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The coronavirus issue

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Contents

Introduction by the Editor

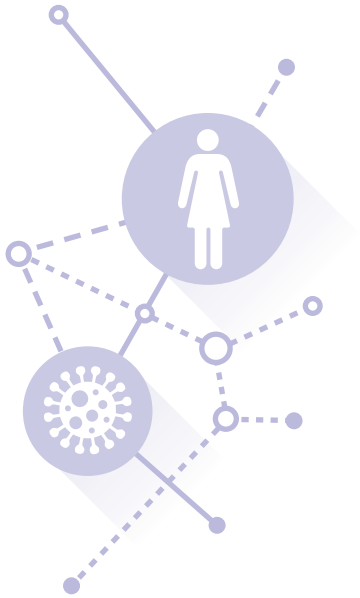
There is a famous saying by the Greek philosopher Heraclitus, 'You can never step into the same river twice' – because every moment the river changes and becomes in some way new.

The struggle against the coronavirus feels like that: every month, if not every day, new information emerges and our perception of the situation alters. In this issue of the *Longevity Bulletin*, we focus on the pandemic and examine some of the most important areas.

Gordon Woo considers the dynamics of further waves of the pandemic, and how control measures can mitigate the problem. Achim Regenauer thinks this point through with particular regard to the winter interaction – what will be the combined impact of coronavirus and influenza? One of the more depressing pieces of news to emerge was that many survivors were not recovering unscathed, but have been affected by what is now being referred to as 'long Covid'. Nicola Oliver outlines this problem, which strengthens the case for prevention rather than cure.

Lockdown has been a standard policy response in many countries. It clearly reduces transmission in the short-term, and hence Covid-19 deaths. But the longer-term impact on economies may increase mortality; Kenny McIvor looks at the relationship between economic health and biological health. In a similar vein, lockdowns have reduced medical support for non-Covid illnesses. Reduced cancer screening activity, for instance, leads to increased cancer deaths. Conor O'Reilly and Steven Baxter describe this issue and estimate the mortality impact.

One aspect of the pandemic that has made it feel more 'political' is the realisation that the burden has fallen unequally across the socioeconomic spectrum, raising interesting issues around the route to infection as well as the survival prospects of those infected. Michael Anderson summarises the main findings on these differentials.



Bringing some of these strands together in the final article, we consider the likely outlook for mortality improvements in the aftermath of the pandemic. Perhaps 'mortality improvements' is a phrase that should be replaced with 'mortality variations', given the range of material negative mortality drivers.

Tan Suee Chieh, in his foreword, notes that we are in a 'VUCA' situation – volatile, uncertain, complex, ambiguous. We know more than we did six months ago, but there is still much that is unknown.

Our job as actuaries is to advise our stakeholders as best we can given this knowledge, aware that it is incomplete. Much of our knowledge relating to the content of this issue will shift and alter as we learn more (noting especially that the articles, by necessity, were written weeks before the date of publication). This is a case study of how to act as actuaries when confronted with a VUCA situation.

Matthew Edwards
Editor

Foreword by the President of the IFoA

The voice and soul of the profession

There is a particularly relevant term to describe the current situation: 'VUCA'. The acronym stands for volatility, uncertainty, complexity and ambiguity; it was coined 45 years ago for the US military.

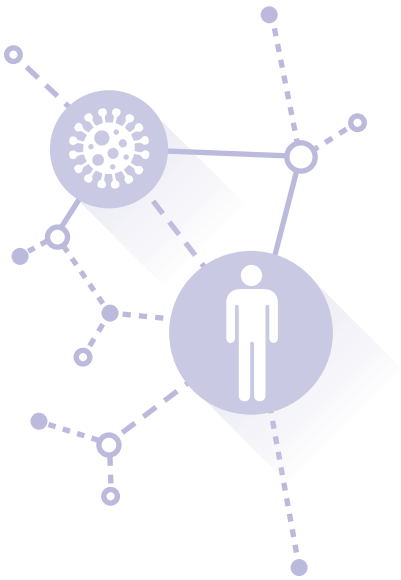
The current pandemic is the first real global 'VUCA event' of our lifetime. I have experienced many uncertain and volatile situations before, from racial riots in Malaysia in my childhood to more recent financial crises and then Brexit. But none of those compares with this crisis.

What can actuaries do in a VUCA environment?

If we look back to our history, actuaries and earlier 'proto-actuaries' worked on problems of uncertainty and chance. Think of Blaise Pascal and Pierre Fermat; they were not actuaries in the modern sense but they worked on probabilities and expectations. Following them came John Graunt and Edmond Halley, who constructed the early life tables. This was the genesis of our profession – new approaches to translate uncertainty into quantified risk and expected values. It was the actuarial equivalent of the 'Big Bang' to our profession.

We have been creating new systems of thinking and problem solving ever since. To the extent that our tools and techniques are unable to guarantee the shape of the future, we rely on our judgment and imagination.

Frank Redington noted our quintessential values of caution, accuracy, consistency, and reticence, but said these would weigh us down if we did not make room for new ones. In the digital revolution these quintessential values can work against us. Curiosity, adaptability and a growth mindset that embraces perseverance and experimentation are new values which must come to the fore.



Our current orthodoxy will not help. Instead we need a new mindset, and to achieve this we must recover our courage and imagination. The Greeks talked in terms of 'phronesis', practical wisdom, and 'sunesis', the ability to join the dots across multiple domains. These are what we need to convert our abstract 'episteme' (knowledge) into a worthwhile and flexible 'techne' (craft) to help our stakeholders.

Of the many challenges of the pandemic, one that actuaries can directly help with is the immediate aspect of health and mortality. We need to see through the fog and discern the signal from the noise. We are still in the earlier stages of this catastrophe, and much of what we now think may turn out to be incorrect – but I applaud these authors for braving their opinions and helping to advance our collective understanding in the spirit of our profession.

Tan Suee Chieh
President, Institute and Faculty of Actuaries

Pandemic second wave risk management

Gordon Woo, Catastrophist at Risk Management Solutions

Introduction

There are various factors that could affect the extent of the second wave of the pandemic. All five recent influenza pandemics had second waves, four of which have been associated with some virus mutation, which could be a factor in Covid-19 as well. Other factors associated with second waves include the reopening of schools, seasonality and the relaxation of social distancing measures. To control a second wave of the pandemic, it is important that best international practice is followed so that the spread of infection is contained. Essential capabilities are mass testing, tracking and tracing of contacts to support effective quarantining. Sharing good-quality infection data is also crucial so that people have early warning of any local rise in infection. An explicit weekly infection rate target for triggering a local lockdown would also contribute to public risk awareness and compliance with government guidance, by giving clarity in terms of what is expected.

Drivers of a second wave of infection

Following on from the first wave of the Covid-19 pandemic, and in the absence of a vaccine, we have seen how a second wave has developed. It is well known that the great 1918-1919 pandemic had a virulent second wave; less well known is that all five most recent historical influenza pandemics had second waves: 1889-1892 (Russian); 1918-1919 (Spanish); 1957-1958 (Asian); 1968-1969 (Hong Kong); 2009-2010 (Mexican).

Analysis of these five influenza pandemics has revealed four principal dynamic mechanisms, which can operate singly or in combination to generate a second wave of infection: [1] mutation of the virus [2] school reopening [3] seasonal weather factors [4] relaxation of social distancing measures. These will be discussed in turn.

Mutation of the pandemic virus

An adverse mutation of the pandemic virus is a major development in a pandemic crisis, requiring crisis managers to have a good scientific understanding of virus mutation and knowledge of how past pandemic viruses have mutated. Four out of the past five influenza pandemics seem to have mutated in the generation of second waves.

RNA viruses, which include the common cold, influenza and SARS-CoV-2, are the most common class of pathogens generating new human diseases. Notable 21st century RNA viruses include influenza, Ebola, MERS, SARS and SARS-CoV-2. RNA viruses have high mutation rates because of the lack of checks in the virus reproduction process. Random mutation and subsequent selection mean that RNA viruses may evolve into a form better adapted for human-to-human transmission. Some historical examples are described below.

The first influenza pandemic in the modern scientific era of molecular virology was the 2009 H1N1 influenza pandemic, which originated in Mexico. In this pandemic, the average number of mutations increased slightly between April and November. Some mutations in receptor binding sites appeared after the first wave ended, and as the pandemic spread, the number of these mutations increased. The higher virulence associated with mutations in receptor binding sites is a driver of a second wave of infection.

The 1968-1969 H3N2 influenza pandemic, which emerged from Hong Kong in July 1968, came in two waves. The second was a larger outbreak with a higher reproduction number (R_0) of 1.21 – 3.58, compared with 1.06 – 2.06 for the first wave. This increase in transmissibility may be associated with mutations to the virus, which originated from the 1957 H2N2 pandemic (Jackson et al., 2009).

The Russian flu pandemic at the end of the 19th century, the first of the railway and steamship era, spread across Europe in three waves: 1889-1890, 1890-1891 and 1891-1892. In England and Wales, the first wave peaked in January 1890 and the associated death rate was 157 per million. By contrast, the influenza death rate in 1891 was 571 per million, even though the epidemic that year coincided with the spring. The third wave coincided with the winter, and the influenza death rate was 534 per million, almost as high as the second wave (Honigsbaum, 2011). As seasonality can be discounted as an explanatory factor, the greater lethality of the second wave suggests that some mutation of the virus occurred in the year following the arrival of the pandemic from Russia.

A few decades later, there were three main waves of the great H1N1 1918-1919 influenza pandemic. The first, in the spring of 1918, was fairly mild, caused comparatively few deaths and mainly affected military personnel. Most of the fatalities in this pandemic occurred during the second wave in the autumn of 1918. Virological distinction of the individual waves is not possible because the only samples are from second wave patients. The possibility that the first wave was caused by a different virus from the second wave is not resolved (Taubenberger and Morens, 2006).

Covid-19 is the worst global pandemic since the great 1918-1919 influenza pandemic. Among other causes, another wave of infection may arise from a mutation of SARS-CoV-2 that conveys selective advantages in transmission. A virus with an advantageous mutation might spread more readily between people, be less well recognised by the immune system, or enable the virus to escape the effects of antivirals. A modified strain might cause increased severity of illness. The emergence of a more dangerous mutation of SARS-CoV-2 is a serious concern, not least because it is outside human control, unlike both pharmaceutical and non-pharmaceutical interventions, such as school closures and quarantine measures.

As of June 2020, several hundred mutations of SARS-CoV-2 had occurred more than once, indicating that the virus was undergoing selective pressure, as it adapted to the human host. The majority of the mutations are likely to be neutral or negative to the virus, reducing the risk of a severe second wave due to mutation. However, some mutations might affect the response of human immune cells, and the ability to kill virus-infected cells, which would make a more dangerous wave more likely.

School reopening

Children are notorious unwitting vectors of contagion during term time. Closing schools during a pandemic is therefore a common intervention. However, the World Health Organization (WHO) does not specifically recommend or discourage school closures, as their benefits and harms are context-specific. It does appear that the school return after the summer has contributed to the second wave taking place.

The 2009, 1968 and 1957 flu pandemics all saw increases in incidence of the disease when schools returned for the autumn term. However, school reopening does not seem to have been a driving factor in the evolution of the 1968-1969 pandemic.

With Covid-19, children under 18 make up only around 2% of total cases worldwide. The most significant risk associated with children being at school is not to themselves or their classmates, but as vectors of the infection, which may then be transmitted to members of their households. However, concern over the long-term harm to children of loss of education restricts the duration and geographical extent of further school closures. Similarly, college students tend to live in towns and cities away from home, even though, as we have seen, infection spreads rapidly through student social networks.

Seasonal weather factors

The transition from summer to autumn and winter in the UK is associated with the onset of the flu season, and may also mark a seasonal change in the prevalence of Covid-19. In temperate climates, such as the UK, flu exists at a low level throughout the year, but there is a marked increase during the winter. The periodic nature of the flu season arises from a complex array of environmental and virological factors (Lofgren et al., 2007).

In colder weather, people spend more time indoors, which increases infectious disease transmission. Large-scale heating of offices and residential blocks may unintentionally create a viral dispersion system. Indoor heating recirculates air of very low humidity. This is significant because air humidity affects the transmissibility of respiratory viruses. When the humidity is lower, viruses expelled from the mouth of an infected person can remain suspended in the air for a longer period (Araujo and Naimi, 2020). In their study of New South Wales, Australia, Ward et al. (2020) found that a reduction of 1% in relative humidity was associated with an increase of 6% in Covid-19 cases.

Apart from aerosol transmission, viral infection may arise through touching infected surfaces. Most respiratory tract viruses can survive on surfaces for several days. This may be extended under refrigeration conditions, which may partly explain clusters of Covid-19 cases in meat-packing factories. Outbreaks of Covid-19 are generally favoured by cold weather. Heat intolerance may be related to viruses being covered by a lipid bilayer which break down as temperatures rise; very high temperatures disfavour virus survival (Ren et al., 2020).

Seasonality also plays a part in human physiological response to infection, and may contribute to the seasonality of the flu season. In the UK, most vitamin D from sunlight exposure is from April to September. The most natural way to absorb vitamin D is through sun exposure of about an hour a week in total. Vitamin D plays a role in the functioning of the immune system, and modulates white blood cells by preventing them from releasing too many inflammatory-causing secretions. In particular, Vitamin D appears to inhibit pulmonary inflammatory responses, while encouraging innate defence against respiratory pathogens (Lanham-New et al., 2020). In preliminary studies, very low levels of vitamin D in older people have been associated with poor Covid-19 outcomes.

Relaxation of social distancing measures

There are numerous ways in which social distancing measures can be introduced and relaxed. To gauge the extent of the impact on pandemic wave phenomena, US experience during 1918 provides one of the largest databases (Markel et al., 2007). Each city devised its own strategy, which has some similarities with the situation today with Covid-19. San Francisco, for example, enforced some stringent protective measures, including quarantining all naval installations. However, the long second wave of mortality that followed the premature advice that masks could be removed and social distancing measures

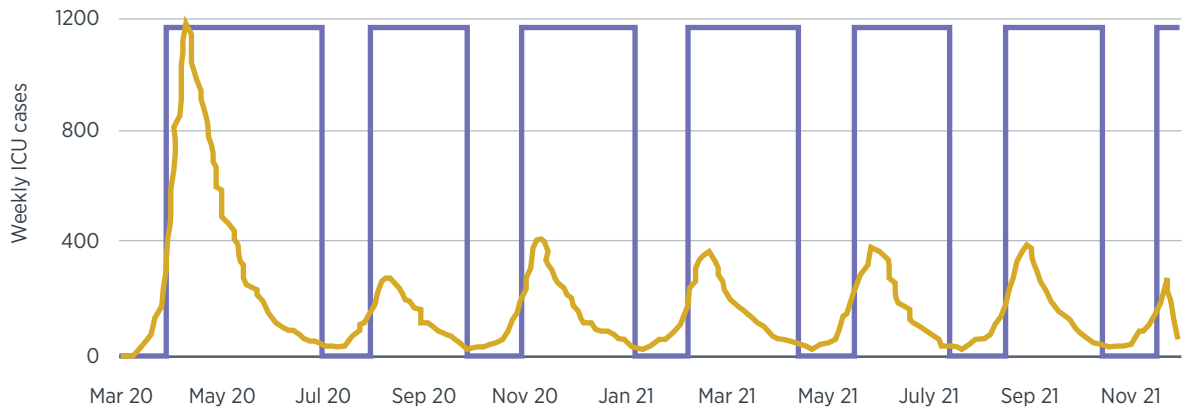
relaxed, warn against complacency over the second wave threat that has now emerged, a century later, in the Covid-19 crisis.

In the USA, many cities saw two peaks in mortality incidence, spaced by only a few weeks, with no connection to the school calendar or climate. Bootsma and Ferguson (2007) have shown that the timing of public health interventions in different cities had a profound influence on the pattern of the autumn wave. In those cities that suffered double-peaked autumn epidemics, control measures were so effective that substantial numbers of susceptible individuals remained in the population when controls were lifted after the first wave. The remaining susceptible pool allowed transmission to resume, leading to another epidemic peak and to the resumption of interventions. Conversely, cities in which transmission continued for longer before interventions were introduced witnessed much smaller second epidemic peaks, or none at all, because insufficient people remained to restart transmission.

On 16 March 2020, Ferguson et al. (2020) made the compelling case for an urgent UK lockdown, and also outlined a practical government strategy for coming out of lockdown through periodic relaxation and strengthening of social distancing measures (see Figure 1). This cycle might be expected to continue until the disease can be effectively controlled.

Each cycle corresponds to an infection wave of variable duration and intensity, as measured in terms of weekly intensive care unit (ICU) cases. The major constraint on relaxation measures is that ICU capacity should not be exhausted. With the rapidly constructed Nightingale hospitals providing a large quantity of additional ICU capacity in the UK, and the ramping up of mass testing capability, the number of new weekly confirmed infections has become a more stringent criterion for switching between social distancing strategies. Commensurate with the rising number of confirmed infections after the summer, social distancing measures were indeed tightened across the UK in September and October 2020, with the latest changes being the introduction of a 'three tier' system for local restrictions.

Figure 1: Schematic chart of UK cycles of relaxation and strengthening of social distancing measures. [Ferguson et al., 2020, fig.4. Licensed under CC BY-NC-ND 4.0]



Containing the second wave

Containing a second wave requires adopting best international practice in suppressing the first wave: early lockdown with strict border closure, mass testing, rigorous contact tracing and strict quarantining.

If the world is spared a dangerous mutation of SARS-CoV-2, the reopening of schools and colleges and the return of the flu season in the autumn pose the greatest risk-management challenge for health authorities. Encouraging as many people as possible in the UK to take up the flu vaccine in 2020 is a welcome intervention, especially as WHO has identified a potentially dangerous swine flu emerging from China. This is a new strain of flu that has not previously spread to humans before and could have the potential to trigger a global flu pandemic.

In order to mitigate the risk of a second wave of Covid-19, many lessons need to be learned from the spring. The example of Vo in northern Italy demonstrated that local containment of infection flare-ups, with strict control on entry and exit, can suppress outbreaks. For a country to contemplate easing social distancing measures, local circuit-breaker lockdowns for several weeks are necessary, with control of entry and exit to regions where clusters of cases are found. This regional isolation was implemented in Leicester, which was the first UK city to be put under local restrictions after the first wave of Covid-19.

As to the general easing of lockdown measures in England on 4 July, Public Health England estimated that at that time there were 20 new infections per 100,000 per week. This was rather higher than the national infection rate in Germany. Adopting the stringent German trigger threshold of 50 new local infections per 100,000 per week would have generated too many local lockdowns in England to be practically viable, publicly acceptable or economically manageable. As shown in Figure 2, which displays data to the end of June, the imposition of this low threshold might lock down half a dozen UK towns at a given time.

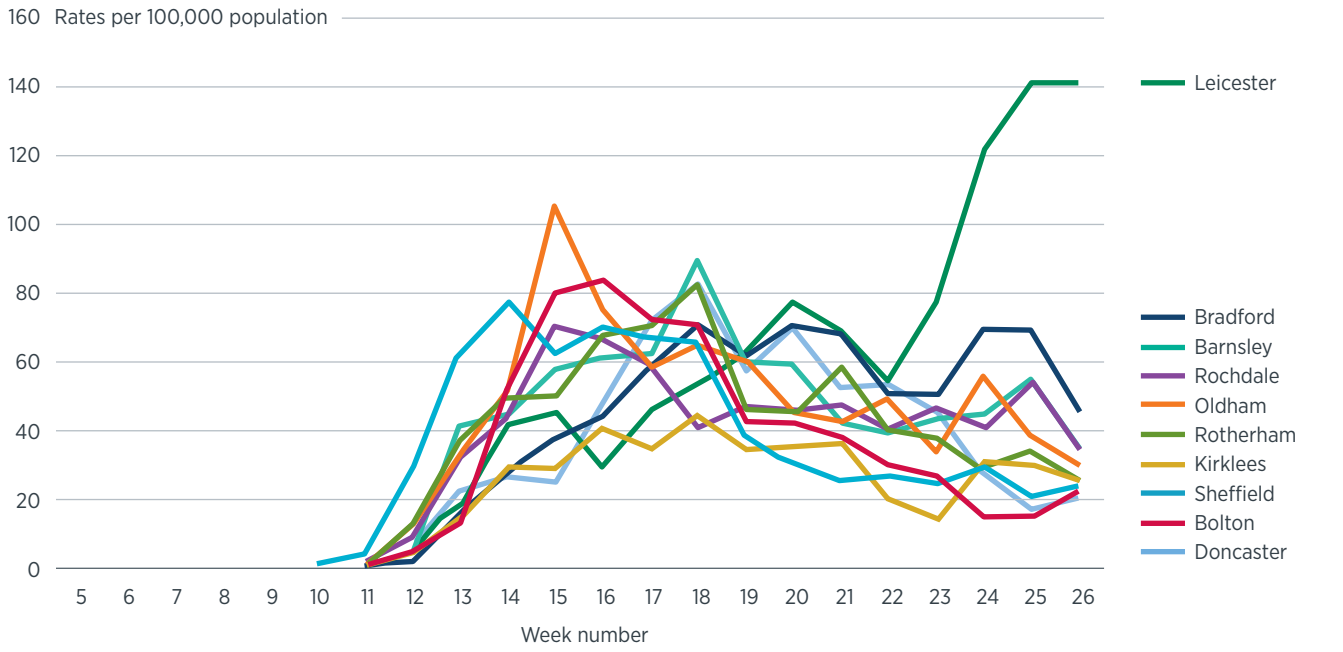


Figure 2: Weekly rates of Covid-19 infection up to the end of June, when Leicester was subject to local restrictions (Public Health England data available from https://www.gov.uk/guidance/coronavirus-covid-19-statistics-and-analysis. Used under Open Government Licence v3.0)

As of July, there was hope that regional spikes of infection in the UK with a higher threshold of 100 weekly cases per 100,000 could be suppressed with local lockdowns. However, with the autumn reopening of schools and colleges, and a reduction in public compliance with social distancing and quarantine measures, the infection rate escalated in many regions of the UK, with more than 10,000 confirmed cases per day in early October. In many parts of northern England, the threshold of 100 weekly cases per 100,000 was exceeded, and in Manchester and Liverpool the weekly infection rate exceeded 500 per 100,000. Social distancing measures can be tightened up to a degree. Political opposition to draconian lockdown restrictions, such as isolating towns, has limited the socially acceptable options for managing the second wave of Covid-19.

Unlocking through superior testing procedures

When social distancing measures were lifted, but the border still closed, New Zealand's Prime Minister raised the possibility of reopening the New Zealand border if there were a rapid and accurate fifteen minute Covid-19 test, and passengers were tested before boarding and after landing. Such a test would be valuable in any setting where social distancing is a practical challenge – not just in air travel. It would be the best weapon to tackle asymptomatic transmission, which is the insidious viral mechanism for generating a second wave of infection.

Currently under development, with some prospects of winter 2020 delivery, are real-time low-cost tests that give results within minutes. Even without new diagnostic technology, in areas where there is low prevalence of SARS-CoV-2, the lengthy and costly procedure for mass testing using standard PCR antigen tests can be substantially optimised. The efficiency gain from pooled testing would enable mass testing of communities, rather than just testing those with symptoms or those who were in contact with someone with symptoms. Mass testing of communities, as in the Italian town of Vo, can cover notable deficiencies in contact tracing due to asymptomatic people not coming forward for testing, or contact lists being incomplete.

The successful development of superior diagnostic testing procedures, together with progress in finding effective treatments and vaccines for Covid-19, would bode well for future international pandemic preparedness in not only suppressing second waves of infection, but containing first waves as well. To further this objective, the UK Prime Minister has called for a new global approach to health security to protect humanity against another pandemic (Johnson, 2020).

Conclusion

Pandemic history provides a stark warning that a second wave can be expected after the first. Despite hope over the summer, Covid-19 has fulfilled pessimistic epidemiological expectations. Until mass vaccination has been achieved, the cycle, anticipated by Ferguson in March, of alternate tightening and easing of social distancing measures, will persist. Pandemic second wave management involves optimising the timing and choice of these measures so as to minimise deaths, subject to practical constraints on economic disruption. For this to be achieved, a highly effective test, track and trace system is essential.

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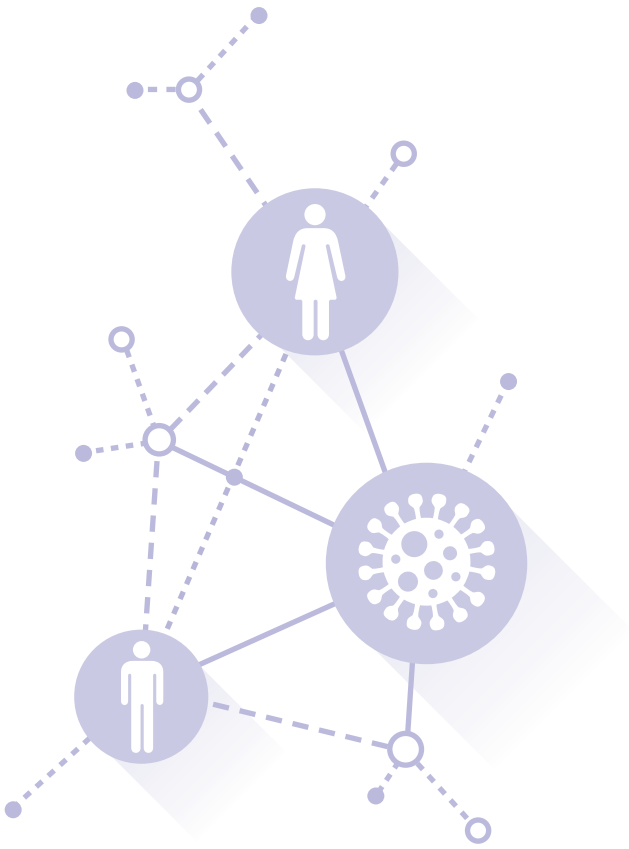
Gordon Woo

Gordon Woo is the architect of the RMS LifeRisks pandemic risk model, which was developed at the time of the avian flu crisis of 2006. He is a visiting professor at UCL, and an adjunct professor at NTU, Singapore. A top graduate in mathematics at Cambridge University, he completed his PhD at MIT as a Kennedy Scholar, and was a member of the Harvard Society of Fellows. He is the author of the book *Calculating Catastrophe* published by Imperial College Press.



Winter mortality 2020/21: what should we expect?

Dr Achim Regenauer, Chief Medical Officer, Life and Health, at PartnerRe

The Covid-19 pandemic is the most serious global disease outbreak in over a century. It is therefore unsurprising that many articles have been written dealing with the direct and indirect effects on politics, society, medicine and the economy. This is a complex topic, with many facets, but the focus of this article is on the short term and what we should expect from the coming winter in terms of mortality outcomes. The factors likely to have the most impact on mortality over this period are also those that will decide whether an effective containment of the virus is possible or not. There are therefore wider implications of the issues considered here, despite the seemingly narrow focus.

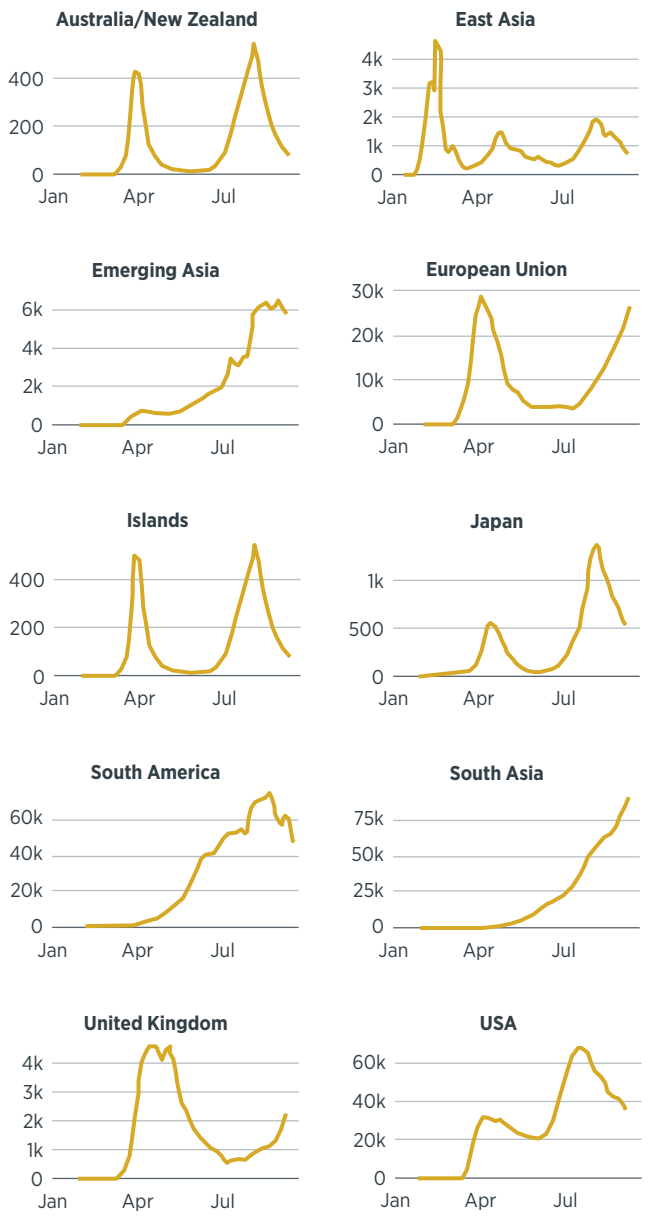
Countermeasures taken to date and implications for winter 2020/21

After much hesitation, the World Health Organization declared the Covid-19 outbreak, caused by the SARS-CoV-2 virus, a pandemic on 11 March 2020. After originating in Wuhan, China, numerous super-spreading events across the world, including a mass religious gathering in South Korea, a Champions League football match in Milan, holidaymakers gathering at ski resorts in Italy and Austria, and attendance in a popular pilgrimage city in Iran, contributed to its rapid global spread.

Comprehensive and consistent lockdown measures in China yielded a sustainable success that prompted many countries, particularly in East Asia and Europe, to implement similar measures. During the spring of 2020 almost half of the world's population had been instructed to stay at home by their governments in order to prevent the spread of Covid-19 (DW.com, 2020). On balance, these measures have been effective on a large scale but with several nuances, as reflected in Figure 1. (Note that 'Islands' refers to Iceland, Taiwan, Australia and New Zealand.)

Countries that imposed lockdowns early and enforced them for longer have tended to be much more effective at controlling the spread of the disease than countries that hesitated to implement these exceptional measures. Of course, there are other factors that are also important, such as the existence of effective testing and contact tracing, but the key point is that an early, large-scale response was critical. Similarly, countries that relaxed lockdown measures too early are facing a vigorous resurgence of the SARS-CoV-2 outbreak with associated strains on their healthcare systems.

Figure 1: Confirmed Covid -19 cases by region – 7-day rolling average



PartnerRe Alanytics
Data: Guidotti and Ardia (2020) **https://covid19datahub.io**

The risk of outbreaks following successful initial confinements is demonstrated by events in Mallorca and Singapore, or more locally Leicester in the UK. Health authorities are now increasingly vigilant and timely in confining these outbreaks and tracing possible sources and secondary contacts. These confinements of recurrent outbreaks were largely successful over the summer. However, there is a growing resurgence of Covid-19 cases in several countries, including France, Spain and the UK. This shows how easily the disease can quickly re-emerge if people are careless with social distancing and mask-wearing on a large scale.

Prospects for a severe second wave of Covid-19 over the winter

The focus of the media and the public has now shifted to a second wave, which is apparently starting to occur and could worsen over the winter, when conditions that lead to the spread of respiratory infections, such as the common cold and influenza, offer a 'good' opportunity for the SARS-CoV-2 virus to be transmitted on a large scale. Hence a double pandemic of both Covid-19 and influenza at the same time cannot be discounted.

The worst-case scenario is that both viruses spread quickly – either independently or in patients with co-infections – and lead to more severe cases of illness, presenting a further burden on the already overstretched resources of national healthcare systems.

Initial findings from March 2020 indicate that one in five people who were diagnosed with Covid-19 were also infected with another respiratory virus (Kim et al., 2020). The reason for such co-infection is that even though the viruses use different cell receptors to gain access to their victim, these have already been weakened by the first infection, making the patient more vulnerable to Covid-19.

However, this is more of a worst-case scenario and it is far from clear how the various respiratory viruses interact and interfere with each other. Furthermore, it is likely that due to behavioural changes people have already adopted, such as social distancing, hand washing and mask wearing, that the impact of seasonal influenza will not be so extensive, due to not being able to spread as widely as usual (Broadfoot, 2020). Be that as it may, a high take-up of the annual flu vaccination, combined with a vaccination against pneumococcal pneumonia, will be critical in keeping excess mortality down during the forthcoming winter. In the UK we have already seen the government announce that they intend to extend the traditional free flu vaccination programme in England to include all over-50s for the first time, as well as anyone who has been on the list of those required to shield and the people they live with (BBC, 2020).

Independently from co-infections with other diseases, experience from previous pandemics shows that essentially all of the major pandemics have involved a second wave around six months later. This second wave has often been more deadly than the first.

The expectation and discussions around the second wave are potentially misleading, as they are biased by the pattern of previous influenza pandemics. Influenza viruses, however, demonstrate quite different characteristics of transmission than Covid-19; they spread much more evenly among populations and do not tend to infect many people during the warm seasons. Neither is the case with SARS-CoV-2. Even warmer countries closer to the equator, such as Brazil, that do not experience much seasonal variation in temperatures, have seen severe outbreaks of the disease.

It is also not certain that the recurring outbreaks of Covid-19 can be successfully contained by national health systems over the long run. A single failure of containment may result in further super-spreading events, which have the potential, even during the summer season, to spread across the globe. Trends in the late summer and early autumn of 2020 in Spain, the UK and France point in this direction.

The SARS-CoV-2 virus has not been eradicated, but continues to smoulder with considerable potential to break out at any location and at any time. Local hotspots in the UK, such as Liverpool, as well as Bolton and Leicester, show the potential for this to occur. Consequently, if using a metaphor to describe the evolving spread of the disease, we should speak of embers that are carried along through time before they spark into another blaze (Hanage, 2020). This metaphor better illustrates the insidious potential of SARS-CoV-2, with its ability to spread very rapidly.

Immunity against the virus and implications for an effective vaccine

These worrying prospects inevitably lead to the question of how can the pandemic be controlled. Several scenarios are possible. The biggest hope is for the development of an effective vaccine. Currently, more than 190 vaccine candidates against SARS-CoV-2 are in development (Regenauer, 2020). Of course, this is unlikely to have an impact in winter 2020/21 as these vaccines will not be ready in time, but since their effectiveness is related to immunity against the virus in general it is worth reviewing here.

Numerous experts expect that a SARS-CoV-2 vaccine could be available by mid-2021. Despite impressive efforts by the pharmaceutical companies, heavily subsidised by many governments, concerns about achieving this ambition cannot be ignored.

It is important to note that, to date, no vaccine has ever been developed against a coronavirus. This includes not only the SARS virus that emerged in 2003, but also four different types of coronavirus that have been present for many years and cause the common cold. We are therefore obliged to live with the impact of these diseases.

Furthermore, it has been observed that for many patients with an asymptomatic or mild form of Covid-19, their antibody levels fell as much as 23-fold in the three months following the first onset of the virus (Seow et al., 2020).

Ultimately this could mean that (a part of) immunity against Covid-19 is limited in duration. It is likely that immunity derived from a new vaccine will potentially function in the same way, meaning we would need several doses to gain full immunity, instead of one combined with annual top-ups in order to maintain that immunity.

Even with such a treatment regime, we currently do not yet know whether the vaccine will offer complete protection against Covid-19, or only against a severe form of the disease. We also don't know whether transmission will actually be stopped, or if the vaccine will not be strong enough to prevent those who have been vaccinated from passing on the virus to others (even if only in a mild form). This would also mean that any immunity that individuals have gained as a result of being exposed to the virus earlier in the year would not help much in slowing the spread of the virus over winter 2020/21.

Of course, if the phenomenon of decreasing immunity against SARS-CoV-2 over time is corroborated, then this would mean the concept of eventually achieving herd immunity would ultimately also prove to be a pipe dream. The level of immunity in the population would be unlikely to remain at the level required in order to prevent the disease from spreading.

The key unknown in terms of vaccination and immunity relates to mutations that are part of the natural evolution as a virus tries to evade human antibodies by continuous adaptation. Fortunately, unlike influenza viruses, SARS-CoV-2 is relatively stable, having only a slow mutation rate (Alouane, 2020). However, the more a virus circulates worldwide, the greater the likelihood that a variant with new characteristics will emerge at some point.

One cannot exclude the possibility that mutations emerge at the most sensitive location in the virus, namely the receptor-binding domain of the spike protein, which enables it to enter human cells and which is therefore the main target of a new vaccine. Such a mutation may make a new vaccine ineffective.

In the worst case does this mean that all hope is gone? Will we forever be hostage to the SARS-CoV-2 virus? This outcome is unlikely. If history tells us anything, it's that in many cases viruses tend to mutate and evolve over time to become less pathogenic while the hosts, namely humans, become more resistant (Heid, 2020). In the very long run it may therefore be the case that even if researchers fail to develop an effective vaccine, SARS-CoV-2 will eventually (in many years' time) become another coronavirus that causes runny noses, common colds and, in a minority of cases, pneumonia.

While this sounds promising, does it mean that in the 'no vaccine' scenario we would have to live with SARS-CoV-2 and the consequent restrictions to public life for many years? Not necessarily.

Other methods for controlling the virus

If we consider the various strategies deployed to cope with the coronavirus around the world, a handful of countries have demonstrated remarkable success in confining outbreaks. One example is Japan, which has been able to avoid the worst effects of this pandemic without severe mandatory lockdowns. This reasons behind this outcome need to be understood, so that other countries can implement actions to achieve a similar degree of success. This is essential, in order to enable the lifting of severe restrictions that are leading to very significant negative economic, and potentially social, effects.

How did Japan manage to achieve such a success? In contrast to Western populations, the Japanese routinely wear masks to ward off hay fever and colds. They also have a 'low touch' culture. In addition, the government strongly recommended that the population abide to the 'three Cs' – avoiding closed spaces, crowded places and close-contact settings - especially where the activity involves loud talking (which is equivalent to greater breath volumes). There are also other factors related to the population, including less vitamin D deficiency among older Japanese compared to European populations, lower levels of obesity, and possible immunity from previous coronavirus infections.

However, in terms of factors that can be controlled in the short term in other countries, the approach to contact tracing is of most interest. Based on lessons learnt from the previous SARS-CoV-1 pandemic in 2003, Japanese health experts implemented a special kind of contact tracing called 'retrospective tracing'. This approach differs from standard methods conducted by other countries which focus primarily on the period after a patient contracted the disease. In contrast, Japan is focused on tracing the most recent week prior to first manifestation of symptoms through retrospective tracing, where health authorities determine a SARS-CoV-2 positive individual's movements and interactions before they became infected.

By mapping the infected individual and cross-referencing them with other infected people, contact tracers can identify common sources of infection – the people and places behind a specific infection cluster. All these secondary contact persons are compelled to self-quarantine for two subsequent weeks unless they are tested with a negative result (Kupferschmidt, 2020). This retrospective testing approach reflects the cluster feature of the SARS-CoV-2 virus, as it mainly spreads in cluster sites. Hence where it cannot be ensured that all visitors of, for example, a restaurant or religious ceremony are SARS-CoV-2 negative, a collective quarantine will be imposed.

Conclusion

Mortality from Covid-19 over winter 2020/21 is likely to be influenced by the ability to control the spread of the disease. This will depend on whether there is any effective immunity from the disease in the population and whether other effective controls can be put in place. In the longer term, a vaccine may allow us to control the disease all-year round, but there are no guarantees that an effective vaccine can be developed. Under a 'no vaccine' scenario, other methods of controlling the disease will be needed in order to ease restrictions that are harming the economy. This will also be critical in the first winter with SARS-CoV-2 (2020/21), as no vaccine is yet available.

The data available to date demonstrate the success of the Japanese government's approach using contact tracing and testing. Other examples of similar strategies can also be identified. It would be advantageous to consider similar approaches in other countries over the coming months. This would enable both economies and societies to live life in the presence of Covid-19, but without large-scale lockdowns and ongoing concerns.

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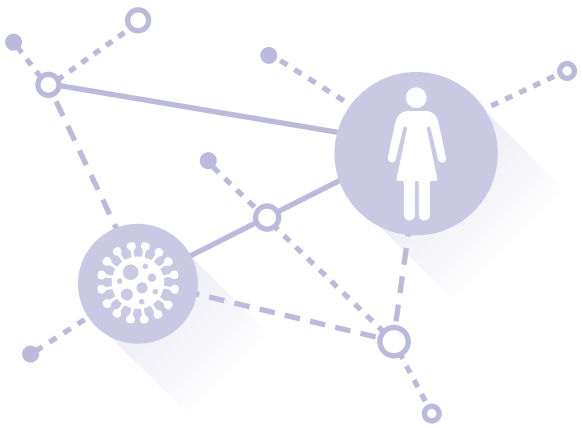

Long Covid: the longer-term effects of Covid-19

Nicola Oliver, Director of Life and Health, Medical Intelligence

The novel nature of the SARS-CoV-2 virus, and the resultant Covid-19 illness, means that any long-term impacts on survivors, whether of severe or mild manifestations, and how this might affect future mortality, are largely unknown.

But evidence has been emerging of major health problems affecting survivors. The situation was summarised well in an article in *Nature* (Marshall, 2020): 'Months after infection with SARS-CoV-2, some people are still battling crushing fatigue, lung damage and other symptoms of 'long Covid'.'

Long-term follow-up of survivors from the 1918 influenza pandemic indicated that long-term health effects may not be confined to the immediate survivors, where there was increased risk of coronary heart disease, but could also affect the next generation through fetal damage.

Chronic inflammation may be triggered by early disease exposure. Inflammation, in turn, is linked with apoptosis and cellular senescence, which are protective against cancer but may predispose to other ageing-related diseases, such as ischaemic heart disease and neurodegenerative disease.

Lessons from SARS and MERS

Insights can be drawn from previous coronavirus outbreaks, of which there have been two outbreaks in the human population in the last 20 years: Severe Acute Respiratory Syndrome (SARS) in 2002, and Middle East Respiratory Syndrome (MERS) in 2012.

Long-term follow-up studies of SARS survivors, in particular, have identified that some experience ongoing physiological impairments; not surprisingly, many of these impairments are related to the respiratory system. Hui et al. (2005), Zhang et al. (2020), and Herridge et al. (2011) provide some insights into the challenges faced by SARS survivors; these include reduced pulmonary function, bone damage as a result of steroid treatment, mental health disorders, chronic fatigue and reduced quality of life.

Acute respiratory distress syndrome (ARDS) is a type of respiratory failure characterised by rapid onset of widespread inflammation in the lungs and can develop in those severely ill with respiratory problems, such as Covid-19. This condition has also been associated with exercise limitation, physical and psychological sequelae, and decreased physical quality of life.

Can we expect similar long-term problems with those who have survived Covid-19, and are these problems likely to have a material impact on mortality?

For the sickest Covid-19 patients who are admitted to hospital and intensive care, this is a reasonable assumption. It is accepted that compromised pulmonary function and long-term mental health conditions are associated with increased risk of mortality.

In addition, there are now reports of possible long-term cardiac and renal damage in Covid-19 survivors, so this should also be considered as a potential future mortality problem.

Lung function

Chronic lung disease patients have their lung function measured at regular intervals, and disease progression is classified according to a number of criteria under the Global Initiative for Chronic Obstructive Lung Disease (GOLD) severity stage classification. Many studies have examined the association between GOLD stage and excess mortality; it is widely reported that worsening severity of lung disease is associated with increased risk of mortality.

In one large Finnish study, the hazard ratio for death was 1.27 for those with GOLD stage 1 lung disease; this increased in a dose-dependent manner to 2.85 for those with the most severe lung disease, GOLD stage 4 (Mattila et al., 2015).

From this, we can infer that survivors with compromised lung function following Covid-19 are at increased risk of mortality. The hazard ratios above can be regarded as worst-case upper bounds on the increase in risk, since lung impairment from SARS is less than that from chronic obstructive pulmonary disease (COPD). For instance, FEV1/FVC ratios – the ratio of forced expiratory volume to the forced vital capacity of the lungs – are relatively stable post-SARS, but materially reduced with COPD.

Mental health conditions

A prominent long-term issue for those who have been diagnosed and hospitalised with Covid-19 is the impact on mental health. As mentioned earlier, the experiences from the previous coronavirus outbreak in 2002 tell us that long-term mental health illness is a likely scenario.

This can range from depression and anxiety to post-traumatic stress disorder (PTSD), and has been observed to be a consistent long-term challenge for those who have been admitted to intensive care.

Post-intensive care syndrome is a collection of physical, mental and emotional symptoms that continue to persist after a patient leaves the intensive care unit (ICU). Focusing on the mental health challenges that post-ICU patients experience, the following have been documented (Cleveland Clinic, 2020):

Brain (cognitive) symptoms:

- Decreased memory, thinking problems
- Difficulty talking
- Forgetfulness
- Poor concentration
- Trouble organising and problem solving

Emotional symptoms:

- Post-traumatic stress disorder (nightmares, unwanted memories)
- Anxiety
- Depression
- Decreased motivation

The association between psychological distress and mortality is clear and dose-responsive; a pooled analysis of around 68,000 UK lives (Russ et al., 2012) reports that in the least severe category of distress, study subjects had a 20% increased risk of mortality after adjusting for age and sex. This risk increased to almost a doubling of mortality as the severity of psychological distress increased.

Cardiovascular disease (CVD)

The association between CVD and increased risk of death is undisputed; indeed, CVD is a leading cause of death worldwide (WHO, 2020). Despite extraordinary improvements in survival from CVD over the last few decades, the concern is that the effects of Covid-19 could exert a negative effect on these improvements.

Clearly, there is currently insufficient long-term data to draw a firm conclusion; however, analysis (Li et al., 2020) summarising available data on severity differences in acute cardiac injury and acute cardiac injury with mortality during the Covid-19 outbreak suggests that cardiac injury is evident in Covid-19 survivors. The level of injury is relative to the severity of the disease.

In addition, there is documented evidence that the clotting mechanism is damaged, which could lead to increased risk of stroke and other thromboembolic conditions (Ahmed, Zimba and Gasparyan, 2020).

Conclusion

While it is too early to be certain, it is likely that the long-term effects of Covid-19 will have a material impact on overall mortality. Evidence from the SARS coronavirus outbreak in 2002 demonstrates that the physiological reach of the virus could extend to respiratory, cardiovascular and mental health complications. Unlike the 2002 outbreak, the SARS-CoV-2 outbreak is a pandemic that has affected millions of people.

Indeed, a number of studies have been instigated in order to understand and improve long-term health outcomes for patients who have been in hospital with confirmed or suspected Covid-19; PHOSP-COVID is one based in the UK (PHOSP-COVID, 2020). Given the multi-system effects, and the likely long-term mental health impacts of Covid-19, we can see that the mortality risk for Covid-19 survivors is material and likely to persist long after the time when Covid-19 deaths cease making headlines.

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Life on pause: the cost of interruptions to non Covid-19 medical services

Conor O'Reilly, Head of Analytics at Club Vita, and Steven Baxter, Head of Longevity Innovation at Club Vita

Introduction

Throughout the pandemic concern has been raised by medical professionals about the hidden cost of Covid-19 in terms of the interruption and disruption to mainstream medical services. Patient nervousness, cancelled appointments and, by September 2020, a patient backlog numbering in excess of three million in cancer screenings alone (Roberts, 2020a), all point to near-term challenges and potentially elevated mortality in the short to medium term.

Below we explore the statistics on non Covid-19 deaths and what might be driving these figures, and describe some of the impacts the disruption caused by the pandemic is having on medical services.

Are we seeing an impact yet?

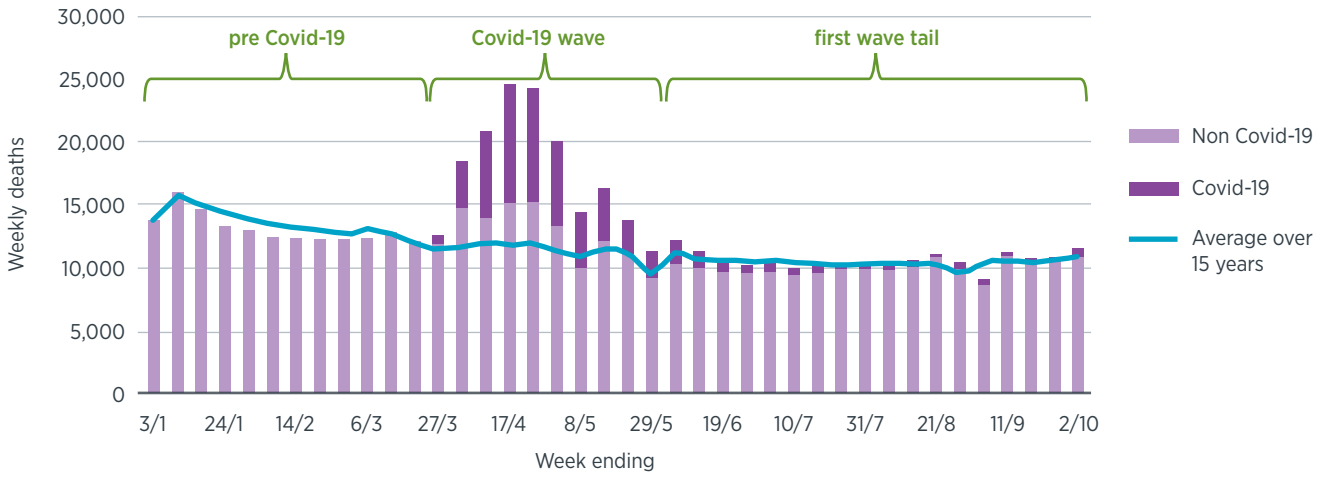
The UK government publishes daily statistics on the impact of Covid-19 on the UK population (Public Health England and NHSX, 2020). The Office for National Statistics (ONS), Continuous Mortality Investigation and Club Vita, among others, have been using this data to track excess mortality – the level of mortality experience compared to a baseline of the average level seen in recent years.

These studies have all drawn similar conclusions – that 2020 so far can be split into three phases:

- A 'pre-Covid-19' phase from January through to the first reported Covid-19 deaths in the UK in mid-March; a benign winter and first quarter flu season served to keep mortality below the five-year average for the time of year
- The first 'Covid-19 wave' lasting from mid-March though to late May, when Covid-19 spread rapidly, triggering a surge in Covid-19 deaths
- The 'first wave tail' from late May to the end of August, when Covid-19 mortality declined substantially and non-Covid-19 deaths dropped to around, or below, the national average.

Figure 1 shows the numbers of deaths registered in the UK each week, split by Covid-19 and non Covid-19, along with the average for the corresponding week in the previous five years. The loss of life during the pandemic so far has been significant – we estimate around 59,000 direct deaths in the UK as of mid-October. This figure is around 16,000 higher than the official statistics published by the UK government, as it includes all deaths where Covid-19 is recorded as a contributory cause on the death certificate, regardless of whether the individual has been tested.

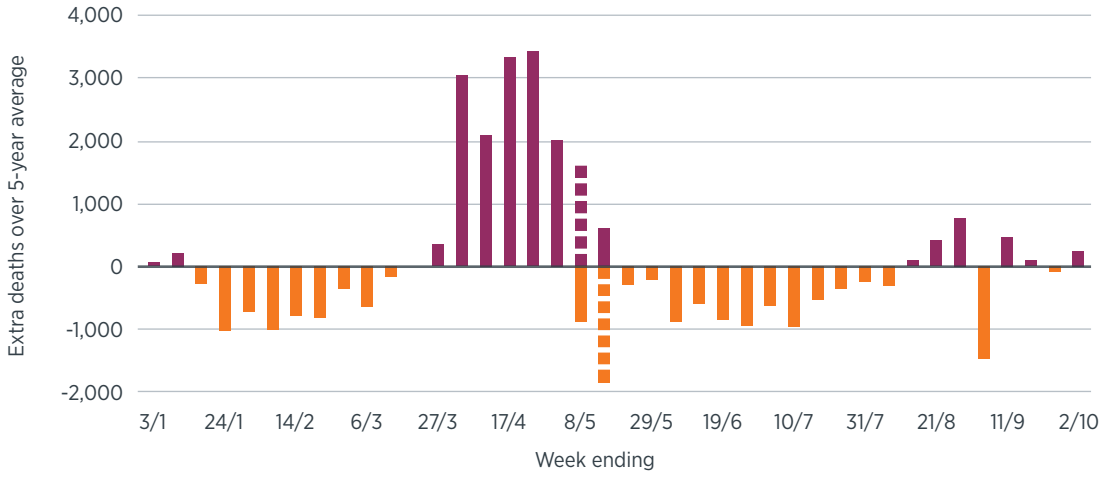
Figure 1: Total UK deaths by week of registration



Source: Club Vita calculations based on weekly death data from ONS, National Records of Scotland (NRS) and Northern Ireland Statistics and Research Agency (NISRA)

Note that the week ending is shown as the date the week ended in 2020. Weeks are numbered by the statistical agencies and the five-year average relates to the corresponding week in each of the preceding five years, which may have ended on different dates in previous years. Weekly figures for Scotland, unlike the rest of the UK, run from Monday to Sunday rather than Saturday to Friday – for charting purposes these are aligned with the week ending on the Friday prior to the Sunday of the Scottish week. The timing of public holidays can also have an impact on the number of weekly registrations.

Figure 2: Excess weekly deaths over five-year average, excluding Covid-19 deaths (UK by week of registration)



Source: Club Vita calculations based on weekly death data from ONS, NRS and NISRA

Notes: The week ending is shown as the date the week ended in 2020. Weeks are numbered by the statistical agencies and the five-year average relates to the corresponding week in each of the preceding five years, which may have ended on different dates in previous years. Weekly figures for Scotland, unlike the rest of the UK, run from Monday to Sunday rather than Saturday to Friday – for charting purposes these are aligned with the week ending on the Friday prior to the Sunday of the Scottish week. Bars with dotted lines are approximate figures post-adjustment for the bank holiday to mark the 75th anniversary of VE Day which fell on a Friday (and so delayed some registrations into the following week).

At the time of writing, as Covid-19 deaths appear to have started to increase again, attention has also turned to non Covid-19 deaths, and the potential for more bad news to come. Figure 2 shows non Covid-19 deaths relative to the five-year average; there is a clear spike in April and May, coincident with the peak of Covid-19 deaths, accounting for around 14,000 further deaths.

Drivers of the increased non Covid-19 deaths in April

The ONS (2020a) investigated non Covid-19 deaths in England and Wales up until the end of April to explore potential explanations for the increase in recorded deaths. They identified five potential drivers:

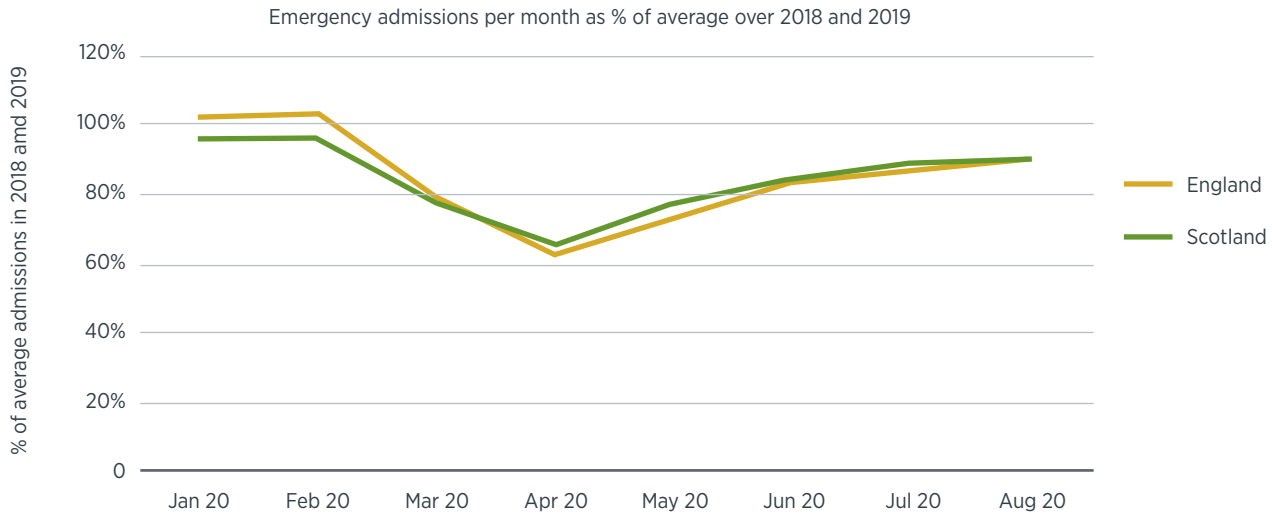
1. Undiagnosed Covid-19 resulting in some deaths being misallocated as 'non Covid-19' deaths
2. Delays in accessing medical services and/or receiving treatment, resulting in an increase in deaths which would otherwise have been prevented
3. Increased pressure on healthcare services resulting in deaths as a result of, for example, lack of capacity in intensive care unit beds, which would not have been the case in normal circumstances
4. Increased deaths as a result of stress-related factors
5. Changes to the death registration process introduced in the Coronavirus Act 2020, which increased the maximum period during which the individual had to have been seen by a medical professional before triggering referral to a coroner from 14 to 28 days, as well as allowing coroners to avoid arranging an inquest into deaths where Covid-19 was a suspected cause.

The ONS concluded that the first three drivers were likely to be factors in the increase in non Covid-19 deaths, and noted the challenge in disaggregating undiagnosed Covid-19 from deaths arising from the disruption to services in March and April, when less was known about the pathology of Covid-19.

Impact of disruption on emergency admissions

Concerns around the perceived risk of catching Covid-19 in a medical setting, a possible desire to avoid causing the NHS 'inconvenience', and the general messaging of lockdowns and social distancing, have all contributed to significant falls in people seeking medical advice since March. For example, a weekly poll by the Scottish government (2020) showed that in mid-September around 1 in 3 agreed with the statement that they "would avoid GP/hospital for immediate non Covid-19 health concerns" (compared to 1 in 2 at the height of the pandemic).

Figure 3: Emergency admissions per month compared to the average for 2018-19



Source: Club Vita calculations based on data in respect of emergency admissions in Scotland and England from NHS Scotland and NHS England respectively

Note that the data for England is published monthly, whereas the data for Scotland is published weekly. In creating the monthly chart we have approximated monthly figures for Scotland by assuming daily admissions are evenly distributed across the week, and so have split weeks that overlap a month end. This is a simplification, as in reality we would expect emergency admissions to typically be higher at the weekend than mid-week. We do not anticipate that this simplification is likely to materially impact on the analysis.

Despite determined efforts by the NHS to stress that individuals should continue to seek medical attention, emergency admissions in England in August were still around 10% below the levels seen in August 2018 and 2019; similarly, by the first week in September, emergency and planned admissions in Scotland were 10% and 30% below 2018 and 2019 levels respectively.

With fewer individuals presenting as emergency admissions, the location of deaths has also changed. Updated analysis published by the ONS (2020b) in early September highlighted how deaths at home have been elevated since mid-April, and are only now starting to decline towards seasonal averages. That same analysis also identified how the numbers of deaths from conditions that require timely treatment to avoid being fatal remained elevated compared to average levels during May and June. This included conditions such as diabetes, epilepsy and hypertensive disease. The ONS analysis suggested that the elevated mortality could be a consequence of delayed access to care.

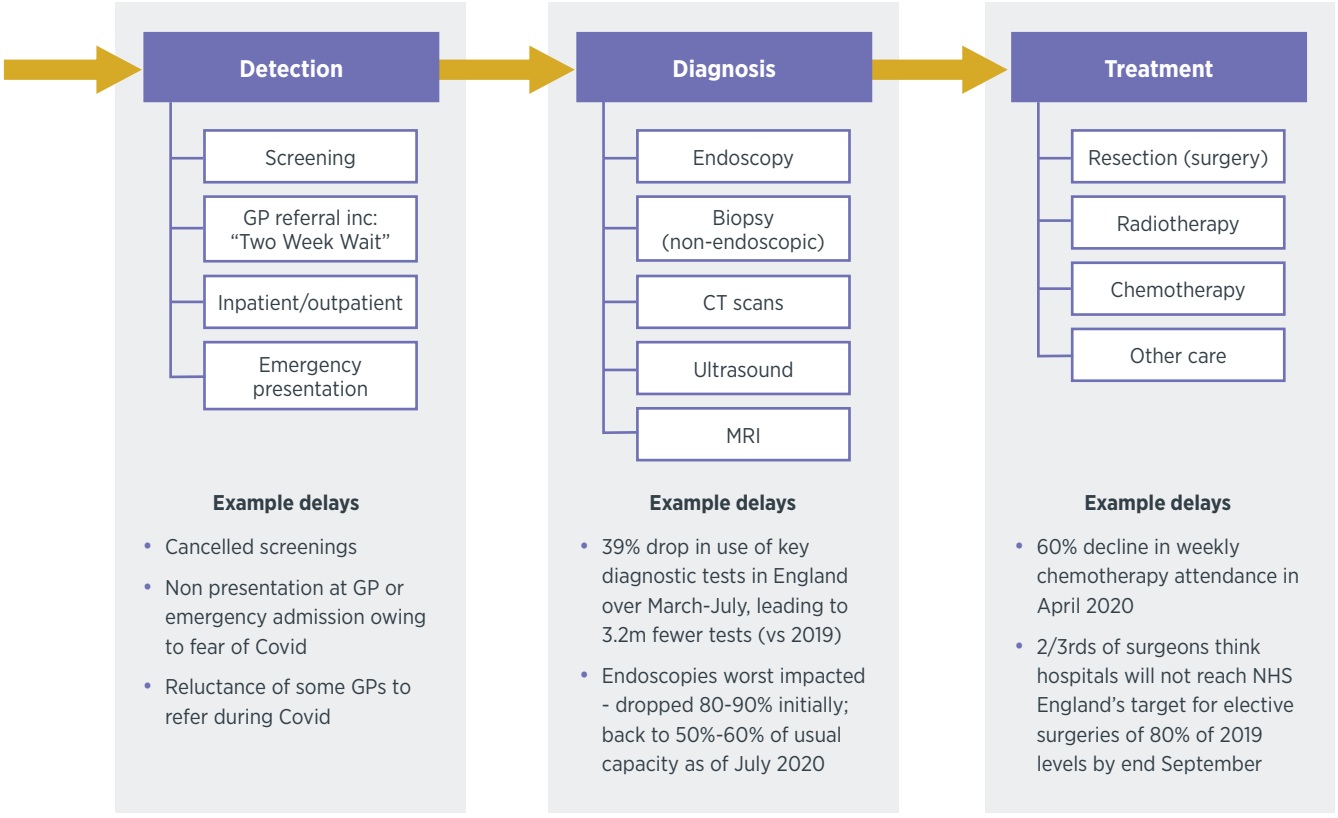
Among working-age adults the ONS highlighted that deaths from cardiovascular conditions, including hypertension, cardiomyopathy, pulmonary heart disease and heart failure, have remained above five-year averages for the time of year. However, some of this may be due to the cardiovascular damage we now know Covid-19 can inflict, rather than treatment disruption per se.

Impact of disruption on cancer diagnosis and treatment

The reduced 'demand' for medical services outlined above, has been combined with reduced 'supply'. For example, GP surgeries have been restricted both in terms of numbers and capacity as a result of social distancing, particularly for face-to-face appointments (BBC, 2020). This disruption will impact many morbidities, but perhaps most starkly cancer diagnosis pathways. Early detection and diagnosis of cancer is key to future health and survival rates; the earlier a cancer is detected, the better the outcomes.

Figure 4 highlights how each step of the pathway – from the initial detection of a potential problem, through to diagnosis and treatment – has been impacted by Covid-19.

Figure 4: Disruptions to cancer detection-diagnosis-treatment pathway



Source: Club Vita consolidation. Diagnosis statistics from Cancer Research UK (Roberts, 2020a). Other references supplied in main body of article.

As an example of the impact this disruption is having, NHS England reported a 60% reduction in urgent cancer referrals (Mahase, 2020) in April 2020 compared to April 2019, while Cancer Research UK estimated that, with some 210,000 people getting screened per week before the 'pause' in cancer-screening services, the screening backlog may be as much as three million people (Roberts, 2020a), potentially resulting in an estimated 2,300 cancer cases being 'missed' each week.

Disruption to services will inevitably result in increased mortality rates from 'preventable' deaths in the future, although Cancer Research UK notes that the exact impact is difficult to estimate (Roberts, 2020b); we need to assess both the impact of delays to diagnosis and the impact of delays to treatment. Research so far helps estimate some of this impact. For example, one recent paper (Maringe et al., 2020) estimated that delays in cancer diagnosis in England could lead to an additional 3,291–3,621 deaths from the four major cancers (breast, lung, prostate and bowel cancer) over the next five years as a result of presenting at a later stage. Surgery is the primary treatment for many forms of cancers, forming part of the treatment for around 80% of breast cancers and 60% of colon cancers (NCRAS, 2016). Another study (Sud et al., 2020) estimated that a three-month delay in cancer surgery could result in more than 4,700 deaths in England, and a six-month delay in over 10,000 extra cancer deaths. A survey by the Royal College of Surgeons of England (2020) found that two-thirds of surgeons did not expect their NHS Trust to meet NHS England's target for elective surgeries of 80% of 2019 levels by the end of September 2020, and over a third said elective surgery was running at 50% of levels seen in 2019.

Other widely used treatments, such as radiotherapy and chemotherapy, have also been interrupted. For example, there was an approximate 60% fall in chemotherapy admissions (Lai et al., 2020) during April 2020. By July, numbers starting cancer treatments had rebounded slightly - up to 80% of pre-lockdown levels. However, many of the patients who have entered treatment in 2020 will be using different treatment methods to mitigate Covid-19 risks (eg switching treatment to radiotherapy rather than surgery and making earlier use of stereotactic radiotherapy). The impact of these treatment changes will only be known in the months and years to come.

Impact on other services

Although we have focused on cancer pathways above, other treatment services have seen similar impacts. The British Heart Foundation estimate that 28,000 heart procedures had been postponed in England (Blake, 2020), numbers attending A&E with suspected heart attacks fell by 50% over March 2020 in England (Bakker, 2020), while a third of those with known heart and circulatory conditions said they found it harder to get the medical treatment they needed.

A significant component of the rise in non Covid-19 deaths seen in April and May was a marked increase in deaths registered in care homes, particularly in England and Wales. It is now apparent that much of this mortality related to undiagnosed Covid-19, including patients returning untested from a hospital setting. Additionally, the stringent lockdowns enforced in an attempt to control Covid-19 in care homes led to prolonged periods without visits, or at best much reduced visiting. For residents with dementia, this increased social isolation can be a significant factor in deterioration of their condition, as well as the increased stress and confusion that comes with changes to routines, staff wearing masks, inability to 'walk about', etc. (Alzheimer's Society, 2020a).

More generally, both primary care and specialist services to diagnose dementia have been impacted by Covid-19. Rates of dementia diagnosis have dipped (albeit not so much as acute care) and the Alzheimer's Society has warned of the impact on undiagnosed dementia sufferers not being able to access the necessary interventions and subsequent support services (Alzheimer's Society, 2020b).

It also seems inevitable that recent high levels of stress as a result of the pandemic are likely to have had a negative impact on some people's mental health. This could arise from concerns around them or their family catching the virus, grief if they know someone who has passed away, uncertainty around income and job security, increased social isolation, and, in some sectors, stressful work environments. Stress levels are known to be a contributory factor in several diseases. At the same time, mental health support services have been disrupted by the pandemic. It seems likely that we will see some increase in deaths owing to mental-health related issues, including suicides, as well as drug and alcohol-related deaths (Moreno et al., 2020).

Combatting the disruption backlog

The widespread cancellation and postponement of treatments, combined with drops in diagnosis rates, has led to a substantial backlog as services begin to resume and people are encouraged to seek medical advice as necessary. Estimating the total impact of the disruption to services requires consideration of the scale of disruption to date, a view on how long it will continue, and the extent to which the developing winter wave of the pandemic will further disrupt services.

Since August the NHS has been implementing the third phase of its response to Covid-19, seeking to accelerate the return to near-normal levels of non Covid-19 health services and make fullest use of the capacity available to clear some of this backlog during the 'window of opportunity' before the anticipated winter demand pressures (NHS England, 2020). With approximately four million people in England waiting for NHS treatment prior to the pandemic, it is likely that waiting times will get materially worse in the short term (NHS Confederation, 2020).

One option to clear the backlog may be to make greater use of the private sector, which already carries out some 1.5 million procedures on behalf of the NHS in England (The Independent, 2020). NHS England has ended the existing 'block booking' deal designed to handle the surge in demand during the pandemic, in favour of local arrangements to deal with regional spikes in demand (Schraer, 2020). However, up to £10bn has been made available to procure private hospital capacity, initially for two years with an option to extend for a further two years, to reduce the backlog caused by the pandemic (TED, 2020). Other proposals include increasing hospital capacity by extending operative hours (although this has knock-on implications for medical and other staffing requirements) and making extended use of, for example, the 'Nightingale' medical facilities.

Ultimately though, capacity has a human constraint with regards to the number of trained clinicians able to deliver the services, and so it will take many months, if not years, to clear the backlog. Tragically, it appears inevitable that we will be feeling the disruptive impact of the pandemic for many years to come.

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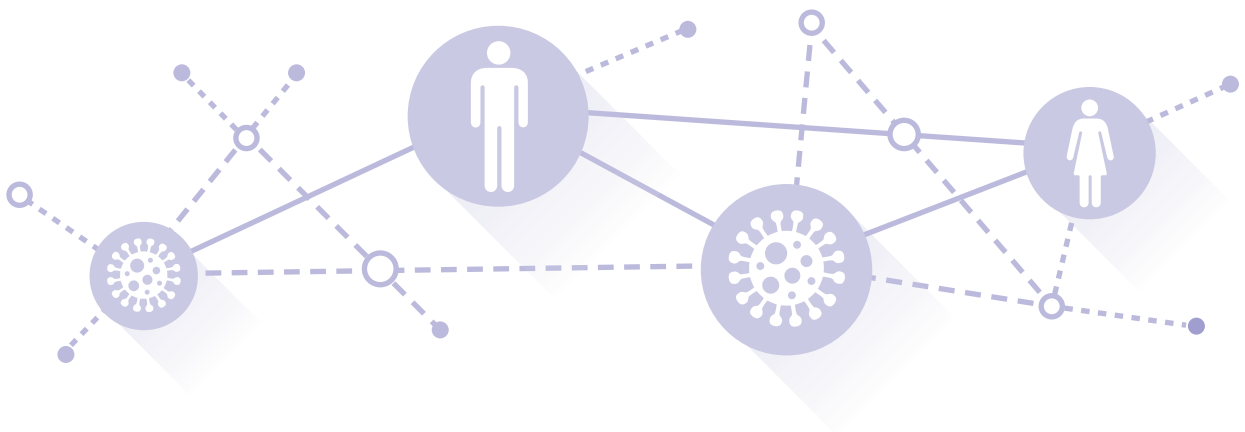


Likely mortality impacts of the post-pandemic recession

Kenneth McIvor, Director at Willis Towers Watson

Introduction

As the pandemic has progressed, collective minds have begun shifting their focus from the direct mortality impacts of Covid-19 to the longer-term implications. One of the defining features over the longer term will be the toll that the pandemic, and policy responses to it, have on the economy – we know from experience that there will be knock-on effects on the health of the population.

This article examines some of the potential impacts on UK mortality likely to result from the forthcoming contraction in the economy. The focus is on how economic recessions have historically affected UK mortality. The importance of various pathways, eg changes to diet or smoking, and levels of financial anxiety or social isolation, are considered, as well as the role these may play in influencing UK mortality during, and in the years following, the current recession. While this article considers an illustrative economic shock, based on the impact of the Covid-19 pandemic, it does not go into health aspects related to the disease itself or to those brought about by efforts to contain the virus (eg weight gain due to lockdown). The direction and severity of the impact of various drivers is estimated and an in-depth look at one of the key drivers is provided: funding the UK's health service. Analysis finds that a fall in GDP of 20%, if passed on directly in lower NHS funding, would see mortality improvements 0.8% p.a. lower than they would have otherwise been over the next 10-year period; this equates approximately to a one-year shortening of life expectancy at age 65.

Table 1

Recession	Typical recession range†	Global pandemic	Global financial crisis	1990s recession	1980s recession	Great slump
Cause		Pandemic leading to lockdown and social distancing measures.	Loss of confidence in the value of sub-prime mortgages leading to a credit and liquidity crisis.	High interest rates, falling house prices and an overvalued exchange rate.	High interest rates and currency appreciation leading to spending cuts and deflationary monetary policy.	Decline in world trade, output of heavy industries and employment.
Period		2020	2008-09	1990-91	1980-81	1930-31
Duration (quarter years)	2-6	2 (ONS, 2020)	5	5	5	6
Peak rate of unemployment	8%-20%	11.9%‡	8.3% (2011)	10.7% (1993)	12.5% (1982)	20% (1930)
Peak to trough GDP change	-20%-0%	-21%	-5%	-1.5%	-4.5%	-8%

Source data: Office for National Statistics, ***https://www.ons.gov.uk****; Office for Budget Responsibility,* ***https://obr.uk/data/***

† Based upon the five economic events in this table.

‡ Based on the central scenario in OBR (2020) which accounts for the end of the Coronavirus Job Retention Scheme (CJRS). Note that the CJRS has been extended to 31 March 2021.

Recession

The UK economy is forecast to be down by 11% in GDP terms over 2020 having experienced its first recession in 11 years, with GDP down by 2.2% in Q1 and a record 20.4% in Q2 as a result of the Covid-19 pandemic and the ensuing lockdown and related policy responses (ONS, 2020).

Table 1 shows the UK's experience over the three most recent recessions: the global financial crisis (or Great Recession) and the recessions of the 80s and 90s. The Great Slump (the UK fallout from the Great Depression of the 1930s) is also shown, as a more severe event, for comparison purposes. Estimates so far suggest that the crisis emerging from the pandemic will be shorter and sharper than anything the UK has experienced before.

While this article gives thought to the exceptional circumstances arising from lockdown and social distancing, these have not been explicitly allowed for in any of this analysis. Likewise, great uncertainty relates to the extent of government policy changes – recession implies a 'default option' of reduced health expenditure, but policy changes might lead to the opposite (at least in the short term – in the longer term, economic reality is harder to avoid).

A subject of vigorous debate

What might the economic recession mean for life expectancy? While the relationship between mortality and the economy is unquestionable in the long term (on average, the richest economies have the highest life expectancies), in the context of economic cycles the relationship is a surprising hotly debated topic (Ballister et al., 2019).

At an aggregate level, some studies have looked at overall mortality trends in Europe in the context of the previous recession. These studies found that the European economies that suffered the worst during the global financial crisis were those that had seen the greatest increases in life expectancy in the years up to and including 2010 (Kristjuhan and Taidre, 2012; Leon, 2016; Tapia Granados and Ionides, 2017). Similar results have been found in the U.S. (Ruhm, 2007). Such views are not unanimous, however (Bartoll and Marí-Dell'Olmo, 2016).

Any rises in average life expectancy in the general population are likely to mask significant deteriorations among pockets of the most vulnerable. To compound the issue, income equality (as measured by the Gini coefficient) has been shown to make economic downturns worse (Lewin, Watson and Brown, 2017). A prevailing argument is that mortality rates rise when the economy declines because unemployment and government austerity lead to a general worsening in health and healthcare. The counterargument is that recessions lead to behavioural changes and reductions in environmental pollution, motor accidents and occupational risks – and these lead to mortality rates falling. Both arguments have merit.

Heterogeneity matters

One of the most striking features of the SARS-CoV-2 virus is the different effect it can have from one person to another. We can understand and tackle the virus better by considering the population as a collection of distinct groups with varying vulnerabilities. We think about the population in the same way when we consider deaths in the context of recession.

Mortality rates of population sub-groups, delineated by age, gender and socio-economic status, are disproportionately affected by drivers of change resulting from recession. Some of these effects work to increase mortality and others to decrease it. We take a closer look at these drivers in the next section.

Drivers and their pathways to mortality

Healthcare

The NHS is at the forefront of the fight against amenable deaths (deaths that are preventable given timely healthcare) but is highly dependent on public spending. Due to the effects of improved healthcare being felt across a wide range of ages, there is a broad scope of dependants, such as the working age population, those prone to chronic health conditions as a result of recession, or those in care homes, susceptible to declines in availability or quality of medical care. Given the importance of this driver, its potential effects are examined in more detail below. This point may be further accentuated given that the lockdown has already put the NHS 'on the backfoot' as a result of curtailments of treatment, postponement of non-urgent surgeries and reductions in intensive care unit capacity.

Conversely, total mortality has been found to increase when job markets strengthen (Gerdtham and Ruhm, 2006). And it can be argued that the people living in countries with strong welfare state systems should be best placed to weather poor health in unemployment (Hone et al., 2019).

Physical health

Some element of the resulting impact of recession comes down to how individuals choose to cope; there are several modifiable health behaviours that play a role. Unfortunately, there is mixed evidence as to how such behaviours change under recession (Margerison-Zilko et al., 2016).

Alcohol consumption has been shown to rise among those made unemployed, but drop at an overall level, perhaps due to tighter budgets. Smoking behaviour is not so clear, but rises have been observed among those made jobless, particularly in lower socio-economic groups (Miyara et al., 2020). Diet and nutrition appear to vary by geography, perhaps due to cultural differences in cooking and cuisine, but there is a tendency in developed Western countries to see higher calorie intake during recession (Clinical Trial Service Unit and Epidemiological Studies Unit, 2009).

As for physical activity, although unemployment has been shown to significantly increase exercise, the harm that financial strain brings to individuals undermines any positive effects that exercise gives (note that physically demanding work usually has a negative effect on health while non-work physical activity is associated with improved general health).

Reduced economic activity also brings about changes in our environment that have been shown to have positive impacts on life expectancy. Reduced traffic activity when the economy is down corresponds with reduced traffic deaths. Air pollution may be more detrimental to health than first thought (Lelieveld et al., 2019). A reduction in air pollution has been one of the more positive features of the lockdown (Higham et al., 2020).

The argument on occupational risks can go both ways. While fewer people in employment means lower exposure, recessions may also force employers to focus on growth and let health and safety standards slide (Devereux, 2014). The relatively stringent health and safety standards in the UK will diminish the extent of such deterioration versus the global average.

Mental health

The psychological impacts of recession also have a negative effect. A rise in suicide rates is observed during recession and the rises are often greatest among young working-age males (Oyesanya, Lopez-Morinigo and Dutta, 2015). One meta-analysis has claimed that loneliness is more detrimental to health than well-established risk factors such as obesity, physical inactivity or pollution (Holt-Lunstad, Smith and Bradley Layton, 2010). This is worrying given the extensive self-isolation and social distancing policies that may have to continue. We could well see a 'perfect storm' of negative mental health factors arising from social isolation, financial anxiety and job uncertainty.

Summary

For each driver, Table 2 provides a potential impact (author's own estimate) based on the range of historical data on recessions as measured on the metrics provided and the academic research referenced. The impact is summarised as low, medium or high, where low impact indicates that the impact may be fewer than 100 deaths per year during the recession, medium impact up to 1,000 deaths, and high impact greater than 1,000 deaths. Note that the impacts given are illustrative and based on broad approximations and assumptions where necessary.

Overall adverse outcomes are expected in the longer term for the elderly and for younger lives in the short term. The negative

Table 2

Driver	Risk factor	Most affected sub-group(s)	Relationship to recession	Relationship to mortality	Direction and severity of impact on life expectancy†
Healthcare	Lower funding of services	Elderly	This is a very important factor given the dependency of a large and vulnerable segment of the population. We therefore investigate the relationship in greater detail in the latter part of this article below.		**– High**
Physical health *smoking and alcohol*	Higher intake of cigarettes / alcohol	Blue collar	Recession leads to rises in abstention from alcohol but a rise of frequent binge drinking in 0.3% of the population (Bor et al., 2013) and falls in smoking prevalence of 15-20% (McClure et al, 2012).	High episodic alcohol intake associated with a 54% proportional increase in mortality rate (Rao and Andrade, 2016). Smokers of 10 cigarettes per day or more associated with a 180% proportional increase in mortality rate (Jacobs et al., 1999).	**– Low**
	Lower intake of cigarettes / alcohol	White collar‡			**+ Medium**
Physical health *diet and nutrition*	Higher intake of calories	Blue collar	One percentage point increase in unemployment associated with increase of 1.6-4.1 kcal per capita (Ng, Slining and Popkin, 2014).	BMI above 22.5-25, each extra 5 points associated with a 29% proportional increase in mortality rate (inverse relationship below 22.5-25) (Prospective Studies Collaboration, 2009).	**– Medium**
	Lower intake of calories	White collar*			**– Medium**

† Analysis of severity based on typical recession ranges.

‡ This is a simplifying assumption in an area where there is mixed evidence, based on rises in intake among blue collar but an overall drop which suggests white collar intake is offsetting.

* This is a simplifying assumption in an area where there is limited evidence, based on less eating out and more home cooking among the white collar segment.

Driver	Risk factor	Most affected sub-group(s)	Relationship to recession	Relationship to mortality	Direction and severity of impact on life expectancy†
Physical health *exercise*	More exercise	Blue collar	One percentage point increase in the employment-population ratio raises minutes spent working by 2.5 and reduces the share that exercises by 0.19 percentage points (Colman and Dave, 2011).	Exercise per week of 10-149 minutes: 34% reduction; 150-299 minutes: 47% reduction; and 300 minutes or higher: 54% reduction (proportional) in mortality rate (Simon, 2015).	**+ Low**
	Less exercise	White collar‡			**– Low**
Physical health *environment*	Less / more workplace accidents / stress	Blue collar, male	Recession accounts for approximately 10% of the fall in workplace injury rates (Health and Safety Executive, n.d.).	Job strain for males with cardiometabolic disease associated with a 68% proportional increase in mortality rate (Kivimäki et al., 2018).	**+ Low / – Low**
	Less car accidents / pollution	No clear differentiator	One percentage point increase in unemployment associated with a reduction in traffic mortality of 3% in the U.S. (Ruhm, 2000), or 2.1% in OECD countries (Gerdtham and Ruhm, 2002).		**+ Medium**
Physical health *diet and nutritio*	Higher levels of anxiety and isolation	Young, blue collar, male	Recession leads to death by suicide rising by 6.5% (150% proportional increase in suicide mortality rate among unemployed) (Reeves, McKee and Stuckler, 2014).		**– Medium**

effects are also weighted more towards blue-collar workers, while white-collar workers see more beneficial effects emerge.

Healthcare funding versus outcomes

Over the last 50 years increases in health spending have been shown to correlate well with improvements in life expectancy across most developed nations – see Figure 1. (The US is a notable exception, largely owing to the nature of its healthcare system.) Data from the UK supports the strength of this relationship further with periods of generous funding increases corresponding to periods of faster improvements in life expectancy – see Figure 2.

Government spending allocated to healthcare in most developed countries, including the UK, has remained an increasing but stable proportion of GDP over the last 50 years. This consistency, as well as the supporting evidence from the slowdown in improvements during the era when priority was placed on reducing the fiscal deficit, underlines the downward pressure on healthcare spending that will inevitably result from the impending recession and raises the question of the consequent effect on life expectancy – see Figure 3.

Quantifying the relationship

The relationship between healthcare spending and longevity is likely to lead to negative longevity outcomes due to the recession, so as actuaries it is natural to seek a quantification of the sensitivity of this relationship. It is important to choose appropriate variables to represent these two concepts to capture the true strength of this relationship after having removed confounding variables and smoothed noise.

Healthcare spending is represented by the 10-year average real spending increases adjusted for ageing and population growth. Such averaging allows for the delayed response in health outcomes resulting from changes in funding, and the ageing adjustment to the real spending increases allows for the increasing cost of providing the same level of care given the degree of ageing and population growth as well as inflation.

To represent longevity we consider the three-year central average age-standardised mortality improvements for the age range 50-80, adjusted for smoking. Age standardisation allows us to ignore the shifting demographic profile of the population, while averaging removes the autoregressive nature of improvements from year to year.

† Analysis of severity based on typical recession ranges.

‡ This is a simplifying assumption in an area where there is limited evidence, based on possible consequence of working longer in understaffed teams among the white collar segment.

Smoking, as a main contributor to the improvements of recent decades, has been adjusted to avoid overstating the effect of healthcare spending and to fairly attribute at least some of the high improvements of the late 1990s and early 2000s to the lagged response to the fast-falling smoker prevalence to the mid-1990s. Only ages 50-80 are considered, as mortality rates for both younger and older lives are driven by causes less amenable to improvements in healthcare than historic spending has funded.

Note that while a correlation between these variables does not prove that the mortality improvements were caused by increases to health spending, the strength of the evidence across a 40-year period is suggestive of what is intuitively expected. Furthermore, while an ageing population does require additional spending, an adjustment to the spending increases is made to remove this effect, and the averaging method used for the respective variables suggests that changes in spending pre-date the corresponding changes in mortality improvements.

The results of a regression analysis show that for every 1% additional funding increase received by the NHS there has been a corresponding 0.4% increase in mortality improvements. If this relationship were to hold, a fall in GDP of 20% passed on directly in lower NHS funding would therefore see mortality improvements cumulatively 8% lower than they would have otherwise been over the next 10-year period as a result of the economic impact of the recession. Equivalently, under this scenario and assumption, mortality improvements would be 0.8% p.a. lower for 10 years, which equates approximately to a one-year shortening of life expectancy at age 65 – see Figure 4.

As noted at the outset, such effects may be mitigated by government policy changes; on the other hand, there are practical limits as to how much the laws of economics can be manipulated. It is also likely that a high proportion of any increase in health expenditure would be passed on to staff via salary increases, given the public mood of gratitude to the efforts of often low-paid healthcare workers.

Summary

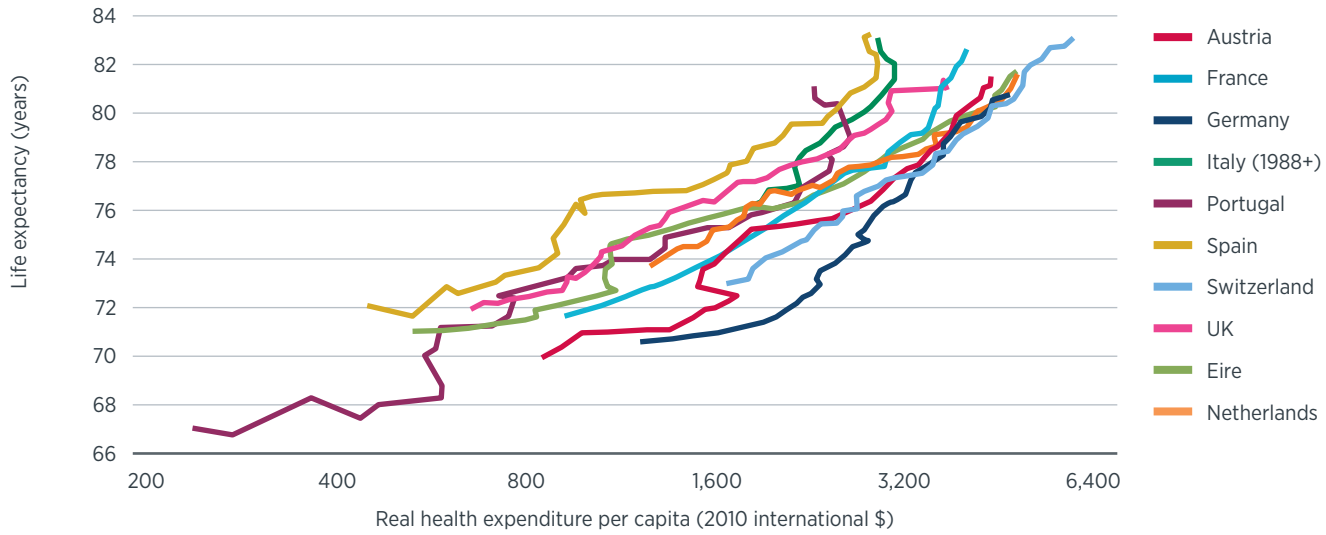
There is a complex relationship between economic performance and health risk factors, and what holds true for one gender, age bracket or social group may not be true for another. We may find that the above relationships vary from country to country, or that the upcoming recession produces results that are different from the recessionary effects of the past.

The simple analysis outlined above shows that we might expect a material reduction in life expectancy, in the order of a one-year reduction relating to reduced healthcare funding.

Additionally, the particular circumstances of the Covid-19 pandemic are likely to exacerbate the recession's impact on health. Factors at play include potential accelerated obesity (ie the 'Covid stone'), disproportionate youth unemployment and other longer-term behavioural changes, such as increased social isolation, particularly among the vulnerable.

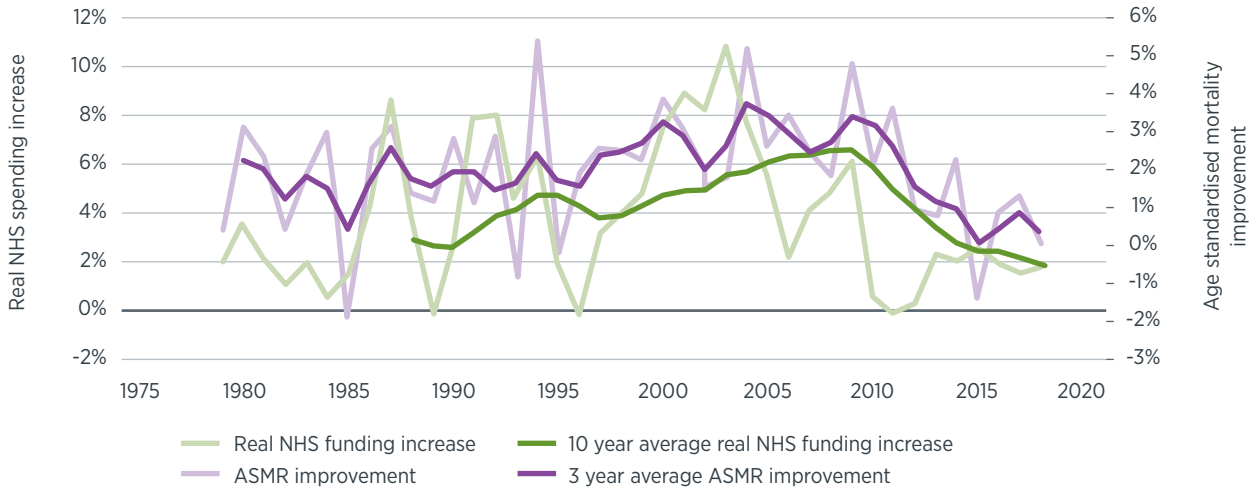
Covid-19's direct short-term mortality impact is disproportionately on the elderly and infirm. The research summarised in this article suggests that the longer-term impacts will bear down on this group further and be disproportionately severe upon the poor, who rely most heavily on the nation's health service.

Figure 1: Real health expenditure per capita vs. life expectancy 1970-2015 Western Europe



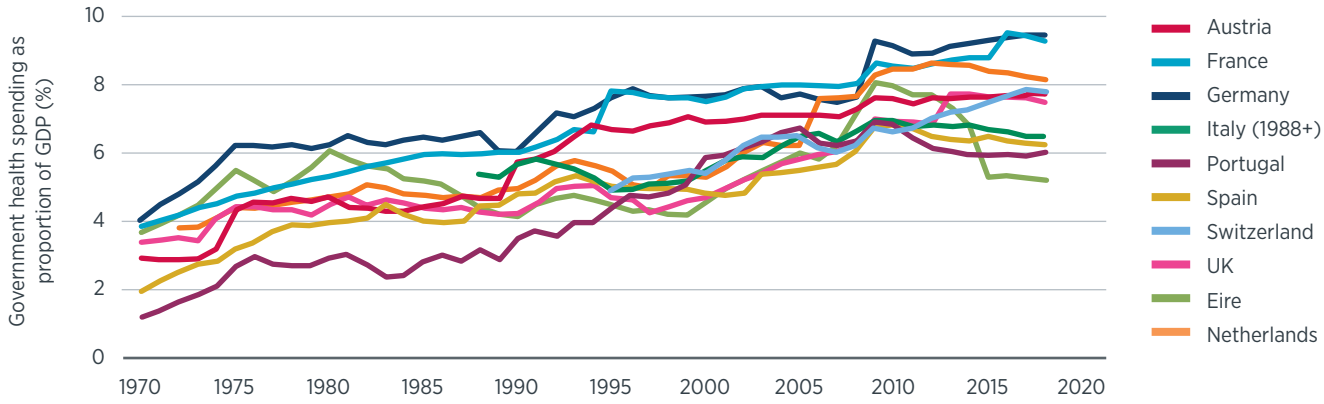
Source data: Organisation for Economic Co-operation and Development, ***https://data.oecd.org/***

Figure 2: Real NHS spending and mortality improvements



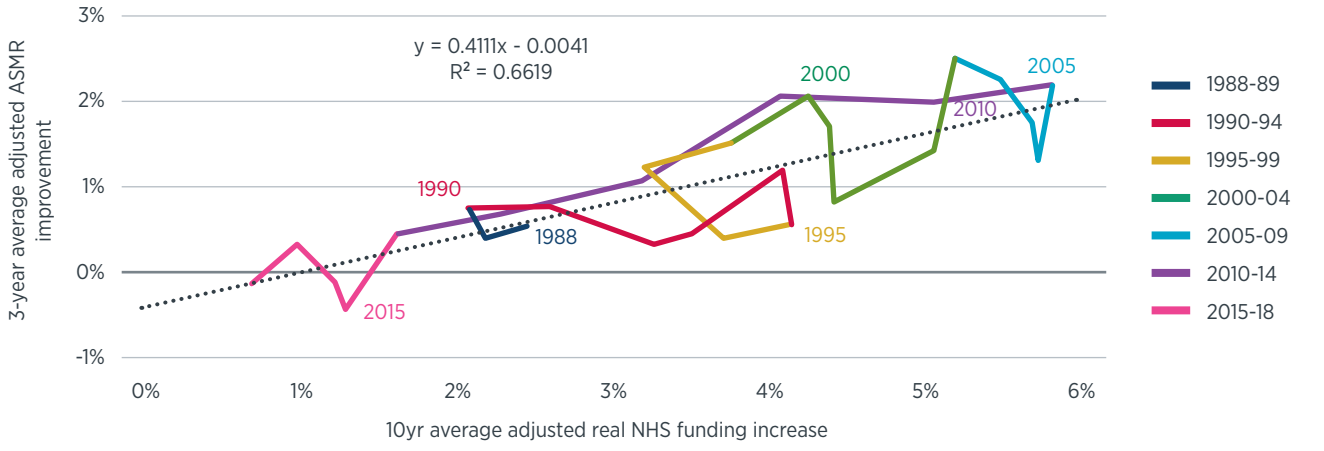
Source data: Institute for Fiscal Studies, ***https://www.ifs.org.uk/research-data;***
Office for National Statistics, ***https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases***

Figure 3: Government health spending proportion of GDP 1970-2018 Western Europe



Source data: Organisation for Economic Co-operation and Development, ***https://data.oecd.org/***

Figure 4: Mortality improvements vs. real NHS spending regression adjusted for smoking and ageing



Source data: Institute for Fiscal Studies, ***https://www.ifs.org.uk/research-data***

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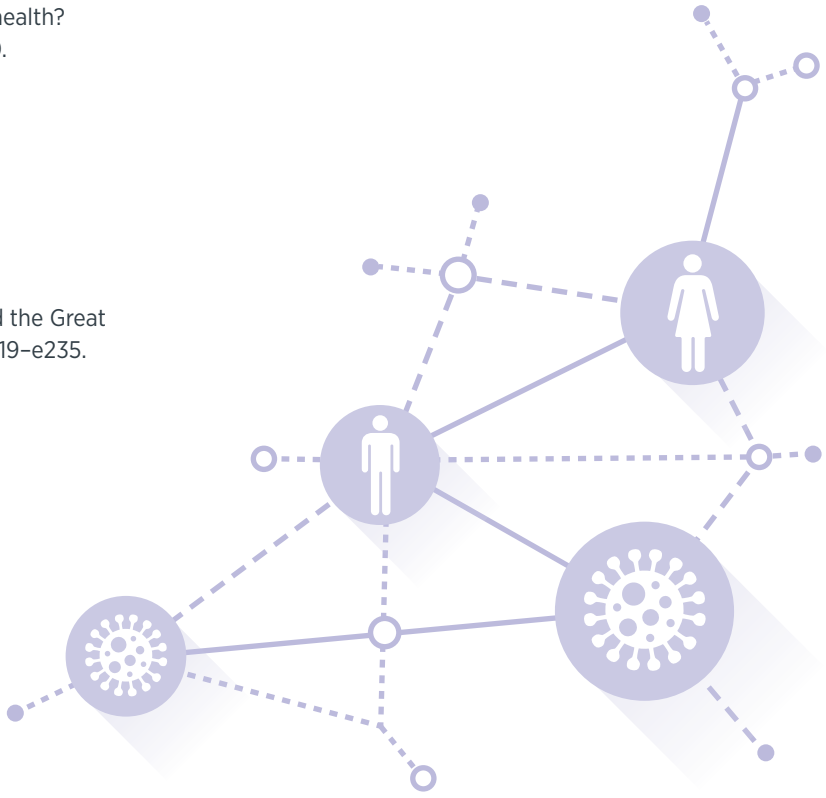


Socioeconomic differences in mortality due to Covid-19

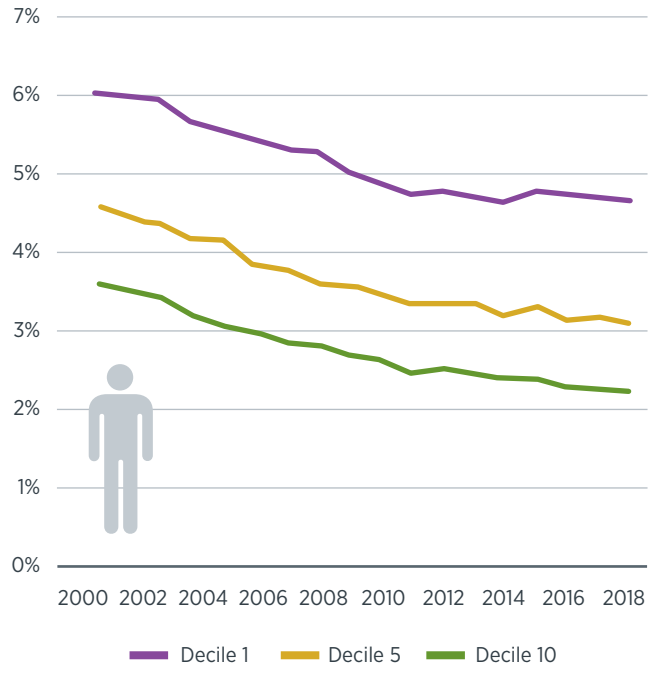
Michael Anderson, Head of Longevity and Catastrophe at Canada Life

Socioeconomic status has been reliably demonstrated to have a material impact on mortality, with those from more deprived socioeconomic groups experiencing higher rates of mortality than those from less deprived groups (for all causes of death). One illustration of this is shown in Figures 1 and 2, in the form of age-standardised all-cause mortality rates in England over the period 2001-2018 split by index of multiple deprivation (IMD) decile. In this case, decile 1 represents the most deprived group and decile 10 the least deprived.

The IMD is a geographically based measure of deprivation, assessed using multiple factors including income, employment, education, health, crime, housing and the living environment.

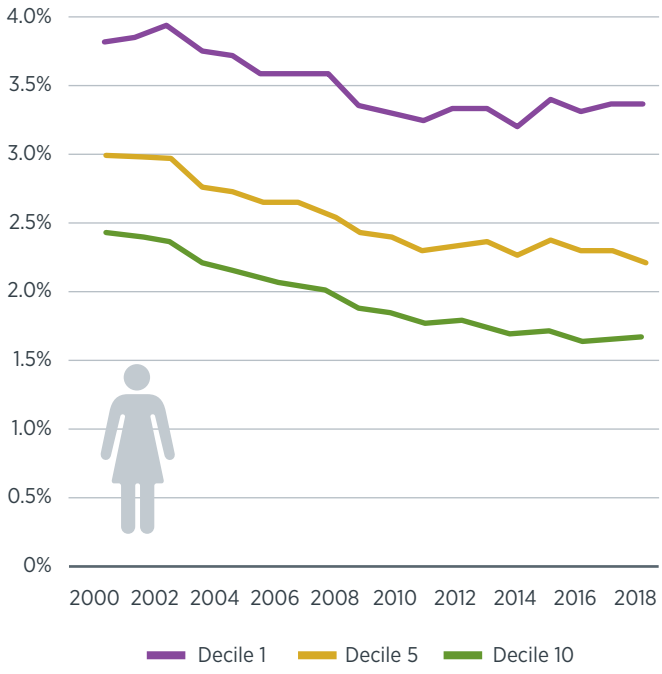
It is a standard measure of inequality used by the UK government (Ministry of Housing, Communities and Local Government, 2015, 2019). As can be seen, the death rates for those from the most deprived groups are substantially higher than those from the least deprived groups, for both males and females (mortality in decile 1 averages around 80% higher than that of decile 10 over the period). This differential has been increasing over the last 10 years with little to no mortality improvement among the most deprived groups, while the least deprived groups continued to benefit from some improvement to mortality. This illustrates the point that both base rates of mortality and mortality improvements differ for different socioeconomic groups. Further evidence is available in ONS (2020a, 2020c) and PHE (2018).

Figure 1: Age-standardised rates of death (males, ages 60-89) in England, by IMD



Source: Author's calculations based on ONS data (ONS, 2020d).

Figure 2: Age-standardised rates of death (females, ages 60-89) in England, by IMD



Source: Author's calculations based on ONS data (ONS, 2020d).

Covid-19 mortality and morbidity: evidence from critical care and mortality data

Those from more deprived groups are more likely to become critically ill with Covid-19, as reported by the Intensive Care National Audit & Research Centre (ICNARC, 2020a) and reproduced in Table 1. This is based on those admitted to hospital with confirmed cases of Covid-19. However, it is interesting to note that the proportions from each IMD quintile were very similar to those becoming critically ill from viral pneumonia for non-Covid reasons over the period 2017-2019. Therefore, while it is true that those from more deprived groups were almost twice as likely than those from the least deprived groups to become critically ill with Covid-19, this is virtually the same as the disparity between other viral diseases associated with respiratory problems. So from this particular perspective, there is nothing especially unusual about the socioeconomic variation of Covid-19 morbidity compared with what has been observed in the past with analogous conditions.

Table 1: Proportions of patients critically ill with Covid-19 and viral pneumonia, split by IMD (Covid-19 patients up to 4pm on 23 July 2020)

IMD quintile	Covid-19	Viral pneumonia, non-Covid-19 2017-2019
1 (least deprived)	14.4%	15.3%
2	16.0%	17.5%
3	19.7%	19.5%
4	24.0%	21.6%
5 (most deprived)	26.0%	26.1%

Source: ICNARC (2020a). These data derive from the ICNARC Case Mix Programme Database. The Case Mix Programme is the national clinical audit of patient outcomes from adult critical care coordinated by the Intensive Care National Audit & Research Centre (ICNARC). For more information on the representativeness and quality of these data, please contact ICNARC.

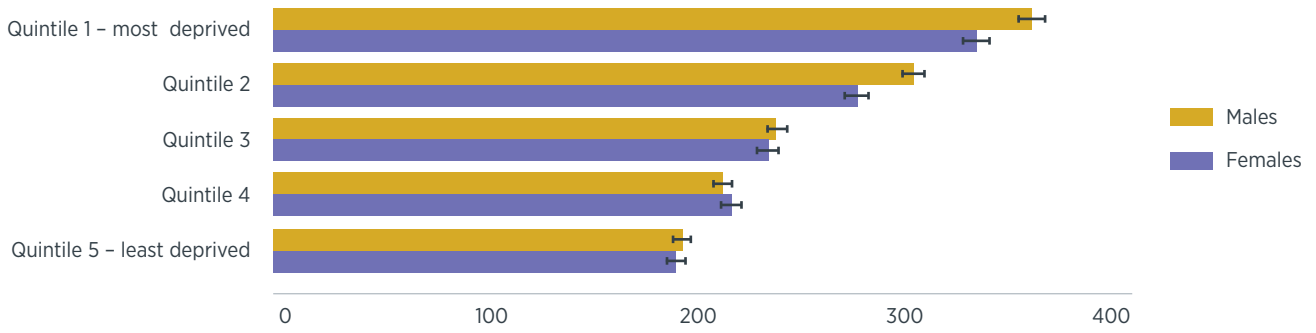
Note that more recent data (collected up to 4pm on 15 October 2020) shows an almost identical pattern of socioeconomic variation in those critically ill with Covid-19.

The above data applies only to those who were critically ill; it would be interesting to see whether a similar pattern holds for all those testing positive for Covid-19. So far, the only readily available data in this area is that compiled by Public Health England (PHE) in May covering the period up to 13 May 2020 (PHE, 2020). This covers the period of the highest rates of incidence and prevalence of the virus and related mortality observed in the general population to that date; however, the results need to be interpreted with some caution.

In describing this data, shown in Figure 3, PHE note, *"The age standardised diagnosis rates were highest in the most deprived quintile in both males and females, and lowest in the least deprived quintile. The rate in the most deprived quintile was 1.9 times the rate in the least deprived quintile among males and 1.7 times among females. In quintiles 1 and 2 (the most deprived) the male diagnosis rates were significantly higher than females, whereas in all other quintiles the rates in the sexes were very similar."*

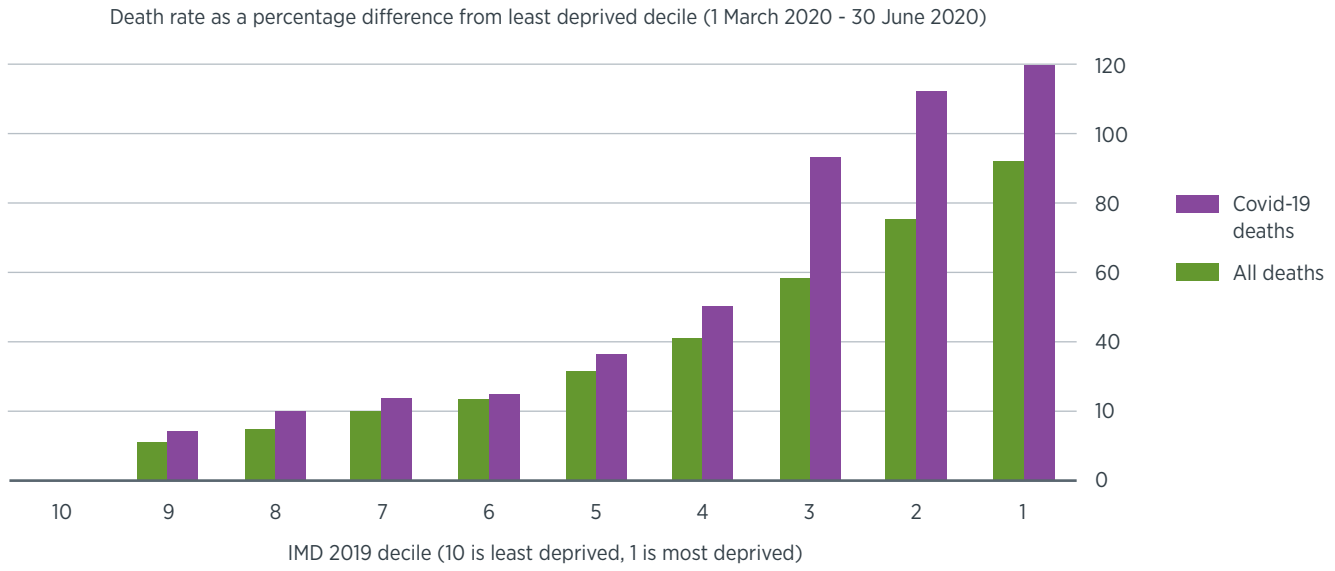
It is interesting that the differential in diagnosis rates between the most and least deprived groups does not seem to have translated into similar differences in proportions requiring critical care in hospital. The ICNARC report (ICNARC, 2020a) also shows that the outcomes for those in critical care with Covid-19 did not vary materially by IMD quintile. Once a patient was admitted to critical care, their chances of survival (around 60% in the first wave) were not really affected by socioeconomic status. Since Covid-19 mortality rates for those from the most deprived groups were higher than those from the least deprived groups (see Figure 3), this suggests that it was those who never made it to critical care (and perhaps not even to hospital) who may have seen the greatest socioeconomic differences in mortality due to the disease. However, this effect may not be that significant as only a small proportion of those infected were admitted to critical care where outcomes were not very different for the different socioeconomic groups.

Figure 3: Age standardised diagnosis rates by deprivation quintile and sex, as of 13 May 2020, England.



Source: Public Health England Second Generation Surveillance System. Reproduced from PHE (2020), p32 under ***Open Government Licence v3.0****.*

Figure 4: Differences in Covid-19 death rates by IMD decile



*Source: ONS 2020b reproduced under **Open Government Licence v3.0**.*

Socioeconomic disparities in Covid-19 mortality

Turning to death rates, the Office for National Statistics (ONS) has published data showing deaths attributed to Covid-19 split by IMD decile (ONS, 2020b), as shown in Figure 4. This shows that in the absence of any additional potential confounding factors, death rates for those succumbing to the pandemic from the most deprived groups were more than double those for the least deprived groups. This is a higher differential than that observed for all-cause mortality (where those in the most deprived groups have death rates around 90% higher those of the least deprived groups). This will be due in part to the higher Covid-19 morbidity among the most deprived groups, as shown in Figure 3.

Cairns et al. (2020) have noted that the regional variation in the incidence of the disease, in particular the difference between cities (most importantly London) and more rural areas, may be a confounding factor here. This is because the ONS analysis is performed using IMD as a measure of socioeconomic profile, which is a geographic-based measure. Therefore, this heightened differential may be a reflection of the fact that there are more individuals in the more deprived groups in large cities, in particular London, than in more rural areas. After applying an adjustment for geographic location, Cairns et al. found that the differences in mortality due to Covid-19 between the most and least deprived socioeconomic groups was similar to that for all-cause mortality.

This conclusion is supported by multivariate hazard rate analysis presented by PHE (2020), which estimates that, after controlling for geographic region and ethnicity, death rates for the over 65s for the most deprived quintile were only 9% higher than for the least deprived (details are available in appendix 3 of that report). Interestingly, the same analysis for ages below 65 estimated that the socioeconomic differential in deaths was much greater for these lives. This may be due to limitations resulting from the much lower numbers of deaths, but would be worth further study now that more data is available.

The impact of regional variation in death rates is therefore an important point to be aware of in any analysis of Covid-19 mortality. However, capturing both geographic and socioeconomic effects simultaneously may be reasonable, as long as any comparisons to other populations (eg insured lives) are performed consistently.

Potential drivers of differences in experience

The reasons for the differences in mortality due to Covid-19 between the different socioeconomic groups are not currently well established. However, a number of different possibilities have been suggested, including:

- More deprived groups experiencing greater difficulty in social distancing, perhaps due to more crowded living conditions
- More deprived groups are more likely to work in manual occupations that have limited capacity to be performed from home, leading to greater exposure to the disease when at work
- Greater numbers of more deprived persons in cities where infection rates were greatest
- Less access to high-quality social care, due to affordability issues, among the more deprived groups
- Poorer levels of health meaning that more deprived groups are more likely to suffer from chronic conditions, such as cardiovascular disease, diabetes and obesity, that are associated with higher Covid-19 death rates.

The main themes are related to the living and working circumstances of the more deprived groups, which would be expected to increase the risk of contracting Covid-19, as well as greater risk of death from the disease. Further evidence can be found in ONS (2020b). Other factors may emerge as further studies are conducted over time. One example for the interested reader is the World Health Organization report (WHO, 2020). It will be interesting to see whether the possibilities posited above will be confirmed as more data becomes available, or whether they will have to remain as plausible hypotheses.

Impact on mortality rates: could Covid-19 widen the gap?

The Continuous Mortality Investigation (CMI), among others, has demonstrated how mortality improvements vary by socioeconomic status. This is shown for more recent years in Figures 5 and 6, in the form of analysis presented in CMI working paper 127 (CMI, 2019). However, these differences tend to vary over time, as discussed by Lu et al. (2014). So, while in more recent times improvements have been less favourable for the more deprived groups, at other times in the past they have been more favourable. Since mortality rates for the less deprived were lower to begin with, this is more a case of the more deprived groups experiencing some degree of 'catch up' with the less deprived groups.

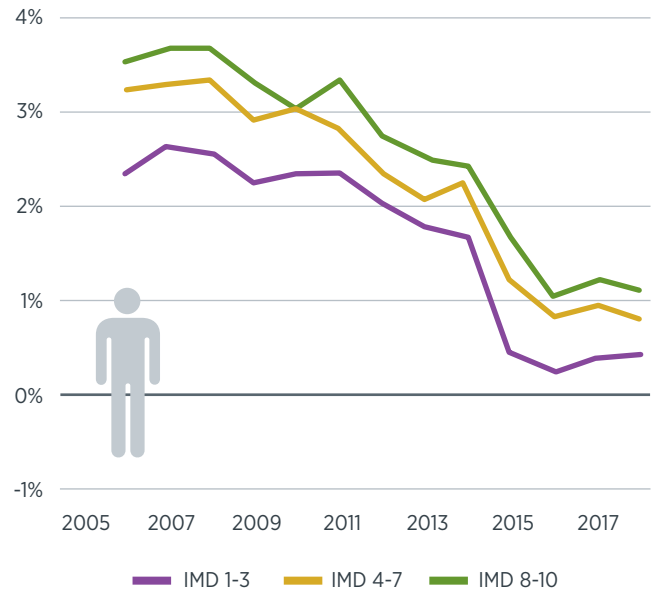
In the short term, the higher rates of mortality among the more deprived groups due to Covid-19 are likely to make the gap in improvements persist for longer. It may even increase the gap for a time with regard to the fact that secondary factors, such as missed medical treatments during lockdown, affect the more deprived to a greater extent. Overall, the extent to which the socioeconomic mortality differentials observed with Covid-19 prolongs, or even widens, the gap depends on the extent of Covid-19 mortality compared with mortality from all other causes.

The socioeconomic variation in mortality due to Covid-19 in the medium to longer term is likely to be dominated by indirect effects of the disease. One aspect of this will be the negative effects on mortality resulting from the recession triggered by the lockdown and other measures taken to control the disease. The ability to weather this downturn will vary by socioeconomic status. The less deprived are likely to have greater job security and access to savings to help offset negative economic effects, meaning that they will not be as badly affected as the most deprived who do not enjoy the same protections. On a more positive note, public health campaigns triggered in response to the pandemic, for example the campaign against obesity, could help the more deprived groups to a greater extent.

The socioeconomic differentials discussed above are of clear interest to all involved in public health policy and implementation. They are of particular interest to actuaries dealing with life insurance portfolios and pension funds, as policyholders and pensioners tend to be from the less deprived end of the spectrum.

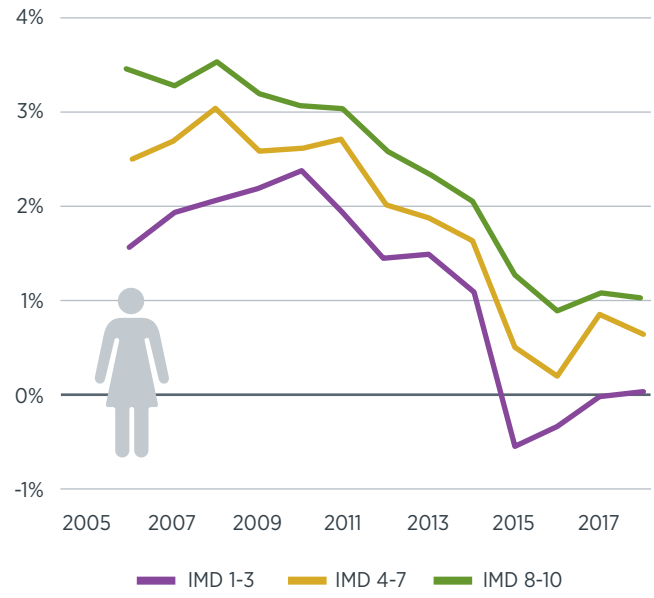
An overall indication of this differential is provided by the CMI's recent working paper 138 (CMI, 2020b), which analyses the mortality experience of pension annuity data collected from insurance companies, split by IMD status. The most relevant lives in insured portfolios are less likely to be heavily affected by the Covid-19 pandemic.

Figure 5: Mortality improvements by IMD decile (males)



Source: CMI working paper 127 (CMI, 2019)

Figure 6: Mortality improvements by IMD decile (females)



Source: CMI working paper 127 (CMI, 2019)

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Sources of future mortality variation resulting from the pandemic

Matthew Edwards, Director, Willis Towers Watson

This article considers the primary ways in which future mortality is likely to differ from recent mortality as a result of the pandemic. To provide greater focus, any further 'direct' deaths resulting from subsequent waves of the pandemic have been excluded.

Outline of main drivers

There are various sources of long-term future mortality variation relating to the effects of the pandemic. These might be best considered as changes to improvement assumptions, rather than as a change to base mortality. They are:

i) **Economic:** The economic impact of the pandemic is likely to be felt at a societal level, with reduced tax revenues for healthcare and social care funding; and at an individual level by those who suffer material economic hardship. (This is considered in more detail in the article by Kenneth McIvor 'Likely mortality impacts of the post-pandemic recession' on **pages 22-29**.)

(ii) **Healthcare impacts:** Distinct from the adverse economic impacts on healthcare funding, there are also various effects on mortality from the combination of reduced focus on non Covid-19 conditions, and individuals choosing not to 'self-refer' to their GPs, attend routine screening, etc. This impact is compounded by the backlog of treatments attributable to the initial stages of the pandemic. (This is examined in Conor O'Reilly and Steven Baxter's article 'Life on pause' on **pages 15-21**.)

iii) **Behavioural:** Covid-19 has resulted in massive short-term behavioural change. Many of these changes seem positive for health, many negative. Which changes are more likely to persist, and will the balance of these be positive or negative? Will that balance be material?

iv) **Mental health:** the prolonged isolation effect of the lockdown, the general increase in anxiety for many, and the traumatic impact of hospitalisation on severely affected patients may all persist to some extent, leading to an associated negative impact on physical health.

vi) **Political and wider societal impacts:** The pandemic could lead to a number of political decisions that have health implications, such as the recent move in the UK to tackle obesity, and the restructuring of Public Health England. In particular, given the spotlight that has been shone on care homes, there may be increased funding for this part of the health system, or other forms of change, leading to improvements in morbidity and mortality for care home residents. However, this is an impossible factor to quantify with any reliability.

Although this may seem to point in a positive direction (as changes would be made only with the intention of improving longevity), the extent of any benefit is limited by a combination of economic realities and 'health campaign realities' – ie the often unsuccessful nature of wider health initiatives (the increase in UK obesity over the last 30-40 years, in parallel with the public health 'Eatwell' campaigns, is a useful reminder of this reality – while the campaign against smoking provides a counter-example, albeit a success partly due to heavy restrictions and punitive taxation rather than positive persuasion).

Approach

Economic and healthcare impacts are looked at in detail elsewhere in this Bulletin. It does not seem worthwhile to consider further the possible political and wider societal impacts due to the immense uncertainty. A reasonable position, from a best estimate perspective, is the default position of no (material) change; on the other hand, longevity risk stresses may need to incorporate a wider range of future events.

Below we consider the other two aspects introduced above – behavioural changes and mental health – and conclude with a summary of the five drivers.

Behavioural changes

There have been several factors driving behavioural change during the pandemic:

- the lockdown
- public messaging about personal hygiene and social distancing
- individual 'coping mechanisms'
- individual health awareness

The lockdown itself led to greatly reduced road and industrial activity, and a concomitant reduction in road traffic accidents and related deaths. Reduced industrial activity led to reduced air pollution. While these can be regarded as 'silver linings' of the pandemic, they are likely to be largely temporary – as normality returns, these benign side-effects will disappear. In the longer term, the health benefit of some months of lower pollution will be immaterial.

Increased personal hygiene and related behaviour is likely to lead to some reduction in the transmission of infectious disease in the future. However, infectious disease mortality contributes little to overall mortality other than at young ages, and the overall effect on longevity is therefore likely to be negligible.

Coping mechanisms for many have included increased alcohol and food consumption. The Royal College of Psychiatrists (2020) announced in September that the number of 'at risk' drinkers had increased by 75% (from 4.8 to 8.4 million), warning at the same time of increased opioid abuse.

This aspect is hard to separate from increased health awareness arising from the pandemic, where the risk factor of obesity has been discussed at length, and the malign impact of smoking is more 'front of mind' in the context of a primarily respiratory disease. Surveys (Verdict, 2020) have reported cigarette smoking as being down by the order of 10% due to these health concerns; however, only sales information will reveal the reality. Surveys on behaviour such as smoking are notoriously influenced by answers that align more with good intentions than facts.

Although it's reasonable to assume some decrease in smoking from the above, the magnitude may be small (and perhaps also temporary). It is also a little understood fact that, given the low levels of smoking now in the UK and the long duration until material mortality benefits emerge from stopping smoking, the overall longevity impact of even large-scale cessation (as opposed to 10% with good intentions) would be small.

Interest in exercise in the UK seems to have increased, both from anecdotal observation and also via search engines such as Google. Using Google Trends to explore search activity for the term 'exercise' shows interest almost tripling from the reference period (Q4 2019) to end of March 2020 (lockdown starting), with interest in September 2020 still up by around one-third.

Figure 1: Google searches for the term 'exercise' (relative to peak defined as 100)

Source: Google Trends

On the other hand, the increased benefits this brings needs to be contrasted with much more sedentary behaviour for most white-collar workers due to prolonged working from home. This has occurred this year by compulsion, but many large office-based firms feel that the future will involve a substantial proportion of working from home.

Overall, therefore, we could summarise the long-term behaviour impacts (across the various factors discussed) as including positive and negative pressures, and in total being likely immaterial in the longer term compared with the other drivers.

Mental health

The prolonged isolation effect of the lockdown, the general increase in anxiety for many, and the traumatic impact of hospitalisation on severely affected patients may all persist to some extent. What is the plausible impact on physical health and longer-term mortality?

Looking first at survivors of Covid-19, Hui and Chan (2020) concluded that 'the long period of isolation and extreme uncertainty during the SARS illness created enormous psychological stress and mood disturbances … personal vulnerability, and psychosocial stressors might have jointly contributed to the development of psychosis in some patients'. Several papers on SARS outcomes have noted PTSD as a common condition for survivors, and the UK-based Centre for Mental Health also reports on studies that found intensive care unit survivors from all conditions often experience PTSD (typically affecting 20% of cases).

For the general population, the effects will of course be less than those for survivors of the disease, but will affect many more people. Durcan, O'Shea and Allwood (2020) of the Centre for Mental Health reported in May: 'At least half a million more people in the UK may experience mental ill health as a result of Covid-19'. The report noted a lasting 'longitudinal' impact as well as the immediate effect. In July, Sinclair, O'Shea and Allwood (2020) added to the list of concerns.

In addition to the effects analogous to those observed from SARS, in this pandemic we can also expect a 'second wave' in mental health problems resulting from the economic shock, to the extent that it brings unemployment in its wake (or, at best, job insecurity and/or reduced income).

Much has been written about the mental health problems associated with the pandemic and policy responses to it. This is clearly a material concern in terms of people's general sense of wellbeing, but is unlikely to lead to widescale worsening of population mortality.

There are material individual impacts on mortality from mental health. Russ et al. (2020) analysed around 68,000 UK lives and reported almost a doubling of mortality for more severe categories. But, if we consider the number of such cases likely to be caused by the pandemic (of the order of 1% of the UK population, per the Centre for Mental Health), we can conclude that the overall population mortality impact is likely to be low (and within typical annual mortality variations).

However, the strange times in which we are currently living force us to think beyond the 'formal' categories of mental health disorder, on which such research has been based. With much of 2020 having involved social isolation for many, and this situation likely to continue for some time for some sections of society, the problem is likely to increase. The onus of enforced (or heavily prescribed) isolation is likely to fall on the oldest, and this may have a material impact on longevity.

There is a growing body of literature on this topic. Steptoe et al. (2013) followed 6,500 people in the UK (ages 52 and over) and found social isolation was associated with a 26% increase in all-cause mortality. In a much larger Danish study (around 21,600 people, with a wider age range than the aforementioned UK group), Laugesen et al. (2018) found social isolation associated with a 60-70% increase in mortality. A meta-analysis by Kuiper et al. (2015) on the interaction between social participation and dementia found social isolation associated with a 40-60% increased risk of dementia in the elderly (the range representing various different forms of social isolation, rather than a particular confidence interval).

None of this research provides precisely the study design we would like, not surprising given the highly unusual situation, and it would be foolish to infer all of the associative effects quantified as being causative (indeed, there may be some reverse causation with bad health leading to greater isolation).

On the other hand, the combined distress and isolation of the current situation may be worse for health than the circumstances underlying these studies. However, consideration of these results in conjunction with their inherent plausibility provides us with some 'order of magnitude' reference points.

Various plausible scenarios to estimate the impact of this problem can be developed. For instance, supposing that 50% of the over-75s endure a long period of either 'formal' social isolation or heavily reduced social participation, and hence see (in line with the lower range of the above studies) a 25% increase in mortality for two years, that would be equivalent to 25% extra deaths for the over-75s in one year, spread over several years.

Overall, therefore, we expect a wave of serious mental health problems, with a material mortality impact likely from increased isolation, but not from typical mental health conditions.

Conclusion

The factors considered above will vary in several 'dimensions':

- 'Sign' (meaning a positive or negative effect)
- Magnitude
- Time frame
- Age group

Other dimensions could also usefully be considered, in particular variation by socioeconomic segment, but these go beyond what can be attempted in this article.

We can therefore construct a simple grid to compare the above sources of mortality variation (not including that relating to major political or societal changes, for reasons noted above). For 'sign', the 'up' and 'down' relate to longevity (life expectancy) rather than mortality, the comparison point being 'the world absent Covid-19'. For 'time frame', short, medium and long are intended to be of the order of 1-2, 3-5, and 5-10 years respectively.

While the pandemic will no doubt have enduring ramifications beyond 10 years, the 'funnel of doubt' affecting any plausible quantification of the difference in annual improvements compared with the 'absent Covid-19' equivalent makes such estimates largely pointless. Even the direction is unclear: there are reasons why improvements might then be higher than otherwise (for instance, greater and more effective 'virtual screening'), or lower (if pharmacological developments are slowed because of the current focus on vaccines and tests, for example).

We have not included the 'age group' column, as the impacts are likely to apply to all age groups but much misunderstanding could arise according to whether we are speaking in relative or absolute terms (eg a large relative impact in mortality at younger ages could be small in absolute terms).

Table 1: Longevity impacts of major post-pandemic factors

	Sign	Magnitude	Time frame
Economic	Down	Material	Long
Healthcare	Down	Material	Medium
Behavioural	Up	Immaterial	Short
Mental health	Down	Material	Medium/ Long

Overall, therefore, in the absence of any major political or societal change, we can reasonably expect the factors considered to lead to materially reduced longevity improvements (from what would otherwise have been the case, absent the pandemic) over a medium-long time frame. As noted, this broad conclusion does not take account of different impacts by age range, nor other likely sources of divergence, such as socioeconomic profiles. The shape of the impact of each driver over time has also not been considered, other than the broad time period over which the impact would plausibly manifest.

While this does not provide a conclusive quantitative recommendation as to the impacts – or even a suggested range – we hope it provides readers with a more solid base upon which to develop a revised assumption regarding future mortality variation (a term that now feels more appropriate than 'future mortality improvement').

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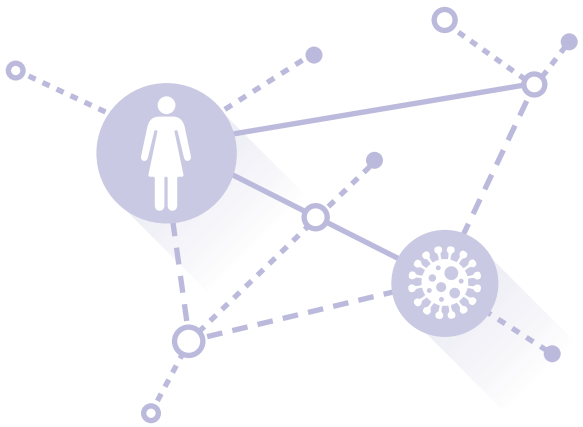

Recent developments

IFoA news

The Institute and Faculty of Actuaries **COVID-19 Action Taskforce (ICAT) (bit.ly/362Kj4s)** was formed in April 2020 to rally the skills of actuaries in providing thought leadership on the wider impacts of Covid-19. As a health crisis that has triggered an economic crisis, the impact will continue to be felt for at least the next decade, with perhaps longer-term implications from a societal perspective. 588 actuaries signed up to **95 workstreams (bit.ly/3fAh2RM)** to work on these and many other aspects of the pandemic.

The ICAT is aimed at members of the IFoA as well the wider public interest. ICAT workstreams produce thought pieces, backed by associated research, to help the readership understand the complex and intertwined impacts of the pandemic. While the press relays the infection and mortality rates presented by governments, discerning readers are keen to delve into the research behind the scenes.

The areas of research ICAT is involved in are diverse. These range from the impact of the pandemic-induced financial market volatility on the investment strategies of pension funds and insurance companies – jointly £6tr of investments – to an analysis of the main published pandemic models and their reliability for the task at hand. The former affects the financial services industry: the ultimate returns received by pensioners and policyholders from their long-term investment contracts – with impacts to be felt over the next few decades. The latter uses the core actuarial skills of selecting an appropriate model, evaluating a range of data and developing appropriate assumptions. In a rapidly moving news cycle, when it is common for the press to report on pre-print (and hence potentially unreliable) research, actuaries provide a valuable independent voice to comment on much of this research.

A high-level breakdown of the research topics being taken on by the ICAT workstreams is as follows:

- Three workstreams looking at using new data science techniques to bring meaning to data quicker
- Fifteen workstreams looking at the financial and economic impacts
- Ten workstreams looking at the impact on general insurance (insurers, policyholders and products)
- Nine workstreams looking at the impact on life and health insurance products and policyholders
- Sixteen workstreams looking at the impact on life insurers and the broader investment markets they participate in
- Seven workstreams looking at mortality and longevity related issues (particularly important to pension funds, life insurers and long-term care providers)
- Five workstreams looking at pension fund specific issues, both defined benefit and defined contribution funds and their members
- Four workstreams looking at resource and environment related topics
- Six workstreams looking at risk management and enterprise risk management topics.

Covid-19 may prove to be the defining event of the century and, as such, ICAT is responding quickly to provide thought leadership on the key topics where actuarial skills can add value to society.

ICAT also seeks to coordinate work with the **COVID-19 Actuaries Response Group (www.covid-arg.com),** which focuses on rapid reactions to events.

ICAT outputs are included as part of the **IFoA Pandemics Hub (bit.ly/2IZhq0s)**, which aims to provide the actuarial perspective on epidemic mitigation and control by gathering together the most relevant research, articles and insights on the subject from recognised experts. Other key actuarial sources include the International Actuarial Association's Actuarial **Resources for COVID-19 section (bit.ly/3m4Xqrv)**, and the Society of Actuaries' **COVID-19 research outputs page (bit.ly/39fizf1)**.

Continuous Mortality Investigation (CMI) Covid-19 update

Mortality experience in 2020 has been abnormal because of the coronavirus pandemic. The CMI has therefore increased its activity to help subscribers, and wider stakeholders, better understand the mortality impacts and implications. As well as the frequent **mortality monitors (bit.ly/373n9ds)**, the CMI has also been providing analysis and reviewing its methods in light of the pandemic.

Annuitant experience to 30 June 2020

The coronavirus pandemic caused abnormally high mortality in the UK during the second quarter of 2020. In **Working Paper 140 (bit.ly/3fx7JlD)** the CMI provides an indicative analysis of annuitant mortality experience to 30 June 2020. This is the first analysis of experience during the coronavirus pandemic that uses a CMI dataset. The paper uses standardised mortality rates to show how the pandemic has affected annuitant mortality, and compares their experience with that of the England and Wales population for the years 2019-2020.

The paper shows that standardised mortality rates for annuitants, for ages 65-95 and for both genders combined, were 19.3% higher in the first half of 2020 than in the first half of 2019. This increase is only slightly lower than the corresponding increase for England and Wales of 22.6%.

In addition:

- The increase was higher for males than females in the general population, but slightly lower for male annuitants than for female annuitants
- The increase was higher at higher ages, for both the general population and annuitants.

Consultation on methods for CMI_2020

The CMI expects to publish the next version of the CMI Mortality Projections Model, CMI_2020, by the end of March 2021. **Working Paper 137 (bit.ly/374Qp3G)** sought feedback from subscribers on two proposed changes in method and the CMI intends to confirm its plans for CMI_2020 in December 2020.

Weighting mortality data for 2020

A key premise of the model is that recent mortality improvements provide a reasonable guide to short-term future mortality improvements. A version of CMI_2020 that gave full weight to the exceptional mortality experience during 2020 would produce substantial falls in projected life expectancies, which would likely be in excess of what most users of CMI_2020 would consider reasonable. To address this, the CMI has proposed modifying the calibration process for CMI_2020 so that users could place more or less weight on data for individual years. At this stage, the CMI proposes to place no weight on the data for 2020 and full weight on the data for all other years.

Change to calibration age range

The CMI proposed a further change, which is not related to the pandemic, to calibrate CMI_2020 to data for ages 20 to 90 inclusive (rather than ages 20 to 100 inclusive as in CMI_2019 and earlier versions). The purpose of this change is to avoid unrealistically low (or negative) initial mortality improvements at high ages caused by limitations in how well the calibration process deals with large shifts in mortality improvements over the 40-year calibration period that also vary significantly by age.

COVID-19 Working Party

In response to the coronavirus pandemic, the CMI set up the COVID-19 Working Party in July to investigate the implications of the pandemic on the CMI and to produce a consistent methodology that could be adopted by the CMI investigation committees. The Working Party has published **Working Paper 139 (bit.ly/3l7zRN8)**, which is publicly available. The paper provides views on:

- Population-level mortality data and a summary of the impact of the pandemic on population mortality in 2020 (by age, gender, socioeconomic status and medical conditions)
- Methods for adjusting data in abnormal years (such as 2020)
- Considerations when setting mortality and morbidity best estimate assumptions in light of the pandemic
- The impact of the pandemic on the uncertainty associated with mortality and morbidity assumptions.

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