Assessing the potential impact of COVID-19 on life expectancy

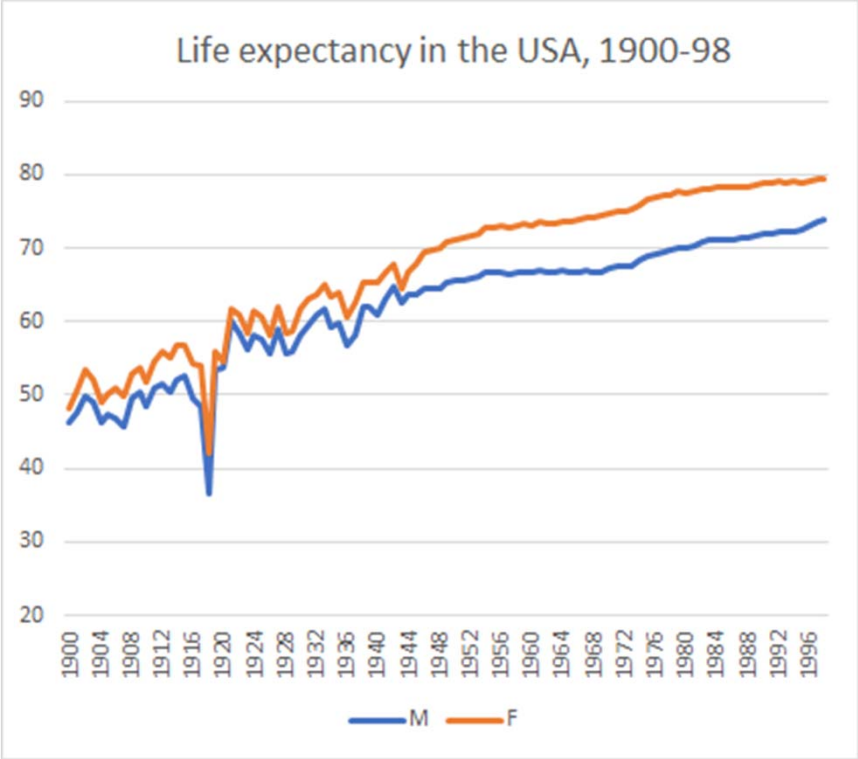
Guillaume Marois[1,2], Raya Muttarak[2,3], Sergei Scherbov[2]

1. Asian Demographic Research Institute, Shanghai University

2. Wittgenstein Centre for Demography and Global Human Capital, International Institute for Applied Systems Analysis (IIASA)

3. School of International Development, University of East Anglia

Demographic Consequences of COVID-19
IIASA-RANEPA Online Symposium
June 29, 2020


Life expectancy in the USA, 1900-98
90
80
70
60
50
40
30
20
1900
1904
1908
1912
1916
1920
1924
1928
1932
1936
1940
1944
1948
1952
1956
1960
1964
1968
1972
1976
1980
1984
1988
1992
1996
M
F

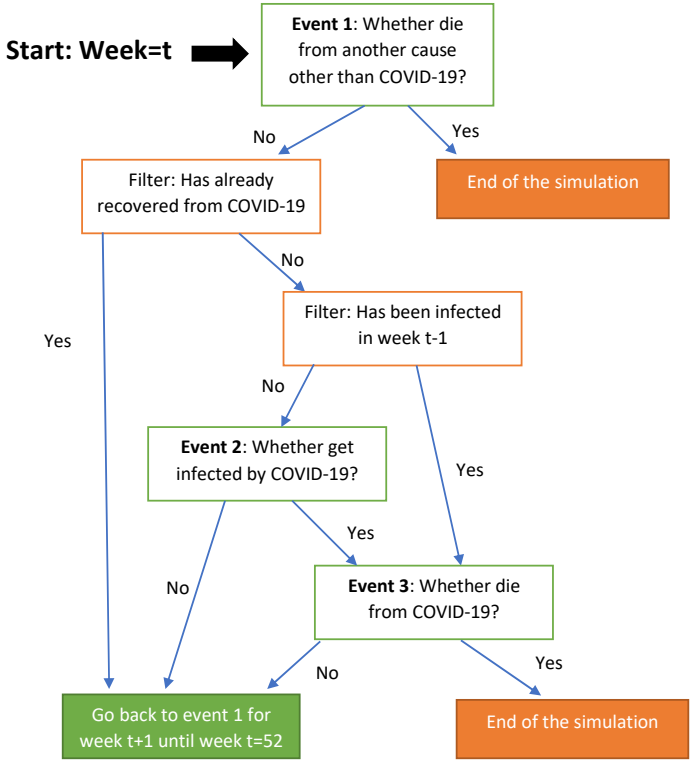
Objectives

- To provide first estimates of the potential impact of the COVID-19 pandemic on period life expectancy
  - Range of scenarios of bias-adjusted age-specific case fatality rates
  - Range of scenarios of prevalence rates
  - Applied to different life tables:
    - 1) North America and Europe;
    - 2) Latin America and the Caribbean;
    - 3) South Eastern Asia;
    - 4) Sub-Saharan Africa.
- Not a prediction of what will happen to life expectancy

Method: microsimulation

- Discrete-time microsimulation model that simulates the life of individuals week by week for a period of one year (built in SAS)
  - Parameters:
    - age-specific probabilities of dying (q_x): taken from aggregated lifetables (5-year age groups) (UN-World Population Prospects 2019);
    - prevalence rate of COVID-19 infection (i_x);
      - No age differential
      - distributed over the year following a normal distribution centered on the middle of the year and with a standard deviation of 10 weeks
    - length of illness (z), which is set at 2 weeks
    - age-specific probabilities of dying from COVID-19 among the infected population (f_x);

Schematic representation of the microsimulation model



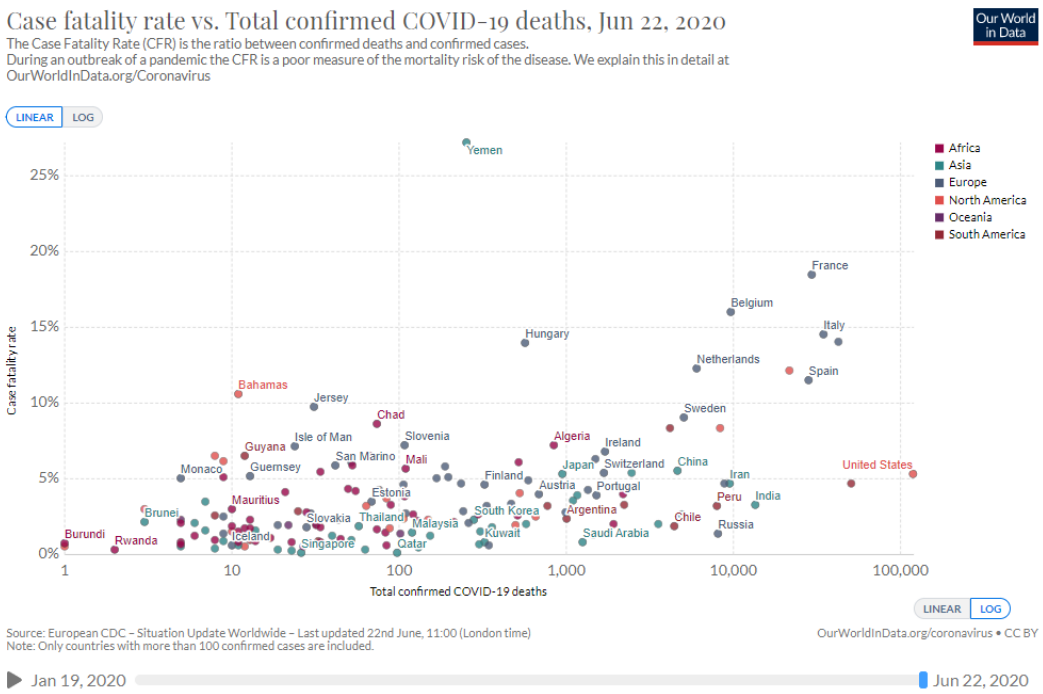
- Discrete time, 52 weeks
- 3 events:
  1. Probability of dying of any other causes (qx)
  2. Probability of getting infected by COVID-19 (ix)
     1. Can only happen once
     2. Last for two weeks
  3. Probability of dying of COVID-19 (fx)

- 100,000 simulations for each age group/region

What are fatality rates?

The official counts have many biases:

- Underreporting of milder cases → Upward bias in the fatality rate
- Time lags between diagnostic and death/recovery → downward bias in the fatality rate
- Methods vary among countries
  - France: 18%
  - Sweden: 10%
  - USA: 5%
  - Russia: 1%
  - Belarus: 0.5%

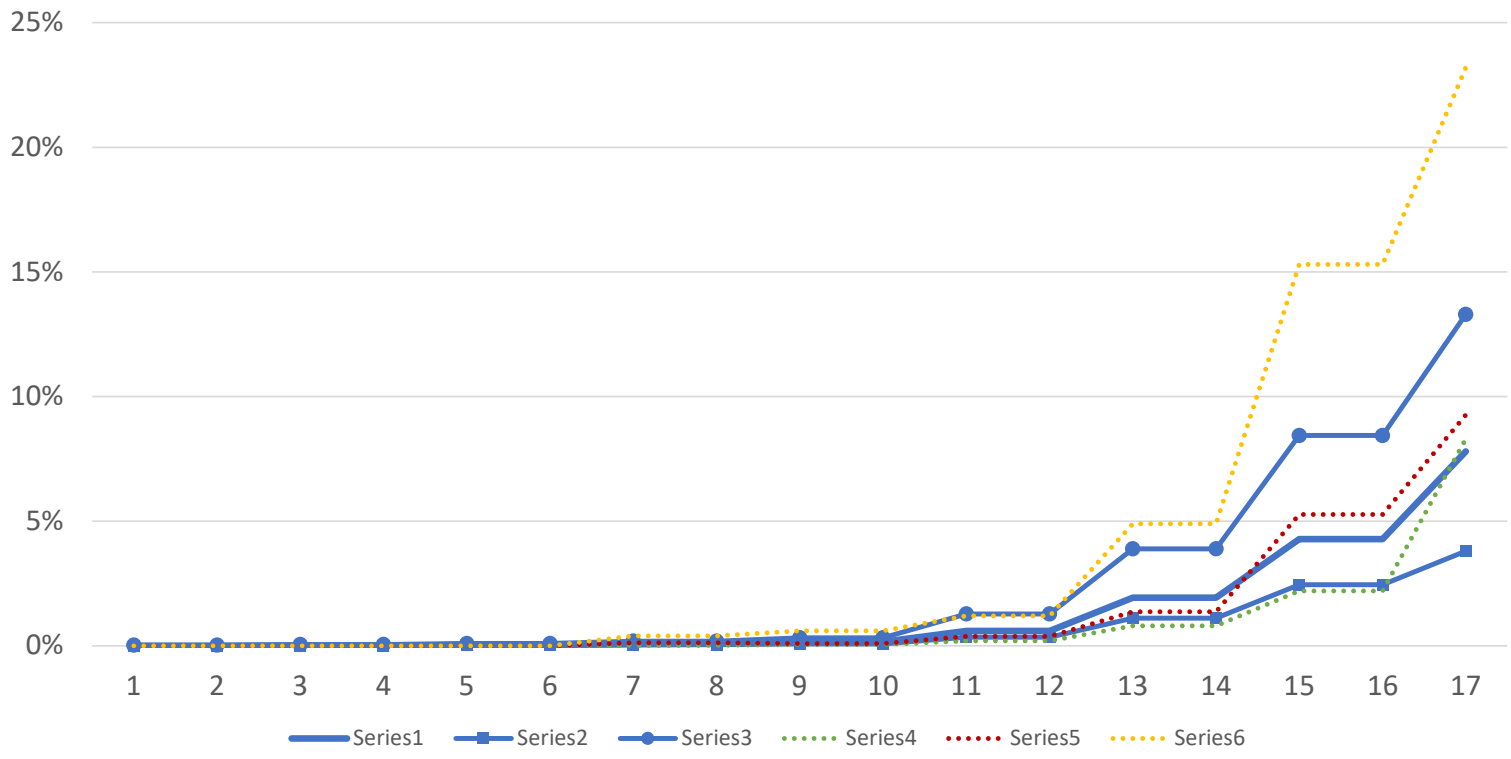


- Source of data for bias-adjusted age-specific case fatality rates

  Verity R, Okell LC, Dorigatti I, Winskill P, Whittaker C, Imai N, et al. (2020) Estimates of the severity of coronavirus disease 2019: a model-based analysis. The Lancet Infectious Diseases

  - accounting for censoring and ascertainment biases
  - Hubei, China

Age-specific fatality rates of COVID-19



There is no clear pattern in age-specific prevalence rates

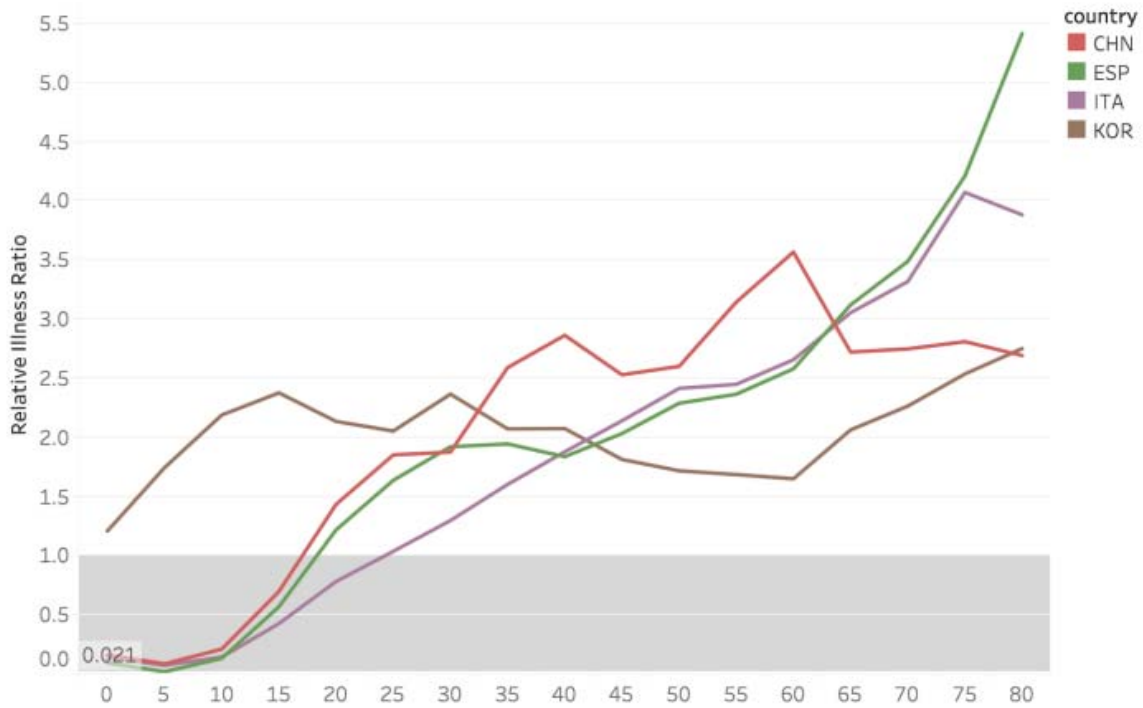


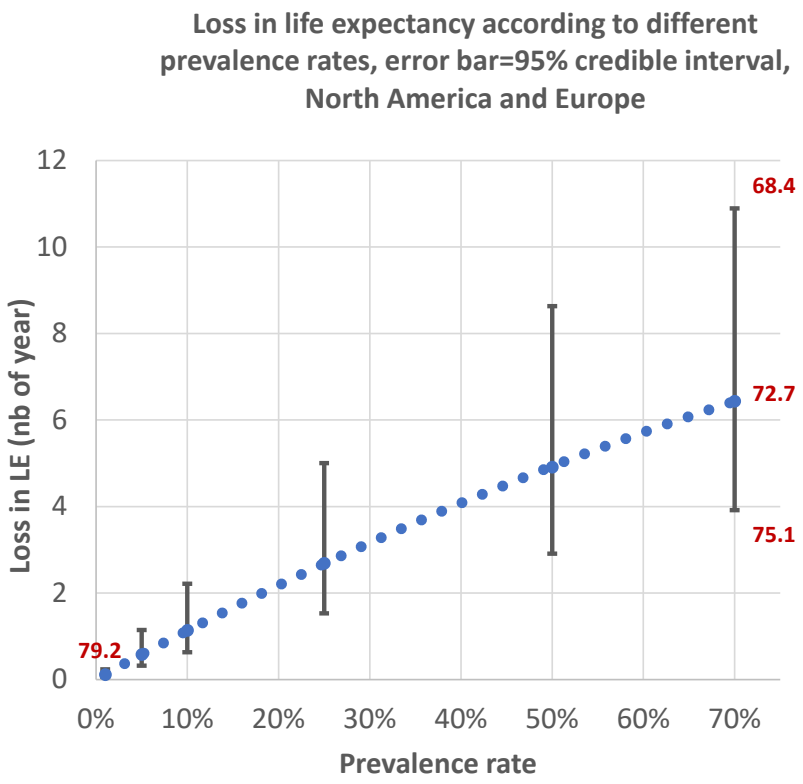
Figure 5 Relative Illness Ratio by 5-year age groups[4].

Source: Natale et al. 2020

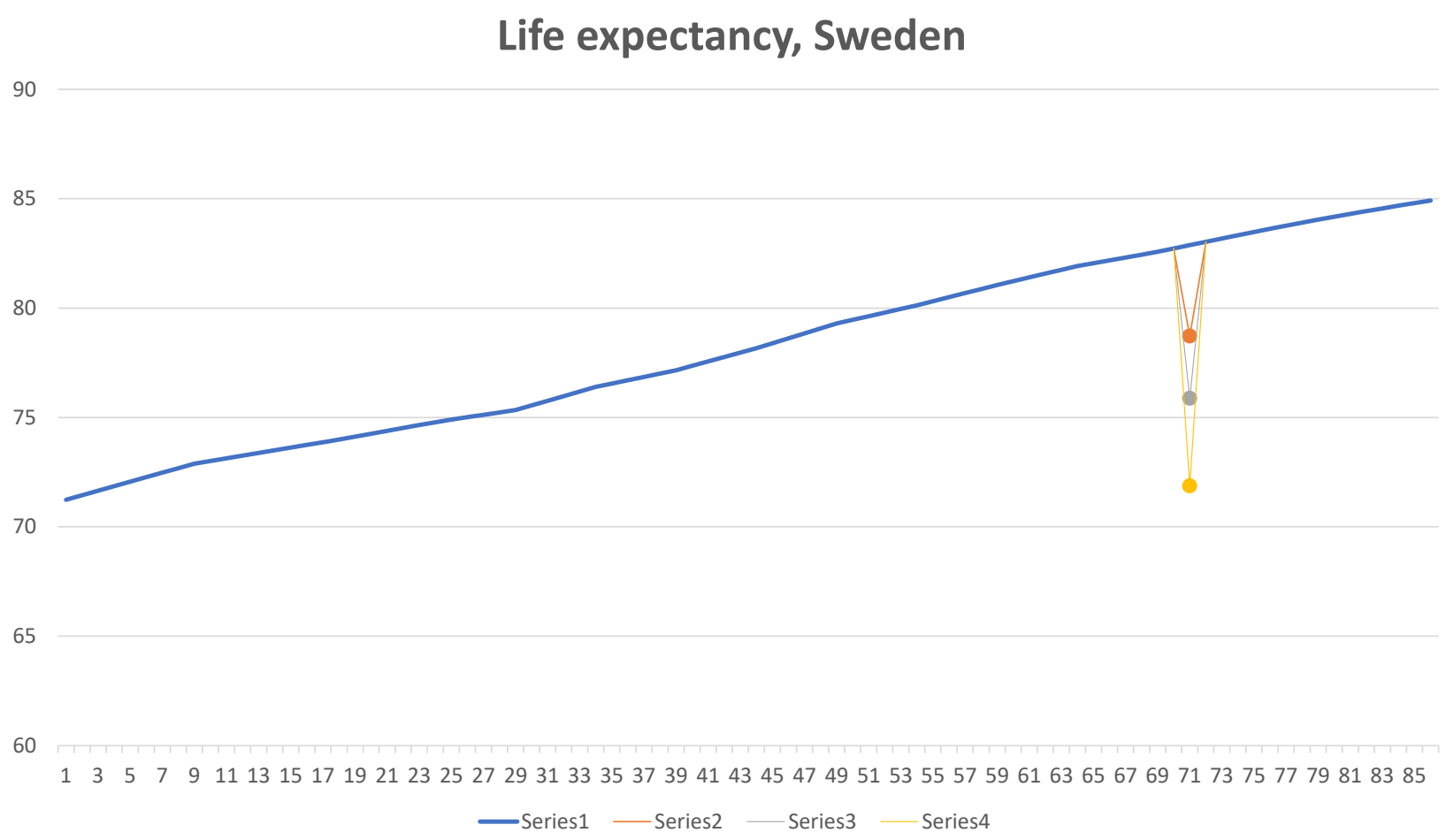
We tested 6 scenarios:

- 1% of the population infected over a year, no age differential;
- 5%;
- 10%;
- 25%;
- 50%;
- 70%

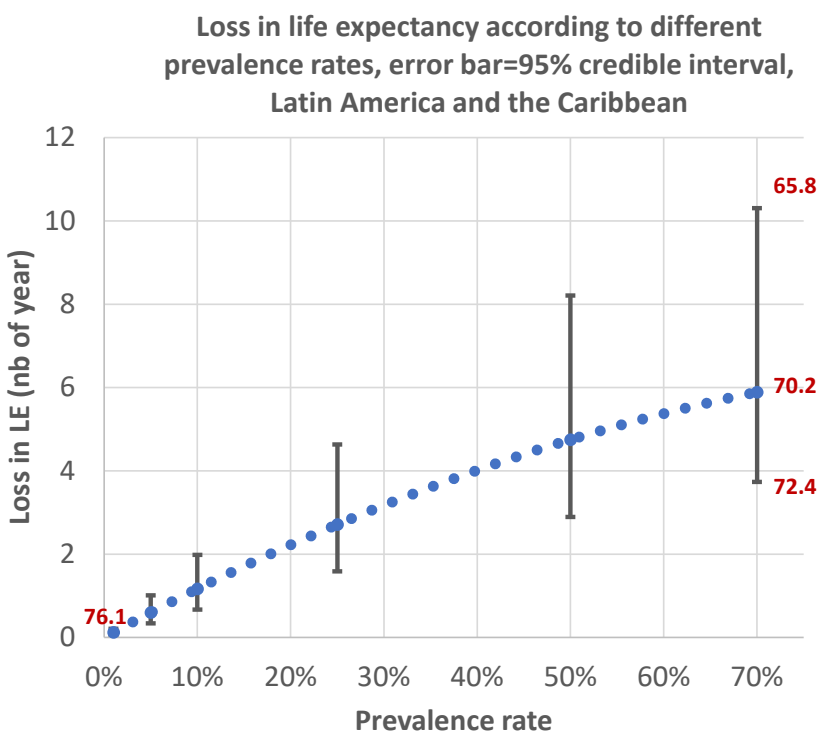
- In high life expectancy regions (North America and Europe), each percentage increase in the prevalence of COVID-19 infection would reduce life expectancy by about 0.1 year.
- At 10% of prevalence, one year is lost. At 70%, almost 7 years are lost.



Total fatality rate, North America and Europe	
f_x = central estimate	1%
f_x = lower limit 95% CrI	0.6%
f_x = upper limit 95% CrI	2.0%

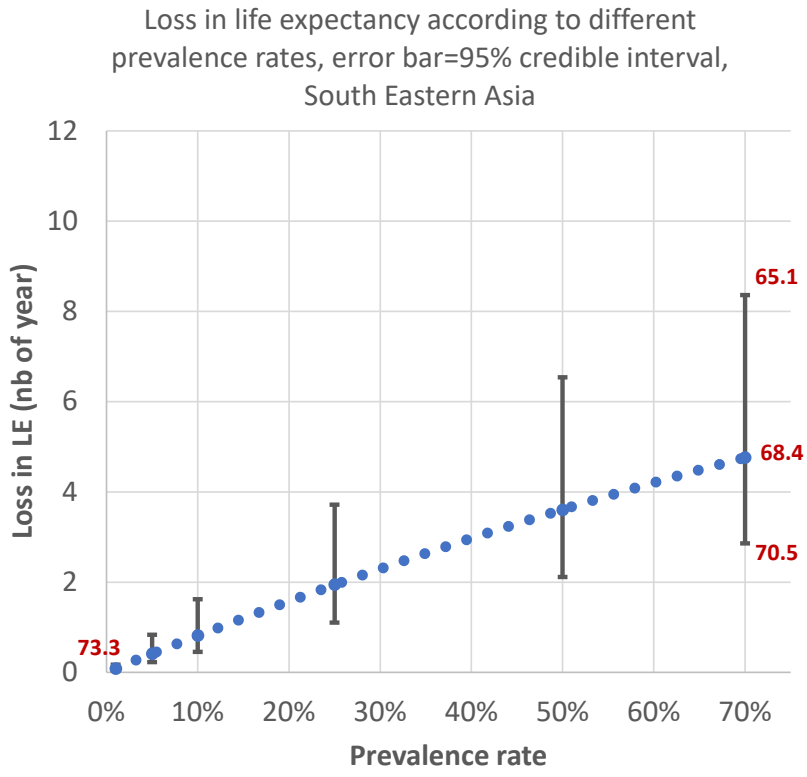

Life expectancy, Sweden
90
85
80
75
70
65
60
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59 61 63 65 67 69 71 73 75 77 79 81 83 85
Series1
Series2
Series3
Series4

- At 70% of prevalence rate, the loss in life expectancy reaches also about 6 years in Latin America and the Caribbean.
- The total fatality rate would however be much smaller than in North American and Europe because of a younger age structure.



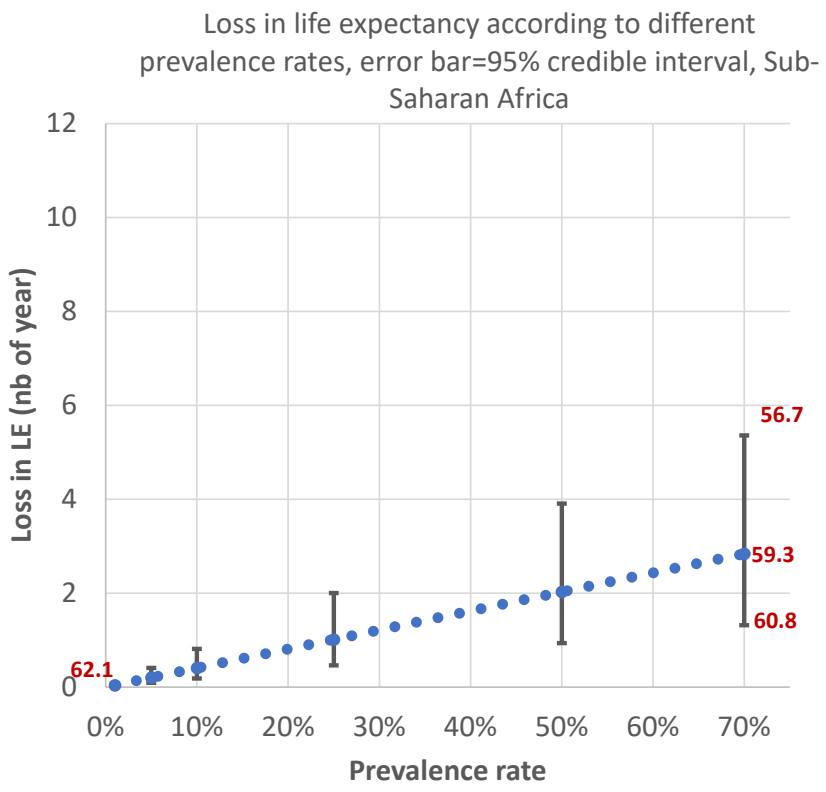
Total fatality rate, Latin America and the Caribbean	
f_x = central estimate	0.5%
f_x = lower limit 95% CrI	0.3%
f_x = upper limit 95% CrI	1.1%

- The less there are survivals at older ages in the life table, the lower is the impact of COVID-19 on the life expectancy.
- One year lost in life expectancy corresponds to a prevalence of infection of about 15% in South Eastern Asia.



Total fatality rate, South Eastern Asia	
f_x = central estimate	0.5%
f_x = lower limit 95% CrI	0.2%
f_x = upper limit 95% CrI	0.9%

- In low life expectancy regions, the impact of COVID-19 would be smaller.
- One year lost in life expectancy would be lost with a prevalence rate of 25%. At 70%, 3 years are lost.
- In Sub-Saharan Africa, assuming the same age-specific fatality rates, the total fatality rate would be 5 times lower than in North America and Europe because of the age structure.



Total fatality rate, Sub-Saharan Africa	
f_x = central estimate	0.2%
f_x = lower limit 95% CrI	0.1%
f_x = upper limit 95% CrI	0.4%

Summary

- As long as the prevalence of COVID-19 infection remains low in a region, the pandemic would not affect life expectancy substantially
- At merely 2% of prevalence of COVID-19 infection, the secular increase in life expectancy (0.2) is likely to be suspended
- At 10% of prevalence, the loss in life expectancy is likely be above 1 year in high life expectancy countries
- At 70%, it would translate into the years of life lost between 4 to 11 years in high life expectancy regions, between 3 to 9 years in medium life expectancy regions and between 1 to 5 in low life expectancy regions.
  - A clear break in the historical trend might be observed and would be visible when plotting the age pyramids in the coming few years
- The evidence from our modelling could be applied to specific areas as well as to countries as a whole at given level of prevalence

Some limitations

- The results should be interpreted in the context that all other things are kept constant, albeit being rather unrealistic
  - likely the true age-specific case-fatality rates differ among regions given country differentials in policy interventions, health infrastructure and population behaviors
- Mortality rates are not independent of the prevalence of COVID-19 infection
  - health infrastructures are likely to be overloaded and to not be able to provide care for everyone who needs it, resulting in higher mortality rates both from the virus itself and from other causes

Thank you

marois@iiasa.ac.at