## COVID-19 in numbers: ten times worse than seasonal influenza?

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**Summary**

Based on the information available to date regarding COVID-19 in Italy, we conclude that COVID-19 is approximately five to ten times more lethal than normal seasonal influenza (for ages 50 and above).

The 'lethality' here relates to death post-infection, and hence the above statement makes no allowance for the high infectiousness of Coronavirus compared with a normal influenza virus.

### Background and introduction

This note considers mortality from COVID-19 with particular reference to how it compares with normal seasonal influenza. We make use of statistics from Italy, on the grounds that these are likely to be more applicable to Western European lives than the equivalent Chinese statistics.

This note considers only the mortality of people infected with the condition: i.e., we do not look at infectiousness, which will be the subject of one of the upcoming bulletins.

We also consider deaths of COVID-19 sufferers and compare them with deaths of normal influenza sufferers. It is impossible in either case to be sure that the deaths are caused directly by influenza or COVID-19. (We are addressing in a forthcoming bulletin the extent to which COVID-19 deaths are attributable to existing health conditions.)

### Italian statistics on COVID-19 mortality

The Italian health body collating and publishing the relevant statistics is the *Istituto Superiore di Sanità* (www.iss.it). The statistics we show below are as at 26 March 2020. At the time this bulletin was finalised, these were the most recent statistics available with an age/gender breakdown of cases and deaths. We will periodically update this note to reflect updates as they become available. (https://www.epicentro.iss.it/coronavirus/bollettino/Bollettino-sorveglianza-integrata-COVID-19_26-marzo%202020.pdf)

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| | Cases | Deaths | Mortality | Cases | Deaths | Mortality |
| 0-49 | 8,770 | 63 | 0.7% | 9,003 | 21 | 0.2% |
| 50-59 | 7,998 | 190 | 2.4% | 6,337 | 52 | 0.8% |
| 60-69 | 8,755 | 606 | 6.9% | 4,394 | 154 | 3.5% |
| 70-79 | 9,309 | 1,846 | 19.8% | 4,781 | 555 | 11.6% |
| 80-89 | 6,195 | 1,808 | 29.2% | 4,734 | 894 | 18.9% |
| 90+ | 887 | 273 | 30.8% | 1,640 | 334 | 20.4% |
| Not known | 135 | - | 0.0% | 106 | - | 0.0% |
| Total | 42,049 | 4,786 | 11.4% | 30,995 | 2,010 | 6.5% |

Note that we have banded young age groups together in the above, as they show insignificant mortality. For reference, the crude mortality above age 50 is:

| | Males | | | Females | | |
|---|---|---|---|---|---|---|
| | Cases | Deaths | Mortality | Cases | Deaths | Mortality |
| Ages 50+ | 33,144 | 4,723 | 14.2% | 21,886 | 1,989 | 9.1% |

Readers will quickly note that the male:female mortality ratio is very high, at around 155% (ranging from nearly 300% at ages 50-59 to a high-age ratio of around 150%).

Cases are split 58%:42% male:female, deaths 70%:30% male:female.

**Normal influenza mortality**

We have used recent data from the USA's CDC[i] that provides an age breakdown, and is also consistent with the World Health Organisation's overall estimate of influenza mortality.

The CDC data shows mortality from influenza of approximately 0.5% for people aged 50 and above (calculated from the table below, rounding up slightly). Note that here we mean mortality in the sense of 'Case Fatality Rate': i.e. the probability of death given the infection, not an overall population rate.

| Age group | Symptoms | Deaths | CFR |
|---|---|---|---|
| 0-4 | 3,633,104 | 266 | 0.0% |
| 5-17 | 7,663,310 | 211 | 0.0% |
| 18-49 | 11,913,203 | 2,450 | 0.0% |
| 50-64 | 9,238,038 | 5,676 | 0.1% |
| 65+ | 3,073,227 | 25,555 | 0.8% |
| All ages | 35,520,883 | 34,157 | 0.1% |

**Adjustments to crude data: undiagnosed cases and time lag effect**

One aspect that makes it difficult to produce a useful comparison between COVID-19 and influenza is the number of undiagnosed COVID-19 cases. The UK's Chief Medical Officer recently suggested a factor in the range 10-20 as a reasonable allowance. If 20% of COVID-19 instances express as severe symptoms this factor could be nearer 5, while intuitively it feels that the number could be materially higher than 20. None of the recent UK Government 'SAGE' publications provides much guidance on this question, and we have therefore produced calculations on a range of plausible values from 10 to 20, as shown below.

By framing our results as a multiple of normal flu mortality, we reduce the extent to which this uncertainty affects our conclusions, given that flu mortality estimates also suffer from the same problem.

There is also a 'contrary' element of uncertainty, to the extent that a material number of deaths from COVID-19 may not have been reported as such, the most likely reason being deaths outside the hospital system. In Northern Italy, the impact of this has been estimated as perhaps a factor of 5[ii]. The estimate is based on comparisons of all recent deaths with deaths in the same period in recent years.

We have not made further adjustments for this aspect, largely to avoid our results straying too far from the range of equivalent CFR results published over the course of March. Although the contention noted in the reference seems valid, and the method described reasonable, the 'undiagnosed case' adjustments assumed could also be materially out.

We also know that any mortality estimate based on deaths and cases will be distorted by a 'time lag' effect. If you are diagnosed with the condition, you are not exposed to the risk of immediate death, and correspondingly it is misleading to compare deaths 'today' with cases 'today'. The time lag is of the order of 10 days[iii].

**Results**

With suitable adjustments and allowances for these aspects, we estimate the mortality of COVID-19 to be around 4% for men aged over 50, 3% for women aged over 50. Thus, it looks to be something like five to ten times as lethal as normal flu (higher end of range for men, lower end for women).

| | Age / gender | Normal influenza | COVID-19 Central | COVID-19 High | COVID-19 Low |
|---|---|---|---|---|---|
| Mortality | M 50+ | 0.50% | 4.3% | 8.0% | 2.1% |
| | F 50+ | 0.50% | 2.7% | 5.1% | 1.4% |
| Multiple of flu mortality | M 50+ | 100% | 900% | 1600% | 400% |
| | F 50+ | 100% | 500% | 1000% | 300% |

The table also shows plausible upper and lower bounds, with particular regard to varying the parameterisation for undiagnosed cases and the time lag effect:

| | COVID-19 Central | COVID-19 High | COVID-19 Low |
|---|---|---|---|
| Factor for undiagnosed cases | 15 | 10 | 20 |
| Time lag | 11 days | 13 days | 9 days |

**Overall (all ages) Case Fatality Rate**

Given the low number of deaths so far at younger ages, and the much greater likelihood of underreporting of cases at younger ages, we have not attempted to estimate a CFR for ages below 50. Correspondingly, we are not estimating on overall (all ages) CFR. This is not to say there is no problem at younger ages: a plausible bad outcome from COVID-19 could be of the order of a doubling of mortality rates – this is clearly extremely material in relative terms for that age range, but still remains small in in comparison with the rates at older ages.

If we were to make a broad assumption that younger age (0-50) mortality was double that of normal flu mortality, this would give us an overall population Case Fatality Rate result of:

- Males: 2.0%
- Females: 1.5%

Note that the above numbers reflect the UK population profile of approximately 50% age below 50 and 50% age above 50, and so are not properly comparable with the Spanish Flu CFR estimate of around 2%. Similarly, these figures are also not transferable to (for instance) African countries with much younger age profiles (although conversely less effective health services).

**Comparison with other sources**

The rates above compare with equivalent assumption of 0.9% used in the Imperial College NPI paper[iv], which were derived (non-transparently) from the Verity paper 'Estimates of the severity of COVID-19 disease' showing results of 3.7% (China)[v], adjusted to 1.4% and 0.7% (other situations).

Results from other countries and sources present a bewildering range (one result is commented on below) – for instance, https://www.cebm.net/covid-19/global-covid-19-case-fatality-rates - but these help to clarify some important points:

- There is great uncertainty in the adjustment to make in respect of undiagnosed cases (and also in respect of the time lag effect, although this is a smaller source of uncertainty);
- There is substantial uncertainty regarding COVID-19 deaths not recorded as such (typically relating to deaths outside the hospital system);
- There will be natural variability between countries.

The last point is very important, and we hope to consider this in a forthcoming Bulletin. For instance, regarding Italy, we have adjusted above for the high age profile. but there are arguments relating to high air pollution in the Lombardy region (especially Milan and surrounding towns), compromising residents' respiratory health.

**Heterogeneity – mortality variation within countries**

There has been substantial amount of comment on social media, seen to some extent also in some mainstream media and private comments by colleagues and contacts of the authors, that COVID-19 is not materially more lethal than normal seasonal influenza.

One of the main sources of evidence for this view is the relatively low mortality seen in the Diamond Princess ship, where there were (approximately):

- 3,700 people
- 700 confirmed cases
- 7 deaths

This shows a crude death rate perhaps an order of magnitude lower than that observed in Italy, and in line with normal seasonal influenza.

One argument for the low CFR is the unusually high amount of testing that was carried out on the ship, compared with an equivalent 'on land' situation.

In addition to that possible reason, rather than these results indicating that COVID-19 is a low-mortality condition, we believe that the Diamond Princess results point to **material heterogeneity** in the mortality experience:

- Generally healthy people (even in their 70s, 80s …) are less affected by COVID-19 in immediate mortality terms
- Generally unhealthy people (eg diabetics, heart disease survivors, smokers, the obese) are heavily affected.

For instance, the Intensive Care National Audit and Research Centre's publication 'ICNARC report on COVID-19 in critical care' of 27 March[vi] showed that around 60% of obese ICU COVID-19 cases died, compared with 40% of non-obese cases. Obesity also conferred greater likelihood of being admitted to ICU in the first place (38% of ICU patients were obese, compared with below 30% for general population, or 31% for ICU patients admitted for viral pneumonia).

At present, we have not seen any data that would allow us to quantify the phenomenon properly, because it requires disassociation of medical conditions from age (e.g., the fact that a large number of deaths were associated with diabetes is conceptually similar to noting that a large number of deaths occurred at high ages, which by itself is unsurprising).

Further to the above point, it is likely (from the author's experience of mortality in wider contexts) that there is a strong socio-economic element at play: after allowing for age and health conditions, the 'white-collar' socio-economic subsets are likely to be in generally better health than the 'blue-collar' subsets, and are therefore more likely to survive infection. This phenomenon – if true – would also at least in part explain the low mortality outcomes from the Diamond Princess.

**References**

[i] https://www.cdc.gov/flu/about/burden/2018-2019.html

[ii] *«The real death toll for Covid-19 is at least 4 times the official numbers», Correre della Sera, 26 March 2020*

[iii] *'Estimating the infection and case fatality ratio for COVID-19 using age-adjsuted data from the outbreak on the Diamond Princess cruise ship', Russell et al.,* https://www.medrxiv.org/content/10.1101/2020.03.05.20031773v2

[iv] *Impact of non-pharmaceutical interventions (NPIs) to reduce COVID-19 mortality and healthcare demand, Ferguson et al., 16 March 2020*

[v] *'Estimates of the severity of COVID-19 disease', Verity et al,* https://www.medrxiv.org/content/10.1101/2020.03.09.20033357v1

[vi] https://www.icnarc.org/About/Latest-News/2020/03/27/Report-On-775-Patients-Critically-Ill-With-Covid-19