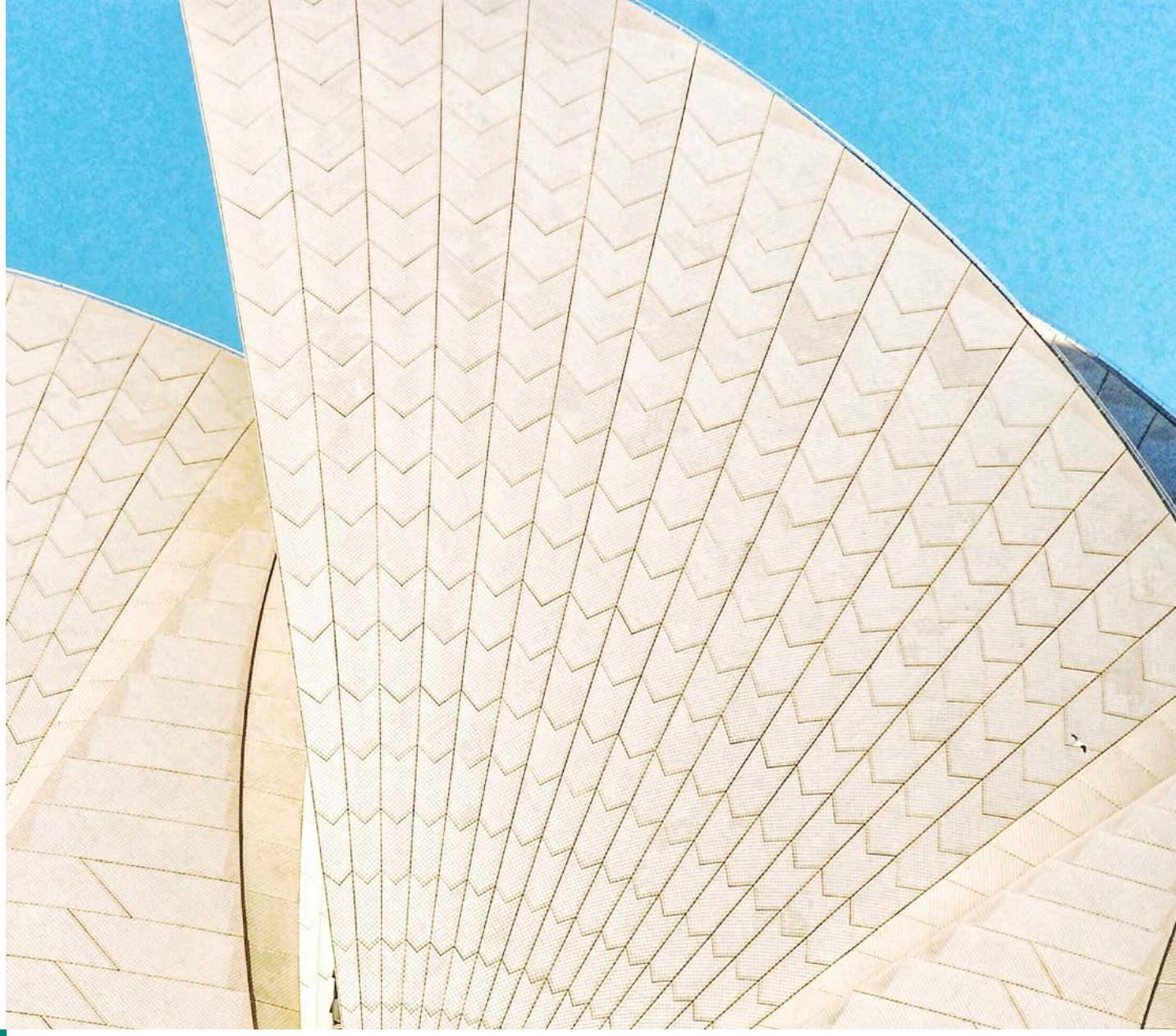

A Neglected Burden: The Ongoing Economic Costs of COVID-19 in Australia

August 2023

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The following is a structured, product- and brand-agnostic, fact-based review of evidence on the economic costs of COVID-19, potential interventions to reduce these costs, and the current approach to these interventions taken by Australia. This report does not constitute medical, legal, financial, or policy advice. It does not recommend specific decisions or policies relating to public health or economic responses, nor the trade-offs between them.

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Preface

It has been over three years since the World Health Organization's declaration of a global pandemic, COVID-19 continues to have a profound impact on societies across Asia Pacific and the entire world. While vaccines, therapeutics, and rapid diagnostics have reduced severe illness, hospitalization, and deaths significantly, COVID-19 is still causing morbidity and mortality, particularly in vulnerable populations. Moreover, it continues to exert an ongoing and adverse impact on the economy. The cost of COVID-19 on healthcare systems, supply chains, and travel has received extensive attention over the past three years. However, as this white paper demonstrates, the indirect cost of workforce disruption is significant and underappreciated.

A deeper understanding of COVID-19's economic costs is critical to inform policies that can protect the growth and prosperity of the Asia Pacific region in the current stage of the pandemic. This report provides insights into these costs through evidence-based estimates across different COVID-19 infection scenarios in Australia.

The purpose of this white paper is to inform policy discussions on assessing and mitigating COVID-19's ongoing economic impact. The report takes a high-level perspective, assessing COVID-19's potential consequences on Australia's economy. It is inspired and informed by efforts to estimate the economic impact of COVID-19 in other economies.[1,2]

The discussion that follows is based on information available at the time of writing, and sources are provided throughout the text. Estimates are based on epidemiological scenarios that extrapolate market-specific hospitalization and transmission rates observed in Australia during various periods between February 2020 and early 2023. All content and estimates have been reviewed for validity and accuracy at the end of February 2023.

This report is not intended to be a research document, and it is recognized that the fluid evolution of the pandemic and policy makers' varied responses to it presents challenges in any attempt to estimate future costs.

Findings in this report are taken from a wider regional report across five markets. Estimates provided in this report should not be directly compared across markets given their highly market-specific nature. The content included in this report relies upon the percentage of GDP and percentage of total cost figures to provide an estimate of trends.

This report is also not intended to be a health technology assessment that re-estimates the value of lost health, nor a marketing or cost-effectiveness analysis between interventions. However, the underlying results present an informed indication that the full economic costs of COVID-19 are greatly underappreciated and are an important, but missing factor in policy discussions. It is hoped that this report provides a fresh perspective that will be useful to policy stakeholders.

1. McKinsey & Company [Internet]. One billion days lost: How COVID-19 is hurting the US workforce. 2023 Jan 9. Available from: https://www.mckinsey.com/industries/healthcare/our-insights/one-billion-days-lost-how-COVID-19-is-hurting-the-us-workforce
2. Guilford G, Weber L. WSJ [Internet]. COVID drag on the workforce proves persistent. "It sets us back." 2022 Nov 7. Available from: https://www.wsj.com/articles/covid-workforce-absenteeism-productivity-economy-labor-11667831493

Executive Summary

This white paper examines the ongoing impact of COVID-19 on Australia's economy, with a more thorough assessment of the hidden economic costs to Australian society than has previously been available. Due to a range of factors including health system capacity, impacts on workforce and business, and heightened vulnerability of certain demographics, Australia finds itself susceptible to the ongoing economic toll of COVID-19. As the market moves from the pandemic to an endemic phase of COVID-19, we present a comprehensive view of the disease's financial impact, with a focus on indirect costs.

Our report begins with a brief introduction of our methodology in Section 2, followed by a deep discussion on the effects of the pandemic in Australia in Section 3, and then a reflection on the countermeasures available to policymakers in Section 4. We conclude this paper in Section 5 by re-emphasizing the significant indirect economic costs and how these can be mitigated using available tools.

Limited previous analyses of COVID-19's economic impact in Australia have provided widely varying assessments – from AUD ~15 billion to AUD ~400 billion p.a. – depending on the type of research carried out. We have adopted a cost-of-illness approach, a technique often used in policy decision-making, to provide a more stable estimate. This allows us to anticipate the ongoing cost of three possible scenarios: a lower-estimate scenario, a base case scenario where current conditions continue, and a higher-estimate scenario.

Should current conditions prevail in Australia under a base case scenario, the annual economic costs of COVID-19 could reach about AUD ~25 billion p.a, representing around 1.0% of the market's GDP. In a worst-case Pandemic 2.0 scenario, AUD ~56 billion p.a would be lost, around 2.2% of GDP.

We study the direct costs of the disease, such as healthcare costs, as well as indirect costs – i.e., productivity losses due to missed work. Our findings show that indirect costs far outweigh direct costs, accounting for 89% of Australia's total ongoing economic cost of COVID-19 in the base case scenario. While direct costs to the health system in Australia are substantial, accounting for AUD ~2.79 billion p.a., indirect costs (such as productivity loss) will remain the bulk of the economic burden well into the endemic phase of COVID-19.

Among other key factors, the report finds Australia faces especially high costs associated with individuals affected by long COVID, both prolonging productivity losses and increasing indirect costs and reliance on health services. In a base case scenario, productivity losses from long COVID could amount to AUD ~8.0 billion p.a., or ~35% of all indirect costs.

The report also reveals the ongoing impact on some of Australia's most critical industries. One important example is the health workforce, which continues to be impacted by high levels of absenteeism and a greater risk of infection compared to the wider community. This susceptibility has significant consequences for health system capacity, efficiency, and quality of care. Meanwhile, the market's logistics, travel and tourism industries are also particularly affected by workforce shortages.

Not all community cohorts face the same level of risk or contribute the same economic burden when infected. Australia's vulnerable populations, such as older adults[3], working age adults with one or more comorbidities (such as high blood pressure, cancer, and/or diabetes), as well as indigenous populations are likely to be disproportionately impacted.[4]

Efforts by Australia's government and policymakers to contain the spread of COVID-19 and suppress the virus have been largely successful over the three-year pandemic period. However, the reopening experience has since showed how the costs of COVID-19 extend beyond the value of health losses and there are far greater economic impacts driven by productivity loss, vulnerable population infections and key industries.

Part of Australia's ongoing endemic response may include further strengthening of existing systems and protocols, whether that be community measures such as contact tracing and mask-wearing mandates, other infection control strategies, or medical responses like vaccines and therapeutics.

Having a full understanding of COVID-19's cost, both current and potential, is therefore vital to designing effective countermeasures that can mitigate the disease's ongoing impact (measures we have identified in the white paper). It is hoped that this paper can help Australian policymakers to anticipate potential developments as they prepare for the future, beginning with an appreciation of the full cost already being borne, including the often-overlooked indirect costs.

Acting now to address these impacts will contribute to protecting Australia's economy, industries, livelihoods, and of course, its population's health.

3. Older adults refers to those aged 65 and above.
4. Yashadhana A., Pollard-Wharton N., Zwi A., Biles B. Indigenous Australians at increased risk of COVID-19 due to existing health and socioeconomic inequities. The Lancet Regional Health – Western Pacific [Internet]. July 2020; 1:100007. Available at: https://www.thelancet.com/journals/lanwpc/article/PIIS2666-6065(20)30007-9/fulltext

1. Looking Forward: Examining The Potential Economic Futures For COVID-19

1.1 Three Key Questions: Characterizing The Economic Future Of COVID-19

As authorities managing the health and economic impacts of COVID-19 consider how to prepare for the next phase of the pandemic, they are grappling with uncertainty about how it will evolve. This uncertainty can be distilled into three key questions:

- What will the future number of cases be and how severe (i.e., the epidemiological future)?
- How does this translate into economic cost?
- What tools are available to reduce the burden of disease and its costs?

Each of these questions, on epidemiology (Section 2.1.1), costs (Section 3.3), and available tools (Section 4) will be examined in this white paper.

1.2 Existing Estimates: Building On Historical Scenarios For The Cost Of COVID-19

Existing estimates of the economic costs imposed by COVID-19 in Australia vary widely. Variation exists not only in the estimates themselves, but also in the methodologies, scopes, and assumptions used to derive them.

The disparity in cost estimates is generally driven by three factors:

- The epidemiological scenario captured in assumptions (often historical).
- A specific intervention being modeled.
- The scope of costs evaluated in the methodology.

This variation makes it difficult for decision-makers to find the relevant cost evaluations to inform whether and how much to invest in ongoing efforts to combat COVID-19. There is a need for estimates which capture plausible future epidemiological scenarios, using the expected or current set of interventions, and focusing on major costs to society. The following examples show that most existing estimates do not include indirect costs from productivity losses in their scope. As the subsequent cost estimate (Section 3.3) will demonstrate, indirect costs are substantial (~0.9% of GDP) and need to be better recognized.

The remainder of this chapter provides an overview of the existing estimates of costs in each market of interest, before turning to the methodology used for estimating economic costs.

Limitations of Estimate

Readers of this report should observe the following limitations in relation to the estimates provided:

- The fluid evolution of the pandemic and policy makers'

varied responses to it presented challenges in any attempt to estimate future costs.

- The findings are not intended to be a health technology assessment that re-estimates the value of lost health, nor a marketing or cost-effectiveness analysis between interventions.

1.2.1 Estimates for Australia

Range of existing estimates of the cost of COVID-19: AUD ~15 billion to AUD ~400 billion p.a.[5] (estimates determined by any intervention modeled, the epidemiological context, and the scope of costs evaluated).

Higher cost estimate: AUD ~ 400 billion p.a.[5] This reflects the impact of Australia's decision not to implement lockdowns, which allowed the virus to spread with little mitigation, in the epidemiological context of the variants prevalent in 2020.[6] The estimate includes direct costs to the health system, as well as the value of lost health, using a 'value of statistical life' (VSL) methodology.[7]

Lower estimate: AUD ~15 billion p.a.[5] This reflects the costs associated with 'reopening' at a national double vaccination rate of 80%, compared with other thresholds,[8] in the epidemiological context of the Delta variant prevalent in the second half of 2021. The estimate includes both direct costs to the health system as well as the value of lost health using a VSL methodology.

In another estimate, the cost impact of removing testing (and the implications this has for case quarantine) was AUD ~54 billion p.a.[5], in the context of the Omicron variant circulating in early 2022.[9] As with the other studies, this estimate also includes direct costs to the health system and the value of lost health, albeit measured using quality-adjusted life years (QALYs).[10]

These disparate estimates demonstrate how shifting epidemiological scenarios tied to specific interventions and differing scopes of costs can result in widely varying estimates.

1.2.2 The need for better targeted, future-looking cost estimates

The variation in existing estimates of the economic impacts of COVID-19 leads to a lack of clarity. An approach better aligned to today's environment could take three steps to establish a more consolidated framework:

- **Establish a set of plausible epidemiological scenarios** that decision-makers find relevant for planning purposes.
- **De-anchor estimates from specific interventions used in the pandemic phase (e.g., lockdowns, vaccinations, welfare payments)** and ensure that estimates instead reflect conditions in today's reopened societies.
- **Target the scope of costs included to reflect the way the pandemic impacts society today:** health service utilization and productivity loss from missed work.

5. The studies in Australia used AUD figures and the amounts are as follows: AUD ~15 billion = USD ~10 billion, AUD ~400 billion = USD ~270 billion, AUD ~54 billion = USD ~36 billion.
6. Kompas, T., Grafton, R., Che, T., Chu, L., Camac, J. Health and economic costs of early and delayed suppression and the unmitigated spread of COVID-19: The case of Australia. PLOS ONE. 2021 Jun 4; 16(6): e0252400
7. Value of statistical life is an approach to estimating the value of reductions in the risk of physical harm. Based on international and Australian research, a credible estimate of the value of statistical life is $5.0m and the value of each statistical life year is $217,000 in 2020 Australian dollars.
8. Chu, L., Grafton, R., Kompas, T. What vaccination rate(s) minimize total societal costs after opening up to COVID-19? Age-structured SIRM results for the Delta variant in Australia (New South Wales, Victoria and Western Australia). PLOS Global Public Health. 2022 Jun 14; 2(6): e0000499
9. Karnon, J., Afzali, H., Bonevski, B. An economic evaluation of government-funded COVID-19 testing in Australia. Applied Health Economics and Health Policy. 2022 Sep; 20(5): 681-691
10. The quality-adjusted life-year (QALY) is a measure of the value of health outcomes. This approach values both quality and length of life, with monetary values attached per condition, in contrast to the VSL approach, which applies a universal value to each life and life-year (unless adjusted).

2. Our Approach: Uncovering The Future Economic Costs Of COVID-19

2.1 The Cost-Of-Illness Concept In Estimating Economic Costs

This white paper uses the cost-of-illness concept to derive cost estimates and present a coherent snapshot of the COVID-19 price tag faced by Australia. Commonly used to support decision-making, the cost-of-illness approach is a pragmatic health economics methodology that assesses two types of cost: direct costs of the illness (i.e., those incurred by the health system) and indirect costs (i.e., those resulting from productivity losses due to work missed by affected individuals). By assessing these two major categories of burden, the approach helps policymakers understand the value at stake when investing in interventions to address the disease.

This report has collated publicly available data and existing cost estimates of both direct and indirect costs into an overall estimate for Australia and a detailed look into the factors affecting the market.

The cost-of-illness approach – particularly the focus on indirect costs – has been recently used in the 'One Billion Days Lost' analysis published by McKinsey & Company,[11] detailing the significant and ongoing economic costs wrought by COVID-19 on the US labor force. The approach to estimating economic costs arising from productivity loss in that piece of research is substantively similar to the approach used in this white paper. This report identifies factors driving productivity loss by focusing on cohorts of key affected individuals, such as working-age individuals (looking at those who can and cannot work from home), and caregivers of children unwell with COVID-19 (looking at the children's age and the caregiver's ability to work concurrently).

Cohorts contributing to direct costs include inpatients and outpatients. Within each cohort, the major determinants of cost are volume (i.e., number of people affected by COVID-19 in that cohort), price or value (i.e., of the service provided), and time (e.g., duration of service provision). For example, the costs arising from the cohort requiring inpatient care for COVID-19 would be the product of the number of patients admitted to hospitals, the average number of days they stay there, and the average cost per day of admission.

This approach does not typically account for the value of lost health, such as that quantified in a value of statistical life (VSL) methodology.[7] As a result, the cost-of-illness approach can lead to an underestimation of costs, as a population's willingness to pay to avoid harm is generally higher than the cost to the economy.

11. McKinsey & Company [Internet]. One billion days lost: How COVID-19 is hurting the US workforce. 2023 Jan 9. Available from: https://www.mckinsey.com/industries/healthcare/our-insights/one-billion-days-lost-how-covid-19-ishurting-the-us-workforce

2.1.1 Three epidemiological scenarios

Epidemiological scenarios help us to consider the potential courses that the COVID-19 pandemic may take in the future, providing a mechanism with which to anchor cost estimates to real-world conditions. Cost estimates can then be adjusted based on potential changes in these conditions.

While the price of medical services or the value of lost work in each cohort affected by COVID-19 is relatively straightforward to establish, other factors are contingent on the course of the pandemic. For example, a novel and more contagious strain may result in a greater number of infected individuals, unlike an earlier variant to which the population has already acquired a reasonably high level of immunity.

Three epidemiological scenarios have been developed:

- Normal 2.0: A lower estimate scenario, with more favorable conditions
- Base case: A middle estimate scenario, where current conditions prevail
- Pandemic 2.0: A higher estimate scenario, with more severe conditions

These scenarios are defined by two key features:

- Infection volume (driven by contagiousness and measured by cases per million population per year), and;
- Case severity (driven by a prevailing strain's virulence and measured by the resulting hospitalization rate).

These features allow low, base, and high scenarios to be used in cost estimates that reflect real-world conditions, improving their applicability to support decision-making. Estimates of the economic costs of COVID-19 using the cost-of-illness approach are detailed in Section 3 (Australia) below.

To note, this report leverages Institute for Health Metrics and Evaluation (IHME)'s 2022 Reference Scenario data (last updated 18 November 2022) to inform the 'base case' for each of the markets in focus. The IHME is an independent global health research centre at the University of Washington. IHME aggregates real-time COVID-19 data and projects future scenarios for a number of markets, using a hybrid modelling approach incorporating statistical and disease transmission models.

This dataset includes:

- Historical actuals for daily confirmed cases and daily deaths
- Estimates of daily infections (not just those confirmed by a positive test) based on the SEIR disease transmission model that leverages data from seroprevalence surveys, daily cases, daily deaths, and daily hospitalisations where possible

IHME draws datasets from local and national authorities, hospital networks and associations, the World Health Organisation, and other sources / aggregators such as Johns Hopkins University and Our World in Data.

3. Economic Cost of COVID-19 in Australia

In Australia, the future economic cost of COVID-19 could range from AUD ~17 billion p.a. (~0.6% of GDP) to AUD ~56 billion p.a. (~2.2% of GDP), depending on the scenario that evolves. These costs are far greater than commonly recognized. COVID-19 not only inflicts health losses through illness and death but also imposes substantial economic costs, including direct costs on the healthcare system and productivity losses from missed work.

Living with ongoing transmission of the virus and the burden of disease it incurs is a reality that nations have had to come to terms with. However, there is an opportunity to better leverage tools available to reduce this burden. To better inform the ongoing discussion on COVID-19's impacts and how we could benefit from addressing these impacts, it is important to understand the full range of economic costs imposed by COVID-19.

There is a range of potential epidemiological scenarios for how the COVID-19 pandemic may evolve. This is reflected in the wide range of existing estimates for the economic costs due to COVID-19 (which also vary due to interventions studied and the scope of costs included).[12] Possible epidemiological scenarios include a base case, where current conditions prevail, and alternative scenarios that differ in the rate of infections and their severity (driven by, for example, the interplay between variants and the level of immunity maintained in the population).

In the base case scenario, total economic costs could be AUD ~25 billion p.a. (equivalent to ~1.0% of GDP), assuming a transmission rate that results in ~20 million infections p.a. and ~193,000 admissions p.a.[13] (including ~109,000 inpatient admissions and ~84,000 home care program admissions), with:

- The majority of costs (AUD ~22.5 billion p.a., ~90%) are due to productivity losses (indirect costs) through missed work by both working-age adults and elderly in the workforce, either during their own illness or while caring for dependents (children and over 65-year-olds) affected by COVID-19, and
- A further cost (AUD ~2.8 billion p.a., ~10%) is borne by the health system (direct costs), in both admissions (AUD ~1.3 billion p.a.) and outpatient (AUD ~1.5 billion p.a.) settings.

12. Australian Bureau of Statistics [Internet]. Economic gains and losses over the COVID-19 pandemic. 2022 Jul 9. Available from: https://www.abs.gov.au/articles/economic-gains-and-losses-over-covid-19-pandemic

13. Includes ~109k inpatient admissions and ~84k admissions to COVID home care programs nationwide (such as 'virtual hospitals' in NSW and the COVID Positive Pathways program in Victoria). Inpatient admissions figures are sourced from the Institute of Health Metrics and Evaluation's (IHME; used with permission) mean estimate of annual inpatient admissions in Australia in 2022, and may differ from other sources.

In a Pandemic 2.0 scenario, economic costs could reach as high as AUD ~56 billion p.a. (~2.2% of GDP). This assumes transmission rates that result in ~26 million infections per year (instead of ~20 million in the base case), and a severity that results in ~130,000 inpatient hospitalizations (compared with ~109,000 in the base case). In contrast, at the lower end of the spectrum, a Normal 2.0 scenario might feature ~14 million infections over the course of a year with only ~45,000 inpatient hospitalizations, translating to direct and indirect costs of AUD ~17 billion p.a. (~0.6% of GDP).

These economic costs are unevenly distributed. The health and logistics workforces, those affected by long COVID, and vulnerable populations are likely to be disproportionately impacted. For example, COVID-19 illness in vulnerable populations contributes AUD ~12.4 billion p.a. in the base case scenario, of which AUD ~3.1 billion p.a. (~25%) is borne by individuals eligible for oral antivirals. Separately, the health workforce is impacted by high levels of absenteeism and a risk of infection that is around 3 times that of the general population, both carrying consequences for health system capacity and quality of care.[14] Economic costs arising from these disruptions to the health workforce total AUD ~2.3 billion p.a. in the base case scenario. Those affected by long COVID (see Section 3.4.6) are impacted most significantly, with the value of lost work and health system utilization totaling AUD ~8.6 billion p.a. or ~34% of all economic costs.

Fortunately, a range of countermeasures remains available that may mitigate the economic costs of COVID-19 (see Section 4), including vaccination, therapeutics, and community measures (i.e., non-pharmaceutical interventions). Strengthening these countermeasures may allow Australia to mitigate the potentially high economic costs of the continuing pandemic.

3.1 Context: The Situation In Australia

Today, Australia is relatively free of restrictive measures. Most of the community measures employed earlier in the pandemic, such as lockdowns and mandatory isolation, have been pared back. In their place, Australia has wide availability and uptake of vaccines and therapeutics such as antivirals. Concerning antivirals, these are available in line with their indication, under the Pharmaceutical Benefits Scheme (PBS) to a subset of the Australian population, based on traditional health technology assessments.

However, in early December 2022, Australia was experiencing its fourth wave of infections arising from the Omicron variant. With ~80,000 new infections per day and an effective transmission number[15] of ~1.05, infection volumes did not peak until later in December.[16] By contrast, in January 2021, before the Delta or Omicron variants emerged, there were ~60 infections per day,[16] this was a time when when most of the nation was subject to international and domestic border closures, rolling metropolitan lockdowns, and social distancing measures. The change in Australia's pandemic response approach is both a reaction to the volume of infections, as well as a driver of subsequent infections.

14. Quigley, A.L. et al. Elsevier Public Health Emergency Collection [Internet]. Estimating the burden of COVID-19 on Australian healthcare workers andhealth system during the first six months of the pandemic. 2020 Oct 29. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7598370/
15. The number of people a single case will infect, on average.
16. As a point of comparison, as Australia's first Omicron wave began to subside in January 2022, there were ~100,000 infections per day and an effective transmission number of ~0.90; Institute of Health Metrics and Evaluation (IHME; used with permission).

Australia's initial measures were effective at containment and then suppression of the virus, while imposing significant economic costs. By international standards, the countermeasures employed during the first phase (2020 to 2021) were largely successful. The number of reported cases (~400,000) and deaths (~2,200) was among the lowest in the OECD.[17] However, these border closures, domestic travel restrictions, lockdowns, social-distancing requirements (including limiting the number of people allowed in indoor spaces), and mask-wearing imposed significant hardships on the community. The successful rollout of vaccines afforded an easing of many restrictions,[18] although the immunity conferred was found to wane over time.[19] This waning immunity necessitated third (and ultimately fourth and fifth) doses, while novel variants capable of immune evasion, such as Omicron, emerged.

Oral antivirals have been added to Australia's response toolkit. As restrictive community measures are only accomplishable in the short-term, whereas COVID-19 continues to pose a health threat in the longer-term, Australia had to broaden its approach to include oral antivirals, which became available via the PBS in March 2022.[20]

Nevertheless, the health and economic outcomes of the reopening phase have been mixed. The vast majority (~92%) of Australia's infections to date occurred in 2022.[21] While infections were not as severe as early in the pandemic, the sheer volume led to the busiest period of the pandemic yet for the hospital system, with ~300 admissions per day on average, compared to ~23 in 2021 and just ~10 in 2020.[22] This translated into the number of deaths increasing significantly, from 1,332 in 2021 and 909 in 2020, to 14,783 in 2022.[22] It is worth noting that COVID-19 has potentially contributed to excess mortality (that is, additional deaths relative to pre-pandemic mortality) both due to deaths caused by COVID-19 and deaths that may have arisen as a second- order impact of COVID-19 on health system capacity. In August 2022 alone, excess mortality was ~10% (+1,700 deaths).[23]

The high volume of infections has also wrought an economic impact, both in costs borne directly by the health system in addressing COVID-19, and the economic losses borne indirectly by society in the form of absenteeism and productivity losses. These will be explored in detail in Sections 3.3.1 and 3.3.2. Australia's reopening experience has illustrated that the costs of COVID-19 borne by Australian society extend beyond the value of health losses captured by traditional health technology assessments. Indeed, productivity losses driven by infections across all age groups constitute a major economic cost.

A better understanding of the economic costs of COVID-19 may better inform the assessment of the costs and benefits of various measures to address COVID-19. Indeed, despite the ongoing burden of COVID-19 on society, vaccination coverage remains incomplete. While 96% of Australians have received two doses of a COVID-19 vaccine, 72% have received three doses and just 44% have received four.[24] This can be compared, for example, to South Korea (~80%) and Japan (100%) where third-dose coverage is higher. While the use of antivirals has tracked infection waves,[25] their use remains relatively uncommon at a prescription rate of ~3% of all infections.

17. Our World in Data [Internet]. Cumulative confirmed COVID-19 cases. Available from: https://ourworldindata.org/explorers/coronavirus-data-explorer?time=earliest.2021-12-30&facet=none&Interval=Cumulative&Relative+to+Population=false&Color+by+test+positivity=false&country=~AUS&Metric=Confirmed+cases
18. As in many international jurisdictions, a vaccine rollout strategy was adopted in 2021 as a conduit for an easing of various restrictions. The resulting population-wide vaccination program (excluding ineligible children) delivered a double-dose national vaccination rate of >90% by November 2021. As of December 2022, 95.9% of people aged 16 and above have had two COVID-19 vaccine doses. Uptake waned somewhat after the second dose, with the third dose reaching only 72.3%. Australian Government Department of Health and Aged Care [Internet]. Vaccination numbers and statistics. 2023 Mar 31. Available from: https://www.health.gov.au/our-work/covid-19-vaccines/vaccination-numbers-and-statistics.
19. Department of Health and Aged Care [Internet]. Our work COVID-19 vaccine information. Available from: https://www.health.gov.au/our-work/covid-19-vaccines/advice-for-providers/clinical-guidance/product-information#vaccine-effectiveness-over-time
20. For details of listing, please refer to www.pbs.gov.au
21. There have been ~30 million infections in Australia in 2022, compared to ~2 million in 2021 and ~100,000 in 2020.
22. Institute of Health Metrics and Evaluation [Internet]. COVID-19 estimates reference scenario. 2022 Dec 16. Available from: https://www.healthdata.org/covid/data-downloads
23. COVID-19 Mortality Working Group [Internet]. Excess mortality continues in August 2022 Actuaries Digital. 2022 December 7. Available from: https://www.actuaries.digital/2022/12/07/covid-19-mortality-working-group-excess-mortality-continues-in-august-2022/
24. Commonwealth of Australia, Department of Health and Aged Care [Internet]. Vaccination numbers and statistics. 2023 Mar 31. Available from: https://www.health.gov.au/our-work/covid-19-vaccines/vaccination-numbers-and-statistics
25. Prescriptions peaked in July at ~35,000 per week, subsiding to ~6,000 per week in early October and increasing again to ~30,000 per week by the end of November as the fourth Omicron wave emerged.

3.2 Key Assumptions In The Australian Context

A range of informed assumptions is used to derive the estimates of economic costs in Australia as a result of COVID. Exhibit 1 illustrates how these assumptions are used and provides a list of key assumptions used, while a full list of assumptions is given in the Appendix section.

Exhibit 1: Use of assumptions in the Australian context

A | Epidemiological scenarios

Scenario	Infections (mn) p.a.	Inpt. admiss. (k)
Normal 2.0	~14	~45
Base	~20	~109
Pandemic 2.0	~26	~130

→

B | Direct costs: borne by the health system

Key Base Case Assumptions	
# Ward admissions p.a.	~104,000
# ICU admissions p.a.	~5,500
% Infections that visit a GP	3-12%
% Infections prescribed OAVs	3%
# Long COVID cases p.a.	~990,000

+

C | Indirect costs: economic productivity losses borne by society

Key Base Case Assumptions	
Working-age infections as proportion of total	67%
Proportion of working-age infections that can work	98.85%
Proportion of working-age infections that can work from home	61%
Average number of working days lost due to acute illness in working-age population	~6
Average daily salary	AUD 173

=

D | Total economic cost to society

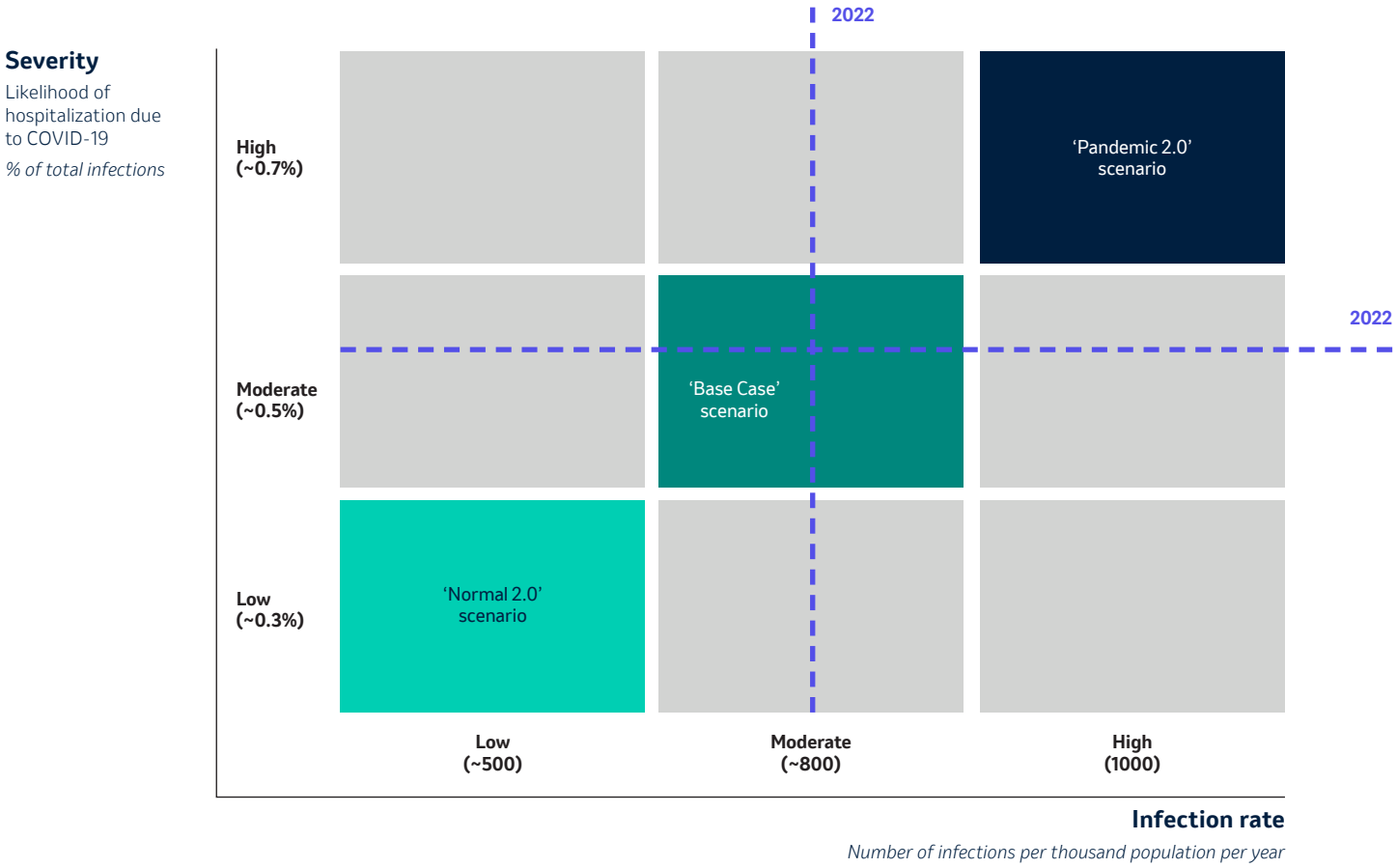
- **Total direct and indirect costs,** broken down by patient/demographic group
- **Costs per person** in each patient/ demographic group

  - E.g., if total admissions costs are $1bn, and 75,000 patients are admitted, the cost per person is ~ $13,000

A full list of assumptions is given in the appendix.

3.3 Future:
Scenario-Based Estimates Of The Economic Costs Of COVID-19 In Australia

Exhibit 2: Potential epidemiological scenarios



Scenarios are indicative only and based on the observed epidemiology of COVID-19 in Australia in 2022.

Scenarios help us to consider and envisage the potential courses that the COVID-19 pandemic may take in the future. One way to express scenarios is in the form of low (Normal 2.0), base case, and high (Pandemic 2.0) epidemiological trajectories.

As Exhibit 2 illustrates, in the Australian context this might mean:

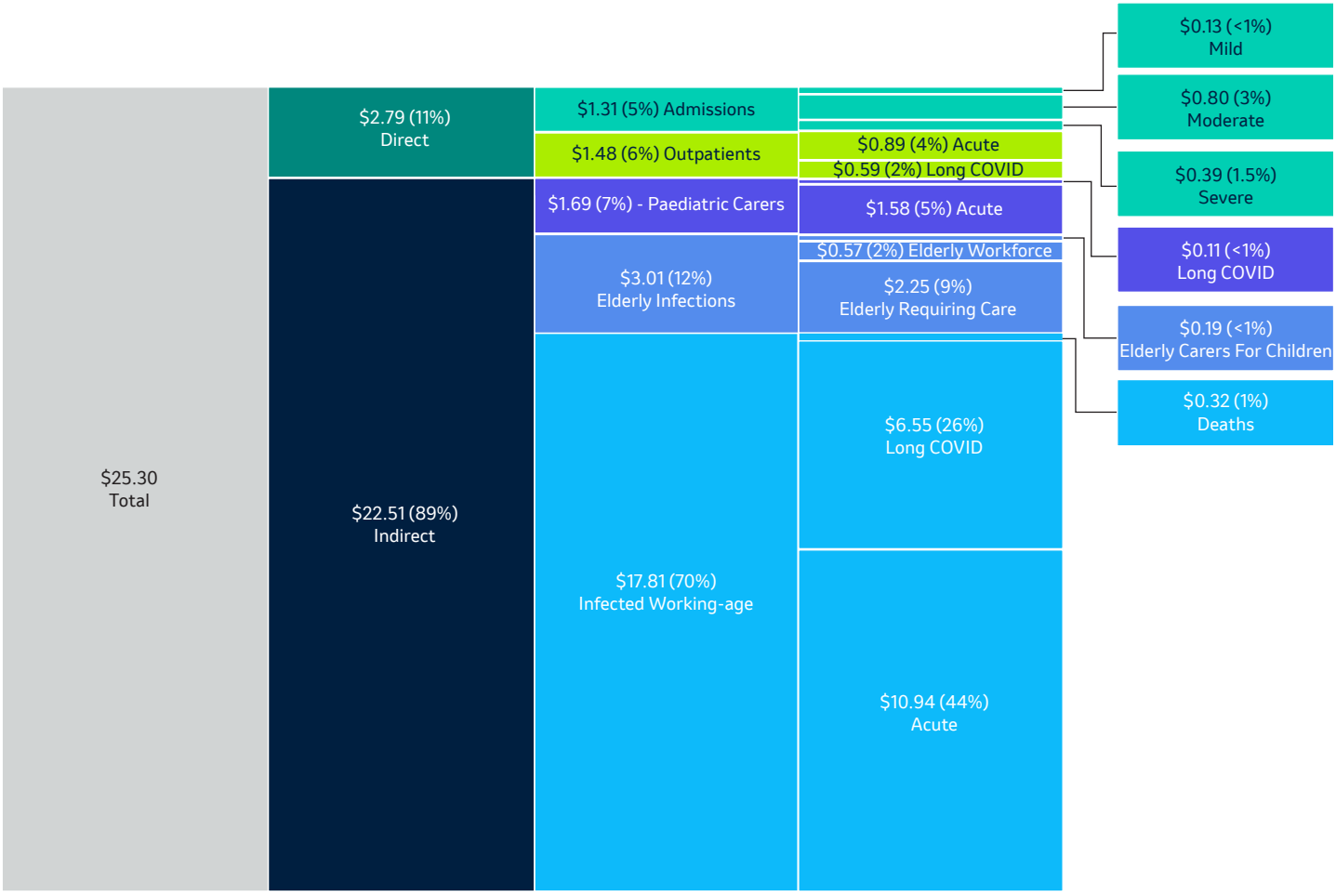
- A base case, with an economic cost of AUD ~25 billion p.a. (~1.0% of GDP and in addition to the value of lost health, such as that already considered in HTAs), which assumes a rate of infection (e.g., ~750,000 infections per million population annually) and a viral severity driving ~193,000 admissions annually,[26] similar to that seen over the course of 2022. This is the scenario shown in Exhibit 3 below and described in the direct (3.3.1) and indirect (3.3.2) costs sections below.

26. Includes ~109k inpatient admissions and ~84k admissions to COVID home care programs nationwide (such as 'virtual hospitals' in NSW and the COVID Positive Pathways program in Victoria). Inpatient admissions figures are sourced from the Institute of Health Metrics and Evaluation's (IHME; used with permission) mean estimate of annual inpatient admissions in Australia in 2022, and may differ from other sources.

- **A high or Pandemic 2.0 case, with an economic cost of AUD ~56 billion p.a. (~2.2% of GDP)** which assumes a higher rate of infection (e.g., 1 million infections per million population per year) and a higher viral severity driving ~285,000 hospitalizations annually, similar to what was seen during the first Omicron wave in early 2022.

- **A low or Normal 2.0 case, with an economic cost of AUD ~17 billion p.a. (~0.6% of GDP)** which assumes a lower rate of infection (e.g., ~500,000 infections per million population per year) and a viral severity driving ~47,000 hospitalizations, similar to what was seen in mid to late 2022.

Exhibit 3: Direct and indirect costs of COVID-19 to Australia's economy in a base case scenario, AUD billion p.a.

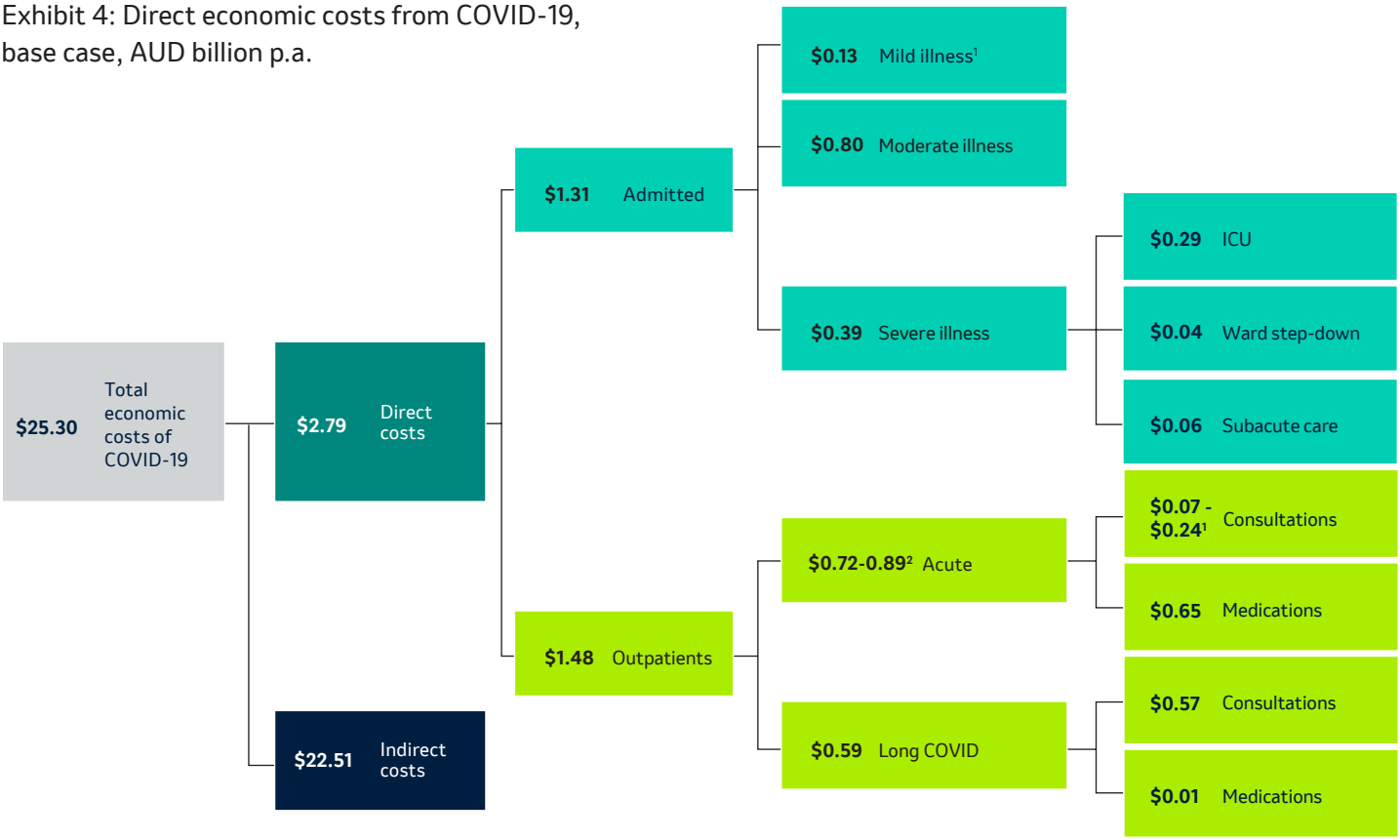


Costs are indicative only and based on the distribution of COVID-19 infections between cohorts in Australia in 2022.

As Exhibit 3 illustrates, the base case scenario is designed to reflect a continuation of recent conditions. To design a base case scenario, infection volumes and the prevailing hospitalization rate from 2022 have been drawn from the Institute of Health Metrics and Evaluation (IHME; used with permission) model of COVID-19.

3.3.1 Direct costs to the health system

Exhibit 4: Direct economic costs from COVID-19, base case, AUD billion p.a.



Note: Totals may not sum due to rounding
1. Patients with mild illness are admitted to COVID-19 home care programs, as distinct from hospital inpatient admissions. Patients with moderate illness are admitted to hospital as admissions.
2. A range is given for acute consultations to reflect the range of possible values for the number of GP consultations for COVID-19 assessment and treatment.

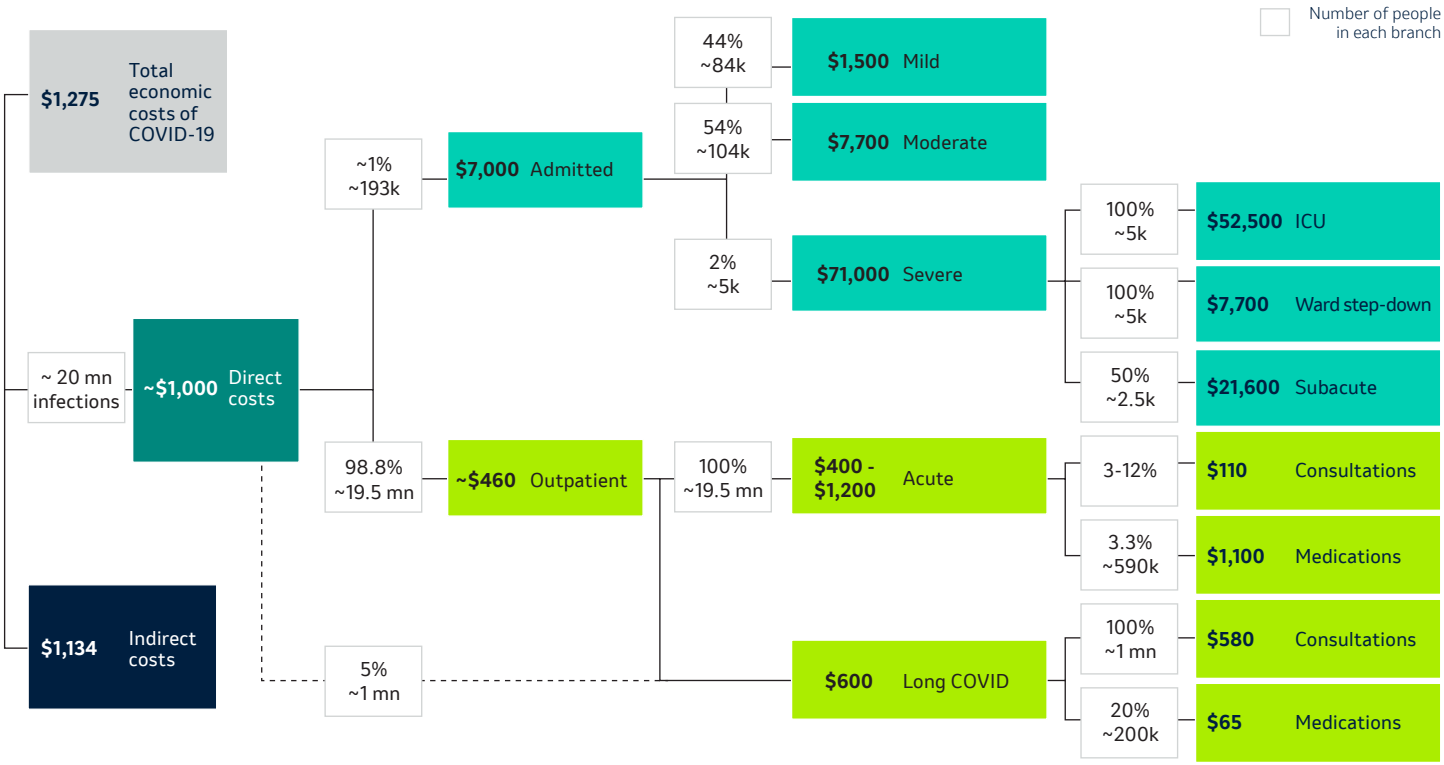
'Mild illness' requires home-based care, 'Moderate illness' requires ward-based admissions care, and 'Severe illness' requires ICU-level care; 'Acute illness' refers to all infections not included in admissions care; Long COVID refers to a small subset (~5%) of total infections and represents infections with symptoms lasting 12 weeks or more.

With ~109,000 inpatient admissions[27] (including ~5,500 to the ICU) and ~1 million cases of long COVID in the base case scenario, preventing hospital and ICU admissions, reducing lengths of stay, recovery time, and the incidence of long COVID are steps needed to reduce the direct costs imposed on the health system. Given that those over 65 are over-represented in the COVID-19 admissions population, preventing severe illness in this cohort would likely be particularly impactful in reducing direct costs.[28]

In this scenario, as displayed in Exhibit 5, COVID-19 could cost the Australian health system AUD ~2.8 billion p.a. This is a significant expense, equating to ~0.1% of Australia's GDP, and alone would constitute ~1.4% of total health expenditure in FY19-20.[29] Despite the magnitude of this figure, direct costs are still a minority of the overall economic impact of COVID-19 in Australia, accounting for ~10% of the total. The remaining ~90% are in the form of indirect costs and are discussed below in Section 3.3.2.

27. Inpatient admissions figures are sourced from the Institute of Health Metrics and Evaluation's (IHME; used with permission) mean estimate of annual inpatient admissions in Australia in 2022 and may differ from other sources.
28. Those over 65 represent ~14% of infections but ~40% of COVID-19 inpatient admissions. Australian Institute of Health and Welfare [Internet]. Admitted patient activity 2020-21. Available from: https://www.aihw.gov.au/reports-data/myhospitals/intersection/activity/apc
29. Australian Institute of Health and Welfare [Internet]. Health expenditure Australia 2019-20. 2021 Dec 17. Available from: https://www.aihw.gov.au/reports/health-welfare-expenditure/health-expenditure-australia-2019-20/contents/about

Exhibit 5: Direct economic costs from COVID-19, per person, base case, AUD p.a.



Costs per person for each segment are calculated by dividing the total cost of that segment by the number of individuals in that segment that utilize a health service; 'Mild illness' requires home-based care, 'Moderate illness' requires ward-based admissions care, and 'Severe illness' requires ICU-level care; 'Acute illness' refers to all infections not included in admissions care, where 3-12% visit a GP and 3% are prescribed medication; Long COVID refers to a small subset (~5%) of total infections and represents infections with symptoms lasting 12 weeks or more.

Despite their relatively lower significance in the wider scheme of COVID-19's economic impact, direct costs remain significant on a per-infection basis. As illustrated in Exhibit 5, each infection that uses some form of health service could impose an average cost of AUD ~1,000. This is concentrated in the costs of admissions care, where a single ward admission could cost AUD ~7,700 and a single ICU admission (with subsequent ward and rehabilitation stays) could cost AUD ~71,000.

As indicated in Exhibits 4 and 5 direct costs are incurred in two major settings:

- Admissions care (AUD ~1.3 billion p.a.; 45%; AUD ~7,000 per person)
- Outpatient (primarily GP-based) care (AUD ~1.5 billion p.a.; 55%; AUD ~460 per person)

The profile of costs of admissions suggests that ameliorating the severity of illness acquired could have a substantial impact on cost. Particularly in a reopened economy, where individuals at risk of severe disease are less protected from infection by community measures, the extent of ongoing costs to the health system underscores the importance of continuing to prevent, test for, and treat the disease.

Costs in this category comprise those arising from mild infections requiring home-based care (AUD ~0.13 billion p.a.; AUD ~1,500 per person), moderate infections requiring ward-based care (AUD ~0.8 billion p.a.; AUD ~7,700 per person), and severe infections requiring ICU admission (AUD ~0.39 billion p.a.; AUD ~71,000 per person). The more costly care for moderate infections is driven largely by length of stay in the ward (~11 days on average), while the cost of care for severe infections is driven mostly by very high bed day costs (AUD ~5,250 per day in ICU), followed by substantial periods of admissions rehabilitation.

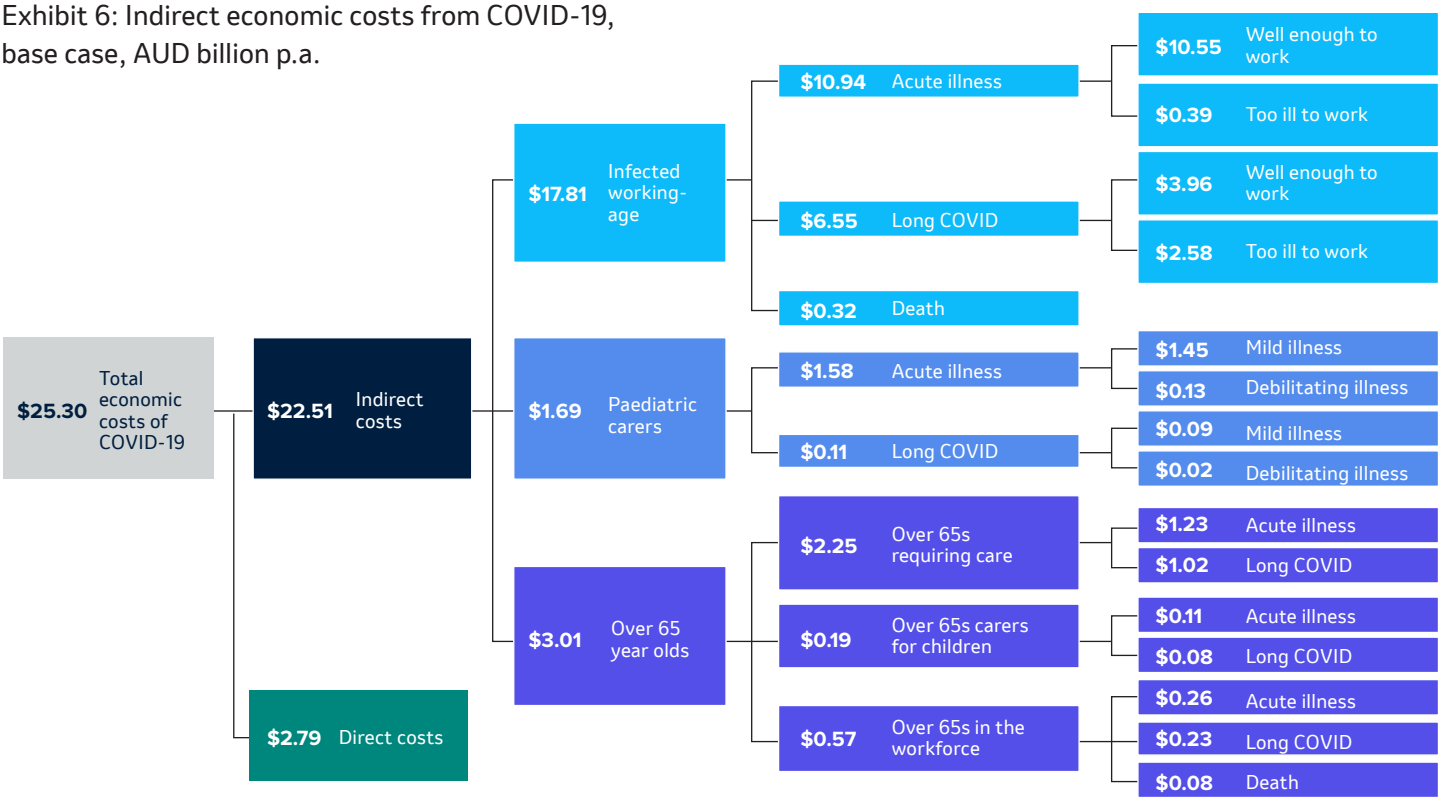
Limiting the incidence, duration, and severity of long COVID-19 would have a substantial impact on outpatient care costs. Outpatient care for COVID-19 infections adds AUD ~1.5 billion p.a. to the total economic costs incurred due to COVID-19. While seemingly less resource-intensive, outpatient infections that use health services are also expensive on a per-person basis, each costing AUD ~460.

Outpatient costs can be separated into acute outpatient care (consultations and medications; AUD ~0.9 billion p.a.) and chronic outpatient or long COVID care (consultations and medications; AUD ~0.6 billion p.a.; see also Section 3.4.6).

While the cost of acute outpatient care is driven largely by the cost of medications (such as oral antivirals, AUD ~650 million), this equates to just ~2.5% of all direct and indirect costs. Medications represent a small investment towards partially reducing substantial additional costs (AUD ~25.3 billion p.a.). Visits to GPs account for the remainder of outpatient costs, which could total more than 2 million consultations per year if ~10% of those infected seek the care of their regular doctor. While the cost of these services is low compared to admissions costs (AUD ~240 million p.a.), it is not insignificant, and the patient volume represents a substantial additional burden on the primary care system.

Together, direct costs from the admissions and outpatient cohorts amount to AUD ~2.8 billion p.a. or 0.1% of Australia's GDP. While significant on their own, these costs are in addition to indirect costs to Australia's economy (discussed below in Section 3.3.2), the value of lost health they represent, and the flow-on effects to the health system (such as its workforce) or other critical industries.

Exhibit 6: Indirect economic costs from COVID-19, base case, AUD billion p.a.



Note: Totals may not sum precisely due to rounding to 2 decimal places

Indirect costs arise from productivity losses incurred due to infection with COVID-19; 'Well enough to work' refers to those who can continue working while infected, albeit with reduced productivity; 'Too ill to work'' refers to those who cannot work, at least for a portion of the time, while infected; 'Acute illness' refers to all infections not included in admissions care; Long COVID refers to a small subset (~5%) of total infections and represents infections with symptoms lasting 12 weeks or more.

3.3.2 Indirect costs to the economy

Reducing the sheer volume of COVID-19 infections and the duration of illness and/or time to recovery for working-age adults, children, and the older population would have a significant impact on the economic and societal costs of COVID-19.

In the base case scenario, and as Exhibit 7 illustrates, COVID-19 could cost the Australian economy AUD ~23 billion p.a. in productivity losses if current epidemiological conditions and response settings continue.[30] This estimate accounts for the removal of mandatory quarantine requirements in Australia, and thus would likely be significantly larger were this requirement still in place. As with direct costs to the health system, this is a significant expense, equating to ~0.9% of GDP and ~11% of Australia's total expenditure on health in 2019-20.[31] While these costs are significant, as with direct costs, they still do not account for the value of health lost due to COVID-19, nor the ripple effects on critical industries and vulnerable populations such as the health workforce.

As illustrated in Exhibit 6, indirect costs result from productivity losses borne by three major groups:

- **Infections in working-age adults (19 to 64-year-olds) – AUD ~17.8 billion p.a.** (~79%; AUD ~1,340 per person)
- **Infections in the older population (>65-year-olds) – AUD ~3.0 billion p.a.** (~13%; AUD ~1,260 per person)
- **Infections in children and adolescents (18 years old and under) – AUD ~1.7 billion p.a.** (~8%; AUD ~390 per person)

Infections in working-age adults impose a significant economic burden on Australia, through productivity losses valued at AUD ~17.8 billion p.a., a significant figure that equates to ~0.7% of Australia's GDP. This burden highlights the impact that an illness that is mild for most but significant enough to last ~12 days – and impair productivity by ~35% for a quarter of them – can have on the broader economy.[32]

Productivity losses incurred by the working-age group can be considered in two ways:

- Acute illness (AUD ~10.9 billion p.a.), chronic illness or long COVID (AUD ~6.6 billion p.a.) and deaths (AUD ~0.3 billion p.a.), or
- Infected adults with mild illness who are still well enough to work but with reduced capacity (AUD ~14.5 billion p.a.), and infected adults who are too ill to work (i.e., are hospitalized) (AUD ~3.0 billion p.a.)

Taking these together, acute illness in those who can still work but at reduced capacity accounts for ~50% (AUD ~10.6 billion) of all productivity losses incurred across the age groups. These figures illustrate that, despite the mildness of the illness for most, when modest reductions in working capacity are multiplied across a multi-day illness affecting ~13 million Australians, the cost impact is substantial.

Infections in the older population impose AUD ~3 billion p.a. in costs from productivity losses on the Australian economy, which highlights that productivity losses are not limited to those borne by working-age adults.

Older people that incur productivity losses due to COVID-19 fall into three categories:

- **Older people with COVID-19 who require care from a working-age person** – ~2.3 million working-age carers each incurring an AUD ~994 productivity loss – resulting in a total impact of AUD ~2.2 billion p.a.
- **Older people who directly participate in Australia's labor force** – estimated to be 15% of over-65s, 50% of whom work full-time. Infections in this group result in AUD ~570 million in productivity losses.
- **Older people (e.g., grandparents) who care for children to enable parents to work** – one survey found that 64% of grandparents providing care for grandchildren did so to enable parents to work. When this work-enabling care is disrupted, the productivity loss amounts to AUD ~190 million.

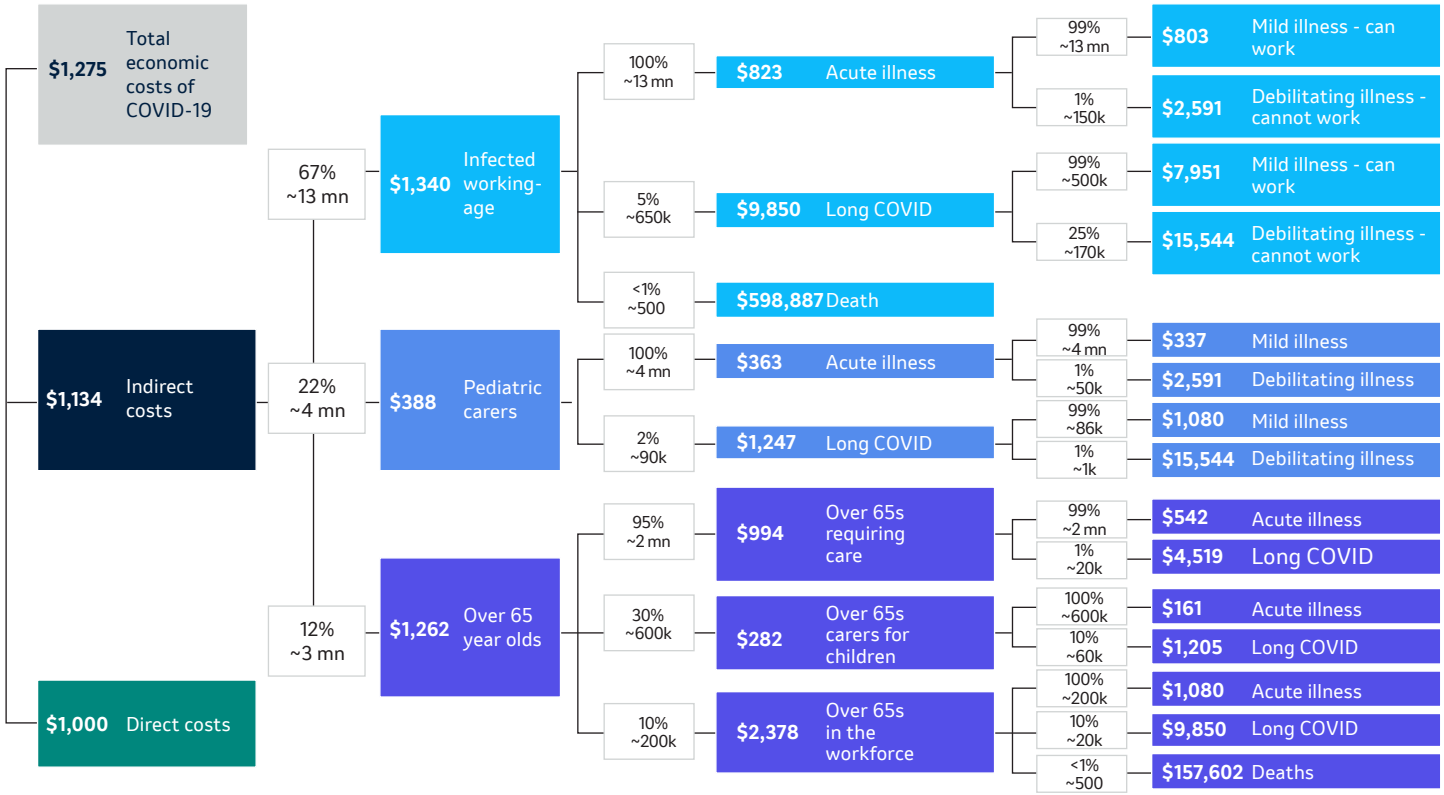
30. Based on a median weekly earnings figure of $1,209. Australian Bureau of Statistics [Internet]. Employee Earnings and Hours, Australia. 2022 Jan 19. Available from: https://www.abs.gov.au/statistics/labour/earnings-and-working-conditions/employee-earnings-and-hours-australia/latest-release#industry
31. Australian Institute of Health and Welfare [Internet]. Health Expenditure Australia 2019-20. 2021 Dec 17. Available from: https://www.aihw.gov.au/reports/health-welfare-expenditure/health-expenditure-australia-2019-20/contents/about
32. Johnsen S et al. European Respiratory Journal [Internet]. Descriptive analysis of long COVID sequelae identified in a multidisciplinary clinic serving hospitalised and non-hospitalised patients. 2021 Apr 20. Available: https://openres.ersjournals.com/content/erjor/7/3/00205-2021.full.pdf

Infections in the older population account for AUD ~3.2 billion p.a., or ~13% of all direct and indirect costs combined, serving as a stark reminder of the need to address costly infections in cohorts adjacent to working-age adults.

Finally, infections in children impose an additional economic cost of AUD ~1.7 billion p.a. owing to productivity losses borne by adults who are absent from or less productive at work while caring for children. As with those from the older population, productivity losses arising from infections in children can be difficult to recognize in advance but are significant when they emerge.

Productivity losses arising from infections in children are predominantly driven by adults caring for children with acute, mild illness. The cohort of infected children, which constitutes the majority (~92%) of productivity losses in adults caring for children with acute illness, is worth AUD ~1.5 billion p.a. This cost is driven by care for ~2.1 million mild infections in children, who despite having a mild illness require one parent to care for them at home. The remaining ~8% is driven by productivity losses from caring for children with debilitating infections. For parents who can work from home (~60%), productivity is estimated to halve, while all productivity is foregone from parents who cannot (~40%). This is a substantial cost driven more by lost work than the illness itself, reiterating that substantial costs imposed by productivity losses are not limited to infections in working-age adults.

Exhibit 7: Indirect economic costs from COVID-19, per person, base case, AUD p.a.



Costs per person for each segment are calculated by dividing the total cost of that segment by the number of individuals in that segment; Indirect costs arise from productivity losses incurred due to infection with COVID-19; 'Well enough to work' refers to those who can continue working while infected, albeit with reduced productivity; 'Too ill to work' refers to those who cannot work, at least for a portion of the time, while infected; 'Acute illness' refers to all infections not included in admissions care; Long COVID refers to a small subset (~5%) of total infections and represents infections with symptoms lasting 12 weeks or more.

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Despite the seeming reduction in resource intensiveness compared to direct healthcare costs, the magnitude of productivity losses imposed by COVID-19 means indirect costs are nearly as expensive on a per-person basis (as indicated in Exhibit 7 above), with each infection costing AUD ~1,130 on average. This is concentrated in productivity losses resulting from infections in the working-age (AUD ~1,340 per person) and the older population (AUD ~1,260 per person).

Together, economic costs arising from productivity losses in these cohorts amount to AUD ~23 billion p.a. or ~0.9% of Australia's GDP and are in addition to the value of lost health and direct costs to Australia's health system. Although already substantial, these costs are likely to underestimate the entirety of the burden imposed on society by COVID-19. These costs do not account for second-order impacts on health system capacity and flow-on effects on the health workforce, supply chains, as well as other aspects of critical industry, which all add to directly measurable economic impacts.

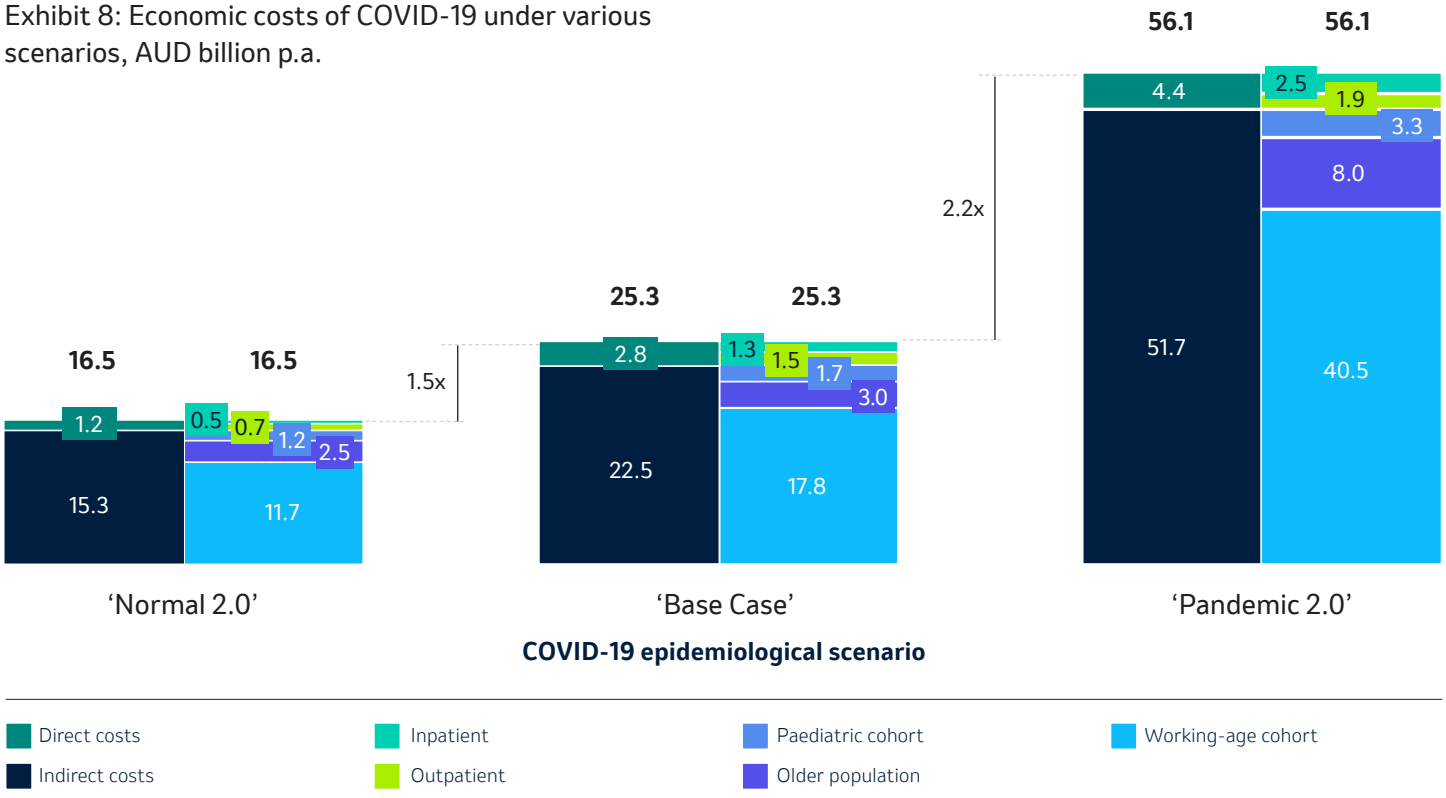
The entirety of the economic burden imposed by COVID-19 also needs to be understood in the context of the prevailing epidemiological scenario, as the impacts and costs described can significantly increase under plausible scenarios where novel variants emerge. Such scenario variations are described below.

3.3.3 Alternative scenarios: costs of Pandemic 2.0 and Normal 2.0

In addition to the base case, two further scenarios have been considered, as illustrated in Exhibit 8:

In a Pandemic 2.0 scenario, total economic costs could reach AUD ~56 billion p.a. Conversely, in the Normal 2.0 scenario, economic costs could decrease to AUD ~17 billion p.a.

Exhibit 8: Economic costs of COVID-19 under various scenarios, AUD billion p.a.



Normal 2.0 refers to a scenario featuring ~500,000 infections per million population and ~47,000 hospitalizations, reflecting conditions observed in mid-late 2022; Pandemic 2.0 refers to a scenario featuring ~1 million infections per million population and ~285,000 hospitalizations, reflecting conditions observed in early 2022.

The two example scenarios represent divergent epidemiological outcomes that are both plausible as the pandemic evolves. Each theoretical scenario is designed with attention to two key features:

- Infection volume (driven by contagiousness; measured by cases per million population per year), and
- Case severity (driven by a prevailing strain's virulence factors; measured by the resulting hospitalization rate)

A Pandemic 2.0 scenario would feature a case volume of ~1 million cases per million population per year (i.e., the entire population is infected once, on average) and a case severity that drives ~130,000 inpatient admissions. This compares to the base case scenario of a case volume of ~750,000 infections per million population and ~109,000 inpatient admissions. These thresholds represent epidemiological conditions very similar to those observed in Australia in late 2022.

In this scenario, economic impacts from COVID-19 could increase to AUD ~56 billion p.a., equating to ~2.2% of GDP and AUD ~2,175 per person. In this scenario, direct costs could be AUD ~4.4 billion p.a. (a 1.6 times increase of AUD ~1.6 billion p.a.) and indirect costs could reach AUD ~52 billion p.a. (a 2.3 times increase of AUD ~29 billion p.a.). These increases would be driven by increased hospitalization rates, longer lengths of stay, and augmented productivity losses from an increased incidence of debilitating illness and longer periods of missed work.

The magnitude of the cost increases that could result from a plausible epidemiological Pandemic 2.0 scenario demonstrates the need for a range of preparedness settings that include options to limit impacts at all junctures.

In addition to economic impacts, a high-demand scenario such as this can also impose 'second order' impacts on health system capacity such as disruptions to elective surgery services and the displacement of care that these disruptions entail. For example, ~200,000 fewer elective surgeries were performed by the public health system across 2019-22, cumulatively, versus a pre-pandemic baseline (2018-19).[33] The largest cumulative volume of displaced care was in general surgery, followed by orthopedics, ophthalmology, and ENT, but there were cumulative deficits in every specialty. Moreover, the annual rate of care displacement appears to be deteriorating rather than improving, with the greatest number of displacements occurring in 2022.

Separate data from the Medicare Benefits Schedule (MBS) demonstrates that these foregone procedures were not picked up by the private system, suggesting that care was genuinely displaced. The volume of (~12.8 million p.a.) and benefits paid (AUD ~2.1 billion p.a.) for surgical procedures in the private system remained flat across 2020 through to Q2, 2022, compared to pre-pandemic levels in 2019. Therefore, this trend represents a reduction against forecast volumes (especially given their pre-COVID growth trajectory), in contrast to an expected small increase if public elective surgery volumes were conducted in the private system.

Over the three-year course of the pandemic to date, a cumulative ~42,000 fewer elective orthopedic procedures took place compared to the 2018-19 baseline, primarily due to the impact of COVID-related disruptions. This suggests that ~4,600 waitlisted total hip replacements and ~6,200 total knee replacements were not performed.[34] With most of these cases due to osteoarthritis, displaced orthopedic care indicates a significant burden of morbidity and disability has been imposed on these patients due to COVID-19 disruptions, as well as an ongoing burden on the health system in managing patients with advanced, complex diseases.[35]

33. Australian Institute of Health and Welfare [Internet]. Elective surgery waiting times 2021-2022. Available from: https://www.aihw.gov.au/getmedia/6348652f-959a-447a-93a5-c8081c085106/Elective-surgery-waiting-times-2021-22.xlsx.aspx
34. THRs accounted for 11% of FY22 case volume and TKRs 15%. Australian Institute of Health and Welfare [Internet]. Elective surgery waiting times 2021-22. Available from: https://www.aihw.gov.au/getmedia/6348652f-959a-447a-93a5-c8081c085106/Elective-surgery-waiting-times-2021-22.xlsx.aspx
35. Johns Hopkins Medicine [Internet]. Osteoarthritis 2022. Available from: https://www.hopkinsmedicine.org/health/conditions-and-diseases/arthritis/osteoarthritis

Conversely, while a relatively small number of procedures in children were not performed (~680), these still carry a significant impact. Common elective procedures in children, such as tonsillectomies and hernia repairs, can lead to sleep, learning, and behavioral difficulties as well as potential pain and intestinal damage if left untreated.[36] Care displacement of this nature serves as one example of the far-reaching impact the ongoing COVID-19 pandemic could have on both patients and the health system in a high-demand scenario.

A Normal 2.0 scenario would feature a case volume of ~500,000 cases per million population per year and ~45,000 inpatient admissions. These thresholds represent the lowest recorded levels for each measure observed in Australia during the pandemic. Under a Normal 2.0 scenario, economic impacts from COVID-19 could reduce to AUD ~16.5 billion p.a., equating to ~0.6% of GDP and AUD ~1,185 per person. Direct costs could decrease to AUD ~1.2 billion p.a. and indirect costs to AUD ~15.3 billion p.a. Decreases in costs would be driven by lower hospitalization rates and diminished productivity losses owing to reduced periods of missed work.

While scenarios help us to consider potential courses that the COVID-19 pandemic may take in the future, their scope is largely restricted to quantifiable economic cost considerations. Equally important to consider are the second-order impacts that COVID-19 could have on health system capacity and ripple effects on vulnerable populations and critical industries.

36. Connecticut Children's Hospital [Internet]. Growing Healthy—Topics you care about 2023. Available from: www.connecticutchildrens.org/healthlibrary/en/parents/tonsil/ and www.connecticutchildrens.org/health-library/en/parents/inguinal-hernias/

3.4 Considerations For Particular Cohorts And Industries

The economic costs of COVID-19 described will impact different populations and industries disproportionately. This includes those that play a critical economic or social role (e.g., health care workers), those that are particularly vulnerable to severe disease (e.g., people with comorbidities), and those that go on to develop long COVID.

Interventions that protect health and productivity losses in these critical industries and populations may yield corresponding disproportionate economic returns. Disruptions to these groups also cause significant economic and societal concern and may be worthy of additional focus when considering countermeasure approaches to mitigate the impacts of COVID-19.

3.4.1 Critical workers and industries

As outlined above, some critical industries experience disproportionate workforce productivity losses that generate significant public concern. Here, the focus is on three industries in particular – healthcare, logistics, and travel and tourism.

The economic costs of COVID-19 borne by critical industries and their stakeholders may increase under a Pandemic 2.0 scenario. In this scenario, these workforces, which are largely unable to work from home, may be required to isolate while they recover. The resulting loss of productive time can be 30% greater (the equivalent of one to two workdays) than individuals in desk-based jobs.

3.4.2 Healthcare

Australia's health system serves as the country's first and last line of defense against COVID-19 and other health threats. The AUD ~202.5 billion industry employs ~650,000 healthcare practitioners.[37,38]

At a potential minimum cost of AUD ~2.3 billion p.a. (~9% of the combined total cost),[39] healthcare workers who become infected with COVID-19 represent a disproportionate contributor to the impacts on the economy. However, this also likely significantly underestimates the total impact on the Australian economy and citizens' welfare, due to flow-on effects on patient outcomes.

Health services experience higher rates of absenteeism due to COVID-19 compared to other industries. Employers reported a 25% to 47% rate of COVID-19 sick leave in 2022, with some hospitals experiencing rostering gaps of up to ~40%.[40,41] Healthcare workers' increased exposure to, and risk of, COVID-19 infection in the workplace is estimated at three times greater than the general population.[42] Productivity losses are not only incurred by sick workers but also by the remaining workers who are required to take up additional responsibilities. The extra workload reduces time to complete additional tasks other than patient care.

The flow-on economic impact of COVID-19-related absenteeism among healthcare workers is significant. COVID-19 exacerbates (pre-existing) workforce shortages, resulting in poorer quality and safety of healthcare provision. Even recently, shortages have contributed to emergency department wait-times of up to 12 hours and record delays in 'lights and sirens' (Code 1) ambulance responses.[43,44] Such reductions in the availability and timeliness of medical care may subsequently lead to prolonged illness or recovery times for patients, who in turn accumulate their own, additional productivity losses.

Additionally, the COVID-19 pandemic has witnessed unprecedented levels of workforce burnout and attrition.[45] Although the initial impact of the pandemic has subsided, global talent shortages and mobility limitations are ongoing challenges.

A countermeasure approach that targets healthcare workers is essential in mitigating overall economic costs as well as COVID-19 impacts on public health. This urgency is backed by the disproportionate costs of COVID-19 infections among healthcare workers against the backdrop of an increasingly constrained talent market.

3.4.3 Logistics

COVID-19 has caused unprecedented disruption to Australia's transport and logistics sector, which delivers vital goods and services across the nation. It is an AUD ~120 billion industry, with a growing workforce of over 550,000 people.[46] During the pandemic, the sector experienced a disproportionate impact of productivity loss from workers, which has snowballed to disrupt local and global supply networks.

Australia's transport operators and distribution centers have experienced significant workforce shortages due to COVID-19 illness. Among this workforce are warehouse staff, forklift drivers, unpack

37. Australian Institute of Health and Welfare [Internet]. Health Expenditure Australia 2019-20. 2021 Dec 17. Available from: https://www.aihw.gov.au/reports/health-welfare-expenditure/health-expenditure-australia-2019-20/contents/about
38. Australian Institute of Health and Welfare [Internet]. Health workforce. 2022 Jul 7. Available from: https://www.aihw.gov.au/reports/workforce/health-workforce
39. Based on a median weekly earnings figure of $1,287. Australian Bureau of Statistics [Internet]. Employee Earnings and Hours, Australia. 2022 Jan 19. Available from: https://www.abs.gov.au/statistics/labour/earnings-and-working-conditions/employee-earnings-and-hours-australia/latest-release#industry
40. Australian Bureau of Statistics [Internet]. Staff absent in 22% of businesses due to COVID-19. 2022 Feb 11. Available from: https://www.abs.gov.au/media-centre/media-releases/staff-absent-22-businesses-due-covid-19
41. Thompson, H. WA Today [Internet]. $40K for 10 days' work: Doctors offered huge pay to fill in at Geraldton Hospital. 2022 Jan 19. Available from: https://www.watoday.com.au/national/western-australia/40k-for-10-days-work-doctors-offered-huge-pay-to-fill-in-at-geraldton-hospital-20220118-p59p4s.html
42. Quigley, A.L. et al. Elsevier Public Health Emergency Collection [Internet]. Estimating the burden of COVID-19 on Australian healthcare workers and health system during the first six months of the pandemic. 2020 Oct 29. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7598370/. Productivity losses are not only incurred by sick workers, but also by those who remain. Remaining colleagues are required to take up additional responsibilities and have less time to complete additional tasks besides patient care.
43. McMillan A, Schelle C. The Age [Internet]. Ambulance Victoria code red called after 'lights and sirens' delay. 2022 Dec 3. Available from: https://www.theage.com.au/national/victoria/ambulance-victoria-code-red-called-after-lights-and-sirens-delay-20221203-p5c3c9.html
44. Dow A, Sambul N. The Age [Internet]. 'Incredibly challenging': All hands on deck as children's hospital faces 12-hour emergency queue. 2022 Dec 6. Available from: https://www.theage.com.au/national/victoria/royal-children-s-hospital-advises-patients-to-go-elsewhere-20221205-p5c3v7.html
45. Willis K, Maple J, Bismark M, Smallwood N. The Conversation [Internet]. A burnt-out health workforce impacts patient care. 2022 May 5. Available from: https://theconversation.com/a-burnt-out-health-workforce-impacts-patient-care-180021#:~:text=This%20review%20cites%20studies%20finding,increased%20mortality%20in%20one%20study
46. Australian Industry Standards [Internet]. Transport and Logistics Industry Outlook 2021. Available from: https://www.australianindustrystandards.org.au/industries/transport-and-logistics/

crews, and technicians, who are unable to fulfill work obligations at home while ill, isolating, or caring for others who have been infected with COVID-19. While absenteeism across all industries has reached peaks of ~10%,[47] reductions in the logistics sector have increased from 20% to half of the available labor.[48,49] Subsequently, these businesses struggle to retain other employees who are required to work longer hours to compensate for the lost labor.

Workforce shortages also have downstream consequences for end-point retailers, users, and customers. In June 2022, over 40% of businesses faced COVID-related supply chain disruptions, and almost half of those to a 'great' extent (e.g., major delays and impacts to revenue). Disruptions have the dual effect of driving inflation in the costs of goods and services and impeding the ability of businesses, and their workers, to deliver them. Among these goods are necessities of particular public importance such as food, life-altering medicines, oil, and gas.

The impact of workforce shortages may point to an incremental opportunity for targeted COVID-19 countermeasures to support Australia's logistics industry, as it grapples with the multitude of challenges (including geopolitical tensions) at the heart of today's supply chain crisis.

3.4.4 Travel and tourism

Despite a strong economic recovery, Australia's travel and tourism sector continues to face headwinds due to workforce shortages. One of the highest-yielding destinations in the world prior to the COVID-19 pandemic, the sector contributed ~2.5% to the national economy and supported ~5% of the national workforce.[50] The pandemic led to a steep decline in tourism revenue due to border closures, lockdowns, and hesitancy to travel.

COVID-19-related absenteeism has wreaked havoc across industries, from airports to accommodation services. Some employers saw staff shortages rise to 25% overnight.[51] In July 2022, Qantas and Virgin Airlines recorded their worst on-time performances,[52] with flight disruptions impeding corporate travelers' productivity and holidaymakers' spending.

Countermeasures targeted at Australia's travel and tourism workforce are needed to help these industries recover from the COVID-19 pandemic.

3.4.5 Vulnerable populations

COVID-19 illness in Australia's vulnerable populations represents a minimum impact of AUD ~12.4 billion p.a. to Australia's economy. These populations are at greater risk of severe COVID-19 disease and are more heavily reliant on the healthcare system than others. Populations that have received particular attention throughout the pandemic include those over 65 years old, those with comorbidities, and indigenous Australians.

COVID-19 illness in Australia's older population (65 years and over) could have an economic impact of AUD ~3.2 billion p.a. (~13% of the combined annual impact), a significant AUD ~1,430 per person. Despite representing just ~12% of confirmed cases, the older population represents over 40% of COVID-19 hospitalizations.[53] This figure is not surprising when considering the high prevalence of comorbidities such as high blood pressure, cancer, and diabetes in this age group, which affect ~65% of those over 70 years old.[54]

47. Whelan S. The Load Star [Internet]. Staff shortages from COVID heighten chronic Australian supply chain delays. 2022 Jan 31. Available from: https://theloadstar.com/staff-shortages-from-covid-heighten-chronic-australian-supply-chain-delays/
48. Whelan S. The Load Star [Internet]. Omicron outbreak in Australia wreaking havoc with supply chains. 2022 Jan 7. Available from: https://theloadstar.com/omicron-outbreak-in-australia-wreaking-havoc-with-supply-chains/
49. Butler B. The Guardian; [Internet]. Australia's supply chain issues likely to continue despite drop in Covid cases. 2022 Feb 13. Available from: https://www.theguardian.com/australia-news/2022/feb/13/australias-supply-chain-issues-likely-to-continue-despite-drop-in-covid-cases
50. Tourism Research Australia [Internet]. National Tourism Satellite Account 2020-21. Available from: https://www.tra.gov.au/data-and-research/reports/national-tourism-satellite-account-2020-21
51. Wiggins J. Australian Financial Review [Internet]. Airports say jobs shortages 'could persist'. 2022 Jun 23. Available from: https://www.afr.com/companies/infrastructure/airports-say-jobs-shortages-could-persist-20220623-p5aw0f
52. Magennis M. 7 News [Internet]. Major airlines on track to record worst ever performances amid staff shortage crisis. 2022 Jul 12. Available from: https://7news.com.au/sunrise/major-airlines-on-track-to-record-worst-ever-performances-amid-staff-shortage-crisis--c-7490084
53. Admitted patient activity. Australian Institute of Health and Welfare [Internet]. Available from: https://www.aihw.gov.au/reports-data/myhospitals/intersection/activity/apc
54. Roy Morgan [Internet]. 1.8 million Australians aged 70+ have a 'comorbidity' condition that puts them at higher risk from COVID-19. 2020 Apr 28. Available from: https://www.roymorgan.com/findings/1-8-million-australians-aged-70-have-a-comorbidity-condition-that-puts-them-at-higher-risk-from-covid-19

Comorbidities in the younger, working-age (19–64-year-old) population could also have a disproportionate impact of AUD ~9.0 billion p.a. Just one comorbidity doubles the risk of severe COVID-19,[55] subsequently increasing the likelihood of hospitalization and prolonging time off work to recover. This could be a reality for at least 47% of 45–64-year-olds in Australia.[56]

COVID-19 continues to exacerbate the health gap between indigenous and non-indigenous Australians. The indigenous community has high rates of chronic illness and faces inequalities in access to health services which heightens their susceptibility to severe COVID-19.[57] In addition, the pandemic has amplified disparities in the social determinants of health, which account for one-third of the health gap. These include employment, hours worked, the completion of schooling, and household incomes – all of which decline when individuals become ill or need to care for loved ones.[57]

Given that almost 50% of combined direct and indirect costs are borne by these vulnerable populations, countermeasures that reduce the duration of illness and/or time to recover for this group alone could significantly mitigate the costly impacts of COVID-19. Countermeasures may include ongoing vaccination, community interventions, or the use of oral antivirals. Although oral antivirals are only available to a smaller subset of vulnerable populations, this subset already accounts for AUD ~3.1 billion p.a. in economic costs or ~12% of the total economic costs to Australia.

3.4.6 Long COVID

Long COVID[58] has a potential minimum impact of AUD ~8.6 billion p.a. on Australia's economy. Individuals who develop this condition experience prolonged productivity losses (increasing indirect costs) and reliance on health services (increasing direct costs).

Direct costs due to long COVID collectively amount to at least AUD ~590 million (AUD ~593 per person), largely driven by consultations. When the incidence, relative complexity, and duration (90 days) of long COVID illness are factored in, ~6 million healthcare consultations are required for this cohort alone.[59,60] Long COVID, therefore, represents a substantial burden on the health system, both in terms of required capacity and economic costs.

Productivity losses from long COVID could amount to AUD ~8.0 billion p.a. (AUD ~8,058 per person and ~35% of all indirect costs). The largest contributor, by a significant margin, is productivity losses arising from long COVID in the working-age population (AUD ~6.5 billion p.a. or ~82%). To illustrate this further, an adult with long COVID, despite being well enough to work, could still lose the equivalent of 46 workdays over a three-month period of illness, due to impairments to productivity.[61]

Given the large share (~32%) of total economic costs that long COVID imposes on the Australian economy, any countermeasure that is able to reduce the incidence and/or duration of this condition would contribute a great deal to mitigating economic costs associated with the pandemic. Conservative estimates place the incidence and duration of long COVID at 5% and 90 days respectively.[62] However, as an emerging field, the full scope of long COVID might still be underestimated.[63]

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55. Liu B, Spokes P, He W, Kaldor J. High risk groups for severe COVID-19 in a whole of population cohort in Australia. BMC Infectious Diseases [Internet]. 2021 Jul 16. Available from: https://bmcinfectdis.biomedcentral.com/articles/10.1186/s12879-021-06378-z
56. Australian Institute of Health and Welfare [Internet]. Chronic conditions and multimorbidity. 2022 June 7. https://www.aihw.gov.au/getmedia/605046ad-f18b-4773-badc-a9256b6f7c7c/aihwphe-291-Infocus.pdf.aspx?inline=true
57. Australian Institute of Health and Welfare [Internet]. Determinants of health for Indigenous Australians. 2022 Jul 7. Available from: www.aihw.gov.au/reports/australias-health/social-determinants-andindigenous-health
58. Also commonly described as 'post-COVID-19 syndrome', long COVID describes the prolonged duration of COVID-19 symptoms beyond twelve weeks after the initial infection.
59. Inquiry into Long COVID and Repeated COVID Infections. Parliament of Australia [Internet]. Available from: https://www.aph.gov.au/longandrepeatedcovid
60. Each case could require 6 consultations on average over the 90-day period of long COVID illness.
61. Based on an average of 9 days of sick leave and reported reductions in productivity while working, due to long COVID
62. Australian Institute of Health and Welfare [Internet]. Available from: Long COVID in Australia – a review of the literature December 16 2022. https://www.aihw.gov.au/reports/covid-19/long-covid-in-australia-a-review-of-the-literature/summary
63. Australian Institute of Health and Welfare [Internet]. Long COVID in Australia – a review of the literature. 2022 Dec 16. Available from: https://www.aihw.gov.au/reports/covid-19/long-covid-in-australia-a-review-of-the-literature/summary

4. Shaping The Future: Our Toolkit For Averting The Neglected Economic Burden of COVID-19

4.1 The Countermeasures Toolkit

In the face of the significant economic costs of COVID-19, there exists access to a wide range of countermeasures to address this burden. As illustrated in Exhibit 9, countermeasures include community measures such as social distancing as well as the utilization of vaccines and therapeutics, including oral antivirals.

However, despite significant ongoing economic costs, uptake of these countermeasures has been incomplete. Examples of incomplete uptake include waning uptake of booster vaccination doses, and variable awareness and availability of oral antivirals. There is an opportunity for policymakers to consider the optimal utilization of the full set of countermeasures available to mitigate the continued economic and societal impact of COVID-19.

When used widely, such countermeasures have been very effective at containment and suppression of the COVID-19 virus, while managing to limit economic costs. For Australia, the countermeasures employed during the first phase of the pandemic (2020 to 2021) were generally very successful. The number of reported cases and deaths in Australia were among the lowest in the developed world.[64] However, border closures, social-distancing requirements, strict contact tracing, and mask-wearing mandates still imposed significant hardships on affected communities. The successful rollout of vaccines afforded an easing of many restrictions in 2022, although the immunity conferred was found to wane over time.[65] The resulting reduced population immunity has been a challenge amid the emergence of novel variants, including Omicron.

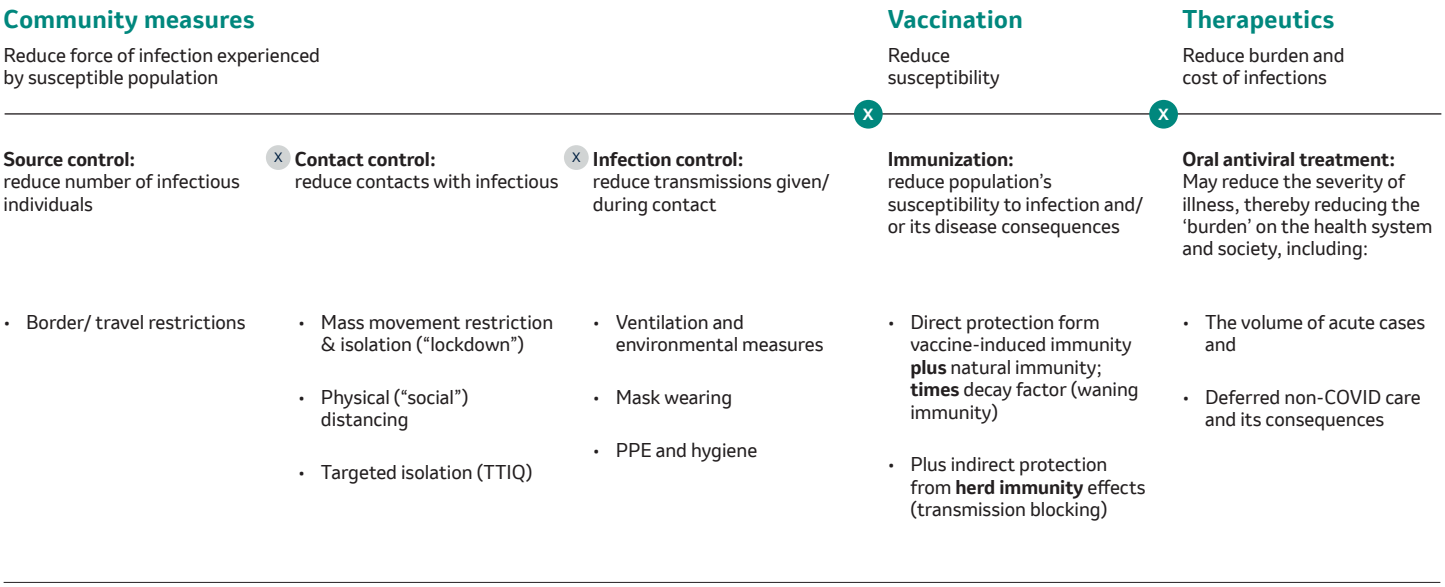
64. Our World in Data [Internet]. Cumulative confirmed COVID-19 cases. Available from: https://ourworldindata.org/explorers/coronavirus-data-explorer?time=earliest.2021-12-30&facet=none&Interval=Cumulative&Relative+to+Population=false&Color+by+test+positivity=false&country=~AUS&Metric=Confirmed+cases

65. Department of Health and Aged Care [Internet]. Our work COVID-19 vaccine information. Available from: https://www.health.gov.au/our-work/covid-19-vaccines/advice-for-providers/clinical-guidance/product-information#vaccine-effectiveness-over-time

Oral antivirals have been added to response toolkits. The necessarily short-term nature of restrictive community measures and the remaining health threat of COVID-19 led Australian authorities to broaden their approach to include oral antivirals.

The three categories of countermeasures and their differing potential to mitigate the economic costs of COVID-19 are summarized in Exhibit 9 below.

Exhibit 9: The countermeasure toolkit



4.1.1 Community measures – reducing the force of infection

Community measures were central to managing the impact of COVID-19 globally, particularly during the initial phases of the pandemic before the development and roll-out of vaccines and therapeutics. Community measures reduce the 'force' of infection through three potential levers:

- **Source control** to reduce the number of infectious individuals, such as travel/border restrictions.
- **Contact control** to reduce contact between healthy and infectious individuals, including 'lockdowns', 'social' distancing, and targeted isolation (TTIQ).
- **Infection control** to reduce infection transmission during contact, including mask-wearing and ventilation measures.

While protecting population health, there are significant challenges and economic frictions associated with community measures. Community measures typically depend on a high degree of collaboration from a market's population, as many perceive social 'freedoms' as being forgone for mask-wearing, lockdowns, and other mandates. As such, monitoring and encouraging adherence to community measures can be resource intensive for authorities. However, they pose broader economic frictions too. For example, the high cost of productivity loss when businesses are forced to close due to revenue losses (especially food and accommodation services) or reduced labor headcounts.

2022 saw a shift away from community measures in the management of COVID-19. This was driven by an epidemiological course of COVID-19 that was considered to be less severe, widespread vaccine uptake, and increasing access to antivirals in the market.[66]

4.1.2 Vaccines – reducing population susceptibility

COVID-19 vaccines have had a significant benefit to economies, in addition to health outcomes for individuals. Australia has achieved high rates of vaccination relative to international peers, with 96% of the population having received two doses.[67,68] By reducing the population's susceptibility (both directly for the recipient of the vaccine and indirectly by reducing the risk of onward transmission),[69] vaccines have the potential to reduce the volume and severity of infections. This lessens the overall costs borne by the health system and costs that arise from productivity losses due to COVID-19 illness. In Australia, COVID-19 vaccines have curbed the economic costs of COVID-19 by AUD ~181 billion.[70]

COVID-19 vaccines highlighted the benefits of rapid and widespread access to medical innovations once they were authorized or approved. The adaptability of health technology assessment (HTA) processes to meet an urgent public need was particularly celebrated. In light of this, stakeholders in the policy and scientific communities are calling for reforms that place greater emphasis on broader social and economic benefits in the assessment of and investment in vaccines and medicines.[71]

The evolution and roll-out of COVID-19 vaccines may be an ongoing investment to combat new variants and sub-variants of COVID-19 capable of evading conferred immunity.

4.1.3 Therapeutics – reducing the burden

Therapeutics have the potential to further curb the economic impact of COVID-19, in both markets with largely vaccinated populations and those with lower vaccination rates. Therapeutics such as antivirals are so far typically limited to high-risk categories. These include older populations and adults with comorbidities/chronic illnesses. For these populations, therapeutics may reduce the chances of being hospitalized or dying from disease, and subsequently the costs due to productivity losses and burden on health systems.[72]

66. Australian Institute of Health and Welfare [internet]. Australia's health 2022, data insights. The impact of a new disease: COVID-19 from 2020, 2021 and into 2022, Chapter One. Available from: https://www.aihw.gov.au/getmedia/c017fa79-be4b-4ad5-bbf3-2878ed0995e5/aihwaus-240_Chapter_1.pdf.aspx
67. Holder J. New York Times [Internet]. COVID Vaccinations tracker. 2023 Mar 13. Available from: https://www.nytimes.com/interactive/2021/world/covid-vaccinations-tracker.html
68. Commonwealth Department of Health [Internet]. Vaccination Numbers and Statistics. 2023 Mar 31. Available from: https://www.health.gov.au/our-work/COVID-19-vaccines/vaccination-numbers-and-statistics
69. Edwards KM, Orenstein WA. UpToDate [Internet]. COVID-19 Vaccines, Impact on Transmission Risk. [cited 2023 Feb 27]. Available from: https://www.uptodate.com/contents/covid-19-vaccines#H1606921902
70. Medicines Australia [Internet]. New report indicates COVID-19 vaccines saved Australia's economy. 2022 Dec 19. Available from: https://www.medicinesaustralia.com.au/media-release/new-report-indicates-COVID-19-vaccines-saved-australias-economy/
71. Medicines Australia [Internet]. New report indicates COVID-19 vaccines saved Australia's economy. 2022 Dec 19. Available from: https://www.medicinesaustralia.com.au/media-release/new-report-indicates-COVID-19-vaccines-saved-australias-economy/
72. Centers for Disease Control and Prevention [Internet]. COVID-19 Treatments and Medications, 2023 Feb 10. Available from: https://www.cdc.gov/coronavirus/2019-ncov/your-health/treatments-for-severe-illness.html

4.2 Utilization Profile: Countermeasures In Australia

Exhibit 10: Summary of countermeasures in Australia between 2020-2022

	Community measures	Vaccination	Therapeutics
2022	• **Mask wearing** - compulsory mask-wearing for public transportation and airports was in place until September • **Isolation** - mandatory isolation requirements for individuals that test positive was repealed in October • **TTIQ** - testing and tracing was pared back by individual states over Q4 2021 and Q1 2022	• All Australians aged 5+ years or 6+ months in the at-risk population are eligible for a government-subsidized COVID-19 vaccination • As of December 2022, ~65 million doses have been administered nationally with 96% of 16+ year olds receiving 2 doses, 72.4% receiving 3 doses, and ~5.4 million receiving a fourth	• Antivirals Lagevrio and Paxlovid were listed on the Pharmaceutical Benefits Scheme (PBS) in March and May respectively • Eligible cohorts include 70+ year olds. 50+ year olds with 2 risk factors, First Nations people who are 30+ with 1 risk factor, and 18+ year olds who are moderately to severely immunocompromised[73]
2020-21	• **Border restrictions** - international borders were closed until November 2021 and some interstate (WA) until February 2022 • **Mass movement restriction and isolation** - bans on non-essential gatherings and "lockdowns" were implemented to varying degrees and durations (e.g., from a few days to months) across Australian states from March 2020 to October 2021	• Between September and May, the Australian government entered agreements with 5 vaccine manufacturers purchasing a total of ~315 million vaccines (manufactured overseas and locally) • Roll-out commenced in February 2021 • By December 2021, ~43 million doses were administered nationally with ~19 million people receiving 2 doses	

As of December 23, 2022.[74,75,76,77]

73. Eligibility may be periodically updated. Please refer to the www.pbs.gov.au for the latest eligibility criteria
74. Australian Government Department of Health and Aged Care [Internet]. COVID-19 Vaccines facts. 2023 Mar 20. Available from: https://www.health.gov.au/our-work/COVID-19-vaccines/is-it-true
75. Australian Government Department of Health and Aged Care [Internet]. Oral COVID-19 treatments. Available from: https://www.health.gov.au/health-alerts/COVID-19/treatments/eligibility#:~:text=This%20will%20take%20effect%20from,symptoms%20from%20COVID%2D19%20begin.
76. Knowlton C. TimeOut Magazine [Internet]. A timeline of COVID-19 in Australia, two years on. 2023 Feb 20. Available from: https://www.timeout.com/melbourne/things-to-do/a-timeline-of-COVID-19-in-australia-two-years-on
77. Australian National Audit Office [Internet]. Australia's COVID-19 Vaccine Rollout. 2022 Aug. Available from: https://www.anao.gov.au/work/performance-audit/australia-COVID-19-vaccine-rollout

5. Conclusion

Early in the pandemic, in 2020, Australia was internationally recognized for effectiveness in containing and suppressing COVID-19, achieving among the lowest number of cases and deaths in the OECD.[78] However, 2022 presented the toughest pandemic year for Australia, testing the market's immunity and economic resilience. Now, following its tumultuous reopening in February 2022, widespread vaccination, and the removal of community measures, Australia is living with the virus and the burden it incurs. But as this report demonstrates, there remains significant cause for ongoing preparedness.

Looking ahead, the ongoing economic cost of COVID-19 on Australia could range from a most optimistic AUD ~17 billion p.a. (~0.6% of GDP) to a worst-case scenario of AUD ~56 billion p.a. (~2.2% of GDP). In a base case scenario, where current conditions prevail, the economic costs could be AUD ~25 billion p.a. (equivalent to ~1.0% of GDP).

While Australia's health system sits at the coalface of this pandemic, those likely to be hardest hit are Australian workers who either contract the virus or must forgo work to care for someone who has. These indirect costs amount to ~90% of the future economic cost for Australia, demonstrating why maintaining supports for workers is so vital to mitigating the burden of COVID-19 on critical industries such as the healthcare, logistics, as well as travel and tourism sectors.

Vulnerable populations, such as Australia's elderly or indigenous communities, children or individuals with comorbidities, represent another major challenge for Australia as it moves into the endemic phase of COVID-19. Disproportionate infection levels and reliance on health system resources pose a significant ongoing cost for the market going forward.

5.1 Economic costs

In our base case scenario, the total economic cost is ~1% of Australia's GDP, with:

- Direct costs to the health system accounting for 10% of the total economic cost. Health system costs could amount to AUD ~2.8 billion p.a., driven by an estimated ~193,000 admissions and ~1 million cases of long COVID.
- The remaining 90% of costs due to productivity losses through missed work by adults as a result of their own illness or while caring for dependents (children and over-65-year-olds[79]); as well as elderly in the workforce affected by COVID-19. These indirect costs could cost the Australian economy AUD ~23 billion p.a.
- COVID-19 illness in Australia's vulnerable populations, which includes those over 65 years old, those with comorbidities, and indigenous Australians, represents a minimum impact of AUD ~12.4 billion p.a. to Australia's economy. Infections in elderly Australians alone could account for AUD ~3.2 billion p.a.

In a Pandemic 2.0 scenario, economic costs could rise to AUD ~56 billion p.a or ~2.2% of GDP. This assumes a higher rate of infection of ~1 million cases per million and a higher viral severity, driving ~285,000 hospitalizations annually, similar to what was seen during Australia's Omicron wave of early 2022. At the lower end, a Normal 2.0 scenario might impose an economic cost of AUD ~17 billion p.a. with ~500,000 infections per million.

78. Our World in Data [Internet]. Cumulative confirmed COVID-19 cases. Available from: https://ourworldindata.org/explorers/coronavirus-dataexplorer?time=earliest..2021-12-30&facet=none&Metric=Confirmed+cases&Interval=Cumulative&Relative+to+Population=false&Color+by+test+positivity=false&country=~AUS

79. In Australia, the retirement age is 65.

Health system capacity

For policymakers, preventing COVID-19 hospitalizations is a major concern not only because of the high cost it imposes on government accounts but also because of its effect on the wider community's access to care.

Our report estimates that Australia's health system faces a potential ongoing cost of AUD ~2.8 billion p.a. under a base case scenario, equating to ~0.1% of Australia's GDP, and a large portion of annual expenditure on healthcare.

With ~109,000 inpatient admissions, including ~5,500 to the ICU, where a ward admission for moderate infection could cost AUD ~7,700 and severe infection could cost AUD ~71,000, there is clear need to continue testing and ameliorating the severity of the illness to reduce dependency on services, especially as infection risks escalate in a fully reopened economy such as Australia's.

Workers and critical industries

Australia's economic trajectory could be expected to be affected by costs associated with infections in working-age adults. Productivity losses driven by missed work due to illness or caring for someone with the illness, could total AUD ~17.8 billion p.a., or ~0.7% of Australia's GDP. Young families with children, meanwhile, face the added burden of productivity loss borne by adults who are less productive while caring for children.

These indirect worker costs translate differently to the various critical industries – healthcare, logistics, as well as tourism and travel. Healthcare workers, as the prime example, are especially susceptible to infection, accounting for AUD ~2.3 billion p.a. (~9% of the combined total cost) in productivity costs. Higher rates of absenteeism and workforce burnout are live issues for Australia as it addresses health system capacity and access issues well into the endemic phase.

Productivity losses associated with Australia's logistics industry have been a key driver of the economic slowdown in Australia. Workforce shortages caused by COVID-19 illness are contributing to significant delays in downstream businesses – in June 2022, over 40% of businesses faced COVID-related supply chain disruptions, and almost half of those to a 'great' extent – and are will likely to persist to varying levels depending on the scenario.

Likewise, Australia's travel and tourism sector still requires support to help it totally recover from past and potential future impacts of COVID-19. Absenteeism was disruptive for travel and tourism operators over the past three years, with the country's two major airlines – Qantas and Virgin – both encountering major staff shortages and operational challenges.[80]

Vulnerable populations

Being especially susceptible to severe COVID-19 disease and heavily reliant on the health services, Australia's vulnerable populations could account for an ongoing cost of AUD ~12.4 billion p.a. to the economy under a base case scenario – almost 50% of all combined direct and indirect costs.

While the elderly community (65 years and over) and younger people with comorbidities make up a large portion of this population's impact – AUD ~3.2 billion p.a and AUD ~9.0 billion p.a respectively – the pandemic has also exacerbated the health gap between indigenous and non-indigenous Australians.

Given the disproportionate impact on these vulnerable populations, Australian policymakers may seek to strengthen countermeasures that reduce the duration of illness and/or time to recover for this group, thereby easing the costs on health systems and productivity.

80. Wiggins J. Australian Financial Review [Internet]. Airports say jobs shortages 'could persist'. 2022 Jun 23. Available from: https://www.afr.com/companies/infrastructure/airports-say-jobs-shortages-could-persist-20220623-p5aw0f

5.2 How can we mitigate COVID-19 and reduce its overall cost?

Fortunately, a range of countermeasures remains available to mitigate the economic costs of COVID-19. These can be categorized as community measures such as contact tracing and mask-wearing mandates, other infection control strategies, or medical responses like vaccines and therapeutics.

Keep community measures on the table and keep innovating

Many of the most effective measures in tackling COVID-19 have been at the community level, including the introduction of digital tools for tracking and analyzing the spread of the virus. Learning from successes elsewhere in the world and developing new, innovative approaches to the social impact of the disease will be vital to ongoing mitigation and cost reduction. Other measures, such as lockdowns and social distancing measures, can also play an important role in blunting infection volumes. However, while these measures are effective in protecting population health, they also impose significant challenges and economic frictions and should not be treated as a first resort.

Continue vaccinating and developing new vaccines

By reducing individuals' susceptibility to the virus, COVID-19 vaccines have provided a significant benefit to the Australian economy and greatly facilitated reopening. In doing so, vaccines have highlighted the benefits of rapid and widespread access to medical innovations. Keeping up the momentum of vaccinations and acquiring new vaccines to address fresh strains and accommodate particular needs is essential to reduce the ongoing incidence and cost of COVID-19.

Inclusion of therapeutics

Therapeutics such as oral antivirals, which became available in Australia in March 2022, have the potential to continue to curb the economic impact of COVID-19 by helping to reduce the disease burden. With Australia now well into the endemic phase, there is opportunity to continue to treat adults at increased risk of hospitalization or death from COVID-19, thereby softening its blow to productivity.

As has been described, the costs of the pandemic on Australia are substantial and wide-ranging, but often not fully recognized in traditional evaluations of its economic impacts. If policymakers respond to the scale of the challenge by strengthening their toolkit of countermeasures, they will be in a stronger position to mitigate the high costs of the continuing pandemic, ensuring that their population and economy are adequately prepared for all eventualities.

Appendix: Assumptions

Australia

Exhibit A1: Key overall assumptions

1st Level	Parameter Name	Value	Source	Commentary
Total economic costs of COVID-19	Total annual COVID-19 infections	19,844,050	Institute of Health Metrics Evaluation, The University of Washington	Q4 2022 infections per million, annualized
	Total COVID-19 deaths	1,064	Institute of Health Metrics Evaluation, The University of Washington	Reported daily deaths, 2022, annualized
	Proportion of infections that are detected	18%	Institute of Health Metrics Evaluation. The University of Washington	

Exhibit A2: Key direct cost assumptions

3rd Level	4th/5th Level	Parameter Name	Value	Source	Commentary
Inpatient	Moderate	Hospitalization rate	0.55%	• Institute for Health Metrics and Evaluation	• Total 2022 hospitalizations / total # infections
		Ward admission rate	95.00%	• Commonwealth & State Health Departments; • Australian Institute of Health and Welfare report on admitted patient activity	• Calculation based on admission data 2020-22 • Published ICU admission rate for 2020-21
		Ward length of stay	11 days	• AIHW Report on COVID-19 admitted activity	• Range of 9-12 days given; rounded mid-point chosen
		Ward bed day cost	$700	• AIHW Report on health expenditure 2019-20 • Independent Hospital and Aged Care Pricing Authority	• Calculation based on total public hospital spending and admitted bed davs • Combined ward and ICU bed day cost of $1.270
	Severe	ICU admission rate	5.00%	• Commonwealth & State Health Departments; • Australian Institute of Health and Welfare report on admitted patient activity	• Calculation based on admission data 2020-22 • Published ICU admission rate for 2020-21
		ICU length of stay	15 days	• AIHW Report on COVID-19 admitted activity	• Range of 10-20 days given
		ICU bed day cost	$5,250	• Medical Journal of Australia study of 36 ICUs' costs per patient day	• 2013-14 mean figure of $4,375 indexed

Exhibit A2: Key direct cost assumptions (continued)

3rd Level	4th/5th Level	Parameter Name	Value	Source	Commentary
Outpatient	Acute	Proportion of infections that visit an ED	0.1%	• Australian Institute of Health and Welfare report on the impact of COVID-19 on 2020 emergency department activity	• Calculated weekly ED attendances per weekly infections volume
		Cost per Emergency Department visit	$800	• Independent Hospital and Aged Care Pricing Authority	• Total cost of a non-admitted ED attendance for COVID-19 2019-20
		Proportion of infections that visit a GP	3-12%	• Journal of Primary Care and Community Health • Calculation based on known volumes of AV prescriptions	• Study of visits to ~1,200 primary care centres across the US in 2020 for treatment of COVID illness; divided by number of infections
		Cost per GP visit	$97	• Medicare benefits schedule • AIHW Report on health expenditure 2019-20	• Accounts for value of MBS item and average practice gap fee
	Chronic	Incidence of Long COVID	5.00%	• Australian National University Evidence from the COVID-19 Impact Monitoring Survey Series, August 2022	• Estimate of incidence in Australia of 4.7%; implies 700.000 annual cases

Exhibit A3: Key indirect cost assumptions

3rd Level	4th/5th Level	Parameter Name	Value	Source	Commentary
Infected working-age	Acute - well enough to work	Proportion of acute working-age infections well enough to work (outpatients)	98.85%	• The Institute for Health Metrics and Evaluation (IHME) • See direct cost assumptions	• Inpatient (1.15%) is based on IHME hospitalization rate + proportion of infections that require hospital in the home (HITH) (see direct cost assumptions) • The remainder (98.85%) is outpatient
		Proportion of acute working-age infections that are asymptomatic	25%	• Healthline (2020) and Global Systematic review (n=28 studies) (2021)	Mid-point taken from: • 20% in Healthline 2020 • 28-31% in Systematic review 2021
		Proportion of people who cannot work from home	39%	• ABC (2022)	• ~61% (workers reporting tasks that can be performed at home) in 2022
		Duration of acute illness	12 days	• Medline (2022)	• 10-14 days for mild to moderate illness
		Proportion of illness days that people take as sick leave	25% (~3 days)	• Wall Street Journal (2022) • Cost-analysis for COVID-19 in Australia (Cook 2021 and Kompas 2020)	• WSJ (2022) - 3-4 days taken off • Cook (2021) - 3-13% of infections take ~10 days off work (includes both inpatient and outpatient illness) • Kompas (2020) - average 18.5 sick days off work (includes both inpatient and outpatient illness)
		Productivity loss on days worked while ill	35%	• European Respiratory Society	• Cross-sectional study of positive COVID-19 diagnosis 3 months after discharge of resolution of acute disease. Uses WPAI. 35% work impairment for non-hospitalised and 10% for hospitalised, 20% overall; make conservative estimate that long-COVID symptoms cause same level of productivity loss as when working with acute illness
	Long COVID	Rate of long COVID	5%	• ANU (2022) • Global Burden of Disease Long COVID Collaborators (2022)	• ANU survey of 3,510 adult Australians - 4.7% had or currently have long-COVID syndrome with symptoms lasting 3 months or more • Collaborators review of 54 studies - 6%
		Duration of long COVID	90 days	• NSW Government (2022)	

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