

Estimating the infection fatality rate of COVID-19

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Folkhälsomyndigheten

Outline

- Concepts and estimation pitfalls
- Recap of IFR study from Stockholm during spring
- Questions

Concepts

- **Definition of IFR:** share of deaths among infected (including unreported cases), for a given population
- **Why interesting?**
 - ▶ To estimate the consequences of the pandemic, given scenarios of spread
 - ▶ Can be used in modelling to estimate number of infections
- **Related concepts:**
 - ▶ Case fatality rate (CFR) = share of deaths among confirmed cases
 - ▶ Population fatality rate (PFR) = share of deaths among population


$$\text{CFR} \geq \text{IFR} \geq \text{PFR}$$

Concepts

- The IFR varies with
 - ▶ age
 - ▶ underlying health
 - ▶ level of healthcare
 - ▶ access to healthcare
- Hence, overall IFR largely reflects composition effects among infected...
- ...but when conditioning on these factors, IFR is conceptually a rather stable parameter

Estimation pitfalls

● Linking deaths and infections

- ▶ Using aggregated data during ongoing pandemic creates mismatch between numerator and denominator...
- ▶ ...due to delay between time of infection and death—a random variable! 

● Deaths

- ▶ What counts as a COVID death?
- ▶ The number of deaths follows a binomial distribution, sample size matters!
- ▶ Reporting delay of up to several weeks

● Infections

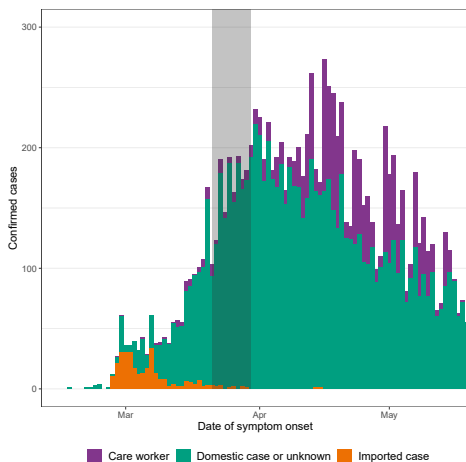
- ▶ PCR-confirmed cases is the tip of an iceberg, depends on test capacity and strategy
- ▶ Need to estimate share of unreported cases
- ▶ or rely on antibody testing → other problems...

Study of IFR in Stockholm

- Published 16 June by Public Health Agency of Sweden (report in Swedish + technical report in English)
- Aim was to estimate the IFR of COVID-19 in the Stockholm region during spring
- Method in short:
 - ▶ deaths estimated from individual case data in SmiNet database
 - ▶ infections estimated from population survey of PCR-positives + mathematical model

Method and data, deaths

- Estimation sample for deaths are 1,667 confirmed cases in SmiNet with symptom onset 21–30 March

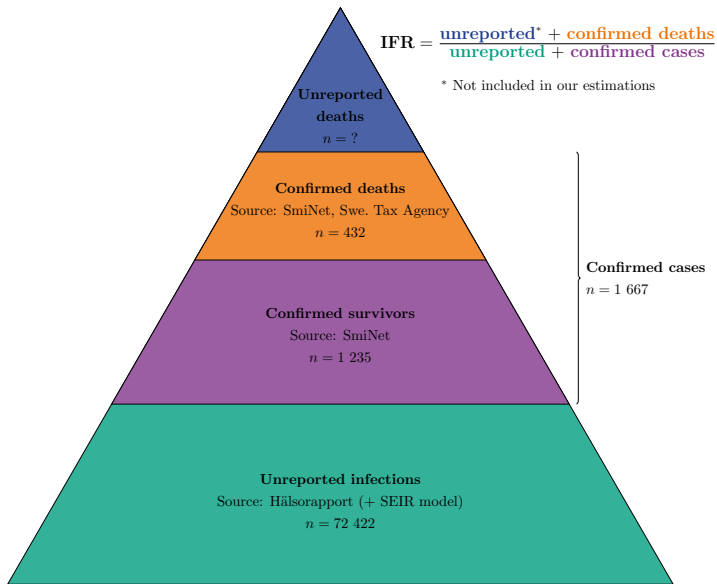


Method and data, deaths

- Onset period chosen to match PCR population survey
- Cases followed prospectively, with COVID-deaths \approx defined as deaths within 30 days of positive PCR test
 - ▶ 432 deaths, CFR = 25.9%
- Deaths *with* COVID \approx deaths *from* COVID, but difference vz excess mortality during peak [graph](#)

Method and data, infections

- Infections estimated with SEIR model calibrated to PCR survey in Stockholm
- Hälsorapport ("Health report")
 - ▶ Web panel recruited by stratified random sampling from the Swedish population, surveying recent symptoms
 - ▶ Stockholm participants were invited to self-administered PCR test 26 March – 2 April → 2.5% positives (95% c.i. 1.4–4.2%).
- SEIR model
 - ▶ Previously used to estimate infections in Stockholm
 - ▶ Updated with median time of PCR-positivity ten days
 - ▶ Estimate of 44 infections per confirmed case
 - ▶ Multiplying with estimation sample size: $1,667 \times 44 = 74,089$



Results

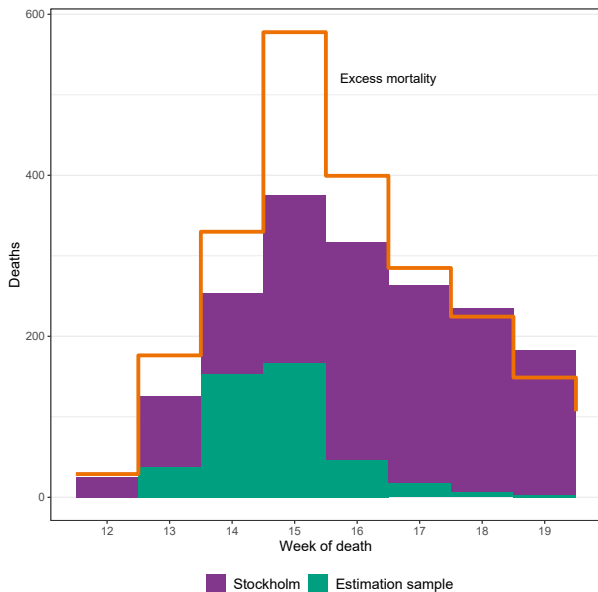
IFR estimates for Stockholm

	Population share (%)	Cases	Deaths	Infected	IFR (%)
All ages		1,667	432 (397; 464)	74,089 (41,660; 117,419)	0.58 (0.37; 1.05)
Age 0–69	88.3	868	61 (47; 76)	65,446 (36,800; 103,721)	0.09 (0.06; 0.18)
Age 70+	11.7	799	371 (344; 396)	8,643 (4,860; 13,698)	4.29 (2.67; 7.73)

Sensitivity analysis

- Robust to larger estimation sample between 14 Mars and 6 April (3,819 cases, 992 deaths)...
- ...but sensitive to assumed PCR test window length
 - ▶ More research needed, mostly studies on hospitalized cases
- Excess mortality?

Excess mortality



Results, interpretation

- 0.6% perhaps conservative estimate in light of excess mortality
- Striking age gradient in IFR (steeper than for CFR)
- But gradient likely underestimated due to assumption of equal attack rate across age
- Estimation sample similar to cases in Stockholm and Sweden as a whole so results should generalize

Comparison with other estimates

- Results close to early estimates of 0.6–0.7%, based on Wuhan and Diamond Princess (Russel et al., Verity et al. and Salje et al.)
- In line with meta-analysis estimate of 0.68% (Meyerowitz-Katz and Merone)
- But considerable spread in estimates (method + composition effects)

Looking forward

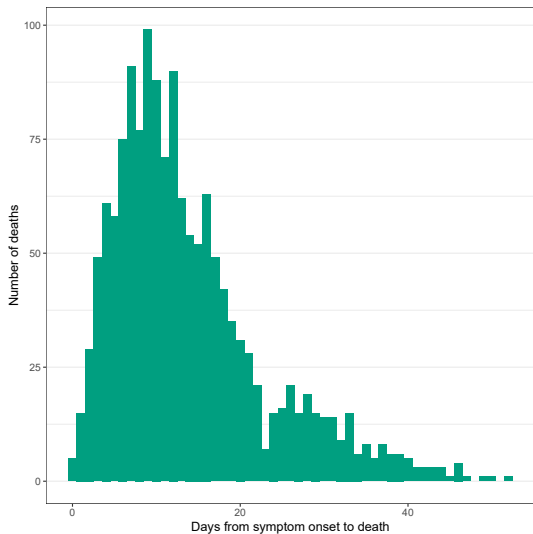
- Has IFR fallen as health care has improved?
- Work in progress: update based on new estimates of share of unreported cases
 - ▶ Better age-conditional estimates

End

- Thanks for listening!
- Questions?

Distribution of delay between onset and death

back



Comparison of different measures of COVID deaths

back

Olika mått på covid-19-dödsfall vecka 12–37, 2020.

Antal dödsfall

