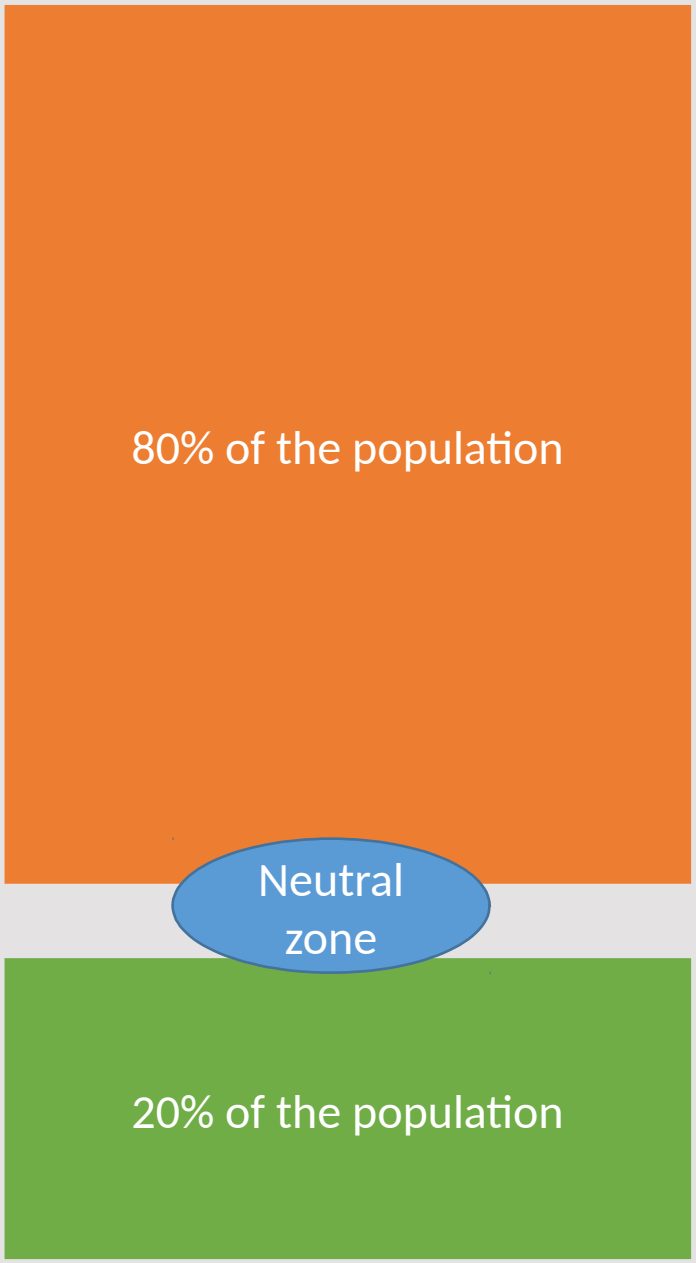
Up to 40% delay in the peak of infected population

Strategy 2: Shielding and Lockdown

Description

- Shield of vulnerable population.
- Similar conditions in terms of tents occupancy and distance between tents are considered.
- Vulnerable:
  - Elderly.
  - People with co-morbidities.
  - Carers/family.
- Lockdown when first symptom is detected.

Shielding vulnerable population within a “green” zone



For a total population of 100 persons

- 50 kids (0-18 yo)
- 35 adults
- Meetings between orange and green in « **neutral zone** » (open tent), no more than 4 people at a time (mixed orange/green). No physical contact (mask and gloves, 1.5 meter distance).

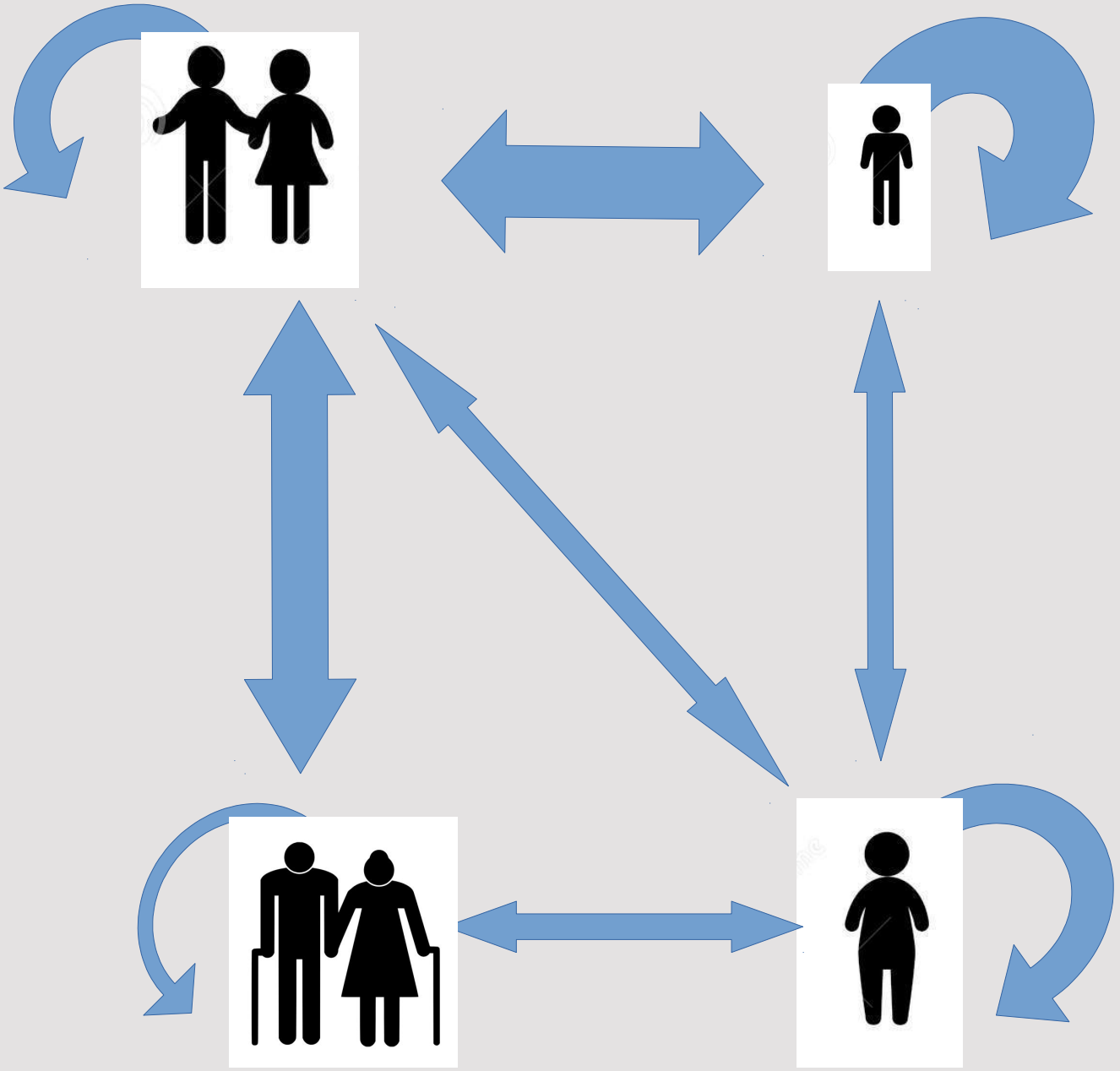
- 0 kid
- 5 elderly (60+)
- 10 middle-aged NCD affected (mainly people 40-60 years old)
- Intra-green zone carers are among the 10 non-elderly NCD
- No unprotected contact with orange zone or external world
- In average, meeting in neutral zone once per week

Shielding vulnerable population within a “green” zone

80% of the population

Neutral zone

20% of the population



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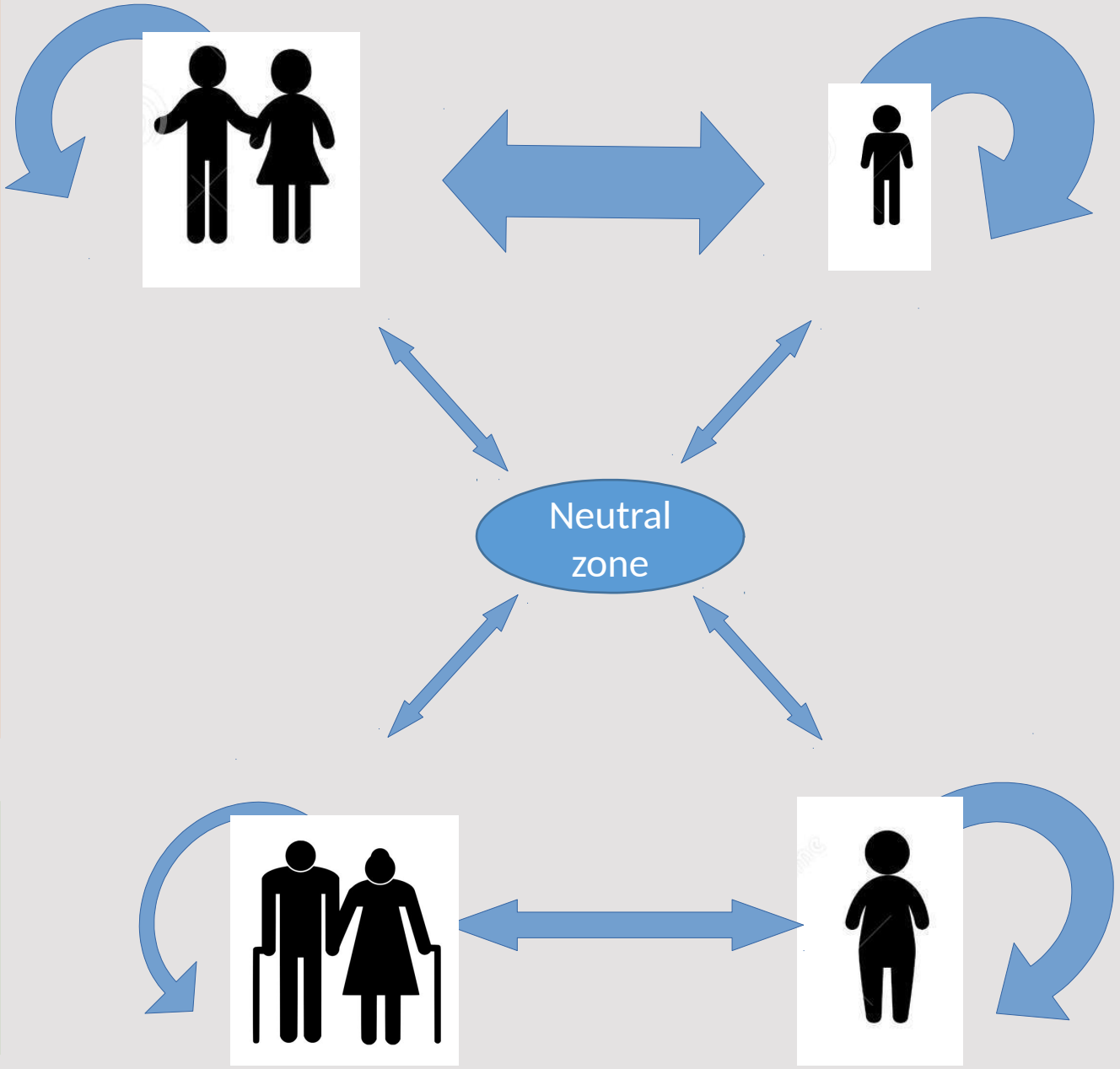
Neutral zone

20% of the population

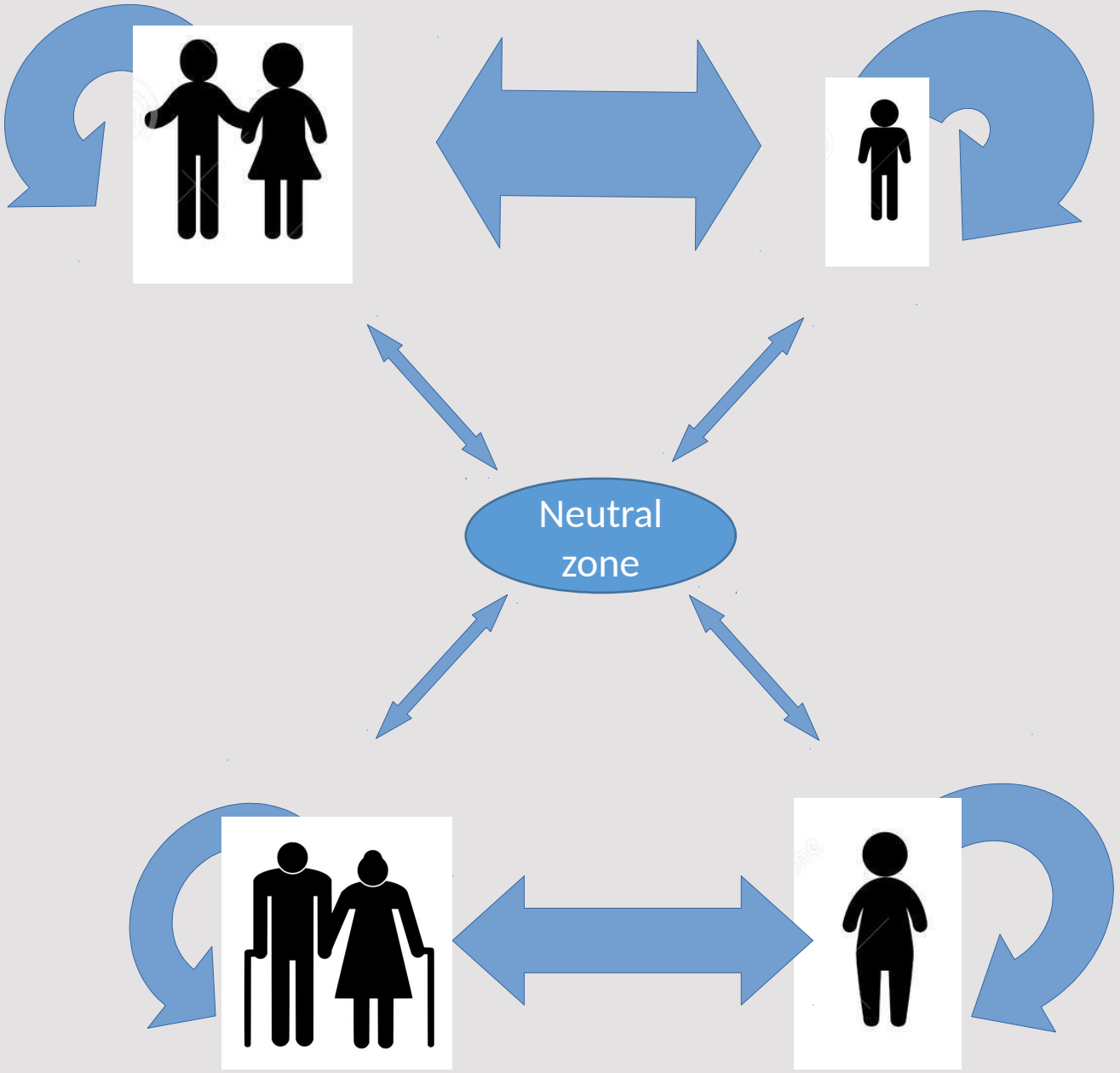


Shielding vulnerable population within a “green” zone

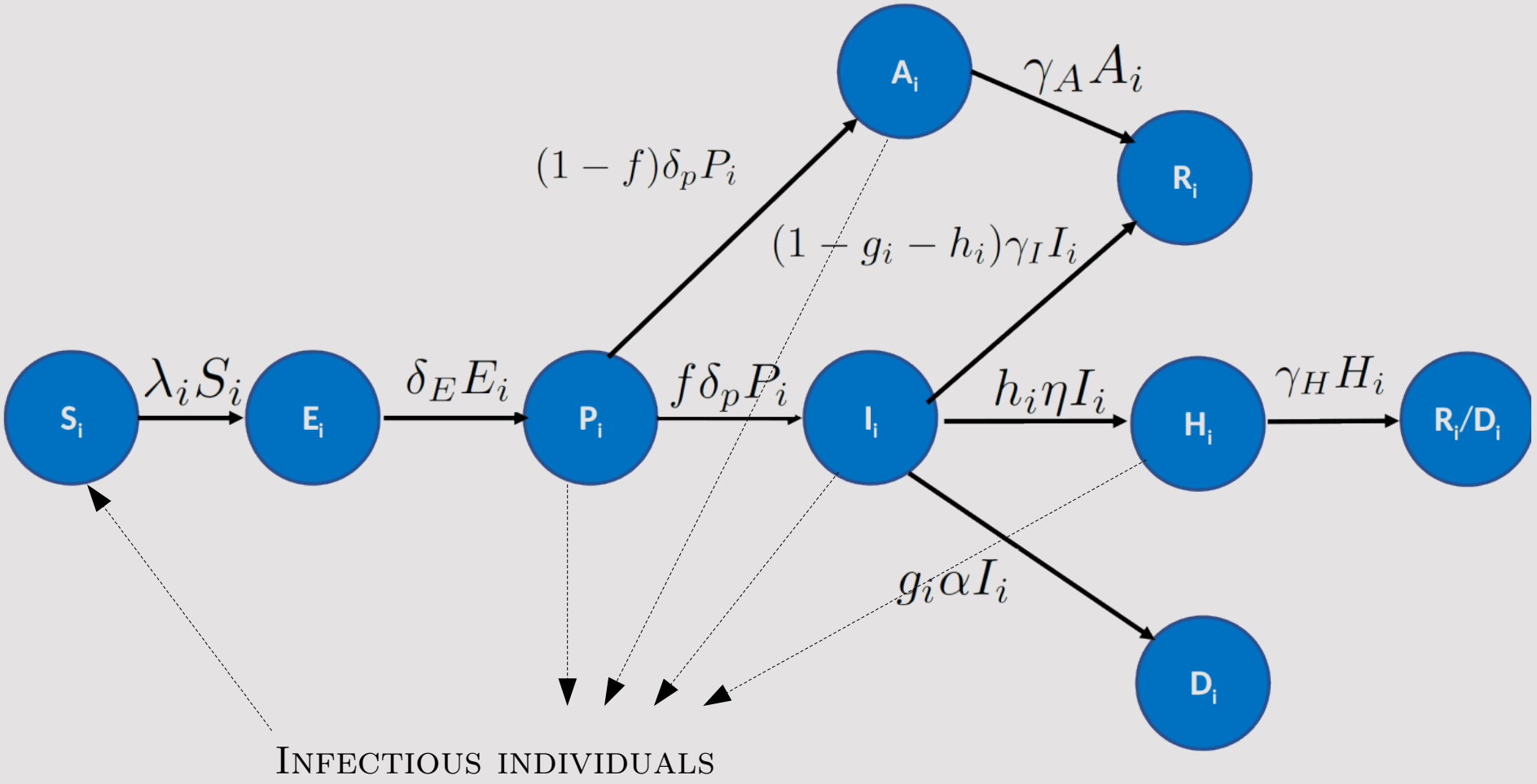
80% of the population

Neutral zone

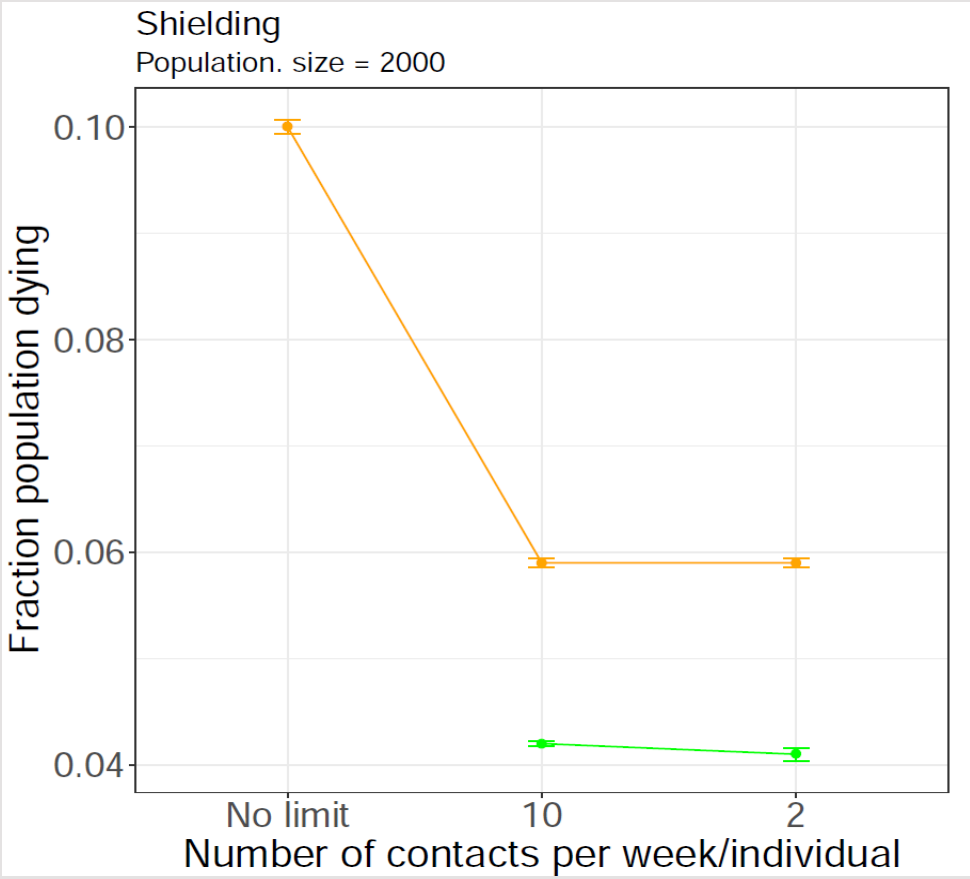
20% of the population



Model

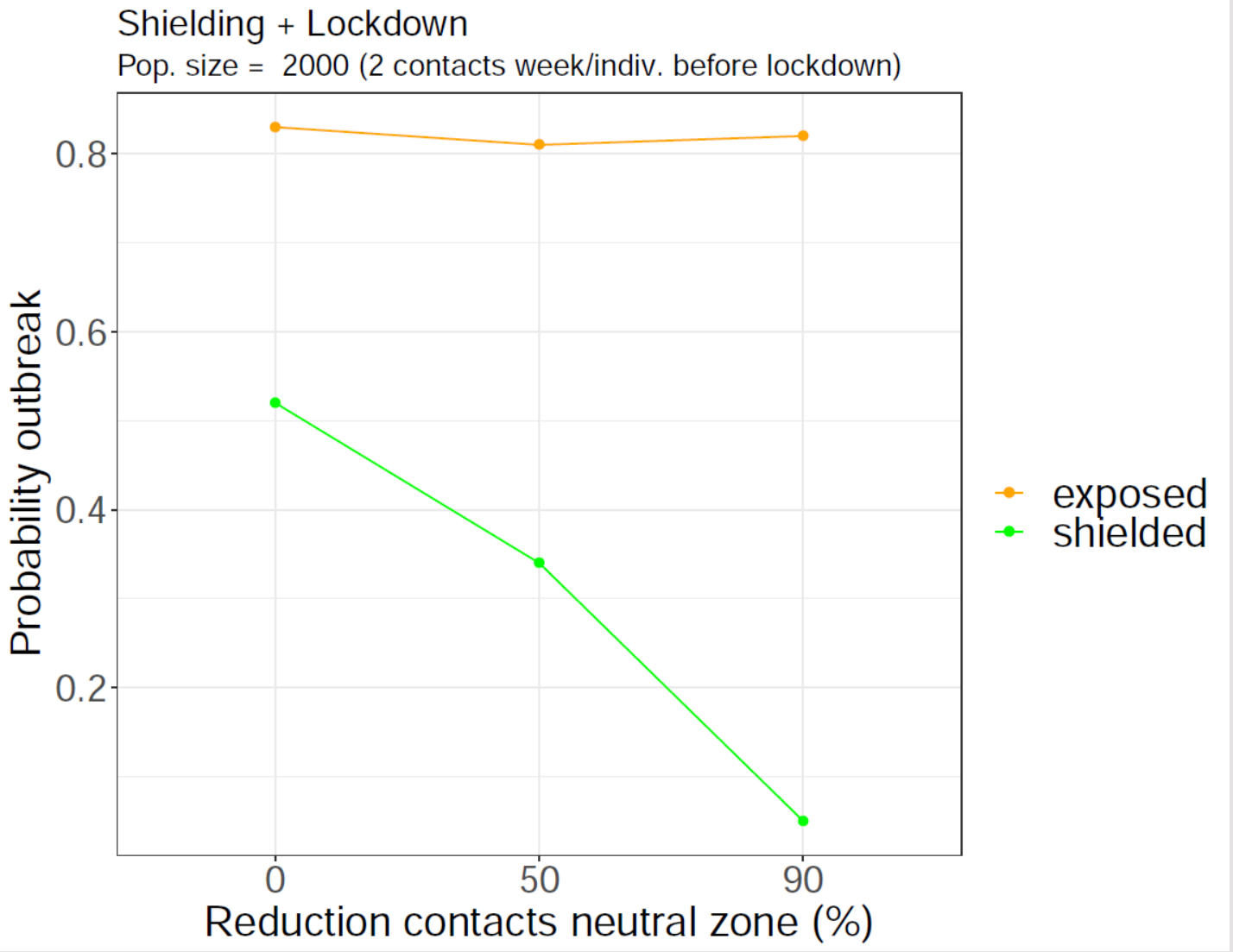

A_i
$\gamma_A A_i$
R_i
$(1-f)\delta_p P_i$
$(1-g_i-h_i)\gamma_I I_i$
S_i
$\lambda_i S_i$
E_i
$\delta_E E_i$
P_i
$f\delta_p P_i$
I_i
$h_i \eta I_i$
H_i
$\gamma_H H_i$
R_i/D_i
$g_i \alpha I_i$
D_i
Infectious individuals

Strategy 2: Shielding only



Strategy 2: Shielding and Lockdown

Strategy 2: Shielding and Lockdown



Strategy 3: Isolation

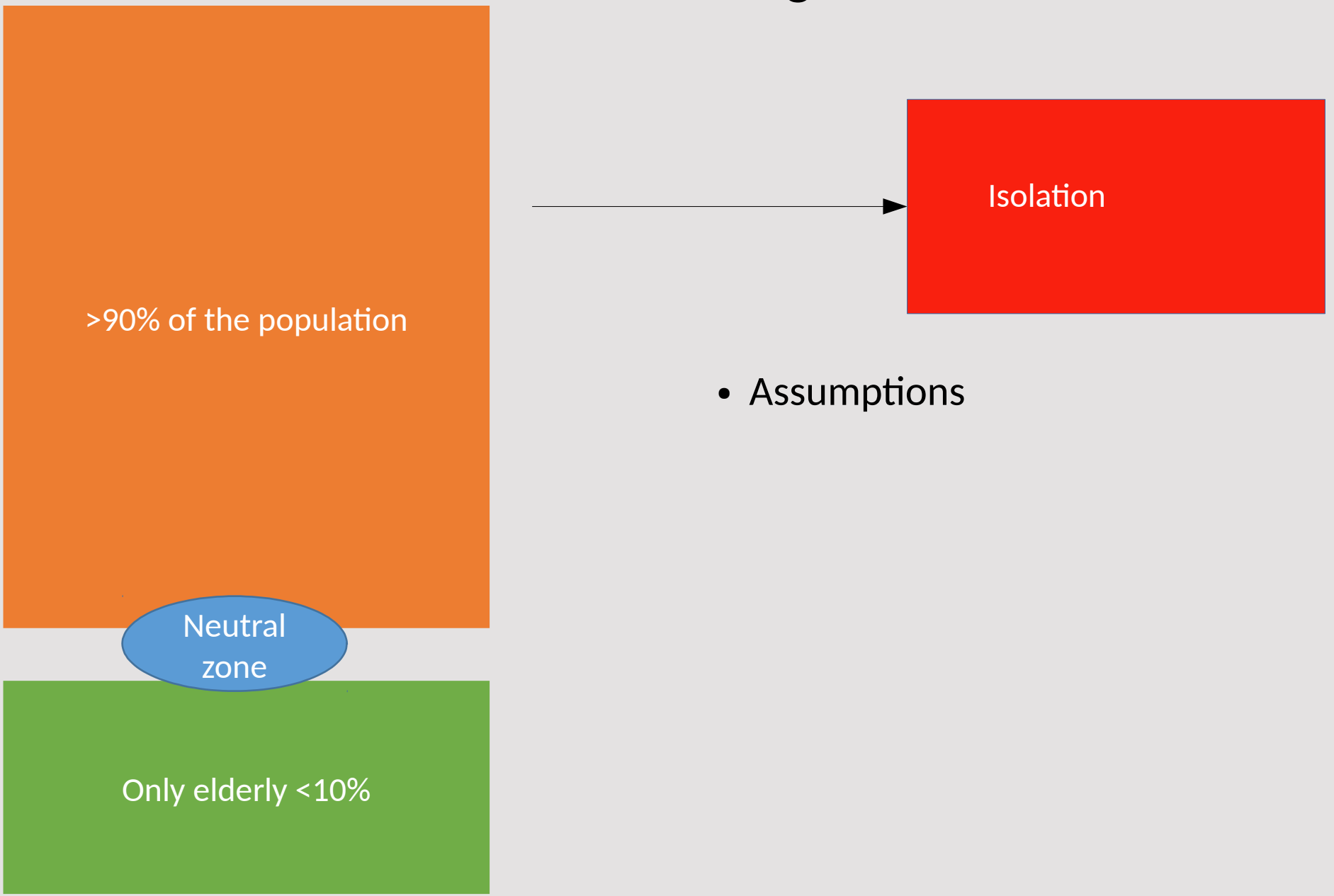
Description

- Isolation of infected individuals
-

Key-points

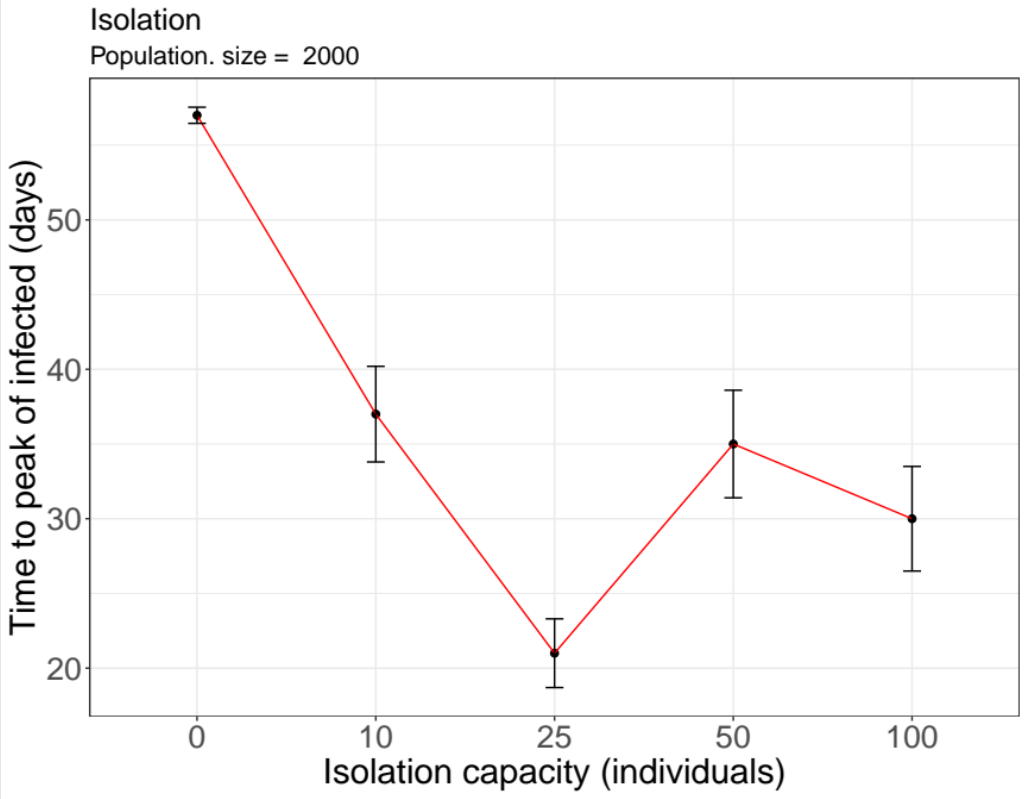
- Remark 1.
- Remark 2.
- Requires quick identification of infected individuals

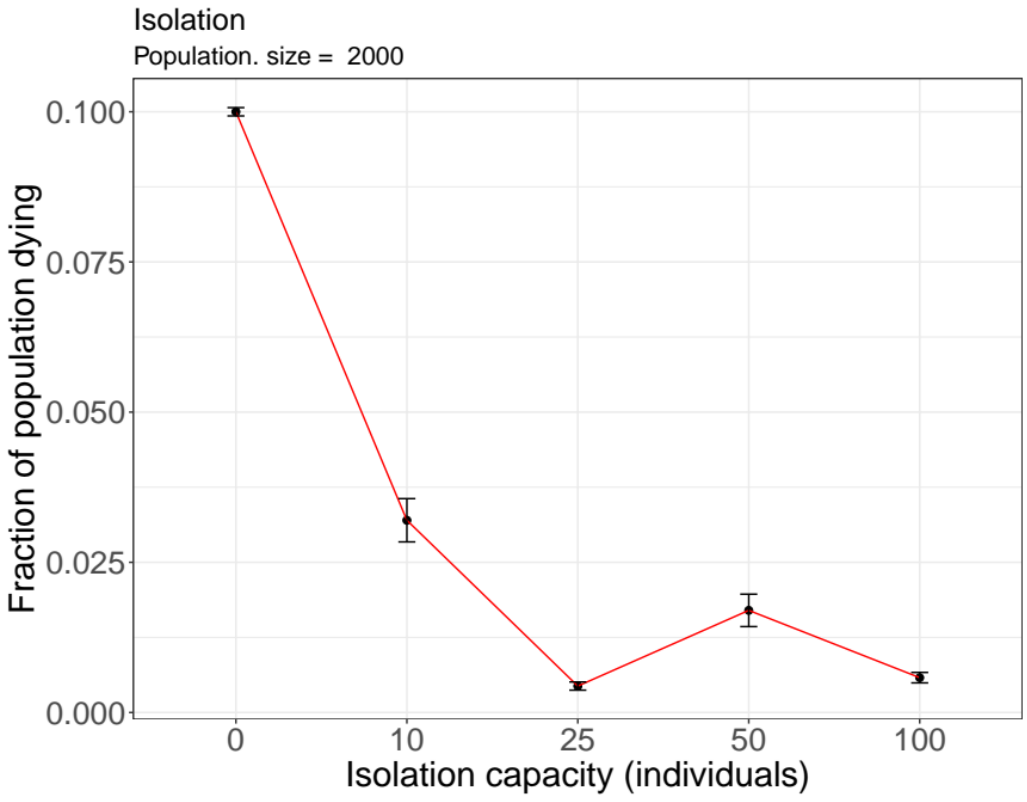
Shielding intervention and evacuation



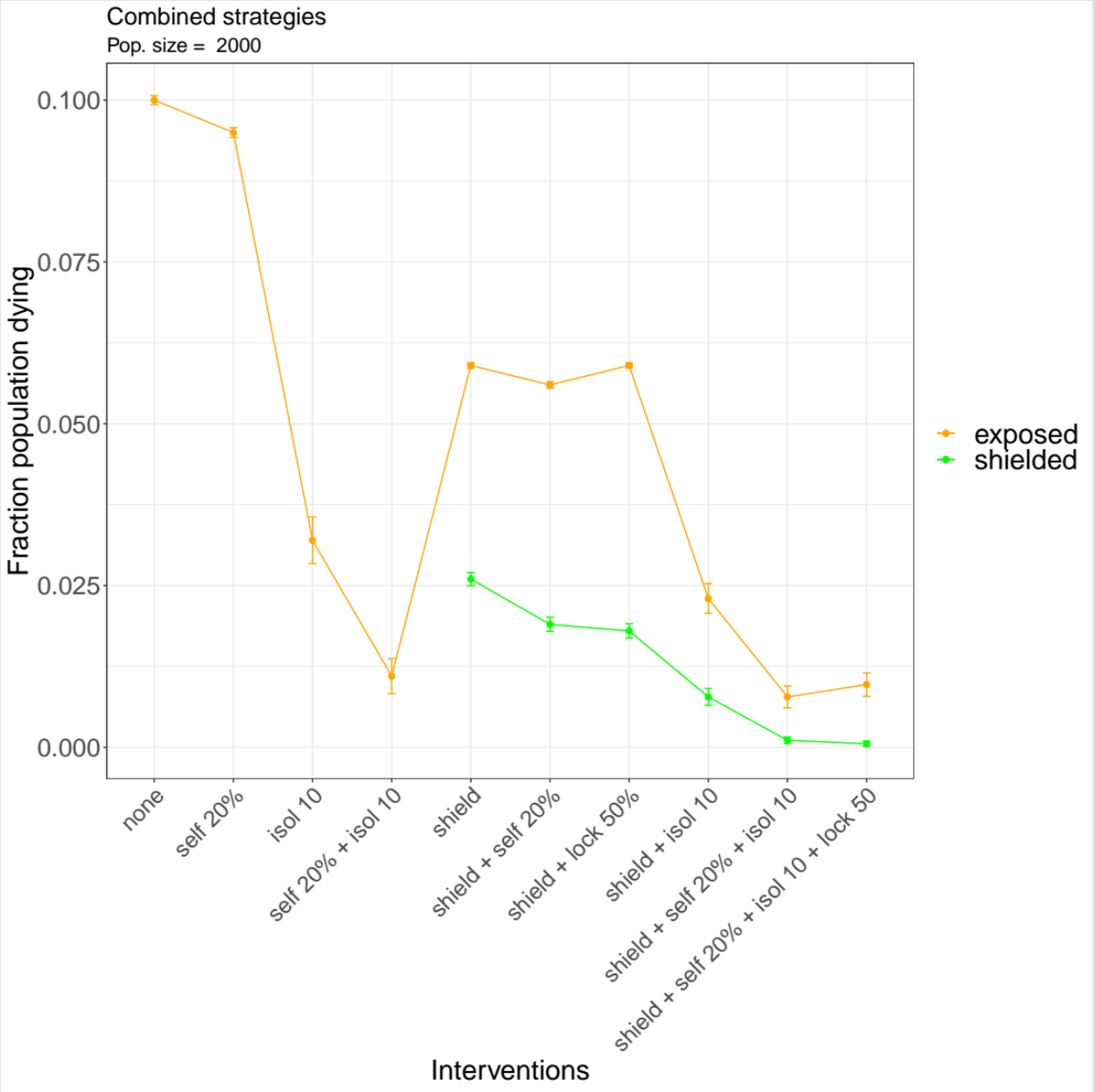
- Assumptions

Strategy 3: Isolation





Combined strategies



Conclusions

- Remark 1
- Remark 2
- Combined strategies have a greater effect.