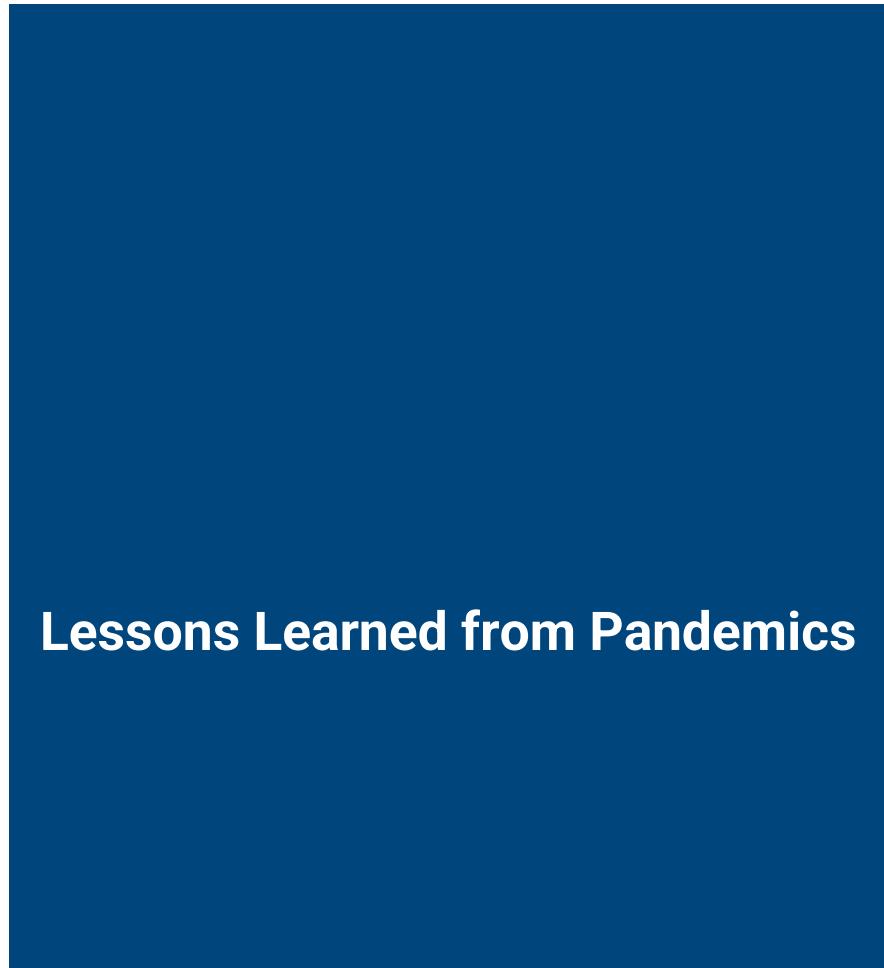




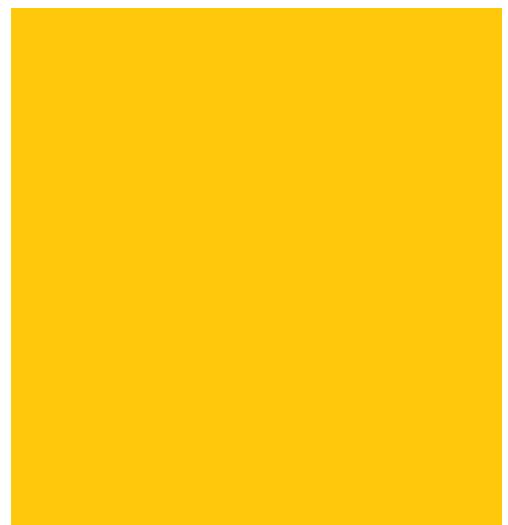
International Actuarial Association
Association Actuarielle Internationale



Lessons Learned from Pandemics

Pandemics Task Force

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IAA Paper

Lessons Learned from Pandemics

This paper was prepared by the Pandemics Task Force of the International Actuarial Association (IAA).

The IAA is the worldwide association of professional actuarial associations, with several special interest sections and working groups for individual actuaries. The IAA exists to encourage the development of a global profession, acknowledged as technically competent and professionally reliable, which will ensure that the public interest is served.

The role of the Pandemics Task Force is to deliver on the Statement of Intent for IAA Activities on Pandemics (SOI) as adopted by Council on 8 April 2022.

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This paper has been approved for IAA publication by the Pandemics Task Force and the Executive Committee in accordance with the IAA's Communications Policy.

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Executive Summary

In this paper of the International Actuarial Association's Pandemics Task Force, we take stock of where we are as the effects of the COVID-19 pandemic have begun to wane. We present a high-level view of the lessons we have learned to date, primarily from the COVID-19 pandemic, but also build on lessons learned from other pandemics such as HIV/AIDS and the 1918 influenza pandemic. The paper reflects various actions and analyses in which members of the actuarial profession have been involved and considers several actuarial practice areas in order to provide education for the profession to respond to future pandemics. It is intended as a reflection of experience, and not as professional guidance.

Key themes have emerged from a review of the impact of pandemics on the actuarial profession, and these are generally true across all practice areas:

1. **Data.** Actuaries are skilled at making sense of data from disparate sources, and this skill takes on a heightened importance and pace during a pandemic. Data sources and metrics may be unreliable or inconsistent, with different methods and time frames for reporting, even within countries.

It is, and will always be, very difficult to get accurate and consistent mortality data from a pandemic. Actuaries need to be able to adapt to the data that are readily available and use these data on a timely basis. For example, many actuaries and models have switched to observing excess mortality instead of COVID-19-specific mortality because of the perceived better reliability of this metric.

2. **Communication and collaboration.** Actuaries can leverage their expertise in financial risk to be translators between other professions and can help to clarify where there is uncertainty (or misinformation) and identify the information needed to improve reliability of modelling exercises.

3. **Health care system.** Efforts to strengthen public and private health care infrastructure, improve data systems and invest in public health interventions will be crucial for the next pandemic. Actuaries can assist with modelling efficient roll-out of vaccines as well as risk management for health care delivery systems and health insurance systems. Actuaries can continue to model out longer-term effects of the pandemic, both direct and indirect, on health care utilization and costs.

4. **Broad risk management.** A pandemic adds to and sometimes amplifies normal and crisis events; some risks are correlated, while others are independent. The interactions between a pandemic and other risk events can lead to feedback loops and tipping points. These need to be carefully monitored and modelled.

Actuaries need to also be aware of the possibility of the existence of threat multipliers (i.e., risks that interact with and make other risks worse). Pandemics, climate change and energy risk are examples.

While risk management plans need to be made in advance, and periodically reviewed, these plans can include development of multiple scenarios based on demographic groups impacted, levels of transmissibility and lethality. A plan that worked for COVID-19 may not work very well for a different type of disease like Ebola or a repeat of the 1918 influenza pandemic, which primarily impacted young adults. Governments will need to adjust their response as the science, and the public's acceptance of it, develops.

5. **Professional practice.** During a global crisis, a sense of urgency often places additional pressure upon normal actuarial practice. Data quality generally suffers, and past experience is not always reliable for use in predictive analysis. Models need to be

flexible and should reflect and communicate the generally heightened level of uncertainty.

Actuarial professional standards need to consider the long-term effects and lessons of COVID-19 and other pandemics.

This paper is intended for an audience of actuaries, especially those who may not have been closely involved with pandemics research or analysis, as well as non-actuarial stakeholders who wish to consider the actuarial response to future pandemics.

1. Introduction

In early 2020, as the COVID-19 pandemic engulfed our personal and professional lives, actuaries began to consider a wide range of potential impacts from the pandemic. Examples include mortality risk for both general and insured populations, the cost and utilization of health care services, volatility in financial markets, the risk to global trade and supply chains, and a range of operational risks that financial services companies may expect to endure.

Historical context may set the stage to help us apply what we have learned. A pandemic is generally described as a geographically widespread appearance of a disease at a particular time (in contrast to an epidemic, which is contained to a given community). Many pandemics have affected humanity throughout history, including plagues, cholera, influenza, HIV/AIDS and most recently COVID-19. Most of this paper is focused on lessons learned by the profession from the COVID-19 pandemic, with some additional references to HIV/AIDS.

Actuaries' training in the use of data, analysis and models to develop trends and project future scenarios proved to be extremely helpful, and the actuarial profession became a leading resource within the insurance, financial services and retirement plan industries. In addition to the research briefs and reports from local actuarial associations such as the Society of Actuaries Research Institute (US), Institute and Faculty of Actuaries Pandemics Hub (UK) and the Actuarial Society of South Africa (ASSA), the COVID-19 Actuaries Response Group¹ began producing regular updates and reports, and the International Actuarial Association (IAA) developed additional briefs and reports. In various countries, the actuarial profession also quickly ramped up its use of social media and LinkedIn postings to disseminate rapidly a growing set of information to actuaries around the world and the public.

The significant amount of effort in these areas, as well as work done in the past on other pandemics, such as the HIV pandemic in the 1980s and 1990s, resulted in the need to understand how pandemics will affect the actuarial profession in future years. In 2022, the IAA's Executive Committee established a Pandemics Task Force (PTF). This paper is the first to be published by the PTF, outlining at a high level the lessons learned for the actuarial profession so that we are better prepared for future pandemics and potentially other catastrophic events. Future planned topics for the PTF include protection gaps and data and modelling.

It is the hope of the PTF that the actuarial profession will play its part in contributing to (supra)national governing bodies and in the business sector to support governance developments. This involvement is crucial for enhancing the robustness of management systems and strengthening resilience, especially in critical sectors like health care, pension/social security systems and financial systems in times of crisis.

The paper opens with a general discussion on modelling, data and reporting during the COVID-19 pandemic. This is followed by sections covering issues specific to various areas of actuarial practice, and an overview of the lessons our profession has learned.

These sections are:

- Life Insurance and Mortality
- Pensions and Social Security
- Health Care
- General Insurance²
- Enterprise Risk Management

The paper then goes on to discuss topics of a more general nature. This covers issues of broader economic and societal impact, plus financial sector resilience and the intersection with other societal and environmental issues.

The paper highlights both the benefit of historical tools and models that proved helpful during the pandemic, and the new concepts and techniques that the COVID-19 pandemic era helped bring to life and evolve.

2. Modelling, Data Analysis, Reporting and Communication

All models are wrong, but some are useful.

George Box

This section provides a discussion of actuarial lessons learned in understanding data associated with a rapidly evolving COVID-19 pandemic, as well as how actuaries modelled the pandemic and shared their analyses. We refer to some common threads from previous pandemics, including work done to model the HIV/AIDS pandemic, with the overall aim of generalizing and demonstrating lessons learned from that work.

With respect to modelling and data for past pandemics, actuaries were faced with a few complicating factors. Several pandemics in just over 100 years – including (but not necessarily limited to) the 1918 influenza pandemic, HIV/AIDS and COVID-19 – caused a large number of deaths worldwide and generated significant uncertainty with respect to the incidence and severity of future pandemics. These pandemics were also associated with quite different risk factors. Additionally, the severity of COVID-19 (and HIV/AIDS) was affected by many country-specific factors, including level of development, politics and culture. Access to vaccines, treatments and other medical technologies, and their global and local roll-outs, also played significant roles.

2.1. Difficulties with COVID-19 Data

With the emergence of COVID-19 many data issues came to light:

- The asymptomatic spread of the disease and limited testing meant daily COVID-19 case figures were unreliable and not representative of infections or suitable for comparisons.
- Incomplete death reporting early in the pandemic, and lack of clarity around causes of death (i.e., death *from* COVID-19 or death *with* COVID-19), led to misestimation of the mortality impact of the pandemic.
- Many disparate data sources and apparently counterintuitive data meant that interpretation was required.
- Comorbidities created challenges in understanding effects of COVID-19 on populations with different age distributions, chronic conditions or other illnesses.
- Misinformation and disinformation emerged as serious challenges.

Although there are clear differences between the COVID-19 and HIV/AIDS epidemics, there are also striking similarities, such as the involvement of asymptomatic spread, limited testing and incomplete death reporting in developing countries. In the case of HIV, these factors were exacerbated by heightened stigma associated with the disease. Misinformation about the disease and, later, about its treatment was also an impeding factor in the ability to mitigate risks.³

During the COVID-19 pandemic, actuaries played a role in interpreting rapidly emerging data and in communicating the problems and potential biases of reported data, including those relating to mortality. For example, the UK COVID-19 Actuaries Response Group⁴ highlighted

the need to focus on excess deaths⁵ rather than reported COVID-19 deaths due to the unreliability of reported deaths at the time.⁶ They also showed how counterintuitive mortality outcomes were explained by Simpson's Paradox.⁷ Simpson's Paradox is when a relationship appears within individual groups of data but disappears or reverses when the groups are combined. This led the Office for National Statistics in the UK to publish mortality rates by narrower age bands, since broader age bands resulted in the general increase in mortality rates by age swamping the differentials caused by vaccination coverage. The UK COVID-19 Actuaries Response Group also engaged with other teams that were working on modelling (e.g., commenting on various models released by Imperial College London researchers⁸).

Actuarial associations in various other countries also formed groups that reviewed and discussed the emerging models and the interpretation of data in their region (e.g., groups in Australia, France, Canada, South Africa and the United States).

One now generally accepted theory that arose from such collaboration is that excess mortality analysis is a better way of estimating the pandemic's death toll. This more objective measure strips out the potentially political decisions involved in recording COVID-19 deaths and distinguishing between deaths *from* COVID-19 versus deaths *with* COVID-19. Excess deaths are discussed in more detail in the Life Insurance and Mortality section of this paper.

Another issue that arose was the accuracy of reported aggregated global deaths. Poor COVID-19 death reporting in some countries, as well as no or limited excess death reporting, posed a problem in terms of tracking deaths globally. Research has shown that India is believed to have significantly under-reported deaths, by a factor of anywhere from six to seven times.⁹ China's figures are also considered to be under-reported by the World Health Organization (WHO).¹⁰ The same is true for many countries in Africa. Since these countries represent a significant portion of the global population (China and India alone accounted for more than 36% of the world's population in 2021), comparative and aggregated global analysis became quite difficult. To address these issues, one approach that could be considered is to first conduct country-by-country analysis for those countries believed to have reported accurately, and then apply the characteristics of this analysis globally. As COVID-19 mortality was heavily age-weighted, adjusting to the age characteristics of each country's population would likely be part of this process. However, it was found there were multiple factors associated with COVID-19 mortality risk and an age-only analysis was inadequate. The alternative was to rely on excess deaths for aggregation, but this is still affected by the accuracy and availability of the underlying mortality reporting basis in the country.

2.2. Sharing and Presenting Useful Analyses

Actuaries contributed to sharing and presenting useful analyses based on data rapidly emerging during the pandemic and thereafter. Some examples include:

- Various efforts to monitor population excess deaths in the UK,¹¹ Australia¹² and South Africa;¹³
- Efforts to monitor insurance experience in Canada,¹⁴ the US¹⁵ and South Africa;¹⁶
- Dashboards and metrics such as the regular updates produced by COVID-19 Actuaries Response Group and shared on social media¹⁷ or estimates produced for the reproductive number of the pandemic in South Africa;¹⁸ and
- Projections such as those published by the Royal Dutch Actuarial Association's AG Mortality Research Committee.¹⁹

It was found that data sources such as reported deaths and hospital admissions were less likely to contain biases than case counts where case definitions were inconsistent, and the coverage of COVID-19 testing varied greatly. However, reported death data also presented some challenges in developing countries and even in developed countries early in the

pandemic. For example, in the US International Classification of Diseases (ICD) coding for COVID-19 was only introduced in April 2020. Focusing on data sources based on severe health outcomes allowed actuaries to present more balanced views as experience evolved rapidly over the pandemic.

In both the HIV and COVID-19 pandemics, collaboration across various professions involved in the dissemination and production of data was key. This enabled a better understanding of data sources and potential sources of bias as well as access to additional expertise (e.g., on clinical interpretation of data and epidemiological factors).

2.3. Actuaries as Modellers

As the number of studies modelling the epidemic and/or trying to identify the best responses grew rapidly, actuaries deliberated on alternative ways to assess the consequent risks associated with the effects of COVID-19. These included impacts on assets and liabilities of pension funds and insurance costs, as well as the impact of mortality and morbidity rates on social protection systems. These assessments also leveraged work in other domains such as studies to determine the impact of the pandemic on economies and the trade-offs between interventions that protect lives and others that protect incomes and jobs.

A number of epidemiological models were shared in the public domain as the COVID-19 pandemic developed. These models were compiled by teams including epidemiologists, mathematicians, data scientists and medical researchers, and drew upon local and global data sources.

One of the early COVID-19 models developed by actuaries was that of the ASSA,²⁰ following in the footsteps of actuarial models for the HIV/AIDS epidemic.²¹ Another actuary adapted simpler Imperial College of London models to South Africa.²² These models used Bayesian modelling techniques which allowed the combination of uncertain prior information with the data to develop estimates for uncertainty on parameters and the projected outcomes. These approaches may be very useful in modelling future pandemics to allow for uncertainty from the start.

Actuaries also assisted with modelling vaccination strategies in various countries.²³ In South Africa, actuaries did similar work for HIV/AIDS, demonstrating the benefits of rolling out antiretroviral treatment in South Africa (and this work continues in the Thembisa model²⁴).

Many challenges arose in the modelling, including the sensitivity to key parameters with little reliable information. These included circumstances in which transmission was most likely to occur and the infection fatality ratio (IFR), as well as the applicability of early data and analyses in and across various countries and regions. Many of the assumptions inherent in simpler compartmental epidemiological models, such as susceptible-infected-removed (SIR)²⁵ models and their variants, were invalidated by actual COVID-19 experience (such as whether infection led to immunity). In particular, age-related risk was often inadequately taken into account in simpler models.

For models to remain useful, modellers had to clearly communicate limitations of the models and highlight sensitivity using explicit modelling of uncertainty and/or via the use of scenarios. A key principle of actuarial reporting is the disclosure of data sources, methodologies, sensitivities and limitations, and these are arguably even more important during a rapidly evolving pandemic. This kind of documentation is key to preserving the intellectual capital for future work and to allow others to build on work being done.

Analysis conducted after the pandemic found that simple models can be useful in testing ideas and can also be reasonably accurate in aggregate.²⁶ Different models may have been built with different objectives and hence were not readily comparable. For example, modelling total cases versus deaths or hospital admissions (or other health resource requirements) may

have required a different focus of key data sources. Geographic differences also confounded modelling.

This experience highlights the value of applying existing knowledge and techniques to emerging data but ensuring that these are adapted as more evidence and data emerges.

2.4. Responsiveness vs. Rigour

A key difference between COVID-19 versus HIV/AIDS was the speed at which the pandemic unfolded. The rapid global spread of COVID-19 resulted in the need for quick analysis and interpretation. The UK COVID-19 Actuaries Response Group touched on it in one of its principles:

Our bulletins and blogs are necessarily often ‘beta versions’ (or work in progress). Better and more complete studies will and can be conducted in the fullness of time. We are mindful of the trade-off between ‘rigour and comprehensiveness’ versus ‘responsiveness and usefulness’ and we seek to tilt our approach to the latter.²⁷

In the case of a rapidly expanding pandemic, actuaries may be pushed to pick up their pace while balancing speed with producing work of a reasonable quality. The difficulties in achieving this balance were not unique to the actuarial profession, and a key consideration for professional guidance is to assess whether the current guidelines provide an adequate reference for the rigour that needs to be applied in developing actuarially sound results while still being agile and responsive to the need for risk assessment in the face of an emerging crisis.

2.5. Key Lessons for the Future

In respect of modelling for future pandemics, some key lessons have emerged to date in the process of interpreting the data, sharing analyses and building models:

- Data collection techniques: Government reporting and data are likely to be inconsistent between (and sometimes within) countries. Actuaries will probably not have control of the data and, to the extent possible, will need to adapt models and techniques to ensure as much consistency and transparency as possible.
- Disease uncertainties: The uncertainty in disease dynamics such as transmission and fatality rates, and the uncertainties involved in the data, interpretation and modelling, are significant. This is likely to remain so in future pandemics. The past will almost certainly not be perfectly predictive of the future, and models should reflect the need to continuously learn as new information rapidly emerges.
- Demographic characteristics: Models should focus on the future and not the past and recognize that the demographic characteristics of the pandemic will drive what needs to be focused on. For example, in the 1918 influenza pandemic, age-specific mortality meant a focus on the population aged 15–30, but in the COVID-19 pandemic the focus was on the older population. Future pandemic modelling should consider these changes and age-adjust where appropriate.
- Demographic shifts: Demographics in many countries are evolving as the average age in many developed countries is increasing very quickly. Models should be regularly refreshed as age-dependent mortality drives experience.
- Future variables: Models allow actuaries to infer what is driving experience and consider alternative future actions that could impact outcomes; this allows actuaries to advise decision-makers of actions that can save lives.

- Collaboration: Actuaries have a role to play while collaborating with other professions in future pandemics and can provide valuable insights to the public and other professions. Actuaries can work to build trust in their skills from governments and policymakers so that they are called upon to collaborate during times without crisis and hence also called upon to inform decision-making during times of crisis.
- Public discourse: Actuaries can also engage professionally in public discourse, while balancing the need to be relevant and timely with the right quality of work.

3. Life Insurance and Mortality

3.1. Measuring Mortality

The COVID-19 pandemic resulted in significant mortality worldwide. The WHO tracked about 7 million reported COVID-19 deaths worldwide as of 12 October 2023.²⁸ As shocking as this number is, as discussed above it is almost certainly understated.

It appears that monitoring excess deaths has emerged as a more effective way to track deaths during the pandemic, especially, but not only, in developing countries, where significant underreporting occurred in official COVID-19 statistics. For example, South Africa tracked approximately 100,000 COVID-19 deaths up until 29 July 2022²⁹ but excess deaths were estimated separately for natural causes (i.e., excluding accidental causes),³⁰ and were nearly three times the official reported number of COVID-19 deaths. Thus, using excess deaths from vital statistics (where available and complete) may allow for a more consistent comparison of the impact of the pandemic between countries because there are fewer differences in reporting standards and quality.

The World Mortality Dataset³¹ is a useful resource to compare excess deaths between countries. It is clear from the data that excess deaths, in relative terms, tended to be higher in developing countries than in developed countries. There are also periods where various countries, such as Australia and New Zealand, had negative excess deaths. This is thought to be due to the fact that many countries had implemented policies to delay the emergence of COVID-19 but also effectively limited the spread of seasonal flu viruses, resulting in better-than-expected mortality.

Not all of the difference between excess deaths and reported COVID deaths represents misreporting. For example, in Peru, reported COVID deaths more than explain the extremely high total excess mortality of 55% in 2020 and 2021; while in the US, the growing opioid epidemic contributed significantly to excess mortality among the working-age population.

The Actuaries Institute of Australia provides extensive analysis of excess mortality in Australia, as well as other global regions, in its July 2023 report.³² This report shows several analyses on excess deaths and relationships to other variables, including GDP, region and time.

In South Africa's case, there were also benefits from fewer deaths from accidental causes during lockdowns. This is likely to apply in other countries as well.

The authors of the World Mortality Dataset do not include excess deaths for many countries, as either they do not have the required vital statistics, these statistics are not complete or they are not readily available. In particular, data are not available for most countries in Africa and many countries in Asia, including the most populous countries: India and China (at least not at a country level). The authors also do not make explicit adjustment for differences in population demographics, which is an important consideration when using the Dataset.

This has led to the development of models to try to estimate excess deaths in countries where data are not available. *The Economist* published such a model,³³ and the latest version estimates that between 17.9 million and 32.8 million people have died in the COVID-19 pandemic. The WHO publishes similar estimates.³⁴ Its estimates suggest a number based on excess deaths between 13.3 million and 16.6 million for 2020 and 2021 combined. These projections are likely hampered by their reliance on limited (and sometimes, non-existent) data from under-developed countries.

3.2. Life Insurance

Given the large numbers of deaths, it is reasonable to expect that the life insurance industry would have also experienced excess deaths. In the UK the Institute and Faculty of Actuaries' (IFoA's) Continuous Mortality Investigation (CMI) estimates excess deaths on mortality term assurances in 2020 and 2021 of +8% and +12% respectively, indicating that mortality for term products was 8% and 12% higher than expected.³⁵ This is broadly in line for the population of similar age as per the table below.

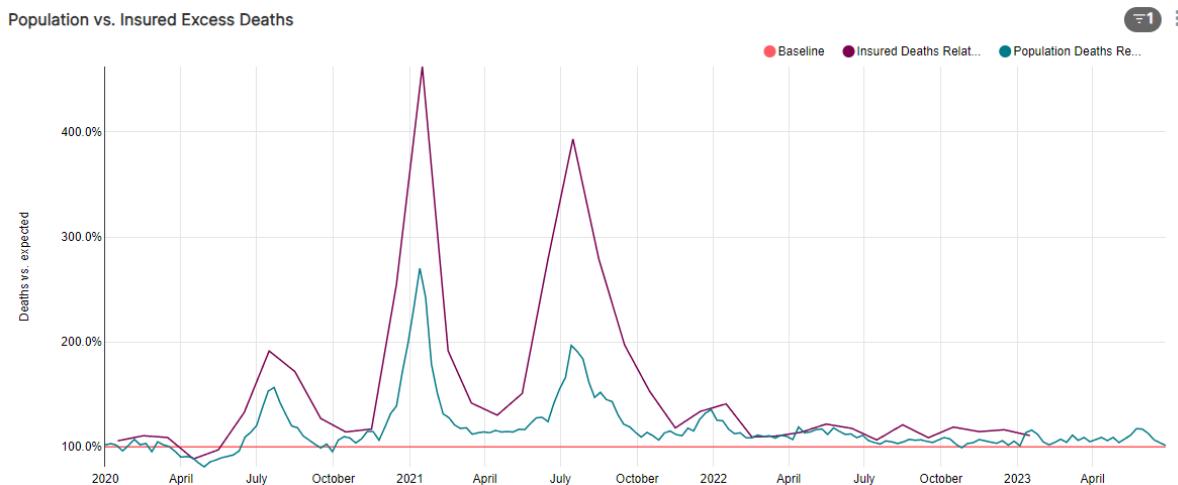
Table 1: Excess Death Rates

Gender	England and Wales Population		Mortality Assurances		Term
	2020	2021	2020	2021	
Year	2020	2021	2020	2021	
Males	+13%	+12%	+11%	+18%	
Females	+9%	+9%	+3%	+4%	
All	+12%	+11%	+8%	+13%	

Source: *Institute and Faculty of Actuaries CMI 2023*

Many actuarial bodies produced similar analyses for individual and group business to try to estimate the impact of COVID-19 on mortality.

In some markets, such as South Africa, there were significant differences in the population experience relative to the insured lives. Actuaries there estimated the excess deaths for traditional underwritten protection polices in the market and compared those estimates with population excess mortality.³⁶ The figure below plots the relative excess death rates in insurance products versus population. In South Africa, insured lives experienced much higher relative mortality during the first three waves of the pandemic, and overall deaths peaked at over four times expected in January 2021.

Figure 1: Population vs. Insured Excess Deaths

Source: Actuarial Society of South Africa

These excess deaths may also be due to the high differential between the underlying insured mortality rates and the general population mortality rates in South Africa. Analyses suggest that the absolute additional mortality experience in the insured lives was likely lower than in the general population.

In countries with significant insurance excess deaths – such as South Africa, various countries in South America, and India – life insurers had to move quickly to reprice group business in particular. Significant losses were observed, and upon renewal, rates were often adjusted very significantly.

Conversely, in some countries, such as Australia, the pandemic appears to have had no obvious impact on insured population mortality. This may have been affected by the age distribution of COVID-19-related mortality, which was skewed towards the older population. The relative impact on the insured population was thus affected by the extent of insurance coverage at older ages.

3.3. Product and Underwriting Changes

Life insurers in some markets had to adapt as the COVID-19 experience unfolded with product changes, underwriting changes and modified claims practices:

- Product terms and conditions were clarified and updated. Changes included adaptation to ensure additional risk from disability claims from minor COVID-19 illness or exposure to COVID-19 could be minimized on new policies, as well as clarifications on unemployment covers.
- In many markets life insurers had to innovate to continue to distribute and underwrite in times when access to medical services and testing was limited. In some markets this resulted in the temporarily relaxation of underwriting criteria, particularly around medicals and laboratory tests, and in others this led to the roll-out of accelerated underwriting programmes that were already in development prior to the pandemic. Underwriting question sets continue to evolve with consideration of COVID-19 as a new condition.
- In markets with significant volumes of claims, procedures needed to be streamlined to ensure continued servicing and timely payment of claims. Insurers also had to ensure that the people working in their claims departments were managing with the added volumes and related stress while also often adapting to hybrid working environments.

3.4. Vaccinations and Underwriting

Life insurers considered using vaccination status as an underwriting criterion in several markets, particularly where there was delay in roll-out and take-up of vaccines. For example, in South Africa the vaccine roll-out only commenced in mid-2021, and when take-up levels waned, underwriting by vaccination status was implemented by a number of insurers.³⁷ In other countries, such as Australia, life insurers did not (and still do not) underwrite on vaccination status.

As vaccination has become more widespread, particularly in most developed markets, the difference between all-cause vaccinated and unvaccinated mortality has continued to narrow but has not disappeared completely.³⁸ It is anticipated that all-cause mortality among the unvaccinated may go below that for vaccinated, because more vulnerable populations (with comorbidities) are more likely to be vaccinated. Vaccination status as an underwriting criterion may thus continue to evolve.

3.5. Key Lessons for the Future

Actuaries and others working in life insurance will need to consider several new factors in the future:

- Many countries continue to experience excess deaths above what would have been expected in the absence of a pandemic. This will affect actuarial modelling in several areas, such as the ongoing impact on mortality improvement, where trends have been interrupted by COVID-19.
- In disability insurance, a pandemic affects the economic environment as well as disability incidence. In addition, missed/delayed diagnoses for cancer and other diseases during the COVID-19 pandemic could result in worse experience on critical illness and disability products (and mortality products) in the coming years.
- When performing pricing and capital modelling, actuaries may need to revise assumptions on the future incidence rates of pandemics.
- There is also the risk of assuming the next pandemic will be similar to COVID-19. The next pandemic could spread more (or less) rapidly, have a different age profile, have higher death rates, be susceptible to a different vaccines development process or have other characteristics not yet contemplated.

4. Pensions and Social Security

The COVID-19 pandemic affected pensions and national social security arrangements in multiple ways, including:

- Impacts on the governance and administration of plans, both private and public, during periods of lockdown and working from home;
- Short- and long-term investment market volatility triggered by the pandemic, affecting all three pillars of retirement security (pensions, social security and personal savings);³⁹
- Work absences and business interruption and their impact on contributions to retirement plans, by both members and employers;
- Short- and long-term impact on the job market, including the effect of accelerated adoption of new technologies, expansion of remote working and increased early retirement;

- The impact on government social security budgets;
- The impact of short- and longer-term sickness on payment of contributions, as well as on entitlement to sickness benefits; and
- Higher-than-expected experienced levels of mortality and potential longer-term impact on life expectancy assumptions.

In some countries, actuaries were at the forefront of responding to these challenges in the short term and continue to be involved in assessing the longer-term impact, both on the financial strength and resilience of public and private sector institutions of retirement provision and on the adequacy of future retirement income for individual members of pension schemes, pensioners and dependents. Different perspectives may be considered, including the interests of individuals, with or without a private pension plan; of plan sponsors; and of governments and public sector entities. The impact of the pandemic showed the need for actuaries to be strongly involved as early as possible in responding to a new and critical situation affecting plan financing. It was also a challenge to disentangle the various factors affecting pension provision in addition to the pandemic, including low interest rates that were in place when the COVID-19 pandemic started.

4.1. Rapid Response Measures

The impacts listed above varied according to the particular structures of pension and social security arrangements in different countries and the nature of measures taken to respond to the pandemic. Some governments used existing national social security institutions to administer emergency financial support to members of the workforce who were unable to work because of lockdown policies, closures of businesses or cessation of different strands of economic activity. Others suspended social security contributions for a period.

The urgency to respond to population needs meant that there was only time for rough attempts to quantify in advance the financial implications of such assistance, and future actuarial reviews will need to assess the impact retrospectively. In some countries, plan sponsors were allowed to delay or skip contributions and there were provisions allowing use of plan funds through loans or hardship withdrawals, to help with emergencies. Subsequent actuarial reviews of social security, pension plans and government expenditure will need to address the consequential impact of all these factors.

In developing countries with limited social security protection, emergency relief tended to be in the form of unfunded benefits which were intended as short-term interim measures. The ongoing economic crisis has led to pressure to extend the duration of these programs without proper actuarial review, which, in some cases, has led to increases in national debt burdens. This has ongoing consequences for the capacity of these countries to develop social protection measures, and emphasizes the need for actuarial assessments to be carried out before making longer-term commitments.

4.2. Impacts on Private Pension Arrangements

Many businesses experienced severe impacts on their financial viability, and a number of them, particularly smaller businesses, were driven to bankruptcy. This had consequential impacts on their employees and the pension arrangements that these businesses were sponsoring. In defined benefit pension environments, trustees, or boards of governors and sometimes regulators, had to address the issues faced by pension plans as a result of some sponsors being significantly weakened. This reinforced the emphasis needing to be placed by regulators and actuaries on the importance of the sponsor covenant.

Some employers experienced difficulties with maintaining contributions to pension plans and asked for reductions or temporary cessation of contributions, although in most cases the shortfalls would expect to be rectified later. A number of countries introduced specific statutory provisions to permit withholding or deferral of contributions which pension plans should have been receiving according to funding rules. The longer-term consequences of these deferrals and contribution holidays will need to be assessed in actuarial reviews and may emerge in the form of lower retirement benefits or the need for longer working lives to provide adequate replacement ratios.

Although COVID-19 infections did drive some sickness absences, absences were more often the result of lockdown-induced labour market impacts. These impacts may also have incentivized early retirement, contrary to the previous general tendency for retirement ages, both statutory and actual, to increase. It is too early to assess the full longer-term impact of disability and sickness on retirements, especially given the still-unknown effects of Long COVID. Since the incidence of sickness from other infectious diseases fell during the period when COVID-19 infections were at their height, many pension schemes, whether in the public or private sector, may not have experienced sufficient disturbance to either contribution income or benefit outgoings to affect their finances in a material way. It is likely that the most directly affected would have been on individuals contributing to defined contribution pension plans where future pension adequacy is affected by being forced to suspend contributions for a significant period. This exposed the critical dependence of this type of plan on maintenance of contribution levels. In general, the impact of the pandemic on individuals was and will continue to be varied and nuanced, and will need to be analyzed carefully by actuaries advising both plans and individuals.

4.3. Mortality Effects

Pension scheme liabilities and assets have been, and will continue to be, affected by a variety of mortality impacts from COVID-19. First, in the short term, higher-than-expected mortality, particularly of pensioners and those with a deferred entitlement, will generally have had a positive impact on scheme finances, notwithstanding the human and emotional toll of losing members too soon. However, the longer-term mortality of those remaining may be lower than expected, offsetting the first impact. Another consideration is the possibility of longer-term increases in mortality rates as a result of the hiatus in diagnosis and treatment of other conditions during the pandemic when health care utilization declined (as discussed later). A learning from this was the need to disconnect the evaluation of recent mortality trends from considerations of longer-term impact on mortality improvement.

4.4. Other Demographic and Health Effects

Social security financing may be affected in the longer term by reductions in fertility, including evidence from some countries that there has been a reduction in planned future family size and child-bearing expectations. This will be an offset to the effect of any reduction in future longevity that may eventually emerge and will need to be fully evaluated in future actuarial reviews.

Wider health impacts, including on mental health or disability from Long COVID or other COVID comorbidities, may also have longer-term consequences for pension plans if more people change jobs, if early retirement experience increases or if such health impacts lead to more fundamental changes in the job market. These aspects will also need to be taken into account in setting assumptions for future actuarial reviews.

4.5. Economic Effects

Although the pandemic – and the economic, health care and other policies adopted as a result – gave a significant boost to inflation, there have been many other contributory and offsetting factors over the past few years, and high rates of inflation have a variety of causes and are not just the result of the pandemic.

Pandemics do not occur in a vacuum. The 1918 pandemic occurred at the latter end of World War I. During the COVID-19 pandemic, short-term government interventions to maintain global economies increased public debt and debt-to-GDP ratios, and a monetary policy of low interest rates created incentives that reduced financial resilience. These measures were necessary in the short term, but the policies will need to be unwound and could have unintended consequences if left in place for too long.

Perhaps the greatest impact on the funded private pension sector in some countries will have been from changes to the economic environment and rising interest rates. The latter, in particular, whilst by no means an outcome from the pandemic alone, has diminished the calculated quantum of liabilities of defined pension plans when these are valued using methods based on bond yields and will potentially have improved their funding position materially (depending on different approaches to actuarial assumptions and funding rules in different countries). Actuarial reviews will be needed to assess the impact on funding levels and future contribution needs. Higher-than-expected mortality may also have affected funding levels. Other long-term effects, such as the shifting of workplaces away from cities and the effect on commercial real estate markets, may in turn affect retirement plan assets, and actuaries need to pay close regard to the impacts on investment portfolios as well as on the liabilities.

4.6. Governance and Responsiveness

The governance challenges for pension funds provided a case study of rapid adaptation to a challenging environment. Although the future was at times very uncertain, most boards of trustees and other governing bodies were reluctant to implement knee-jerk reactions to investment volatility. Governing bodies and their actuaries moved quickly to holding meetings virtually, with the consequence that they were able to accommodate more frequent and quickly summoned meetings, which accelerated decision-making and almost certainly will have longer-term beneficial consequences for scheme governance. Working from home also had immediate consequences for pensions administration and ensuring that pension benefits continued to be paid and transactions processed. Actuaries have learned much about adapting to new ways of delivering advice in a timely way on funding and investment strategy.

Where it will be harder to unwind the potential adverse consequences will have been in respect of individual retirement decisions at times of economic and market uncertainty, and loss of pension contributions for those whose employment or business was affected by disruption to earnings during the height of the pandemic. Actuaries can advise on the need for supplementary contributions to bring retirement plans back on track.

The pandemic also demonstrated the value of social security support in times of crisis, particularly with respect to income protection. This is likely to lead to increasing political pressure on delivering such programs and increase the political risk of changes to social security programs, as France has experienced with its efforts to increase the retirement age. Actuarial reviews of the long-term implications for social security financing are a key tool to support decision-makers and assist transparency with the public on the need for changes.

4.7. Key Lessons for the Future

A number of key lessons have emerged for actuaries and others regarding the effect of a pandemic:

- Pension funds and social security plans, and their administrators and actuaries, proved surprisingly adaptable in the face of the challenges of the pandemic.
- Retirement is a long-term proposition, and the impacts can take time to realize. During a crisis, there will be a tendency to focus on short-term issues, which can lead to many changes and redirection of policy. Longer-term issues can be studied and isolated from other economic factors if possible and subjected to actuarial review.
- Retirement issues need to be considered in tandem with financial wellness. Financially fragile people may view retirement funds (if they are available) as a source of emergency financing, especially with financial uncertainty that can come with a pandemic, and the potential consequence of this is lower future retirement benefits. Government support is very important and there are a variety of different ways to provide such support to manage the consequences. However, the cost implications, in both the short and long term, will need to be evaluated thoroughly in future actuarial reviews.
- Pandemics can change when and how people expect to retire, and this can be built into projections of retirement plans and actuarial reviews.

5. Health Systems and Health Care

The impact of COVID-19 on health systems has been profound and far-reaching. The unprecedented scale and severity of the pandemic have strained health care infrastructure and resources worldwide. Health systems have faced challenges in terms of capacity, with hospitals and health care facilities becoming overwhelmed by the influx of COVID-19 patients. This strain has not only affected the treatment of COVID-19 cases but also disrupted routine health care services and elective procedures, leading to delays in non-emergency care for non-COVID-19 patients. The need for specialized equipment, such as masks, ventilators and personal protective equipment (PPE), highlighted gaps in the supply chain and logistics management.

Global health systems were generally successful in that patients were not afraid to be treated at hospitals when needed, and sought care to the extent of facilities being overwhelmed. Many countries developed field hospitals to support treatment and used other spaces such as sports stadiums for providing care. While some locations, notably some nursing homes, were viewed as a place you were likely to die (and in fact were the destinations for many COVID patients discharged from hospitals), the care facilities used limited family visits and what PPE they could obtain to do their best. The comparable event in 1918 saw people afraid to go to a hospital for treatment, which exacerbated mortality.

There was, however, an impact on access to health care facilities for non-COVID-related causes, and a notable reduction in screening. This arose from people being reticent to use health facilities for other conditions during the pandemic, and restrictions on access to reduce transmission risk. Financially, some countries offered funding to keep non-COVID treatment centers and other health care providers solvent during the lockdown.

The financial impact on all health systems has been significant, with increased testing, treatment and vaccine distribution, placing overwhelming pressure on funding and delivery of care. Systems weighted towards private funding simultaneously experienced revenue losses from decreased utilization of non-COVID-19 services. And, while such systems received

temporary public health relief, in many areas that relief has ended, or will end, leaving these systems (and all health systems) potentially vulnerable to future surges or new pandemics.

The pandemic has underscored the importance of preparedness, coordination and resilience within health systems to effectively respond to future public health emergencies. Efforts to strengthen health care infrastructure, improve data systems and invest in public health interventions have become crucial to mitigating the impact of COVID-19 and building more resilient health systems.

5.1. Impact on Health Care Treatment, Delivery and Health Insurance

One of the most significant impacts of COVID-19 has been on health care delivery itself. The medical care delivery system was massively impacted by COVID-19. The resulting influx of patients needing assistance with breathing and protective care exceeded emergency health care capacity for months at a time. Involved medical personnel were forced to work endless hours of overtime, and stress, burn-out and mental health challenges drove significant staffing issues. Forced to make room for an ever-expanding stream of COVID-19 patients, hospitals had to delay non-emergency procedures (e.g., hip and knee replacements, cancer treatments). In some countries, the resulting backlog of non-emergency procedures took months or more to clear; even COVID-19 tests were difficult or impossible to find, accelerating transmission. In addition, the full impact and longer-term consequences of delayed treatment and reduced use of preventive screenings remains to be determined but is expected to contribute to increases in disease burden and health care utilization, especially among those with acute and chronic diseases such as cancer and diabetes. This will affect actuarial projections of disease incidence into the future.

For countries utilizing private-pay insurance, the COVID-19 pandemic has had a significant impact on the health insurance industry. This has been in terms of a period of significant uncertainty during the pandemic as well as shifts in utilization patterns as health requirements and access to health services were impacted by the pandemic. In those countries that tie health insurance to employment, the early stages of the pandemic meant that people may have lost both their job and insurance coverage. During the pandemic there was an increased demand for health care services, including testing, treatment and hospitalization, resulting in higher claims costs for insurers where these fell under (sometimes mandated) policy benefits. In some cases, testing was covered by public health systems, dampening the effect on health insurance.

There were therefore mixed effects depending on the nature of coverage. For example, the increase in acute treatment requirements associated with COVID-19 was offset by lower utilization associated with elective surgeries and inaccessibility of (or hesitancy to visit) health services for less serious conditions or screenings. There has been some evidence of a resurgence of utilization levels as the pandemic has receded and there are also longer-term consequences of the reduction in utilization of preventive health services such as more late-stage diagnoses of cancer. These contribute additional uncertainty to projections of health care costs as well as disability costs. Some countries' regulators, such as those in Australia, required health insurers to increase reserves early in the pandemic period, although lower utilization in later months showed that such reserves may not have been needed.

The changing nature of COVID-19 variants was (and continues to be) a complication for coverage and treatment. The Delta variant required health systems to focus on keeping infected patients alive, while the Omicron variant exposed health systems to the challenge of treating large numbers of patients with comparatively mild symptoms.

In some countries hospitalization insurance (which may be written by life insurance companies, as is the case in Japan, for example) proved to be highly exposed to escalating

claims. Public pressure also led to the relaxation of conditions of entitlement and resulted in heavy losses.

The effects of COVID-19 on mental health are both direct – including the impact of COVID-19 and Long COVID on short-term mental health – and indirect – including the impact on mental health of isolation, loneliness, financial stress, and care for and loss of loved ones. Poor mental health can manifest itself with anxiety, depression, substance use and misuse, or other symptoms, and is exacerbated in some countries by a shortage of mental health providers and available treatments.

COVID-19 rapidly accelerated the use of telemedicine and digital health tools as virtual care was rolled out to address the need for access to medical advice during lockdown and to reduce transmission risk. This has had a positive impact in terms of embracing these innovations and the need for the development of ethical and clinical standards for appropriate use.

The pandemic has highlighted the need for comprehensive and universal coverage, including coverage for telemedicine services, mental health support and preventive care. Insurers have had to adapt their policies and offerings to meet the evolving needs of policyholders during these challenging times. Insurers in some countries, such as the Netherlands, cooperatively sought alternative financial solutions, and such collaboration has continued to some degree post-pandemic.

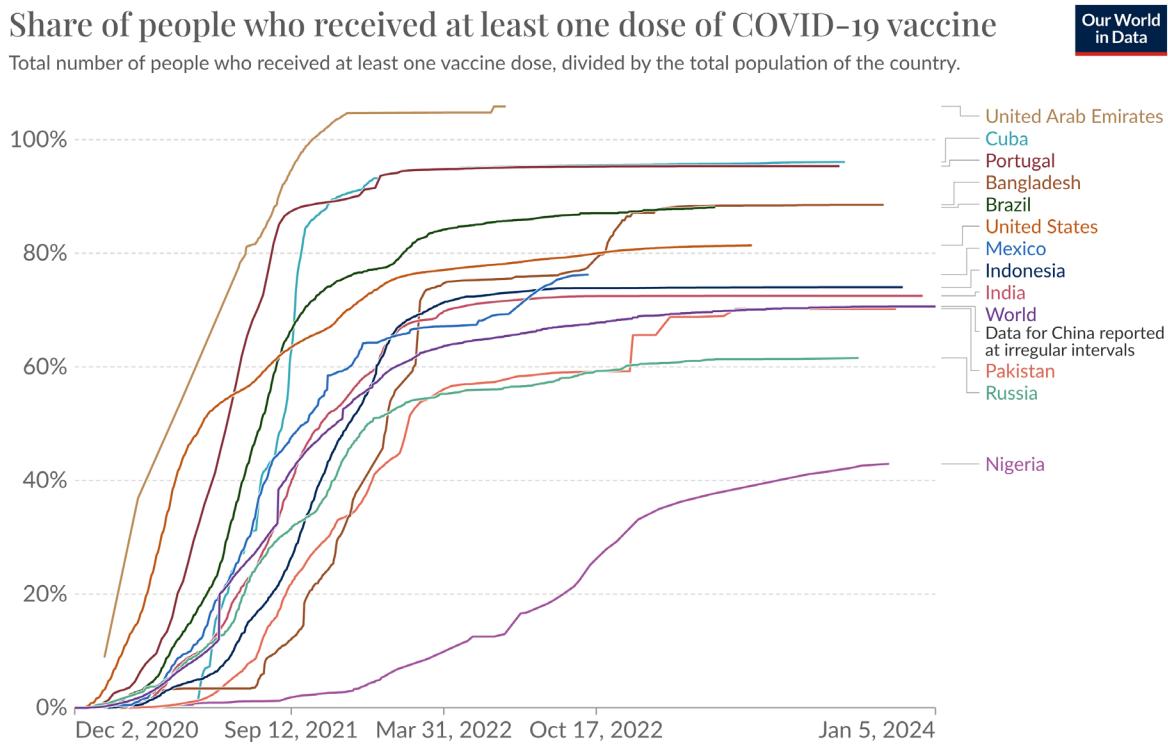
The pandemic has also highlighted the importance of risk management and mitigation for insurers, as they have had to reassess their underwriting processes and pricing models to account for the increased uncertainty and volatility in the health care landscape. Overall, the COVID-19 pandemic has brought about significant changes in the health insurance sector, emphasizing the importance of flexibility, resilience and innovation to ensure the provision of accessible and affordable coverage to individuals and communities.

5.2. The Impact of Vaccines

A key route out of the pandemic was the rapid development of multiple vaccines against COVID-19, which had varying levels of effectiveness. These began to be administered in the latter part of 2020. The supply, delivery and uptake (by individuals) of COVID-19 vaccines was subject to a number of issues which affected public health responses as well as the broader economic and societal impact of the pandemic around the world. The development and supply of vaccines was limited to a few locations around the globe with sufficient expertise for their production (e.g., the US, European Union, UK). As a result, other countries, typically emerging markets and developing economies, were forced to wait in line for vaccine shipments until sufficient supply became available for shipment internationally. This delay occurred despite access of developing countries to COVAX⁴⁰ funding. A further issue which affected the uptake of vaccines (i.e., rate of vaccination) was that some individuals held strong beliefs against the use of vaccines. This resulted in civil disobedience in at least one country and likely prolonged the duration of the pandemic in some countries.

Actuaries were involved in vaccine roll-outs in several ways, including advising on funding requirements and prioritization of vaccine roll-outs (with many countries adopting an age-based roll-out and some including other comorbidities) based on risk assessments of cases.

The graph below shows the uptake by region, using uptake as a proxy to illustrate how access to the vaccines varied across the world. The delay in being able to initiate widespread vaccination access due to challenges with accessing vaccines during early 2021 impacted on mortality in poorer regions since the prevalent variants had relatively high case fatality rates at that time.

Figure 2: Share of People Who Received At Least One Dose of COVID-19 Vaccine

Source: Official data collated by Our World in Data; [CC BY](#) licence

There was some public anxiety regarding the safety and efficacy of vaccines given the fast-tracked development and approval processes. Given the newness of the vaccine at the time, the evidence was mostly related to short-term effects. The key features of the compiled evidence are as follows:

- Vaccination had a significant favourable impact on the incidence of severe disease, hospitalization and death relative to an unvaccinated population, with relative reductions of up to 90% in vaccinated populations. The evidence was more mixed or showed a lower impact when measuring rates of less severe infection as well as rates of transmission, with some studies showing up to a 60% effect and others reporting no effect or a negligible effect.
- While the duration of both vaccine and natural immunity remains uncertain,⁴¹ immunity was found to wane over a period of several months, which led many countries to allow people to receive so-called “booster” vaccines after a period of time.
- The evidence is again unclear⁴² on the efficacy of vaccine-induced immunity relative to infection-acquired immunity (also referred to as “natural immunity”), but it is generally believed that vaccines provide a predictable immunity⁴³ (in terms of both knowing who in the population has immunity and the underlying immune system responses⁴⁴ to the virus⁴⁵ and vaccines⁴⁶ respectively) relative to natural immunity, and as such most countries have used vaccination roll-outs as a key part of their COVID-19 response.
- While some side effects of vaccination have been reported, the body of evidence (albeit collected over a short period) supports the idea that the benefits of vaccination outweigh the risks, even in populations where specific additional risks have been identified,⁴⁷ and further that the risk arising from infection with the COVID-19 virus

outweighs that from vaccination. Monitoring of side effects remains an important consideration internationally.

- Some consider that because of the virus' ability to quickly spread and adapt, the COVID-19 pandemic is an "arms race" between the virus and the vaccines. In that regard, the mRNA vaccine is a powerful weapon that was not available in previous pandemics and is likely to be an even more powerful weapon in the future.

Countries were required to take on the adverse event risk associated with vaccines, and serious adverse event experience appears to be at lower levels than experienced with other public health vaccine programmes.

5.3. Long COVID

Long COVID, the condition where individuals experience persistent symptoms and complications after recovering from the acute phase of COVID-19, has had a notable impact on health care utilization and disability. The long-lasting nature of this condition poses challenges for public health systems and insurers in terms of coverage and pricing. As individuals with Long COVID often require ongoing medical care and support, insurers may need to review and adjust their coverage policies to include necessary treatments, therapies and rehabilitation services. Additionally, the increased health care utilization associated with Long COVID can lead to higher claims costs for insurers. This could potentially result in premium adjustments or changes in coverage terms to manage the financial implications. Insurers may also need to invest in better risk assessment and monitoring tools to accurately identify and manage the risks associated with Long COVID. Finally, Long COVID remains ill-defined in terms of symptoms and duration, and currently this condition remains poorly understood, further complicating projections of utilization.

Overall, the emergence of Long COVID has brought attention to the importance of comprehensive and inclusive health insurance coverage that addresses the long-term health needs of individuals affected by this condition.

5.4. Changing Nature of Utilization of Health Care

As the pandemic has receded, there is some evidence of utilization levels returning to pre-COVID-19 levels, although it is still too early to know the longer-term effects on utilization. There are some shifts in utilization associated with factors such as higher demand for mental health services and later diagnosis of certain conditions, as well as effects not yet known related to Long COVID and new COVID variants and their symptoms. There has also been a shift in how health care is accessed and delivered, with greater use of digital health tools, including telemedicine. This presents a great opportunity for expanding access to both preventive care and medical treatment.

The pandemic caused some health care to be delayed, which in the short term caused or hastened death, and in the longer term exacerbated acute and chronic conditions. This problem is likely to occur again in future pandemics when the disease involved is very highly infectious, as is COVID-19.

Early evidence⁴⁸ indicates that COVID-19 infections can result in the development of new health conditions such as diabetes, heart conditions, blood clots or neurological conditions, and/or exacerbate pre-existing chronic conditions. This phenomenon will affect health care utilization and potentially life expectancy for people with these conditions. Modelling should incorporate these impacts to more accurately predict future utilization.

5.5. Pandemic Resilience Per Country

The data indicate that countries' level of economic development and demographics affect their resilience to pandemics. For the COVID-19 pandemic, simple cross-country regressions show that, other things being equal, death rates decline with the increase in the level of GDP per capita and the number of hospital beds per capita, and increase as a function of the average age of the population. Even after controlling for region-specific characteristics, these three variables remain statistically significant.⁴⁹

GDP per capita can be considered a proxy for several socioeconomic dimensions: state capability to mitigate the impacts of the pandemic, the share of the population living in urban versus rural areas, and the resources that households have to mitigate health shocks and cope with them.

The number of hospital beds per capita is a rough proxy for the capacity of a health system to respond to the crisis, not only in terms of providing treatment to those who become seriously ill, but also in terms of managing caseloads efficiently so that resources are allocated to those who need them the most. But the impact in terms of saving lives is relatively less important, perhaps because access to treatment will not necessarily guarantee survival.

Historically pandemic mortality rates have been associated with certain age ranges and hence the age distribution of a population is an indicator for the proportion of the population that is more exposed to the risk of death. In the case of COVID-19 it quickly became evident that case fatality rates increased with age. Thus, older countries with a larger share of elderly population and therefore a higher average age were likely to be more vulnerable. As sufficient data accumulated, other risk factors became clearer, and this supported the development of resilience indices for the assessment of risk at a population level.⁵⁰ These resilience measures could be used for things like prioritization of preventive measures and triaging of cases which were more severe and presented higher mortality risk. For example, a health insurer in South Africa developed a resilience index which was used to identify people at high risk who were provided with pulse oximeters as their risk of rapid progression was much higher.⁵¹ This initiative was lifesaving for a number of these patients.

These models should be regularly updated to reflect current and projected demographics of a region to reflect factors such as longevity, fertility rate and migration applicable to a future event.

5.6. Key Lessons for the Future

The long-term impact of COVID-19 on all facets of health care is not yet fully known, but a few key lessons are apparent:

- Public health support is critical in the rapid response to a pandemic; in the case of COVID-19, public health funding in many countries facilitated the availability of health care services such as testing, treatment and vaccinations. Actuaries can support public health finance systems to ensure accurate cost projections and equitable distribution.
- Risk management strategies can be incorporated into the health care delivery system to mitigate the impact of a pandemic emergency and prepare these systems for a future pandemic. Nursing homes and hospitals were especially vulnerable to COVID-19.
- In privately funded systems, subsidies may be required to health care providers who do not provide care directly to COVID-19 patients, and who have seen a reduction in utilization.
- Vaccinations are a powerful tool in the fight against pandemic diseases and ongoing development of diseases that are not yet pandemics. In order to be effective in

combating a pandemic, vaccines need to be developed and rolled out much more quickly than has been the norm historically. Actuaries can use demographic models to help governments and health systems optimally deploy vaccinations as well as testing and treatment or other potential tools that may be useful in future pandemics.

- COVID-19 has characteristics that proved challenging to containment of the disease: up to 40% of those infected with COVID-19 were asymptomatic, and it could take days for COVID-19 to manifest into symptoms, during which time it was extremely infectious. Because of these characteristics, in many countries (with exceptions such as Australia, New Zealand and several southeast Asian countries), contact-tracing and other public health tools proved to be of limited utility in containing the disease. Even for those who proactively prepared to roll out these tools, they may just have bought more time before the pandemic hit in full force; but given the incredibly rapid development of the mRNA vaccines, certainly by historical standards, buying time may be of value in future pandemics.
- Long-term health impacts of a pandemic affect health care utilization in direct and indirect ways, and projection models should incorporate these effects to the extent possible.

6. General Insurance

Although the impact of the COVID-19 pandemic was most immediately apparent in the life and health fields, general insurance was also affected. At the insurance operations level, the normal course of work and claim settlements faced unprecedented disruption. In addition, coverage language was tested by claimants experiencing unprecedented economic circumstances. Such language did not always stand up to the stress of the pandemic, indicating a potential need for updates. More broadly, reduction in some forms of risk (through lockdown measures, for example) brought its own set of new risks. Disrupted economic activity led to pandemic-related business interruption losses, but many companies had inadequate or no insurance cover, leaving losses to be absorbed by individuals or by governments in terms of emergency funding. Developing countries had fewer resources to cover this support, and this also affected the ability of these economies to recover after the pandemic.

The extent of protection gaps was experienced differently across economic sectors. For example, service industries suffered more extensive effects of lockdown measures than knowledge-based sectors. This section explores a few examples of the impact of the COVID-19 pandemic on general insurance products and coverages.

6.1. Businesses Closures

After a major event like a hurricane, earthquake or tornado, businesses, even those which did not suffer any damage, are often forced to close. Business insurance policies generally provide coverage to protect against lost income due to such closures if they are caused by physical damage.

Since there was no physical damage to property, during the initial stage of the pandemic many insureds were told that they were not covered. Moreover, many policies (most, in some jurisdictions) excluded disease outright. Policyholders responded with legal actions which advanced various legal theories regarding expectations from coverage. In one case, business owners contended that the changes to their premises (Plexiglass barriers, separation of tables, etc.) constituted physical “damage” that should trigger coverage. In another case, policyholders asserted that viral deposits on surfaces similarly constituted “damage” to the

business owner's physical property. A key consideration for some business interruption contracts was whether government-imposed lockdown constituted a covered event.

Going forward, both insurers and policyholders will need to sort out the vagaries of how different jurisdictions will respond to a pandemic, assuming that the risk is insurable. Some states and cities will mandate closures. Policy language will need to adapt or cover a spectrum of civil requirements. Consequent coverage restrictions may incentivize policyholders to seek a remedy in the courts.

Given the highly correlated nature of catastrophic losses during a pandemic, it is an open question whether the resulting business interruption is an insurable loss. Standard policy language increasingly would seem to presume that it is not insurable, as more and more contracts are excluding coverage for closures related to disease. And yet, knowing what could happen, business owners will have an interest in such coverage. Governments continue to consider action to address this situation in the future. Potential solutions that have been suggested include an aggregate reinsurance cover similar to the Terrorism Risk Insurance Act in the US, a publicly available source of funds made directly available to business owners, or perhaps a contingent capital arrangement like a catastrophe bond (which is largely untested for pandemic risk). Other countries have government-sponsored retrocession programs for catastrophic risks such as flood and terrorism, and it may be that the business interruption risk resulting from a major pandemic could be covered by such over-arching programs, rather than normal private insurance policies.

6.2. Employees and the Workforce

The pandemic further emphasized key differences in the workforce. Businesses that require physical contact between people and products or services had to find a way to continue working on premises to keep workers and customers safe, while knowledge workers could continue to work remotely.

Many workers were exposed to risks at work for which coverage may or may not have existed. Historically, communicable disease was not coverable under workers' compensation because it did not relate to the conditions of work (as it can be difficult to prove that the workplace was where the disease exposure occurred). During the pandemic, where the degree of communicability and the severity of illness were significantly higher than with other common diseases, this position was difficult to maintain. Governments responded by allowing for rebuttable presumptions (i.e., the assumption that infection is associated with employment rather than the need to prove this) for certain job classes (such as first responders), thereby allowing for workers' compensation coverage for the COVID-19 illness. Whether these rebuttable presumptions will remain or be extended to other job classes is yet to be determined.

The pandemic forced companies to come up with new rules for remote work. When should employees return to work? What liability would companies take on in the event that a remote worker became ill after returning to work? What is the employer's liability for the employee's remote work environment? To what extent could or should employers restrict employee behaviour in the office, or at home? These are all issues that will need careful consideration in crafting liability cover with respect to employment practices in the future.

6.3. Unexpected Experience

The pandemic caused reductions in the number of people driving, which resulted in lower frequencies of auto/motor vehicle accidents. Increasing work from home and lockdown also had positive effects on domestic property cover related to theft in some markets. This improved the claims experience for auto carriers, and some eventually responded with

premium rebates and discounts. In other cases, policyholders responded to the credits and premium discounts with lawsuits on the basis that the reaction from the industry was too little too late, or that carriers had taken advantage of their customers' misfortune.

By the third quarter of 2020, both the absolute number of fatalities and the rate of deaths had increased in many regions and consequently there was a continued reluctance to use public transportation even as lockdown measures reduced. This may have led to higher auto use than pre-pandemic.

Early in the pandemic government spending and loose monetary policy created stopgap measures but also created an inflationary environment. This had consequences across many lines of cover, including property insurance. For example, the costs of materials and replacement parts were impacted by supply chain shortages and domestic cost increases.

6.4. Cyber Risk

While cyber risk was a significant threat well before 2020, the pandemic created an environment which only heightened the risk. Some statistics show that, in the early days of COVID-19 (April 2020), the COVID-19 Cyber-Threat Coalition⁵² identified around 26,000 malicious URLs or websites trying to take advantage of the pandemic.

Unanticipated lockdowns imposed a fast adaptation to teleworking, often resulting in a dangerous mix of (unsecured) personal devices with company systems (secured but not necessarily to the proper scale). From the positive side, the experience of COVID-19 contributed to highlighting the importance of cyber hygiene and cyber education, and urged the industry to increase its maturity regarding cyber security. However, the lack of cyber security experts compared to the high demand slowed down progress.

A concerning lesson learned about cyber risk during a pandemic is the apparent correlation with other risks during a crisis. This is simply because it is profitable for the malicious actors to take advantage of any crisis. The consequence is that cyber risk is likely to generate an additional burden to crises that may not seem to have anything in common.

Another concern is related to attacks driven by geopolitical motivations and/or industrial espionage. In addition to attacks against health services (as reported, for example, by the National Health Service in the UK), attacks against laboratories searching for cures or vaccines have been reported, and the European Securities and Markets Authority (ESMA) was especially targeted at the start of the period when it was supposed to homologate vaccine candidates. A pandemic creates geopolitical tensions that may result in cyber-attacks, potentially striking many victims simultaneously.

6.5. Key Lessons for the Future

Looking ahead, the general insurance markets will continue to evolve in response to COVID-19, and actuaries will need to assist with modelling and decision-making. The near-term issues include the following:

- Business interruption coverage for pandemic-related risks may not be insurable in the private market. Governments may need to be prepared to step in and assist and alternative risk-carrying mechanisms may need to be considered.
- Rebuttable presumptions providing workers' compensation coverage for communicable disease may be extended beyond what was seen in the past (such as for first responders and the health care industry).
- The pandemic began a shift to remote work, but the cessation of the pandemic may mean a "new normal". Employment practices liability insurance may require evolution.

- Insurers will need to invent new pricing strategies for “silver lining” phenomena when risk decreases, or when risk increases unexpectedly.
- Insurance policies need to be extensively stress-tested for crises such as a pandemic. Scenarios could include circumstances under which key exclusions might fail, resulting in unexpected increases in claims.
- Pandemics can have indirect impacts on seemingly unrelated risks (e.g., auto insurance, property cover).

7. Enterprise Risk Management

It is not about responding to a one-time crisis, not rebounding from a setback. It's about continuously anticipating and adjusting to deep, secular trends that can permanently impair the earning power of a core business.

Gary Hamel

The COVID-19 pandemic demonstrated the value of actuarial tools in enterprise risk management (ERM), particularly how these tools give actuaries the ability to work across disciplines to recognize the correlated impacts of large-scale events. While solvency and risk management are important for carrying risk, reinsurance is a critical tool for insurance companies, and reinsurers may absorb some catastrophic losses during a pandemic. To mitigate their risk, reinsurers themselves may purchase pandemic bonds, such as those issued by the World Bank in 2017.

7.1. Some Reflections on Country Experience

The discussion below provides some examples of ERM-related outcomes based on varying responses to the COVID-19 pandemic.

Lessons learned from the UK’s experience emphasize the importance of comprehensive and adaptable plans that consider different population segments and potential future developments. They highlighted the UK’s national need for a broader range of scenarios in the country’s pandemic planning.⁵³

The Swedish government was viewed as having a “fundamentally correct” national catastrophic recovery plan by the Swedish Commission.⁵⁴ The government combined timely implementation of basic principles of pandemic prevention and control with a mostly voluntary no-lockdown strategy. However, there were areas identified for improvement, such as enhancing material and mental preparedness at the national leadership level and adopting a more targeted approach to different segments of society. Sweden’s experience demonstrates the importance of preparedness and the need for continuous evaluation. Strategies need to accommodate evolving circumstances rather than attempt to apply broad-brush, “one size fits all” arrangements.

Japan’s insurance industry faced somewhat unique challenges during and after the pandemic. The insurance supervisory authority asked the industry to pay hospitalization benefits to individuals forced to stay at home due to a lack of hospital beds (effectively treating it as a hospitalization event). Whilst this was reasonable initially, as the situation evolved with the emergence of the Omicron mutation, hospitalization benefits continued to be paid even for mild or asymptomatic cases.

Lessons learned from this experience include recognizing the importance of assessing political risks and the need for collaboration between private and public sectors. External risks such as national/regional lockdowns, health care accessibility, government monetary and

fiscal policies, or market reactions have proven to have a profound impact on financial institutions' sustainability and resilience. Anticipation of the consequences of national actions and implementing preventive measures could have better prepared institutions and their portfolios. Systematic and comprehensive enterprise-wide risk management, including recognizing external political and geopolitical risks, and active collaboration and stewardship with governing bodies to improve preparedness for catastrophic and pandemic scenarios, is necessary.

7.2. Risks Arising from the Pandemic

Some key actuarial considerations associated with ERM that emerged during the COVID-19 pandemic and the emerging post-pandemic period are considered below. Changes in reserving requirements depend on several factors. These include:

- The nature of the business: For example, life insurers required additional reserves because of higher mortality, while short-term lines like auto insurance may have experienced a reduction in risk due to less driving.
- Trends: Assessing trends in severity and frequency of claims is more challenging due to the disruption effect of COVID-19, and whether there will be a reversion to pre-pandemic experience or an updated stable level to incorporate direct and indirect (e.g., Long COVID, mental health) ramifications.
- Regulations, legislation and government policy: Changes in regulation in reaction to the pandemic can affect reserving methodology. Government monetary and fiscal policy directly and indirectly impact pricing factors like inflation and interest rates. Higher levels of debt make the economy more uncertain and less resilient, and thus susceptible to other shocks.

Increased volatility in asset markets and credit risks during the pandemic, as well as the downgrading of bonds, have made asset management challenging. The insurance and banking sectors, and to some extent the pension sector, have recognized that maintaining a robust solvency and asset and liability management (ALM) risk management system has always been a material requirement, especially so for those writing long-term businesses. It is also widely accepted that the risk transfer of financial and underwriting risk in the event of a pandemic faces regional capacity limitations and a lack of risk dispersion. This event has highlighted both the reason why companies had always performed financial stress and scenario testing, strategic asset allocation, and ALM strategies in managing financial risk and ensuring business portfolio resilience as part of their normal course of business management, and the importance of them doing this.

At the start of the pandemic, preventing the spread of the virus among employees was a priority in order to mitigate reputational risks and potential damage to clients' trust in management of the enterprise. To mitigate this, companies had to quickly adapt their management systems to promote vaccinations, introduce virtual team-building activities and implement safety protocols for in-office premises to accommodate essential workers. These efforts aimed to safeguard employee productivity, customer experience and long-term sustainability.

However, working culture in some markets has fundamentally shifted towards greater remote working and increased automation. Job losses in the short term, along with the need for upskilling and concerns about mental health and anxiety among employees, have arisen. The adoption of technologies like AI, automated processes and link analysis⁵⁵ in systems has transformed the industry. As business processes are transitioning and changing, employment risks in ERM risk registers have shifted from physical workplace safety risk to risks relating to the emotional and social conditions of employees, technological proficiency, cyber security

and evolving employee work practices. These new risks require careful management and inclusion in risk registers to ensure organizations can navigate the changing landscape effectively.

It is necessary to assess the impact on risk of changes in consumer behaviours such as remote working. In addition, actuaries need to consider risks not previously considered, such as the silent underwriting of additional cyber risk associated with more remote accessing of data management systems, and new anti-selection risks inherent in pandemics.

Pricing in the post-pandemic environment is challenging because future claims and discount rates experience greater uncertainty, and competitive and economic pressures limit the capacity to load rates for this uncertainty.

Pandemics reflect potential systemic risk for financial institutions, and many in the industry need to update their risk process. As one example, rating agencies may need to adapt their ratings based on new risks, decreasing liquidity of assets, changes in reinsurers' financial conditions and the impact of rapid new business reductions/renewals due to economic and affordability pressures. Regulators may also need to review their capital calculations for adequacy.

Depending on the line of business, insurers can manage through the crisis that results in surplus reductions due to higher claims and asset market risks, and deal with surpluses arising in lines of business where claim levels reduce. For example, during COVID-19 lockdowns, some short-term insurers granted premium rebates, and this became a competitive and reputational matter. Health insurers faced the challenge of managing surplus arising from lower utilization levels while planning for a potential post-pandemic claim surge due to factors such as elective procedures and higher costs related to delayed care. The impact on product lines is not uniform and, while capital management and solvency is the main concern, reputation and fairness may also impact future viability.

A pandemic response team can be staffed in advance and utilized as conditions change and evolve. Part of their role is to provide historical background to those added to task forces and decision-makers, building flexible tool kits that can be distributed early in a crisis.

7.3. Key Lessons for the Future

The pandemic clearly demonstrated the need for proactive ERM, collaboration with external stakeholders, adoption and application of systematic enterprise systems and frameworks, and effective preparation to navigate complex challenges. These actions will promote resilience and maintain business sustainability in the face of extreme crises or unexpected events.

The key points can be summarized as follows:

- Proactively anticipate a range of scenarios impacting global, national and company results: Institutions need to study and anticipate the potential consequences of national actions for pandemics via stress and scenario testing.
- Promote risk awareness: Businesses can promote pandemic-based preventive risk awareness, particularly for insurance and pension funds. This may be a new category of duty of care and fiduciary duty to protect business profitability and sustainability.
- Implement hedge protection: Businesses can also have appropriate hedge protection arrangements and strategies (financial and non-financial) to safeguard against potential pandemic-driven financial and operational instability in the market caused by external (e.g., governmental) actions or inactions.

8. Broader Economic and Societal Impact

In our modern, crowded and highly interconnected world, COVID-19 has resulted in broad economic and societal impacts, in addition to its direct impact on mortality and morbidity.

Actuaries have an important role in advising clients and the public on the risks posed by pandemics, including consequential effects and tipping points such as those evidenced by their impacts.

8.1. Similarities and Differences to Prior Pandemics

Pandemics traditionally have led to absences from work and school, and reduced productivity, socialization, fighting effectiveness in a war zone (as with the Spanish Flu) and economic activity.

However, COVID-19 presented some notable differences. For example:

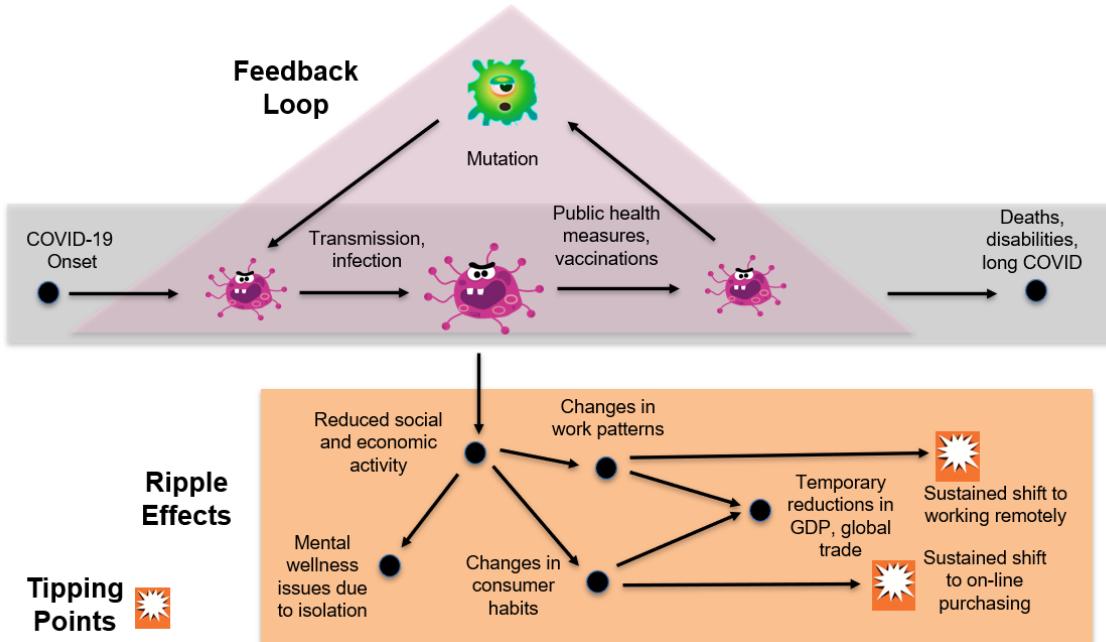
- The speed and distance of transmission, particularly asymptomatic transmission: It spread around the globe within weeks of its outbreak in China, thanks to air travel, the volume of global passenger traffic and the ease of airborne transmission between people.
- The speed of communication: News of COVID-19 was passed to all corners of the globe on a minute-by-minute basis thanks to the internet. Speedy communication enabled timely health measures to be introduced, and it also triggered mass changes in population behaviour to be made within days and weeks of COVID-19-related news. On the downside, the internet led to easy spread of misinformation and disinformation. It can be hard to identify accurate information in this environment.
- Our crowded, complex and interconnected world: The global population grew from 1.8 billion in 1918⁵⁶ to 7.7 billion in 2019. In the same period, global GDP grew from US\$5 trillion to US\$131 trillion.⁵⁷ In 2019, our world revolved around global trade and the concept of “just in time” supply chains. COVID-19 caused massive disruption to both trade and commerce.

8.2. Examples of Broader Impact

Some aspects of COVID-19’s impact were temporary for the duration of the pandemic, while other aspects appear to be of much longer duration. An example of the former is the reduction in tourism-based travel, while examples of the latter include a shift to working remotely, uncertain disability outcomes due to Long COVID and a significant reduction in business travel.

This subsection provides a few examples of the broader impacts of COVID-19 to illustrate the interconnected nature of our world and demonstrate that a significant event such as COVID-19 creates ripple effects and can trigger tipping points in other areas of our economy and society. Figure 3 provides a visual representation of these issues.

Figure 3: Illustration of COVID-19 Spread, Feedback Loop, Ripple Effects and Tipping Points



Source: Pandemic Task Force 2023

In addition to the tipping points illustrated above, the adoption of new technologies and the speed of this adoption can also be considered.

8.2.1. Impact on GDP and Global Trade

In a conversation with the World Economic Forum⁵⁸ in September 2020, Nariman Behravesh, Chief Economist at IHS Markit, said:

Looking at historical precedents, it's [COVID-19] about three times as bad as the global financial crisis of 2008 in terms of GDP decline on an annual basis. It's not quite as bad as the Great Depression in the 1930s, where the output drop was sustained over a three-to four-year period, and the unemployment rate went up to 25% in the US. This time so far it only went up to 13% in the US, but it's the worst downturn we've had globally since the 30s.

This finding was echoed in a March 2022 Organisation for Economic Co-operation and Development⁵⁹ report on global trade and COVID-19. The report found that while the year 2020 was marked by some of the largest reductions in trade and output volumes since World War II, there was a V-shaped recovery and trade continued to grow strongly in 2021. The trade in services declined more and has been recovering at a slower pace than the goods trade. Not surprisingly, trade in travel and tourism services slumped dramatically, but trade in digitally delivered services, such as telecommunication and information technology services, boomed. This highlights the complexities of modelling economic impacts, since exposure to these industries varies by region.

In reaction to the COVID-19 pandemic, many countries developed initiatives to use government funding to encourage economic growth. The resulting significant increase in debt has left the global economy less resilient for future shocks.

At the much more granular level of the individual, COVID-19 affected the livelihoods of a large portion of the world's population. In some cases, certain businesses stopped functioning altogether for the duration of the pandemic (e.g., travel, hospitality, dining, theatres).

Governments were forced to consider expensive measures to support the lost income of the affected workers. In other cases, businesses and workers were able to pivot to remote work with little loss of income from a worker perspective.

8.3. Key Lessons for the Future

In our highly interconnected, complex and crowded world it is important to consider that a global event as significant as a pandemic will have consequential ripple effects and tipping points such as those described (and others) in this section. Some actuarially relevant observations are:

- Economic effects varied significantly by industry.
- In emergencies, it is very important to act fast, requiring different methods of decision-making than in normal times.
- Pandemics can speed the adoption and acceptance of new technologies as well as decision-making, creating new expectations for how organizations will function in the future.
- The impact of pandemics can be concentrated in areas where disease spreads quickly, and where it is difficult or impossible to isolate people. Prisons, meat packing plants and nursing homes were examples of places that had concentrated numbers of cases.
- When a pandemic wanes, some of the effects may continue on a temporary or permanent basis. Examples include: employees not wishing to return to the office, direct health impacts such as Long COVID, or mistrust of vaccinations or health systems in general, as well as the effect of the detection and treatment of other health conditions being delayed during the pandemic.

Actuaries have an important role in advising clients and the public on the risks posed by pandemics, including their broader impact.

9. Financial Sector Resilience

Government intervention in response to the economic and social effects during the COVID-19 pandemic was generally effective, reducing food and financial insecurity for many. However, to prepare for the next pandemic, more could be done to build resilience for national governments, regional/state/local governments, central banks, businesses and individuals. It is important for actuaries to understand and provide input about these government and financial sector factors as they respond to a pandemic in their own areas of practice and engage with regulators and policymakers. Actuaries are members of one of the few professions that have a broad knowledge base that crosses medical outcomes, finance and demographics.

COVID-19 demonstrated that some of the factors impacting the ability of governments to effectively respond to pandemics include:

- Levels of debt-to-GDP, which limit the fiscal space for additional measures;
- The responsiveness of public health systems; and
- Citizens' trust in government and the likelihood they will comply with official pronouncements.

Emerging markets are vulnerable to a strong currency of a trading partner, which can be deflationary, and are also vulnerable to supply chain reshoring. All countries can plan for liquidity shortfalls, scams and fraud, stress on rural hospitals and food security. Too much

stimulus can create artificial bubbles and slow the process of innovation due to low borrowing rates.

Just as mortality impacts from a pandemic come from both direct and indirect drivers, financial impacts come from causes that are not always straightforward. Resilience is therefore stronger with diversification and financial stability. The rate of change is especially important. As conditions move out of historical ranges, rules of thumb developed over many years fail to work and updated solutions need to be rebuilt from first principles.

To avoid concentration risk and build financial resilience, individuals and businesses can consider limiting dependence on debt funding and build a strong community network for support. Government preparation could include plans such as:

- Lowering the debt-to-GDP ratio to build a cushion for anticipated stimulus spending;
- Stockpiling supplies, such as PPE, antibiotics and antivirals;
- Funding research so teams are already in place when needed, including vaccine developers, and liaisons between human and animal disease research communities and medical/financial scenario planners – it is important that those new to the topic are aware of this preparatory work and reviews of historical events so they are not recreated but can be a foundation for solutions;
- Reviewing automatic stabilizers – an example of this in the US is to reduce ties between health care and employment; or by reviewing and adopting solutions adopted elsewhere, such as furlough systems in Europe;⁶⁰
- Improving data collection techniques – for example, governments could ensure consistency among data collected or expand reported age groups beyond age 100, while allowing for transparency of data so external experts can analyze the large data sets in near real time and confirm or challenge conclusions;
- Including financial experts to provide input to health and political decision-makers in pandemic response planning – lockdowns have economic consequences that cost-benefit analysis and risk management scenarios can consider; and
- Communicating regularly about these plans to citizens to strengthen trust and create support.

Aside from government preparation, the private sector may also consider various opportunities, including (but not limited to) the following:

- Businesses can plan based on the assumption that they need to make their own contingency provisions rather than relying on government support. This is not always feasible for small enterprises, however, where social protection is needed.
- Because of this advance planning, institutional investors such as insurers and reinsurers can provide leadership, capital and ideas.
- Health insurers may be able to help less developed and informal health sectors with ideas and options like telehealth and microinsurance that have been successfully implemented elsewhere.
- Technology can help, such as data collection via smartphone apps and medicines sent by drones.
- Financial liquidity can be addressed with multiple sources guaranteed in advance.

Developing qualitative and quantitative scenarios, with realistic assumptions, can aid individual and business success while offering input to health and government plans.

9.1. Key Lessons for the Future

Building resilience across multiple scenarios when stimulus is needed to invigorate the economy during a potential crisis is important for long-term sustainability. Failure to control spending during periods of growth and stability limits options when they are needed in a crisis situation such as a pandemic. Some key considerations include:

- A pandemic catastrophe response differs from one where infrastructure needs to be rebuilt. In a pandemic, cash can be put into the hands of those suffering, but it does not need to be spent physically rebuilding buildings and roads.
- Monetary policy can positively affect the reserve currency, but may sometimes negatively impact those who rely on it.
- Including pandemics (with recovery periods) in scenario-building on an ongoing basis, and including scientists, public health experts, financial experts and government representatives in the scenario design, will lead to better outcomes.
- Being aware that just-in-time inventory systems and supply chains that cross boundaries and regional trading partners to minimize costs can create risks during extreme events that cannot be quickly solved.
- Data collection techniques that are transparent and consistently report in real time build trust with the public.

10. Intersection with Other Societal and Environmental Issues

A pandemic adds to and sometimes amplifies normal and crisis events, and can be a threat multiplier, defined as a risk event that can lead to feedback loops and tipping points.

An example is the interaction between climate change, population growth and pandemics. Humans continue to encroach on animals' natural habitats, increasing the risk of zoonotic spillover and new pandemics.

Responses to a pandemic could also affect the frequency and severity of other risks. Climate change drivers like greenhouse gas emissions may initially have been reduced as the economy slowed, but supply chain issues may convert green initiatives into fossil-fuel energy projects as nearshoring and reshoring projects are implemented.

COVID-19 has shown the importance of planning for indirect health impacts. As discussed above, delayed health care can cause diseases such as cancer to be identified later and at higher levels of progression. Lockdowns create mental health stresses that have contributed to so-called "deaths of despair" in some countries. It has become clear that each age group needs to be considered separately when developing resilience plans (with corresponding challenging age discrimination issues). Another complicating factor is whether citizens' behaviours can be forced to follow government health directives.

COVID-19 also magnified the impact of inequalities in terms of country, socioeconomic status, race, gender, age and other factors. Vaccine distribution favoured large and wealthy countries, and within countries distribution tended to be away from more vulnerable populations. Many developing countries discovered they lacked the capability to manufacture COVID-19 vaccines. As a result, despite having access to funding to pay for them (such as through COVAX), these countries found that the countries with vaccine manufacturing capacity were reluctant to release them beyond their own borders. This was exacerbated by wealthier countries pre-ordering vaccines to cover multiples of their population while poorer countries were unable to secure orders. The intentions of the COVAX initiative regarding promoting equitable access were almost impossible to achieve in these circumstances.

Scenarios need to be developed separately by country due to differences in past responses. For example, in some countries, citizens adopted behaviour to accommodate mandates and recommendations, while elsewhere lawsuits were filed based on perceived personal freedoms. Successful responses will require solutions that incorporate the local circumstances and culture.

While plans need to be made in advance, and periodically reviewed, multiple scenarios can be developed based on demographic groups impacted, levels of transmissibility and lethality. A plan that worked for COVID-19 may not work very well for a different type of disease like Ebola or a repeat of the 1918 influenza pandemic that primarily impacted young adults. Governments will need to adjust their response as scientists and the public learn about a new pathogen.

Transparency of information and an accelerated peer review process for academic papers, involvement of financial experts in the decision-making process and a willingness of volunteers to help governments analyze large data sets will aid the response. Actuaries have a role to play that utilizes our broad skill set.

10.1. Key Lessons for the Future

- Pandemic risk belongs to the category of so-called threat multipliers, risks that interact with and make other risks worse. Responses to a pandemic could affect both the frequency and severity of other risks.
- The world is an interconnected place, with physical and financial risks each impacting the other. Plans that anticipate socioeconomic differences and think about changing demographic and climate assumptions will be better able to develop solutions.

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