Estimating effective infection fatality rates during the course of the COVID-19 pandemic in Germany

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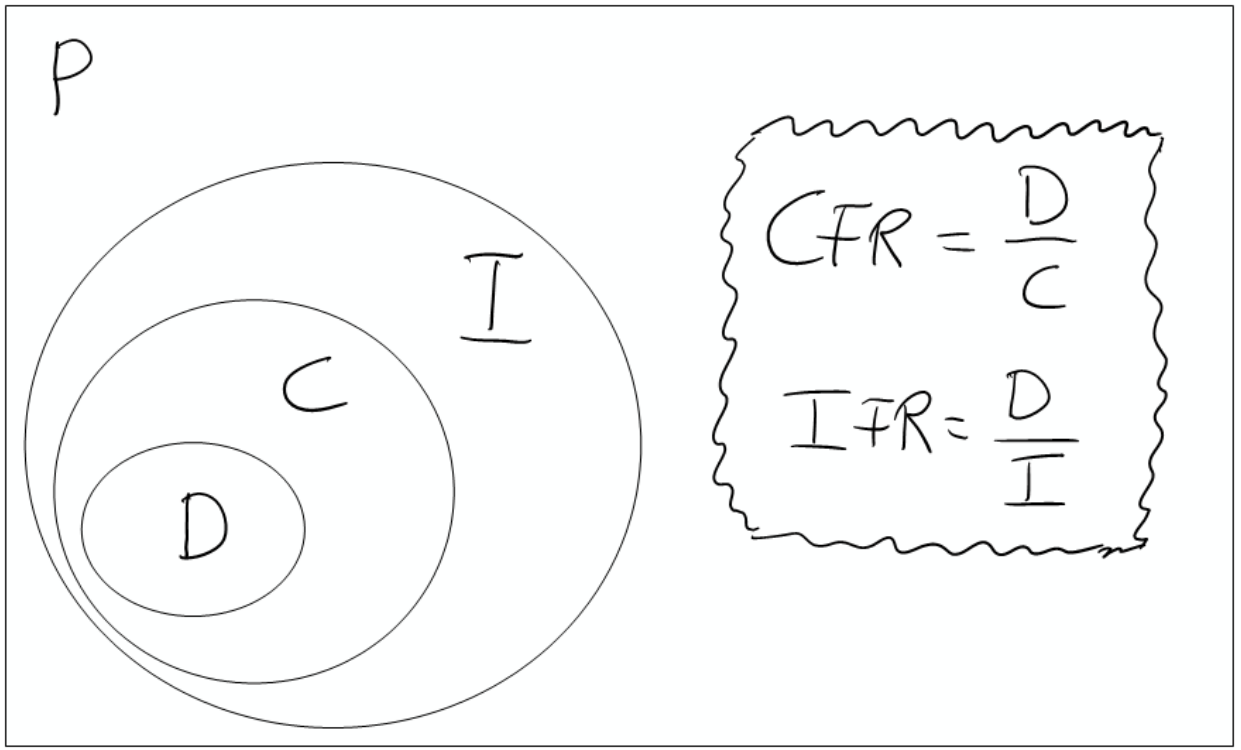
DGEpi 2021

20.09.2021

Probability of death?

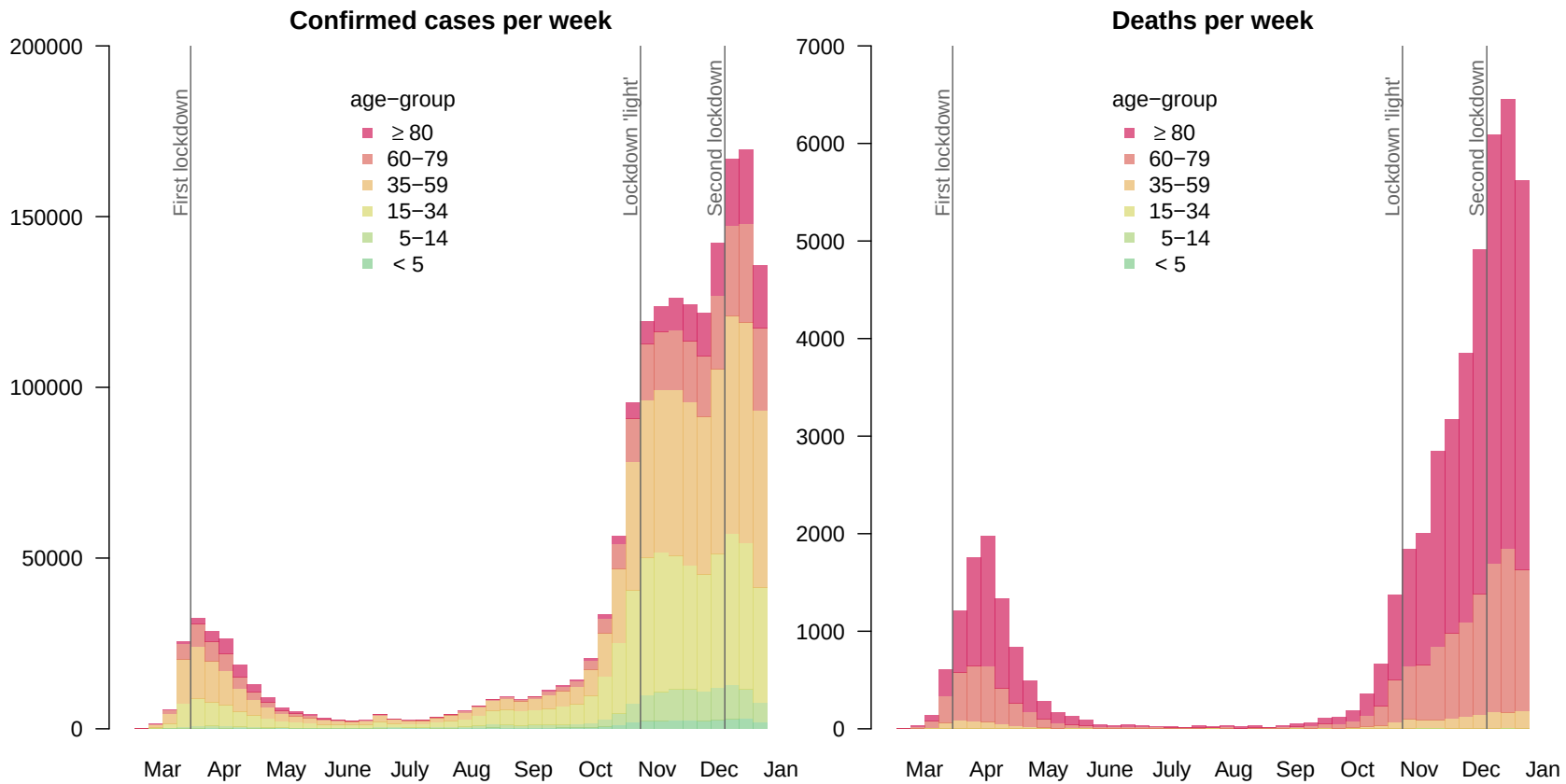


Conditional probabilities

→ **Case Fatality Rate (CFR)**

→ **Infection Fatality Rate (IFR)**

COVID-19 pandemic in Germany (2020)



→ **Age-specific IFR and CFR**

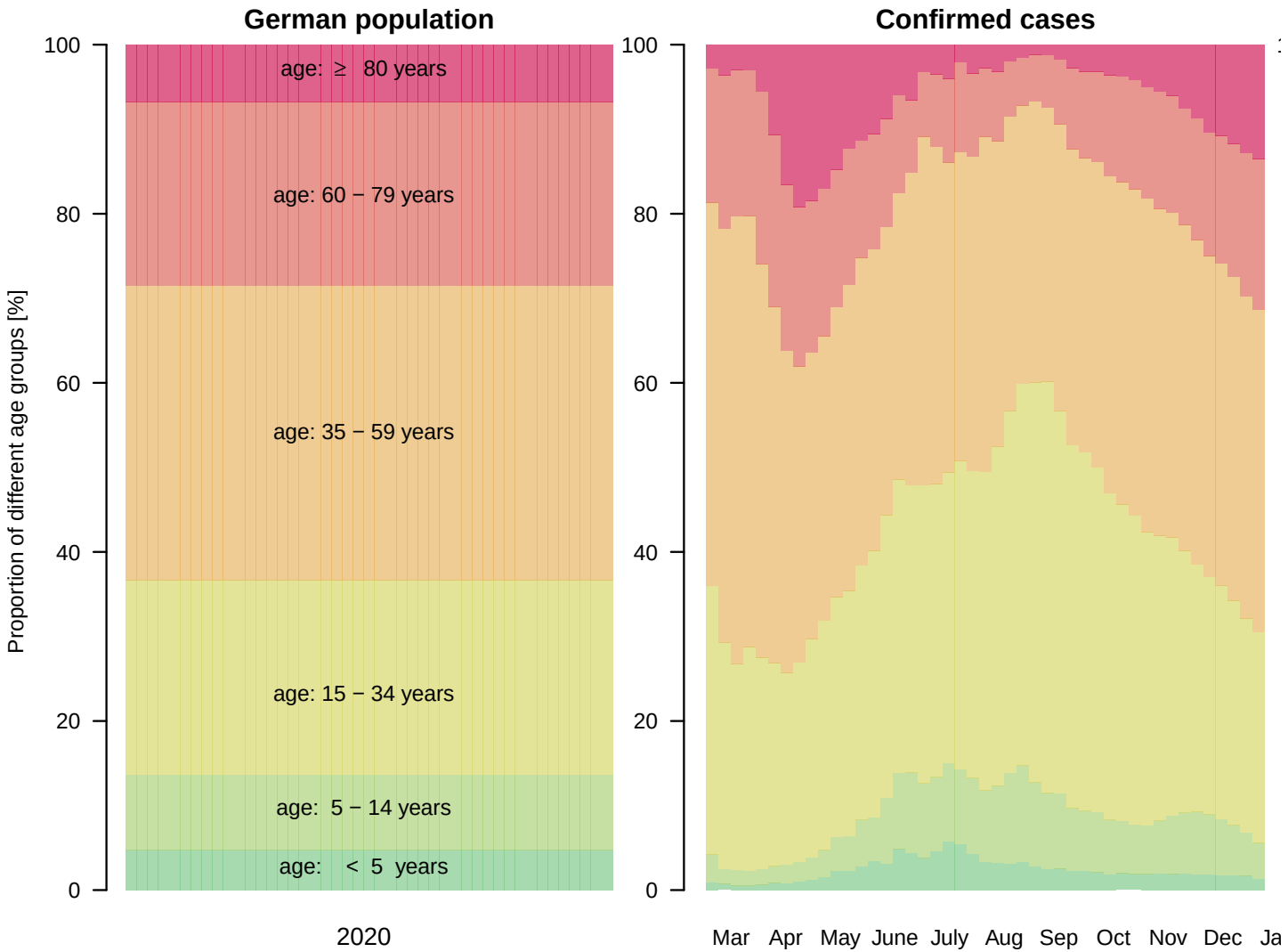
Age-specific IFR

Age group-specific IFR estimates (in 2020)

Age group	O'Driscoll [5]	Verity [11]
0-4	0.002 [0.001; 0.002]	0.002 [0.000; 0.025]
5-14	0.000 [0.000; 0.000]	0.004 [0.001; 0.037]
15-34	0.009 [0.007; 0.010]	0.041 [0.019; 0.110]
35-59	0.122 [0.115; 0.128]	0.349 [0.194; 0.743]
60-79	0.992 [0.942; 1.045]	2.913 [1.670; 5.793]
80+	7.274 [6.909; 7.656]	7.800 [3.800; 13.30]
$\overline{\text{IFR}}^{(i)}_{\text{DE}}$	0.756 [0.717; 0.796]	1.296 [0.694; 2.453]

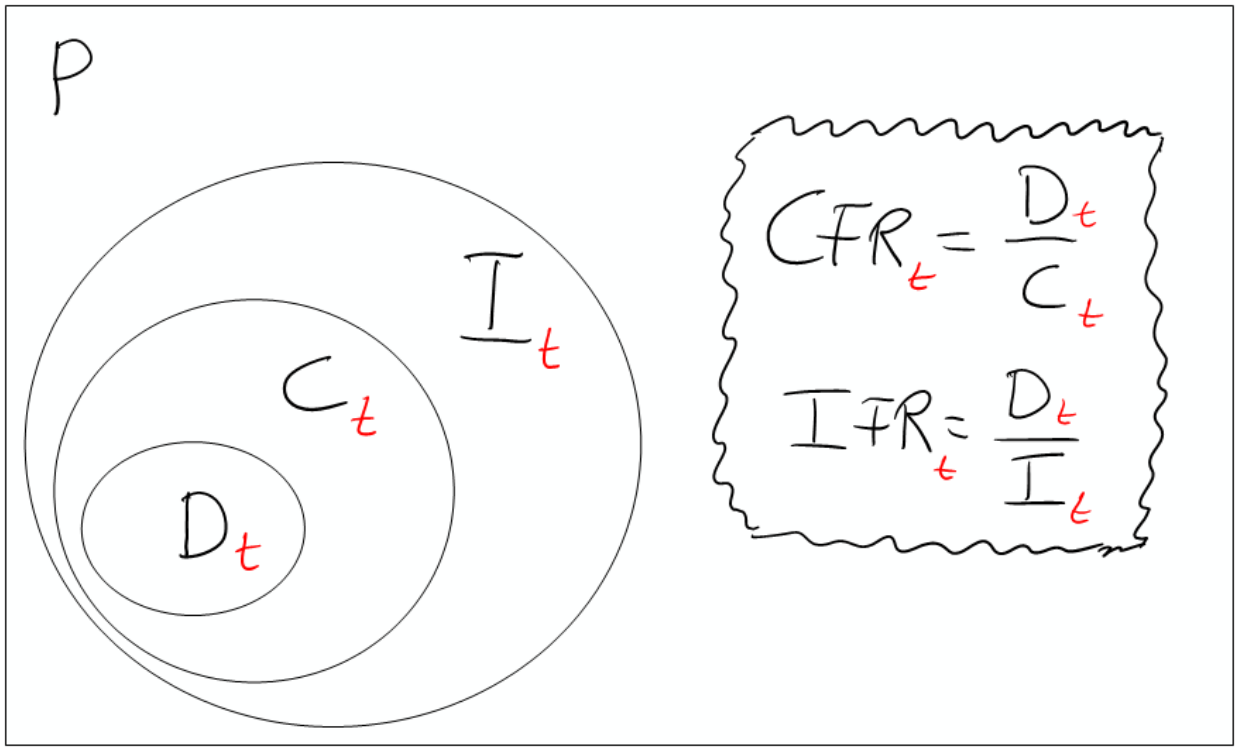
IFR estimates are given in percentages (with 95% confidence intervals in brackets)

Evolving age distribution of cases in 2020



→ **Age- and time-dependent infection risk**

Effective IFR and CFR are dynamic



P: Population

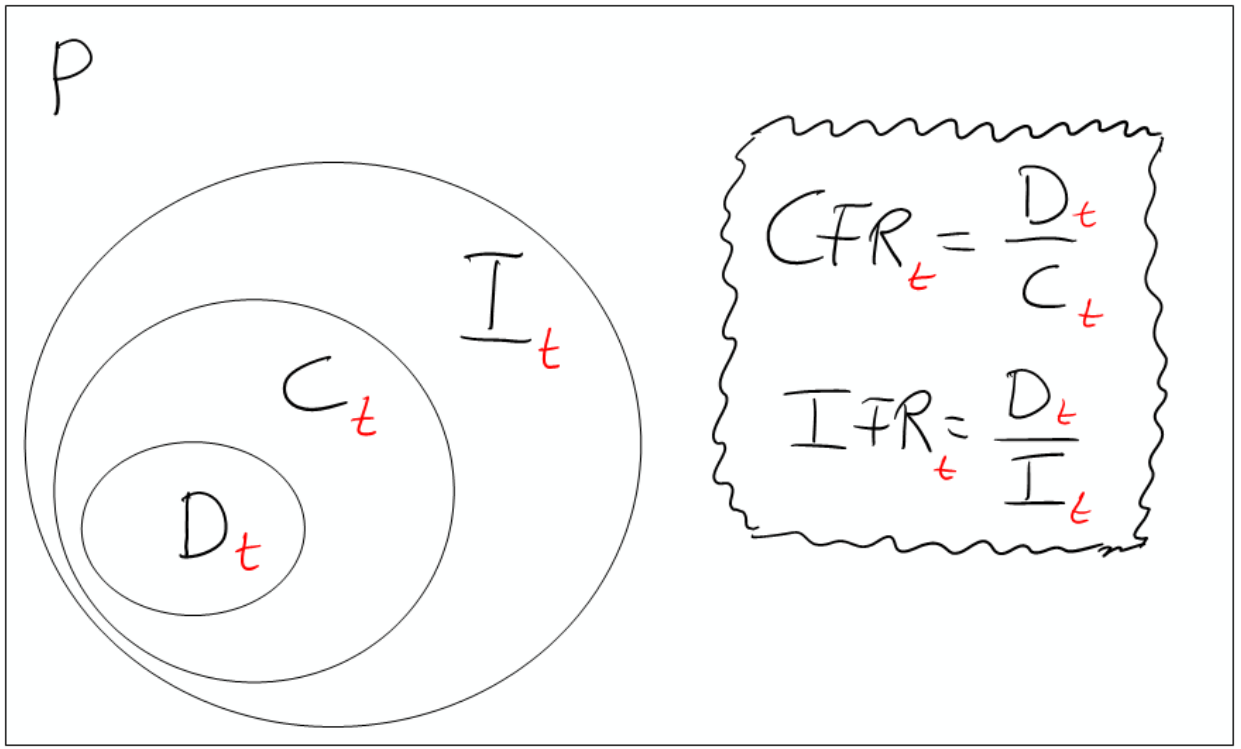
I_t: Infections

C_t: Cases

D_t: Deaths

t: Time

Effective IFR and CFR are dynamic

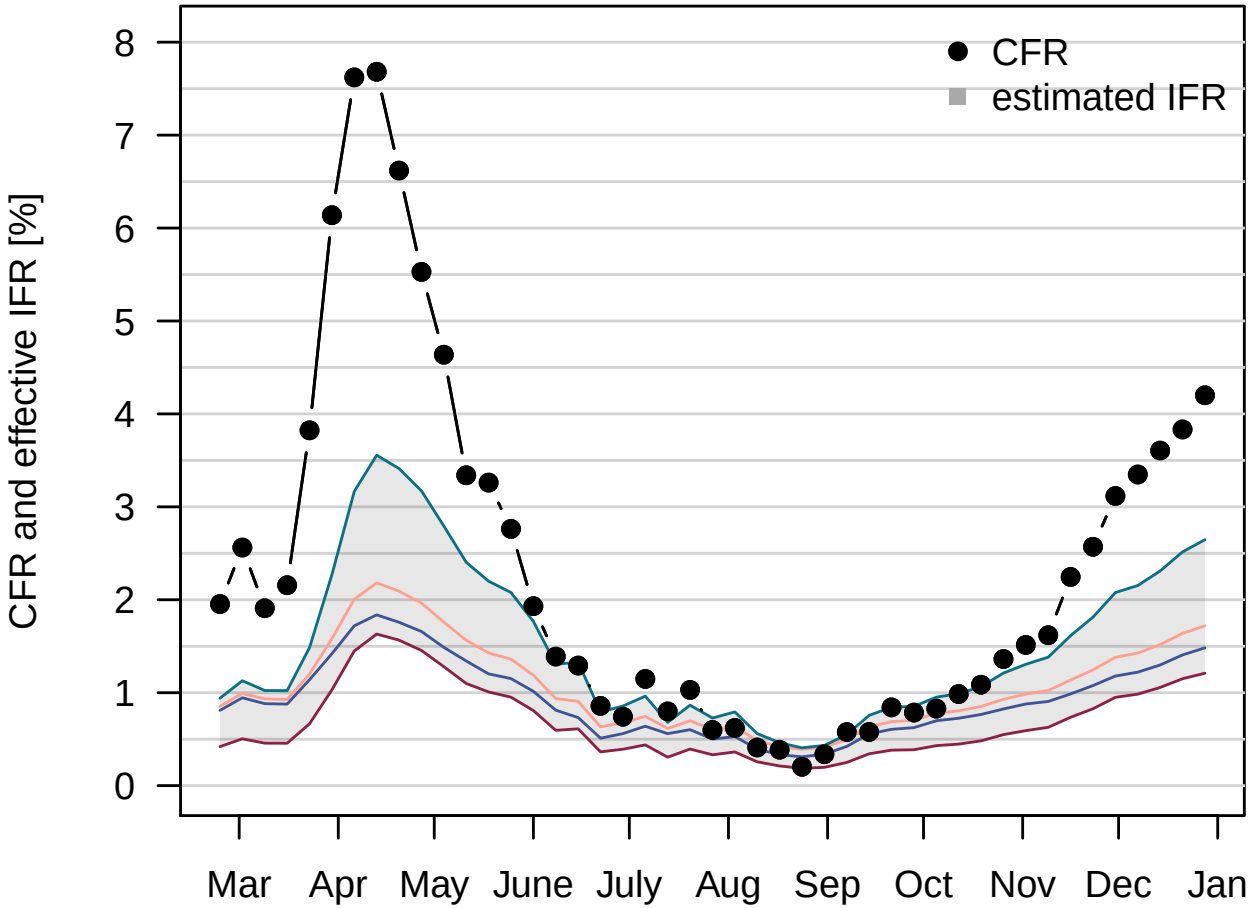


Effective IFR estimated by weighted average of age group-specific IFR estimates from different studies (i):

$$\widehat{\text{IFR}}^{(i)}_{\text{eff},t} = \sum_{a \in A} \hat{\omega}_{a,t} \cdot \widehat{\text{IFR}}^{(i)}_{a} \,,$$

with $\hat{\omega}_{a,t}$ estimated fraction of infections in age group a in week t.

Effective IFR and CFR in 2020



→ Effective IFR and CFR reflect changing age distribution of infections/cases

Conclusion

- Age-specific IFR and CFR
- Age- and time-dependent infection risk
  (also when accounting for dark figures)

  $\rightarrow$ Effective IFR and CFR are dynamic over time

Staerk, Wistuba, & Mayr (2021). Estimating effective infection fatality rates during the course of the COVID-19 pandemic in Germany. BMC Public Health 21, 1073.

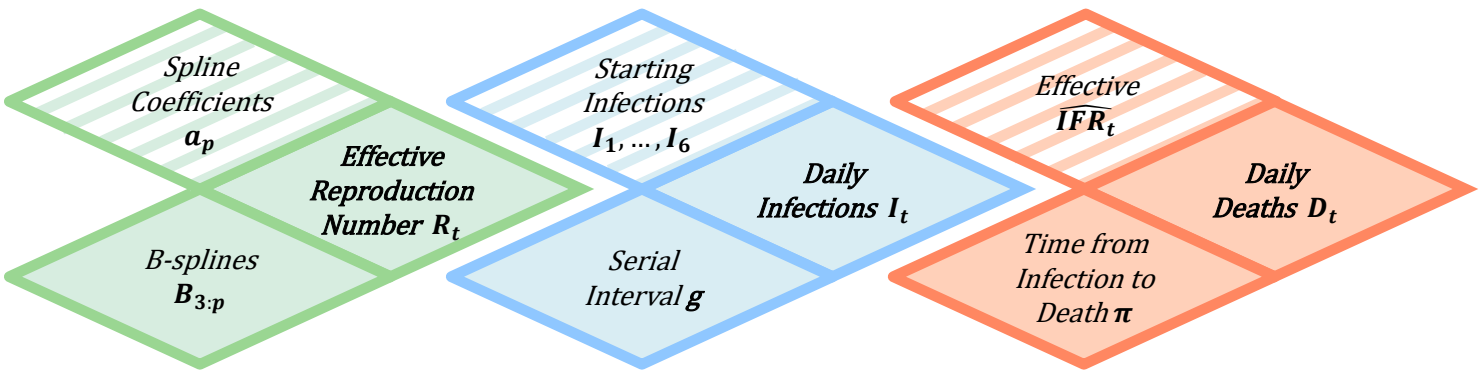
Conclusion

- Age-specific IFR and CFR
- Age- and time-dependent infection risk
  (also when accounting for dark figures)

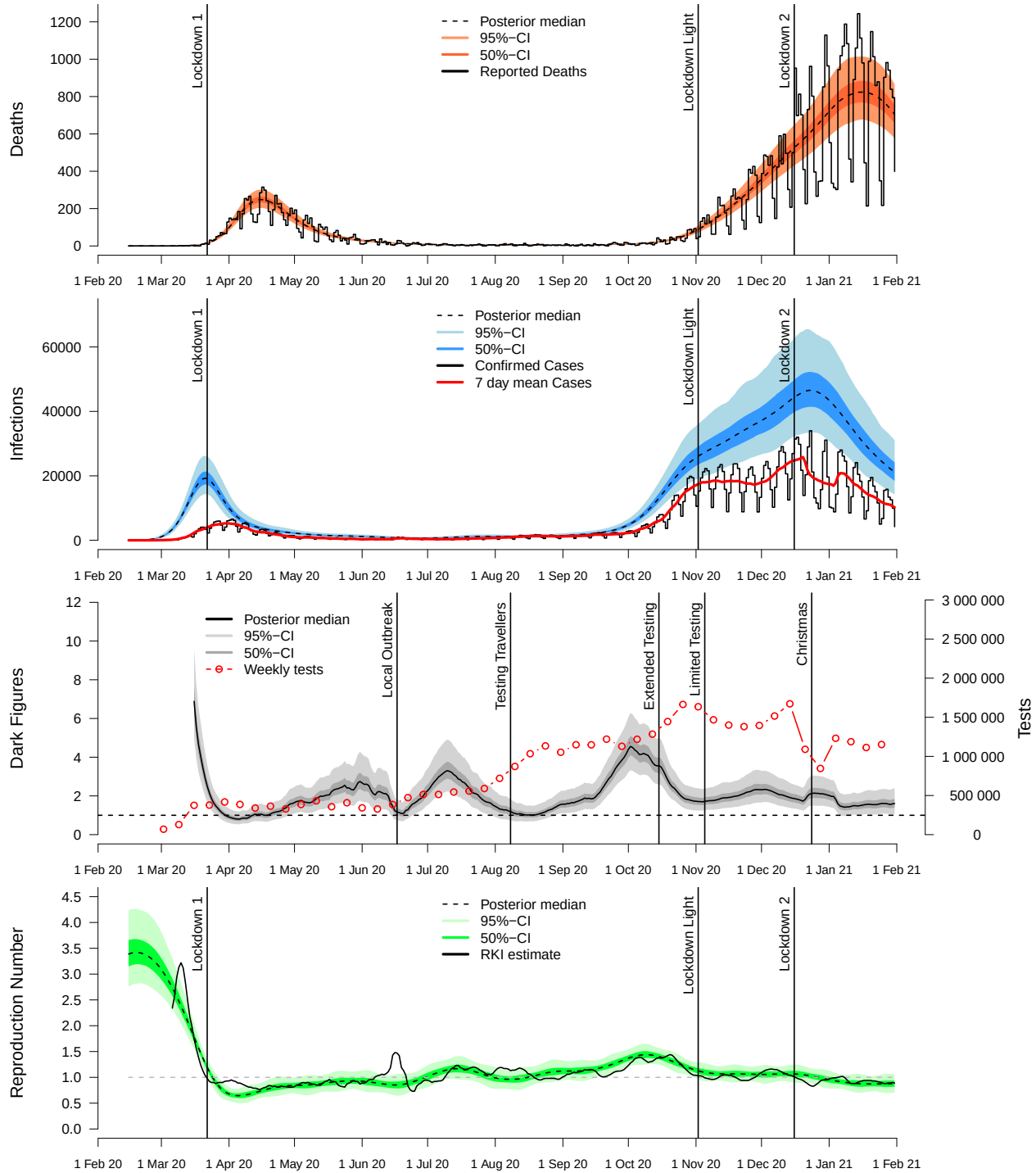
  $\rightarrow$ Effective IFR and CFR are dynamic over time

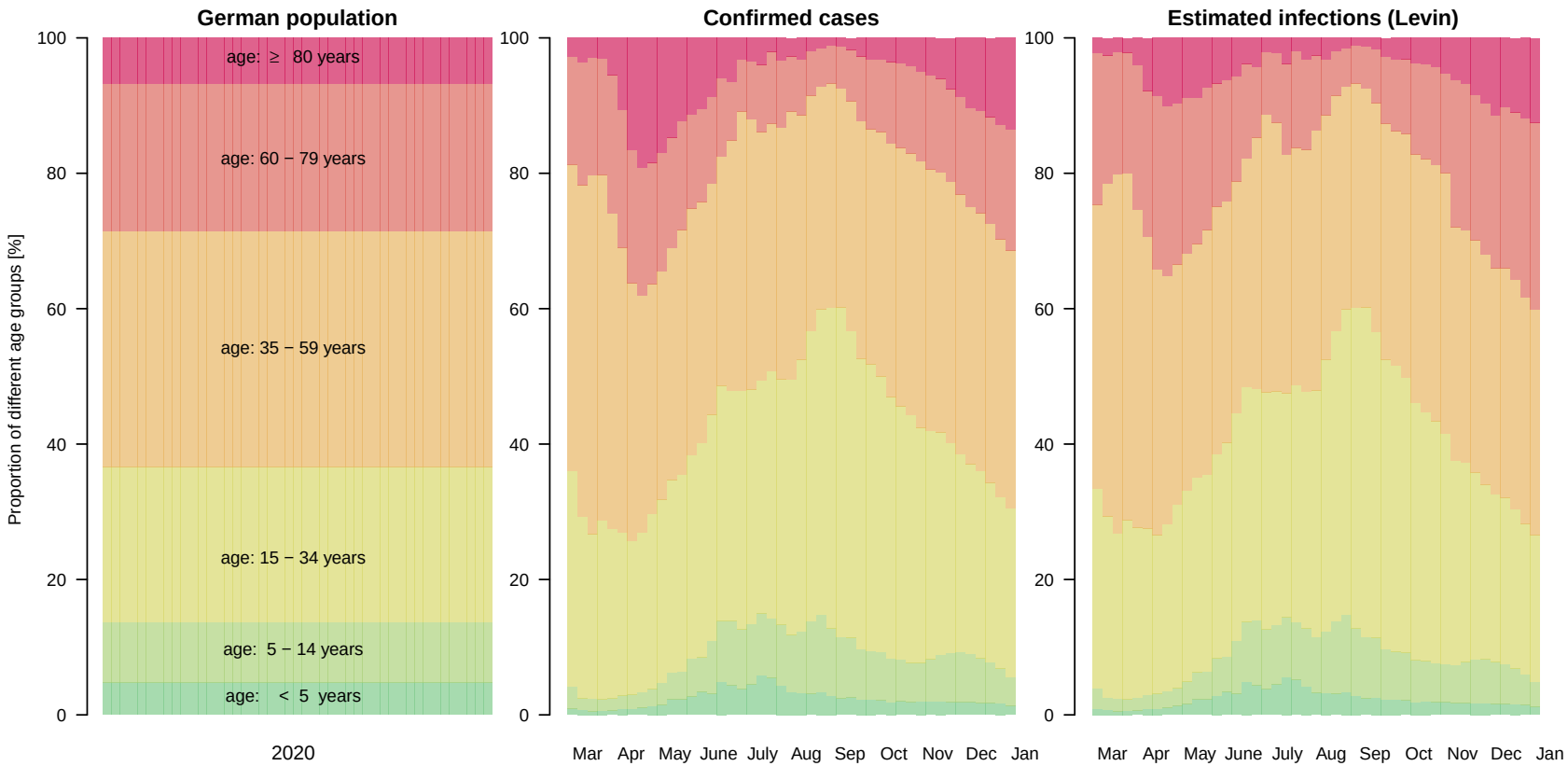
Staerk, Wistuba, & Mayr (2021). Estimating effective infection fatality rates during the course of the COVID-19 pandemic in Germany. BMC Public Health 21, 1073.

$\rightarrow$ Hierarchical modelling based on changing effective IFR

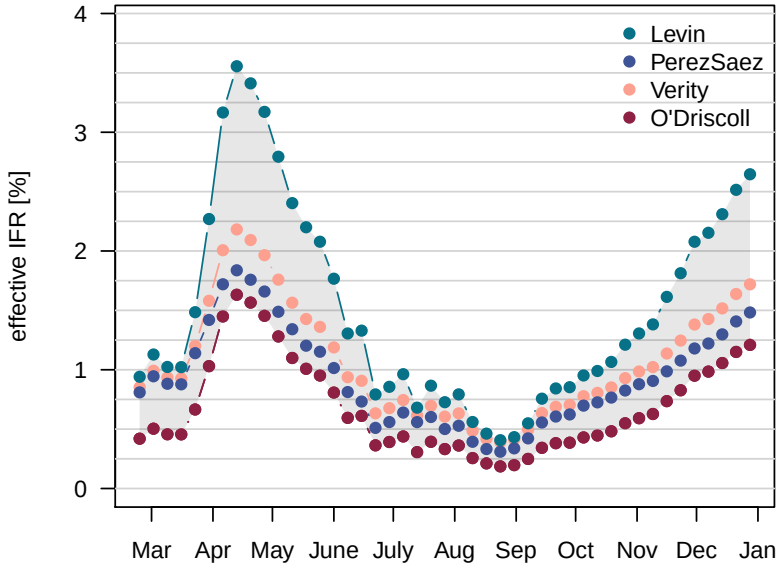


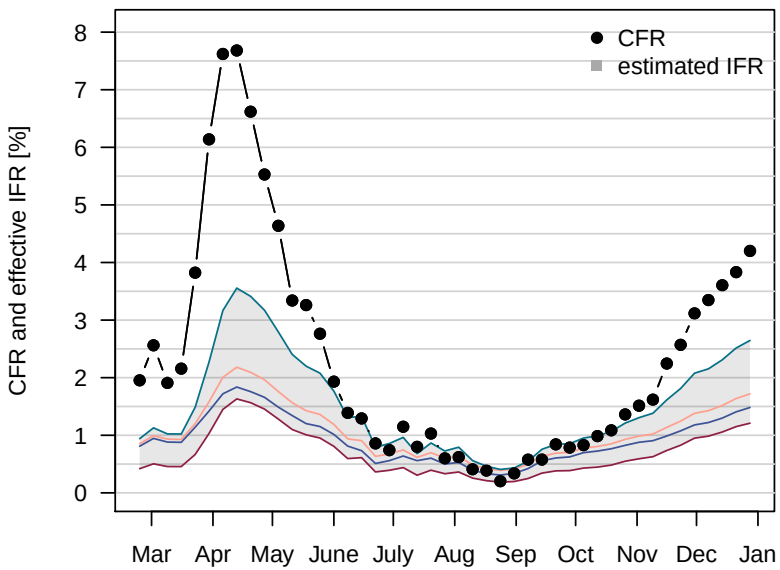
Wistuba, Mayr, & Staerk (2021). Estimating the course of the COVID-19 pandemic in Germany via spline-based hierarchical modelling of death counts. arXiv preprint, `https://arxiv.org/abs/2109.02599`.


Deaths
Posterior median
95%−CI
50%−CI
Reported Deaths
Lockdown 1
Lockdown Light
Lockdown 2
Infections
Confirmed Cases
7 day mean Cases
Dark Figures
Tests
Weekly tests
Local Outbreak
Testing Travellers
Extended Testing
Limited Testing
Christmas
Reproduction Number
RKI estimate
1 Feb 20
1 Mar 20
1 Apr 20
1 May 20
1 Jun 20
1 Jul 20
1 Aug 20
1 Sep 20
1 Oct 20
1 Nov 20
1 Dec 20
1 Jan 21
1 Feb 21

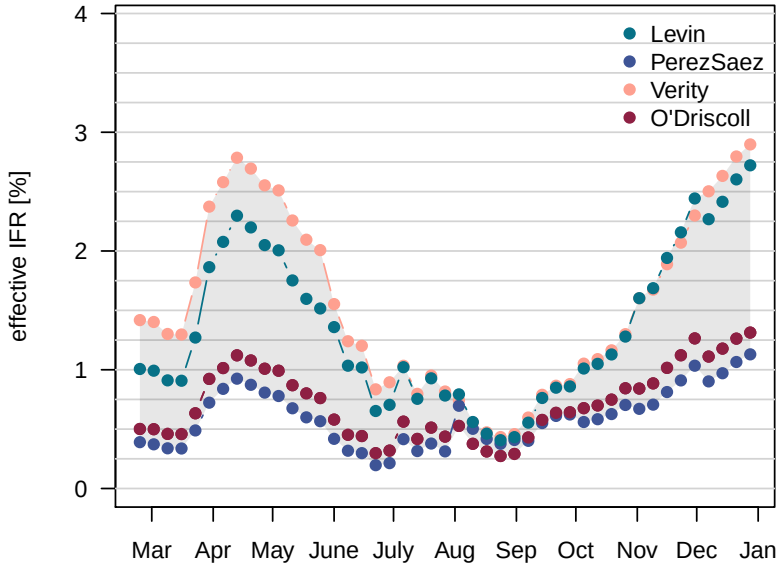

German population
Confirmed cases
Estimated infections (Levin)
Proportion of different age groups [%]
100
80
60
40
20
0
age: ≥ 80 years
age: 60 − 79 years
age: 35 − 59 years
age: 15 − 34 years
age: 5 − 14 years
age: < 5 years
2020
Mar
Apr
May
June
July
Aug
Sep
Oct
Nov
Dec
Jan

Effective IFR based on confirmed cases





Effective IFR based on estimated dark figures



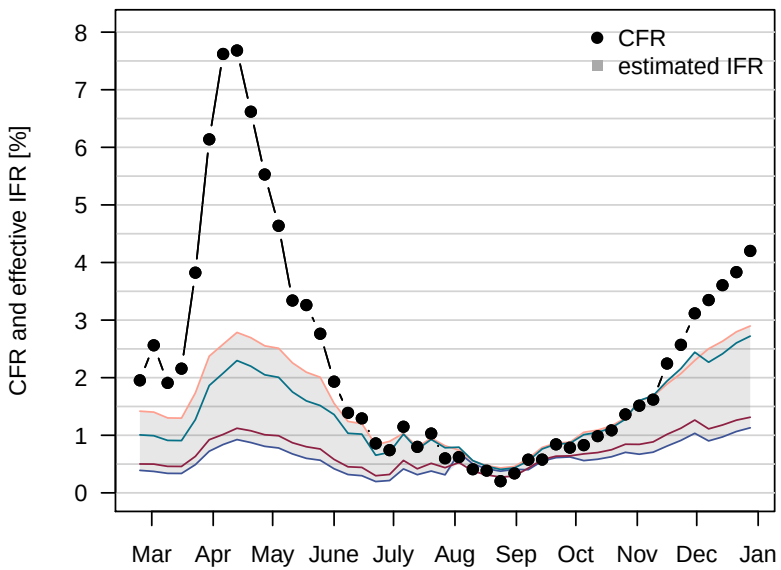


Table 1 Age-group specific estimates $\mathrm{IFR}_a^{(i)}$ as well as population-averaged estimates $\overline{\mathrm{IFR}}_{\mathrm{DE}}^{(i)}$ for Germany under age-independent infection risk, based on studies $i \in$ {O'Driscoll[5], Verity[11], Perez-Saez[12], Levin[6]}

Age group	O'Driscoll [5]	Verity [11]	Perez-Saez [12]	Levin [6]
0-4	0.002 [0.001; 0.002]	0.002 [0.000; 0.025]	0.002 [0.000; 0.019]	0.001 [0.001; 0.001]
5-14	0.000 [0.000; 0.000]	0.004 [0.001; 0.037]	0.001 [0.000; 0.011]	0.002 [0.001; 0.003]
15-34	0.009 [0.007; 0.010]	0.041 [0.019; 0.110]	0.007 [0.003; 0.013]	0.016 [0.014; 0.020]
35-59	0.122 [0.115; 0.128]	0.349 [0.194; 0.743]	0.070 [0.047; 0.097]	0.226 [0.212; 0.276]
60-79	0.992 [0.942; 1.045]	2.913 [1.670; 5.793]	3.892 [2.985; 5.145]	2.491 [2.294; 3.266]
80+	7.274 [6.909; 7.656]	7.800 [3.800; 13.30]	5.600 [4.300; 7.400]	15.61 [12.20; 19.50]
$\overline{\mathrm{IFR}}_{\mathrm{DE}}^{(i)}$	0.756 [0.717; 0.796]	1.296 [0.694; 2.453]	1.254 [0.959; 1.661]	1.687 [1.407; 2.139]

IFR estimates are given in percentages (with 95% confidence intervals in brackets)