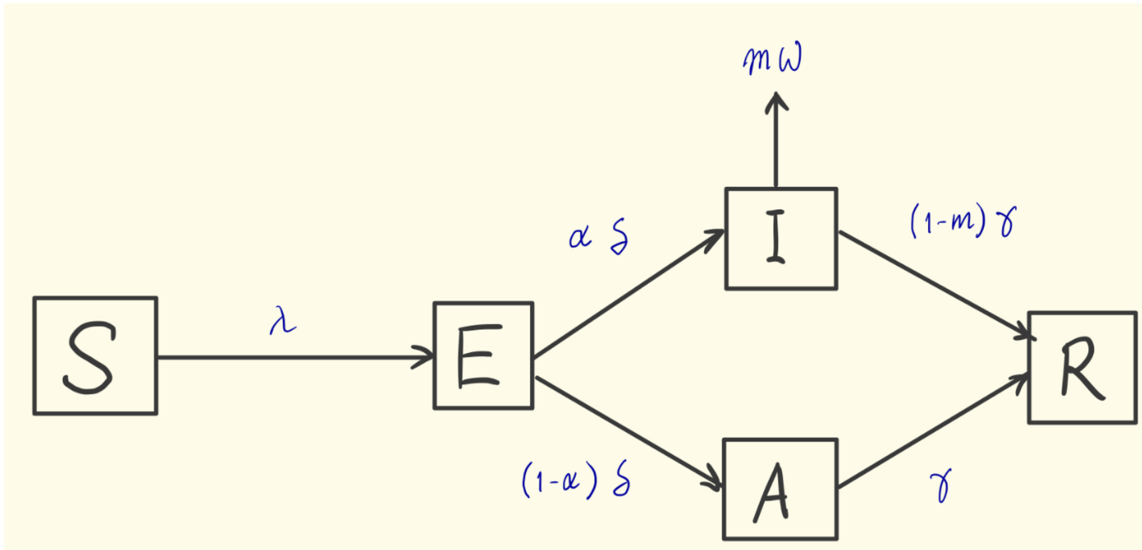
Epidemiological Modeling of the COVID-19 Epidemic in Santa Clara County

Preliminary Report

March 18, 2020

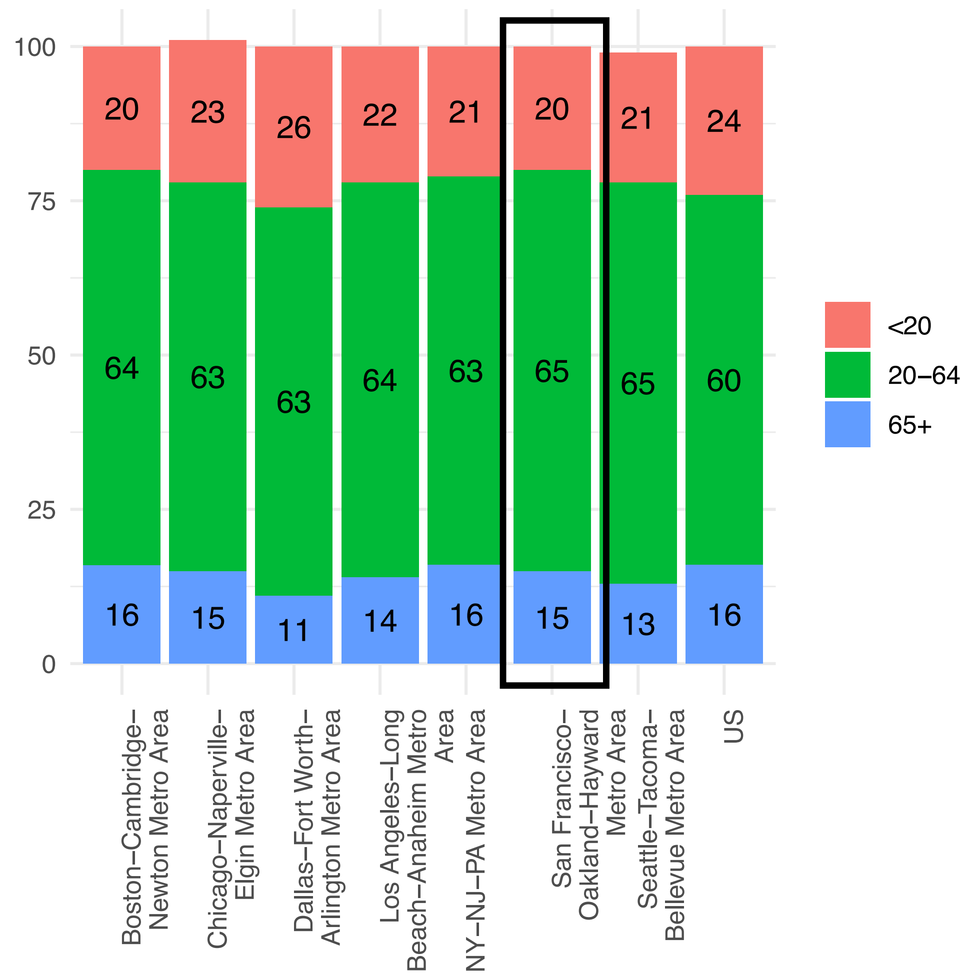
Model structure



Similar to Prem, et al medRxiv and Zhao et al. medRxiv

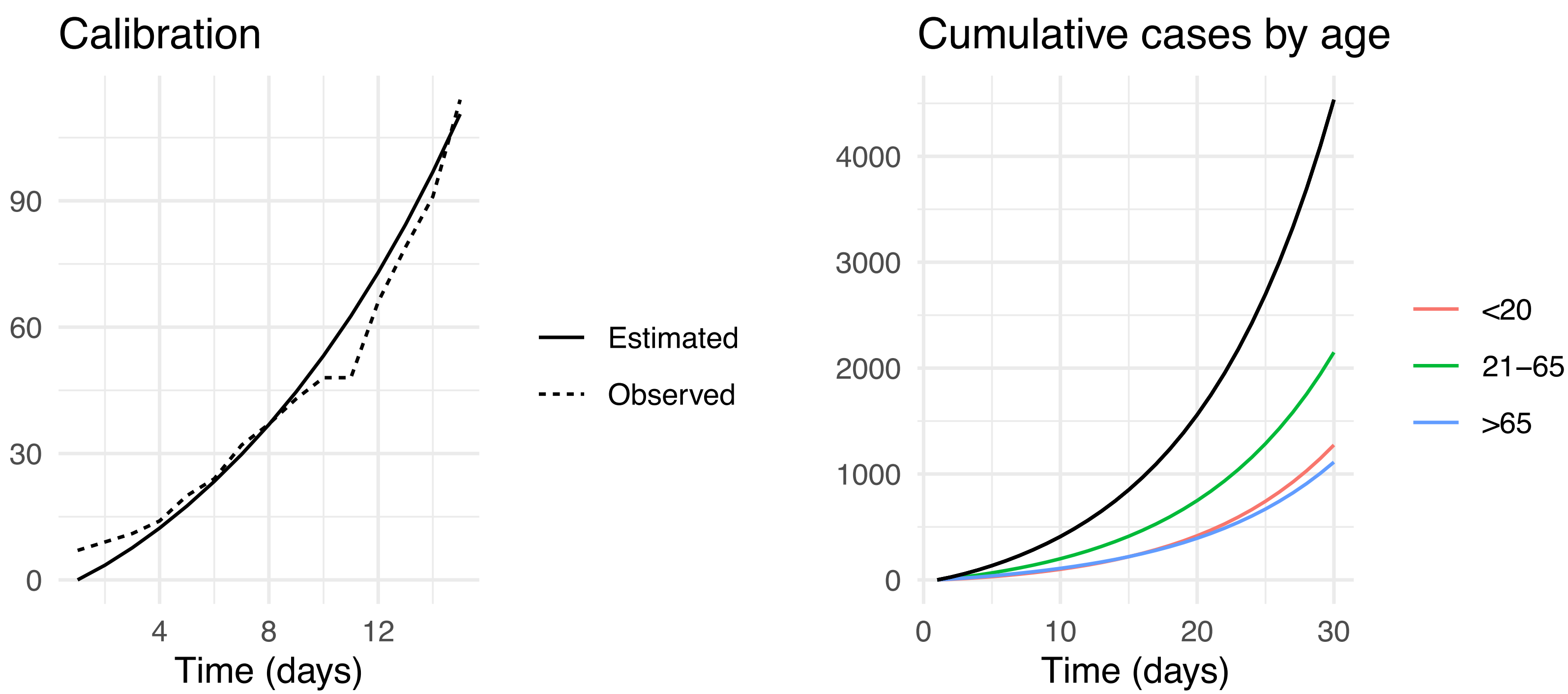
- **S**: Susceptible
- **E**: Exposed (infected). Not infectious yet. No symptoms. Incubation period and latent period.
- **A**: Infectious, without symptoms.
- **I**: Infectious, with symptoms.
- **R**: Recovered. Not infectious. No symptoms.

Age stratification



Source: American Community Survey (2018)

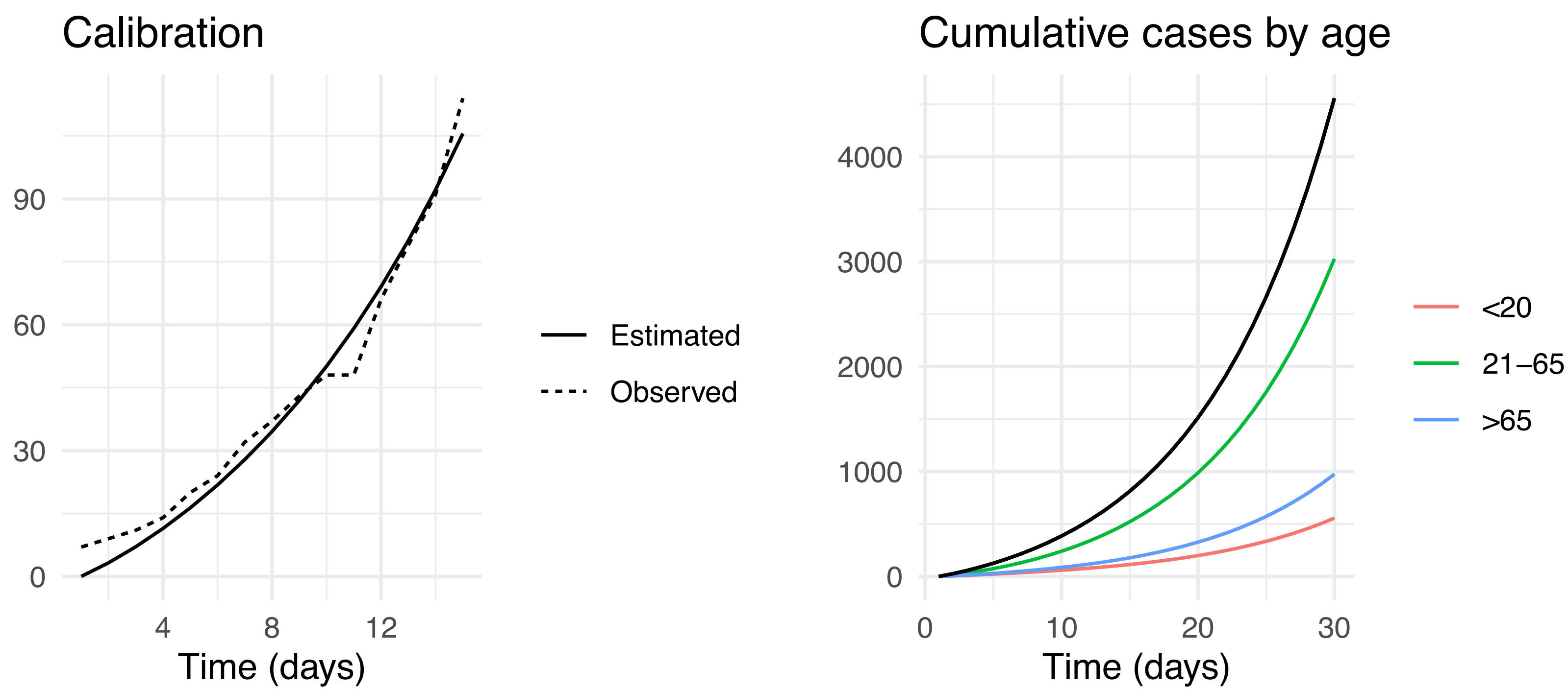
Observed data fits to different models.



Assumptions

- 13% case ascertainment over March 1-March 15
- Low transmission in asymptomatic individuals (RR = .25)
- Children as susceptible as adults

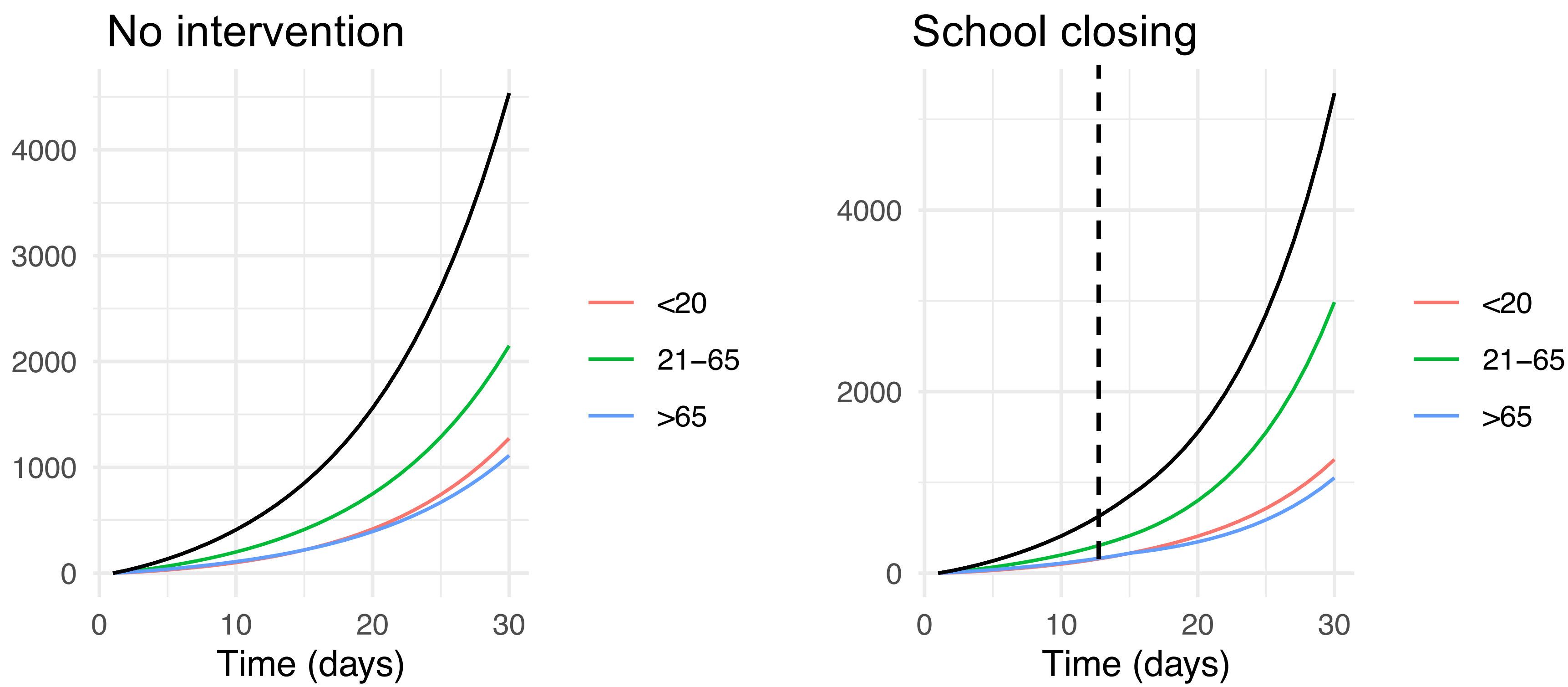
Observed data fits to different models.



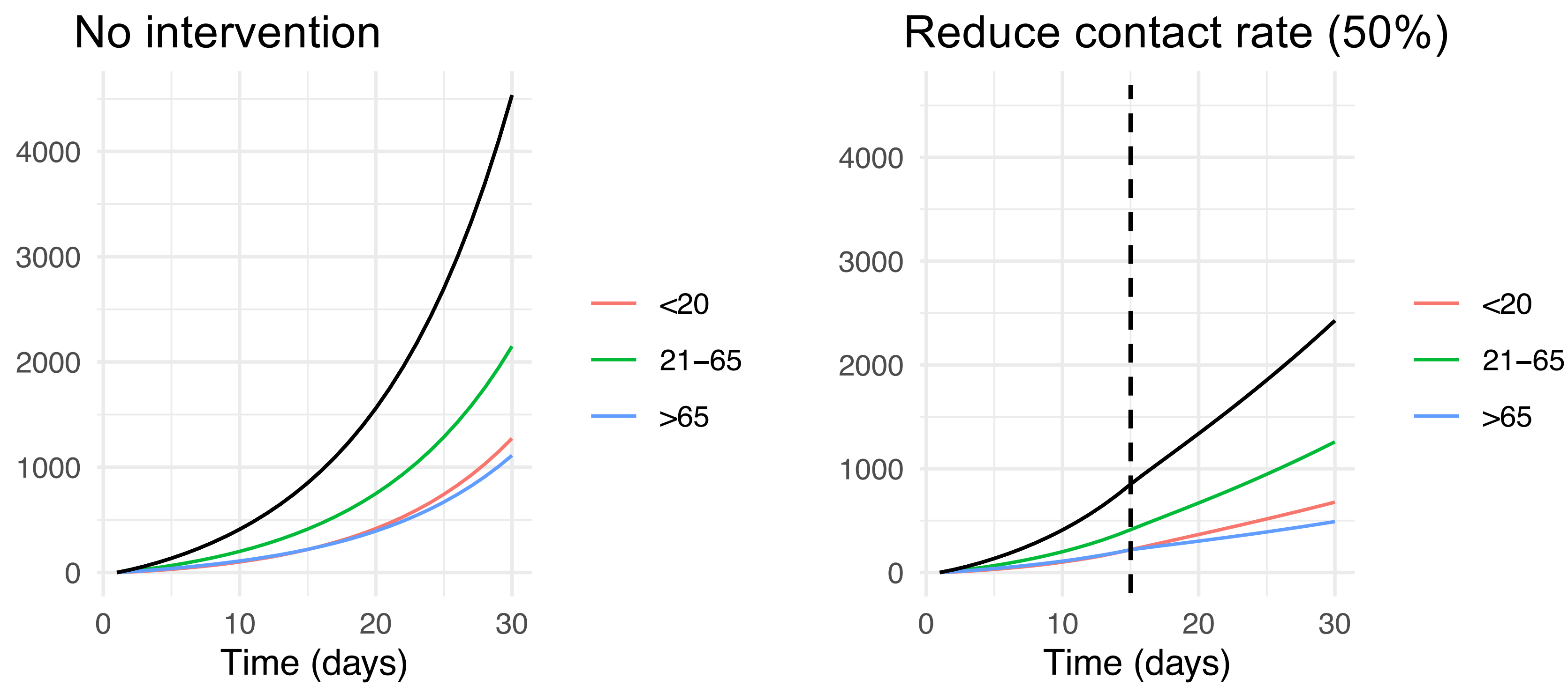
Assumptions

- 13% case ascertainment over March 1-March 15
- Higher transmission in asymptomatic individuals (RR = 0.38)
- Children less susceptible than adults (RR = 0.5)

Contact patterns are important.



Social distancing can slow the epidemic.



Appendix

Contact rates by strata

We use the estimated age-structured contact matrix for the US derived from projections from POLYMOD Mossong et al. (2008, 2017) survey data to US demographics Prem et al. (2017) as a starting point. Since we are interested in 3 broad age-classes, we bin the projected contacts according to US Census Bureau age-distribution estimates for 2018 (United States Census Bureau (2019)).

To calculate the substitution of contacts resulting from the closure of schools, we consider weekend contacts as a proxy for contacts given school closures. Using the *socialmixr*(Funk (2018)) R package, we create separate contact matrices for the weekends and weekdays from the POLYMOD survey data in 8 European countries, and use the *ratio* between elements in these two contact matrices for each country to inform the relative change/substitution in contacts that would result from school closures.

We also consider other social distancing measures that limit other forms of contact. The POLYMOD data-set breaks down the type that each contact recorded represents ("home", "school", "work", "transport", "leisure", and "other"), and we can consider the effect of different rates of reduction of each of the latter types of contacts on the resulting contact matrix.

Epidemiological parameters

Description	Base case	Range
basic reproductive number (R_0)	2.2	(1.5, 3.2)
relative rate of asymptomatic transmission	0.375	(.25, .5)
proportion of individuals < 20 that do not ever experience symptoms	0.75	(.5, .9)
proportion of individuals 20-64 that do not ever experience symptoms	0.3	(.2, .4)
proportion of individuals 65+ that do not ever experience symptoms	0.3	(.2, .4)
average length of pre-symptomatic infected period	0.5	
average length of incubation period	5 days	(4-6)
average duration of infection	5 days	(3-7)
case fatality rate (< 20)	0	
case fatality rate (20-64)	0.005	
case fatality rate (65+)	0.1	
percentage of cases observed at baseline	0.13	(4-30)
number of cases observed at baseline	100	calibrated
ratio of latent group to infected group at baseline	1	
relative testing rate of kids	1	
relative infectiousness of kids	1	(.5-1)
relative susceptibility of kids	1	(.5-1)