Demographic account of COVID19 statistics

Dalkhat M. Ediev

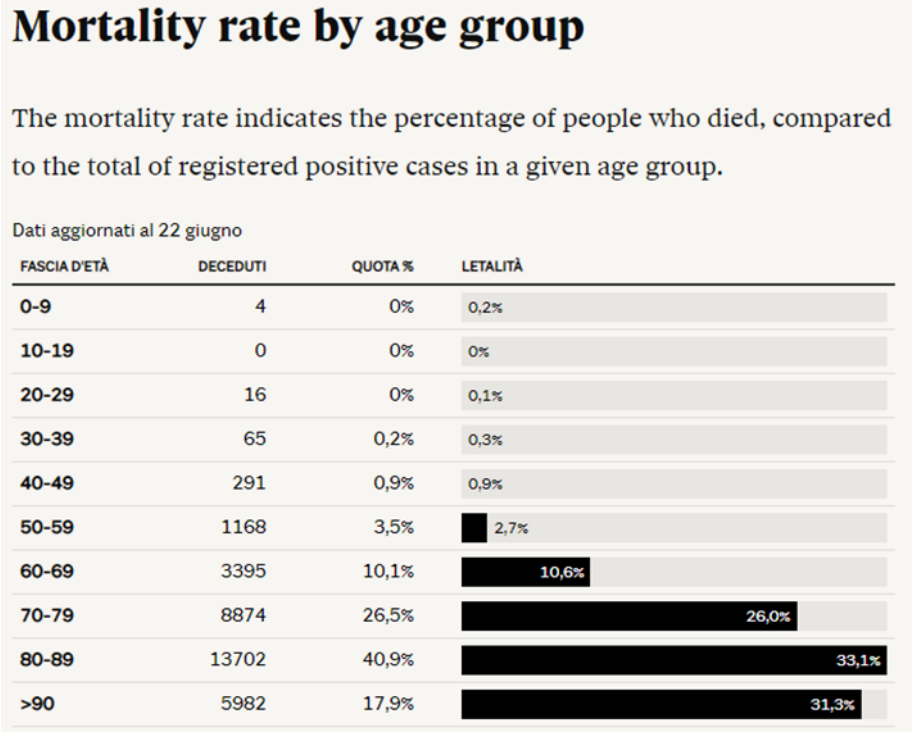
(ediev@iiasa.ac.at; dalkhat@hotmail.com)

Demographic Consequences of COVID-19

IIASA and RANEPA June 29, 2020

Why to account it demographically?

- Demographic cost (lives, years lost, excess mortality) of the pandemic
- Comparing scenarios for lockdown, fatality, vaccination, weather etc.
- Post factum checks of COVID statistics
- Mortality vs fatality in addressing questions:
  - Is the COVID-related mortality ‘really’ high?
  - Is the COVID-related mortality higher than flue-related one? [Mind different timing]
  - Is the virus selectively fatal for elderly?
  - What would happen IF the prevalence of the infection were higher/lower?



Mortality rate by age group

The mortality rate indicates the percentage of people who died, compared to the total of registered positive cases in a given age group.

Dati aggiornati al 22 giugno

FASCIA D'ETÀ	DECEDUTI	QUOTA %	LETALITÀ
0-9	4	0%	0,2%
10-19	0	0%	0%
20-29	16	0%	0,1%
30-39	65	0,2%	0,3%
40-49	291	0,9%	0,9%
50-59	1168	3,5%	2,7%
60-69	3395	10,1%	10,6%
70-79	8874	26,5%	26,0%
80-89	13702	40,9%	33,1%
>90	5982	17,9%	31,3%

[https://lab24.ilsole24ore.com/coronavirus/]

Demographic account: o/e rates

- Types of exposure (aca. SIR)
  - E_0: person-years before getting infected
  - $E_1 = iE_0\gamma_E\Delta$: person-years while infected
  - $E_2 = E - E_0(1 + i\gamma_E\Delta)$: person-years after recovery

$$E_2 = \beta i E_0 (1-f)(T - \gamma_E\Delta - a_0)$$

$$\boldsymbol{E_0 = \frac{E}{1 + \beta i (1-f)(T - \gamma_E\Delta - a_0) + i\gamma_E\Delta}}$$

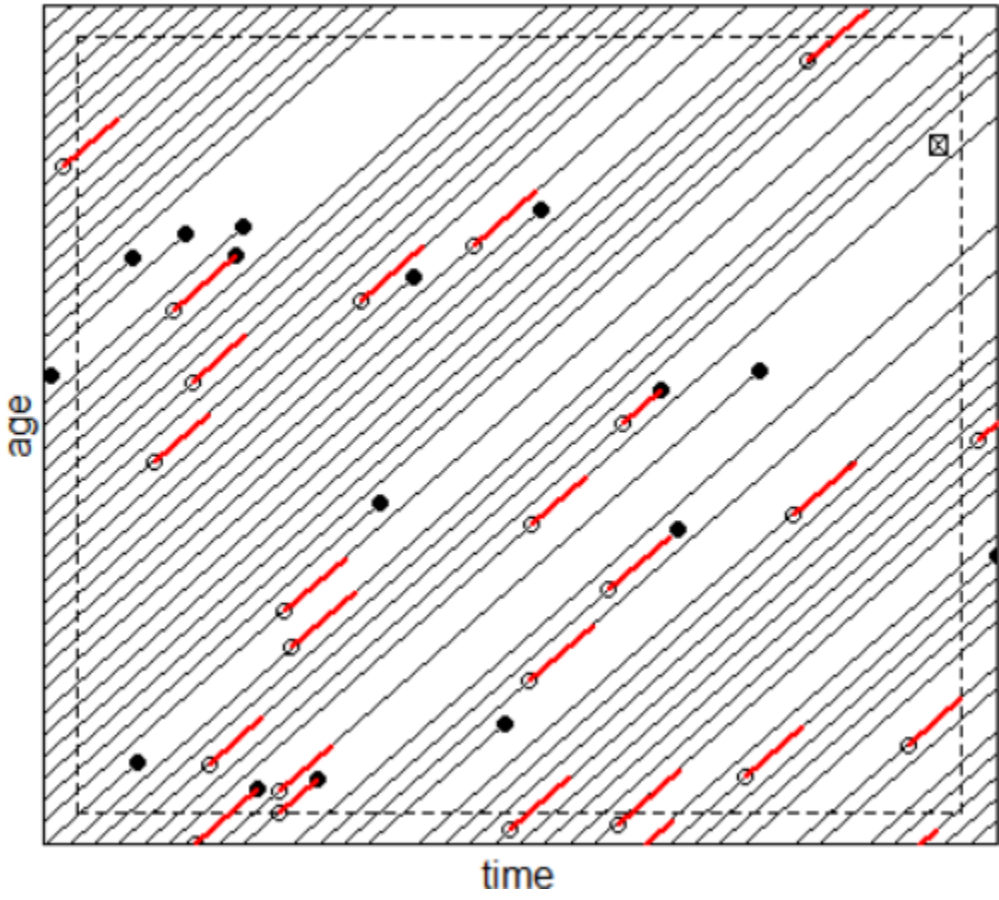
- Deaths in three states

$$D_0 = E_0 m_0$$

$$D_1 = E_1 m_1 = D_{10} + D_{11} = E_1 m_{10} + I\gamma f^C$$

$$m_1 = m_{10} + \frac{\gamma f^C}{\gamma_E\Delta} \qquad \boldsymbol{f^C = f - m_0\frac{\gamma_E\Delta}{\gamma}}$$

$$D_2 = E_2 m_2 = \big(E - E_0(1 + i\gamma_E\Delta)\big)m_2$$



Demographic account: o/e rates

- The period death rate

$$m = \frac{D}{E}$$

$$= m_0 + \frac{i\gamma_E\Delta(m_{10} - m_0) + \beta i(1-f)(T - \gamma_E\Delta - a_0)(m_2 - m_0)}{1 + \beta i(1-f)(T - \gamma_E\Delta - a_0) + i\gamma_E\Delta} + \frac{i\gamma f^C}{1 + \beta i(1-f)(T - \gamma_E\Delta - a_0) + i\gamma_E\Delta}$$

Scenario 0. No correlation between CoVid and 'usual' mortality: $m_{10} = m_2 = m_0$

$$m = m_0 + \frac{i\gamma f^C}{1 + \beta i(1-f)(T - \gamma_E\Delta - a_0) + i\gamma_E\Delta}$$

$$f^C = f - m_0\frac{\gamma_E\Delta}{\gamma}$$

Scenario 1. CoVid-deaths are selective $m_2 < m_0$

$$m = m_0 + \frac{i\gamma f^C}{1 + \beta i(1-f)(T - \gamma_E\Delta - a_0) + i\gamma_E\Delta} + i\frac{\beta(1-f)(T - \gamma_E\Delta - a_0)}{1 + \beta i(1-f)(T - \gamma_E\Delta - a_0) + i\gamma_E\Delta}(m_2 - m_0)$$

Relating fatality to mortality

- The period death rate (scenario 0)

$$m = m_0 + \frac{i\gamma f^c}{1 + \beta i(1-f)(T - \gamma_E \Delta - a_0) + i\gamma_E \Delta}$$

CHINA

worldometers.info/coronavirus/

Age	Covid fatality	Age-specific death rate
10-19	0.2	0.03
20-29	0.2	0.06
30-39	0.2	0.09
40-49	0.4	0.18
50-59	1.3	0.47
60-69	3.6	1.56
70-79	8.0	4.82
80+	14.8	13.42

ITALY

10.1101/2020.03.15.20036293v1 (1)

lab24.ilsole24ore.com/coronavirus/ (2)

Age	Covid fatality (1)	Covid fatality (2)	Age-specific death rate
10-19	0.0	0.0	0.01
20-29	0.0	0.1	0.03
30-39	0.2	0.3	0.04
40-49	0.2	0.9	0.12
50-59	0.8	2.7	0.31
60-69	2.7	10.6	0.78
70-79	10.8	26	2.11
80-89	17.5	33.1	7.51
90+	21.1	31.3	21.92

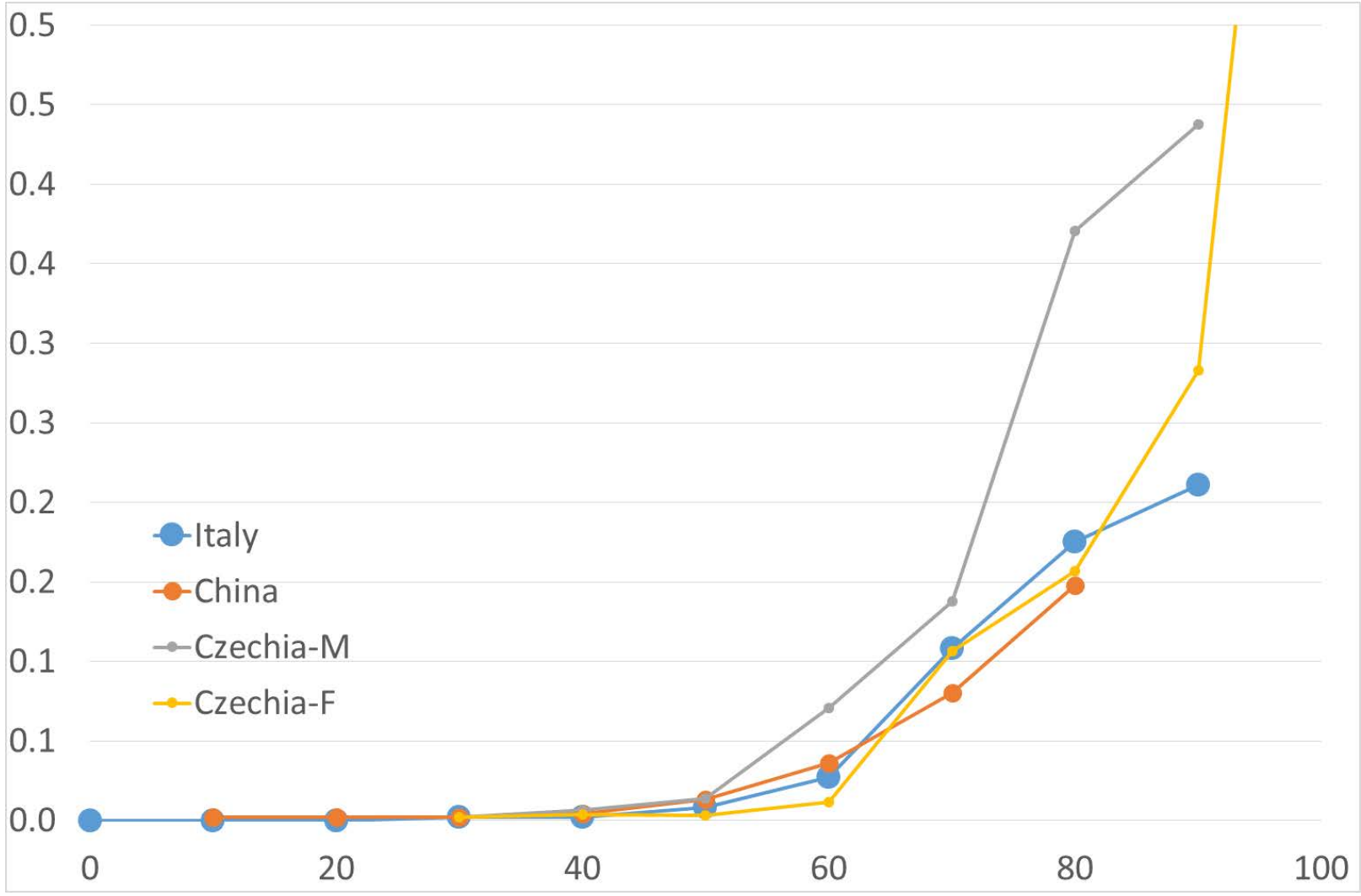
CZECHIA

Krystof Zeman

Age	Covid fatality	Age-specific death rate
30-39	0.2	0.1/0.0
40-49	0.7/0.3	0.2/0.1
50-59	1.4/0.3	0.5/0.3
60-69	7.1/1.1	1.5/0.7
70-79	13.8/10.6	3.5/1.9
80-89	37.1/15.6	8.7/6.5
90-99	43.8/28.3	25.1/22.1
100+	-/100	72.8/71.9

Relating fatality to mortality

Fatality by age:

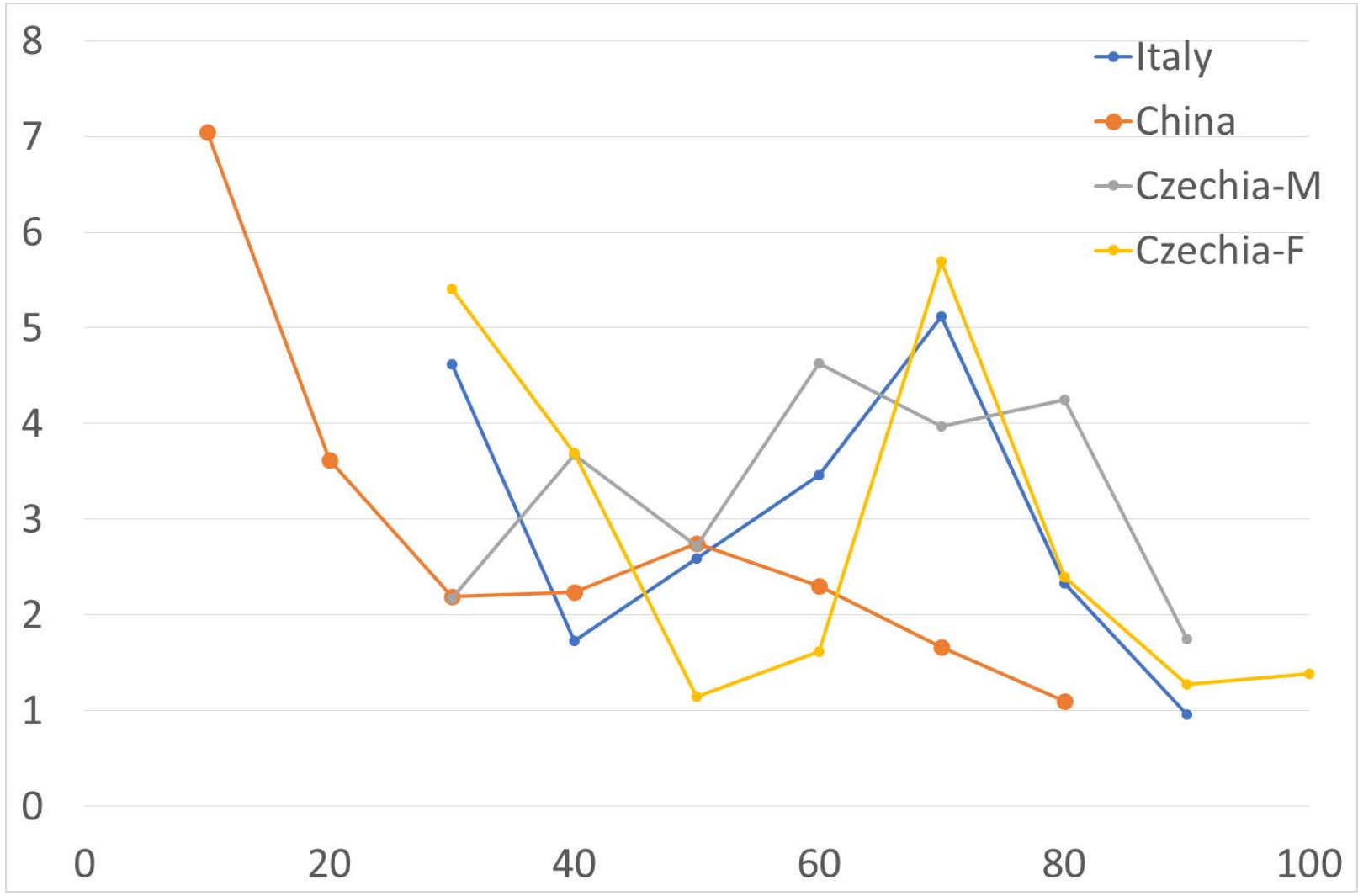


Relating fatality to mortality

Fatality per Mortality by age:

$$m = m_0 + \frac{i\gamma f^C}{1 + \beta i(1-f)(T - \gamma_E \Delta - a_0) + i\gamma_E \Delta}$$

$$f^C = f - m_0 \frac{\gamma_E \Delta}{\gamma}$$



Relating fatality to mortality

f=2*m0

	30	40	50	60	70	80	90
I \ m/m0	**0.000433**	**0.001159**	**0.003084**	**0.007789**	**0.021077**	**0.07513**	**0.219195**
0.01	2%	2%	2%	2%	2%	2%	2%
0.025	5%	5%	5%	5%	5%	5%	5%
0.05	10%	10%	10%	10%	10%	10%	10%
0.1	20%	20%	20%	20%	20%	20%	20%
0.2	43%	43%	43%	43%	43%	43%	43%
0.3	67%	67%	67%	67%	67%	67%	67%
0.4	94%	94%	94%	94%	94%	94%	94%

I	e0 increase
1%	**0.2**
3%	**0.5**
5%	**1.0**
10%	**2.0**
20%	**4.1**
30%	**6.5**
40%	**9.1**

f=3*m0

	30	40	50	60	70	80	90
I \ m/m0	**0.000433**	**0.001159**	**0.003084**	**0.007789**	**0.021077**	**0.07513**	**0.219195**
0.01	3%	3%	3%	3%	3%	3%	3%
0.025	8%	8%	8%	8%	8%	8%	8%
0.05	15%	15%	15%	15%	15%	15%	15%
0.1	32%	32%	32%	32%	32%	32%	32%
0.2	72%	72%	72%	72%	72%	72%	72%
0.3	121%	121%	121%	121%	121%	121%	121%
0.4	183%	183%	183%	183%	183%	183%	183%

I	e0 increase
1%	**0.3**
3%	**0.7**
5%	**1.5**
10%	**3.1**
20%	**6.9**
30%	**11.6**
40%	**17.6**

e0=80; H=0.12; pars=1

What prevalence will we have in the end? Mind heterogeneity!

Population heterogeneity is a critical factor of the kinetics of the COVID-19 epidemics

Dalkhat M. Ediev

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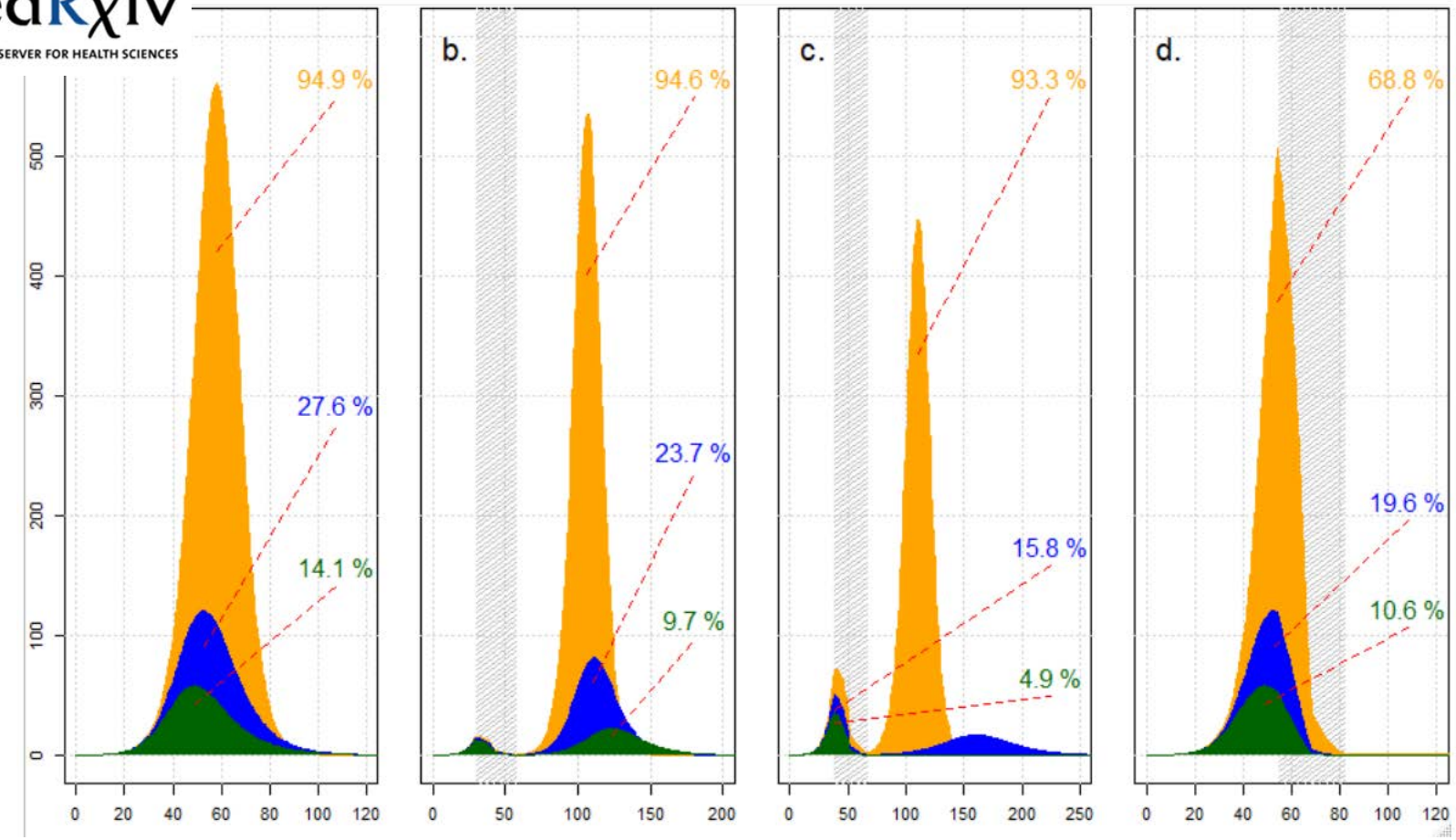

We may expect losses of Life Expectancy

of 1-3 years (heterogeneous case)

or in dozens of years (homogeneous case)

Stay negative, live long!

ediev@iiasa.ac.at
dalkhat@hotmail.com