Mortality impacts of the pandemic – survivor mortality

By Matthew Edwards for

COVID-19 Actuaries Response Group – Learn. Share. Educate. Influence.

Summary

COVID-19 mortality is associated with risk factors such as obesity and diabetes that also imply higher 'normal' (all-cause) mortality. This feature may lead the overall mortality of the post-pandemic 'survivor pool' to be lighter than it was pre-pandemic.

This Bulletin sets out how we might estimate this impact, and the example used shows that the effect is likely to be low other than in subgroups of the population with a high proportion of COVID-19 deaths.

Other aspects which will affect the mortality of the 'survivor pool', and which we will consider in a later bulletin, are:

- How are future mortality improvements likely to differ because of the pandemic?
- What is the effect on human physiology of surviving infection by COVID-19?

Introduction

The question of what we can expect the mortality of the 'survivor pool' to be is important for life insurers, reinsurers and pension funds in particular, but also for society as a whole. Given the complexity of the question, and the different facets, we are breaking our commentary on this question into three bulletins:

- What is the likely mortality of the 'survivor pool' in the short term?
- What are appropriate ways to consider setting mortality assumptions at the 'post-pandemic' stage?
- What are the long-term mortality implications of the pandemic?

In this bulletin we look at the mortality of the 'survivor pool' in the short term. The objective is to consider what the mortality of the population will be after the initial pandemic, not allowing for any '*nth* wave' returns of the coronavirus.

What will affect the mortality of survivors?

The overall mortality of the survivor pool will be different from the equivalent pre-pandemic mortality to the extent that the COVID-19 fatalities exhibited different mortality (pre-pandemic) from those who survived.

What do we know about the COVID-19 fatalities that may have affected their 'pre-pandemic' mortality? Clearly they were primarily the old, and primarily male: however, demographers and actuaries (amongst others) will take account of age and sex in considering mortality, and hence these aspects are not relevant to the question here.

To estimate the mortality of the 'survivor pool', we can work through the following thought process:

- What aspects of COVID-19 lead to disproportionate deaths for some types of people?
- What would be the likely mortality (pre-pandemic) of these people?
- Thus, what would be the likely mortality (pre-pandemic) of all those dying from COVID-19?
- If we remove those people from the overall population, what is the remaining average mortality?

What aspects of COVID-19 make deaths arise disproportionately?

So far, we know that the following factors are particularly relevant (where we provide also some indication of typical mortality impacts, expressed as 'odds ratio' multipliers – so e.g. the figure of 1.5 for obesity means an obese person would have 150% the mortality of a non-obese person, all other things assumed equal – that can be combined, so eg an obese diabetic would have mortality of approximately x 1.5 x 2.0 = x 3 normal mortality):

Factor	Comment
Obesity	An important factor. The effect of obesity is of the order of 1.5.
Diabetes	Very important. The effect is of the order of 2.0.
Other chronic conditions	For common conditions (eg history of heart disease, cancer), of the order of 1.25
SE Class (IMD quintile)	Top quintile 0.8 of middle (ie average) quintile, lowest quintile 1.4 of middle
Ethnicity	BAME 1.5-2.0

Note that the figures in the above table are approximate and indicative only. We have commented specifically on risk factors in [link to bulletin], and since then further papers have emerged (many of which we have noted in our Friday Reports).

What would be the likely mortality (pre-pandemic) of the people in those groups?

We know from existing research that people in the above groups have normal (ie all-cause mortality absent the coronavirus) mortality somewhat different from the average. Using the same way of presenting this effect as we did in the above table[i], the factors as they would apply to people in the 60-80 year old age group are, very approximately:

Factor	Mortality effect (all-cause)
Obesity	1.2[ii]
Diabetes	1.3[iii]
Other chronic conditions	2.0[iv]
SE Class (by IMD)	1.5 (ratio bottom to top IMD quintile)[v]

What would be the pre-pandemic mortality of those who die from COVID-19?

We can use the known (disproportionate) nature of COVID-19 to estimate how the deaths break down, for instance as follows (considering here just diabetes and obesity for simplicity). We can then calculate the expected pre-pandemic mortality of these subgroups, and hence the overall average 'pre-pandemic' mortality of the whole group of COVID-19 fatalities.

Splitting just by diabetes and obesity, this table shows the proportion of COVID-19 deaths we might expect (from the first table above on COVID-19 mortality risk factors in conjunction with population prevalence).

Group	Population prevalence[vi]	Proportion of COVID-19 deaths	All-cause mortality multiplier
Normal	65%	48%	1
Obese, non-diabetic	20%	22%	1.3
Obese, diabetic	10%	22%	1.6[vii]
Diabetic, normal BMI	5%	7%	1.2
Total	*100%*	*100%*	
All-cause mortality	*1.10*	*1.20*	

This table also shows the all-cause mortality multiplier, weighted by population prevalence, and also weighted by proportions of COVID-19 deaths.

We can therefore calculate that the expected 'pre-pandemic' mortality of the group who died from COVID-19 is 1.2 / 1.1 = 109% of the same number of people randomly selected from the population.

With the COVID-19 deaths no longer in the overall population, what is the survivor mortality?

Suppose 1% of the population die from COVID-19. Although this is a high (hopefully unrealistically high) figure for the whole UK population, it is a reasonable figure (perhaps even an under-estimate) for older age groups.

Having estimated the mortality of the group of all those who died from COVID-19, we can estimate the relative mortality of the survivor pool:

Group	Proportion	Relative mortality
COVID-19 deaths	1%	109% of normal
COVID-19 survivors	99%	99.9% of normal
Combined population	*100%*	*100% of normal by definition*

The 99.9% above is 'solved for' by finding the value that, combined with the 109% of normal mortality for the COVID-19 deaths group, takes us back to 100% for the combined group. Thus the mortality of the survivor pool is (in this example) around 0.1% below normal (pre-pandemic) mortality.

The effect is light in this example largely because we have assumed a small proportion of deaths from COVID-19 in the 'base' group. For high age (and male) segments of the population, we expect higher proportions to die from COVID-19 and hence a greater eventual differential between pre- and post-pandemic mortality.

The figure is also lighter than the 'real' figure will be because, in the above, we have looked at only two categories (obesity and diabetes). Introducing more categories (e.g., other common medical conditions, or socio-economic splits) accentuates the effect (if, for each extra category, we have both an increased risk of death from COVID-19 and increased 'all-cause' mortality, which is generally the case).

Further work by the author testing the effect of this extra granularity increases the all-cause pre-pandemic mortality ratio of COVID-19 deaths to normal population from 109% to of the order of 130%.

Conclusion and further work

COVID-19 mortality is associated with various risk factors (such as obesity and diabetes) that are themselves associated with higher 'normal' (all-cause) mortality. If we consider this aspect only, ignoring for now other aspects (noted below), then the overall mortality of the post-pandemic 'survivor pool' will be lighter than overall population mortality pre-pandemic (allowing for age and sex effects).

The example calculation above, which illustrates the underlying dynamics, shows that the effect is likely to be low other than in subgroups of the population with a high proportion of COVID-19 deaths.

The other aspects to be borne in mind in estimating the likely mortality of post-pandemic survivors are:

- How are future mortality improvements likely to differ because of the pandemic? (For instance, what effect might the associated economic shock have on healthcare expenditure or personal health-related expenditure that may affect mortality?)
- What is the effect on human physiology of surviving a 'severe symptoms' (hospitalisation necessary) infection of COVID-19? (For instance, the Spanish flu was associated with long-term features that had a material morbidity / mortality effect.)

In the next two bulletins on this subject, we consider the points above, and we also consider how, once we are 'post-pandemic', we could conduct an experience analysis in a way that allows appropriately for the largely 'one-off' nature of the pandemic.

Matthew Edwards
27 May 2020

---

[i] Note that we have excluded ethnicity from further consideration in this paper
[ii] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4855514/
[iii] https://www.ahajournals.org/doi/full/10.1161/JAHA.118.011295
[iv] Order-of-magnitude value from author's underwriting experience (underestimate)
[v] Order-of-magnitude value from author's underwriting experience
[vi] 2018 Health Survey for England – ages 65+, assuming diabetics approx. 2/3 obese, with rounding
[vii] 1.6 rather than 1.2 x 1.3 = 1.56 for reasons of rounding but also reflecting some interaction effect eg https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6106950/