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

August 2023

MSD
INVENTING FOR LIFE

Table of Contents

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 approaches to these interventions taken by Hong Kong. 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.

MSD
INVENTING FOR LIFE

MSD
INVENTING FOR LIFE

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 Hong Kong.

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 the Hong Kong 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 hospitalization and transmission rates observed during various periods between February 2020 and early 2023 in Hong Kong. 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 Hong Kong's economy, with a more thorough assessment of the hidden economic costs to its society than has previously been available. As Hong Kong 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 Hong Kong 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 Hong Kong have provided widely varying assessments depending on the type of research carried out, from an estimated USD ~56 million (which took the impact of vaccines into account) to USD ~1 billion (based on allocated funding for pandemic-related expenditure).[3] 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 Hong Kong under a base case scenario, the annual economic costs of COVID-19 could reach about HKD ~41.6 billion p.a., representing around 1.4% of the market's GDP. In a worst-case Pandemic 2.0 scenario, HKD ~108.7 billion p.a. would be lost, or around 3.8% 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. While direct costs to the health system in Hong Kong are substantial, accounting for HKD ~5.07 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. In our base case scenario, indirect costs account for 88% of Hong Kong's total ongoing economic cost of COVID-19.

One important example of such ensuing costs is in the health workforce, which continues to be impacted by personnel shortages and experiences a greater risk of infection compared to the wider community. This susceptibility has significant consequences for health system capacity, efficiency, and quality of care.

The report also shows an uneven distribution of costs, as not all community cohorts face the same level of risk or contribute the same economic burden when infected. Vulnerable populations, such as older adults[4] and working-age adults with comorbidities (such as high blood pressure, cancer, and/or diabetes), are likely to be disproportionately impacted. The economic impact from

3. These studies had been conducted in USD currency.
4. Older adults refers to those aged 60 and older.

older people infected with COVID-19 is around HKD 12.6 billion per year, while that of working-age adults with comorbidities is around HKD 3.5 billion per year.

Meanwhile, individuals affected by long COVID experience prolonged productivity losses, which increase indirect costs and reliance on health services, further escalating direct costs. This exerts a substantial burden on the health system, both in terms of capacity requirements and economic costs. In a base case scenario, the total value of lost work and use of health systems due to long COVID would be HKD ~15.9 billion p.a., which amounts to 38% of Hong Kong's total economic cost of COVID-19.

Looking ahead, policymakers may consider strengthening 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. Such efforts can help to ensure that Hong Kong's population and economy are better prepared for future challenges to the healthcare system, ranging from mild endemic diseases to severe pandemics.

Having a full understanding of COVID-19's cost, both current and potential, is therefore vital to designing effective countermeasures that can mitigate the ongoing impact (measures we have identified in the white paper) of the disease. It is hoped that this paper can provide Hong Kong policymakers with a useful frame of reference 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 Hong Kong's economy, industries, livelihoods, and of course, its population's health.

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 Hong Kong 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 (~1.2% 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 Hong Kong

Range of existing estimates of the cost of COVID-19: USD ~56 million to USD ~1 billion. As in the other markets, the range of estimates is due to the various interventions explored, the epidemiological contexts assumed, and the different scope of costs evaluated.

Lower estimate: USD ~56 million. This is based on calculations of a comparison of probable costs resulting from COVID-19 in several markets, and the effect of vaccination on these costs. Direct costs taken into account include vaccination program costs and medical treatment costs, while indirect costs include productivity loss due to sick days and premature death before retirement. Epidemiological scenarios calculated include a comparison of costs when 0% versus 50% of the Hong Kong population is fully vaccinated. A vaccination rate of 50% is predicted to save USD ~40 million, reflecting the epidemiological context of vaccination rates in Hong Kong in September 2021.[5] This estimate also includes the value of lost health, albeit measured using quality-adjusted life years (QALYs).[6]

Higher estimate: USD 1 billion p.a. This is a historical estimate based on the reported funding allocated by the Hong Kong Special Administrative Region to the Hong Kong Hospital Authority (public health system) in 2022 for pandemic-related expenditure.[7] The estimate includes direct healthcare costs as well as costs associated with public health measures, such as vaccinations and operating costs for isolation and treatment facilities. This estimate reflects the impact of rapidly escalating infections from a novel variant in the setting of a vaccination rate of ~60%, reflecting the epidemiological context when the Omicron variant emerged in late 2021.

One estimate of the economic losses associated with COVID-19, based on the recorded fall in economic activity experienced during 2020, was a 6.1% reduction in Hong Kong's GDP.[8] This estimate reflects the context of public health measures such as social distancing, lockdowns, and border closures, with none of the population vaccinated – which was the epidemiological scenario experienced by Hong Kong in 2020 at the start of the pandemic.

As an interesting aside, an estimate for the whole of China put forward by the University of Hong Kong estimates the indirect economic cost of COVID-19 at USD ~46 billion per month, or 3.1% of GDP.[9] This estimate reflects the impact of implementing targeted lockdowns and the associated fall in economic activity.

5. Zhang W. Statista [Internet].COVID-19 vaccination doses in Hong Kong 2021-2022. 2022 Jun 8. Available from: https://www.statista.com/statistics/1297793/hong-kong-covid-19-vaccination-doses/
6. 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).
7. Epidemic-related expenditure of Hospital Authority. The Government of the Hong Kong Special Administrative Region Press Releases [Internet]. 2022 May 4. Available from: https://www.info.gov.hk/gia/general/202205/04/P2022050400430.htm
8. Hong Kong Monetary Authority. Annual Report 2020 [Internet]. Available from: https://www.hkma.gov.hk/eng/data-publications-and-research/publications/annual-report/2020/
9. Hancock T. Lockdowns cost at least $60b a month: study. Financial Review [Internet]. 2022 Mar 29. Available from: https://www.afr.com/world/asia/china-lockdowns-cost-at-least-60b-a-month-study-20220329-p5a93g#:~:text=Hong%20Kong%20%7C%20China%27s%20COVID%2D19,if%20more%20cities%20tighten%20restrictions.

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.

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 Hong Kong. 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 Hong Kong 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,[10] 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.[11] 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.

10. 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
11. Value of statistical life is an approach to estimating the value of reductions in the risk of physical harm.

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 (Hong Kong) 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 Hong Kong

In Hong Kong, the future economic cost of COVID-19 could range from HKD ~4.0 billion p.a. (~0.1% of GDP) to HKD ~108.7 billion p.a. (~3.8% of GDP), depending on the scenario that evolves. This represents a far greater cost to society than is 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.

Hong Kong society has now generally accepted the reality of living with ongoing transmission of the virus and the burden this incurs. However, there is an opportunity to better leverage the tools available to reduce this burden. To better inform the ongoing discussion on COVID-19's impacts and the benefits of addressing them, it is helpful to first understand the full range of economic costs imposed by COVID-19.

There is a variety 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 different interventions explored and the scope of costs included).[12] Our epidemiological scenarios include a base case, where current conditions prevail, as well as more and less severe scenarios with differing rates of infections (as affected by, for example, different variants and levels of population immunity).

In our base case scenario, total economic costs could be HKD ~41.6 billion p.a. (equivalent to ~1.4% of GDP), assuming a transmission rate that results in ~8.7 million infections p.a. and ~36,000 hospitalizations p.a., with:

- The majority of costs (HKD ~36.6 billion p.a., 88%) due to productivity losses (indirect costs) through missed work by both working-age adults and elderly people in the workforce, either during their own illness or while caring for dependents (children and over 60 year-olds) affected by COVID-19, and
- A further cost (HKD ~5.1 billion p.a., 12%) borne by the health system (direct costs), in both inpatient (HKD ~1.7 billion p.a.) and outpatient (HKD ~3.3 billion p.a.) settings.

12. See Section 1 for further details.

In a higher Pandemic 2.0 scenario, economic costs could reach as high as HKD ~108.7 billion p.a. (~3.8% of GDP). This assumes transmission rates that result in ~15.5 million infections per year (instead of ~8.7 million in the base case) and a severity that results in ~108,000 hospitalizations (compared with ~36,000 in the base case).

At the lower end of the spectrum, a Normal 2.0 scenario might feature ~928,000 infections over the course of a year with only ~2,500 hospitalizations, which would translate to direct and indirect costs of HKD ~4.0 billion p.a.

These economic costs fall unevenly. 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 (see Section 3.4.3) contributes HKD ~16.1 billion p.a. in the base case scenario (~39% of total economic costs); these costs result from infections in people eligible for oral antivirals, who tend to be older and/or affected by comorbidity. Meanwhile, the health workforce is impacted by high levels of absenteeism and a high risk of infection, with consequences for health system capacity and quality of care. Economic costs arising from these disruptions to the health workforce total HKD ~793 million p.a. in the base case scenario. Those affected by long COVID (see Section 3.4.4) are impacted most significantly, with the value of lost work and use of health system resources totaling HKD ~15.9 billion p.a. or ~38% of all economic costs.

Fortunately, a range of countermeasures remains available that could 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 Hong Kong to mitigate the potentially high economic costs of the continuing pandemic.

3.1 Context: The Situation In Hong Kong

Today, Hong Kong is relatively free of restrictive measures. Most of the community measures employed earlier in the pandemic, such as lockdowns, mandatory isolation, and mandated mask-wearing have been pared back or discontinued. In their place, Hong Kong has wide availability and uptake of vaccines, and there is some usage of therapeutics such as antivirals – which have been made available to a subset of the Hong Kong population after conditional approval.

Over the three months up to January 2023, Hong Kong was experiencing one of several waves of infections and hospitalizations following the city's progressive reopening in late 2022. With ~15,700 new infections per day (accounting for under-detection) and an effective transmission number[13] of ~1.01, infection volumes were stabilizing. By contrast, in the first quarter of 2022 – the peak of the first Omicron wave – there were ~42,100 infections per day, with an effective transmission number of ~1.7. The change in Hong Kong's pandemic response posture since then is both a reaction to the lower volume of infections and a driver of subsequent infections.

13. The number of people a single case will infect, on average.

Hong Kong's initial set of pandemic response measures was very effective at containing the virus, while also imposing significant economic costs. By international standards, the countermeasures employed during the first phase (2020 to 2021) were very successful. The numbers of reported cases (~12,650) and deaths (~213) were among the lowest in the developed world. However, border closures, lockdowns, social-distancing requirements (including capacity limits on indoor spaces), and mask-wearing mandates imposed significant hardships on the community. The successful rollout of vaccines[14] conferred widespread population immunity, but this was found to wane over time. Waning immunity necessitated third doses, while novel variants emerged, such as Omicron, which were capable of immune escape.

Oral antivirals have been added to Hong Kong's response toolkit. These became available in Hong Kong in February 2022 to help address a significant outbreak at the time.[15] Antivirals remain a part of the SAR's response toolkit following the general reopening of its borders and economy in early 2023.

The health and economic outcomes of the reopening phase have been mixed. The vast majority (~99%) of Hong Kong's infections to date occurred in 2022.[16] While the severity of infections remained relatively mild compared to that seen early in the pandemic, the high volume of infections nevertheless gave the hospital system its busiest year of the pandemic so far, with ~82 admissions per day on average, compared to ~3 in 2021 and 2020.[17] This also meant that the number of deaths increased enormously, to ~10,000 in 2022 compared with 65 in 2021 and 148 in 2020.[18] 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.

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. Hong Kong's reopening experience has illustrated that the costs of COVID-19 borne by Hong Kong society extend beyond the value of health losses captured traditionally by 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 could 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. As of February 2023, 94.6% of Hong Kong residents have received at least one dose of a COVID-19 vaccine and 83% have received three doses.[19] Hong Kong's three-dose coverage is higher than South Korea's (~80%) for example but less than Japan's (100%). And while the use of antivirals has tracked infection waves, their use remains relatively uncommon, at a prescription rate of ~3% of all infections.[20]

14. As of February 2023, ~94.6% of the population had received at least one dose of a COVID-19 vaccine, while ~93.1% had received two doses and 83.7% had received three doses. Coronavirus website of the Hong Kong authorities [Internet]. Local situation dashboard. Available from: https://chp-dashboard.geodata.gov.hk/covid-19/en.html
15. They are currently available for all COVID-19 positive patients over the age of 18 and with one additional risk factor, or for those over the age of 60 regardless of risk factors. Risk factors include a range of chronic illnesses.
16. There were ~7.3 million infections in Hong Kong in 2022, compared to ~44,000 in 2021 and ~37,000 in 2020.
17. Institute of Health Metrics and Evaluation, used with permission. Available from: https://www.healthdata.org/covid/data-downloads#
18. Institute of Health Metrics and Evaluation, used with permission. Available from: https://www.healthdata.org/covid/data-downloads#
19. Coronavirus website of the Hong Kong authorities [Internet]. Local situation dashboard. Available from: https://chp-dashboard.geodata.gov.hk/covid-19/en.html
20. Legislative Council of the Hong Kong SAR [Internet]. Official record of proceedings of 2023 January 11. Available from: https://www.legco.gov.hk/yr2023/chinese/counmtg/floor/cm20230111-confirm-ec.pdf#nameddest=app_01_07

3.2 Key Assumptions In The Hong Kong Context

A range of informed assumptions is used to derive the estimates of economic costs in Hong Kong as a result of COVID-19. Exhibit 1 illustrates how these assumptions are used and provides a list of the key assumptions used, while a full list of assumptions is given in the Appendix section.

Exhibit 1: Use of assumptions in the Hong Kong context

A | Epidemiological scenarios

Scenario	Infections (mn) p.a.	Hosp. rate (%)
Normal 2.0	~0.9	0.3
Base	~8.6	0.4
Pandemic 2.0	~15.5	0.7

→

B | Direct costs: borne by the health system

Key Base Case Assumptions	
# Ward admissions p.a.	~33,000
# ICU admissions p.a.	~3,200
% Infections that visit a GP	8-12%
% Infections prescribed OAVs	3.4%
# Long COVID cases p.a.	~434,000

+

C | Indirect costs: economic productivity losses borne by society

Key Base Case Assumptions	
Working-age infections as proportion of total	61%
Proportion of working-age infections that can work	99.6%
Proportion of working-age infections that can work from home	45%
Average number of working days lost due to acute illness in working-age population	~6
Average daily salary	HKD 18,700

=

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

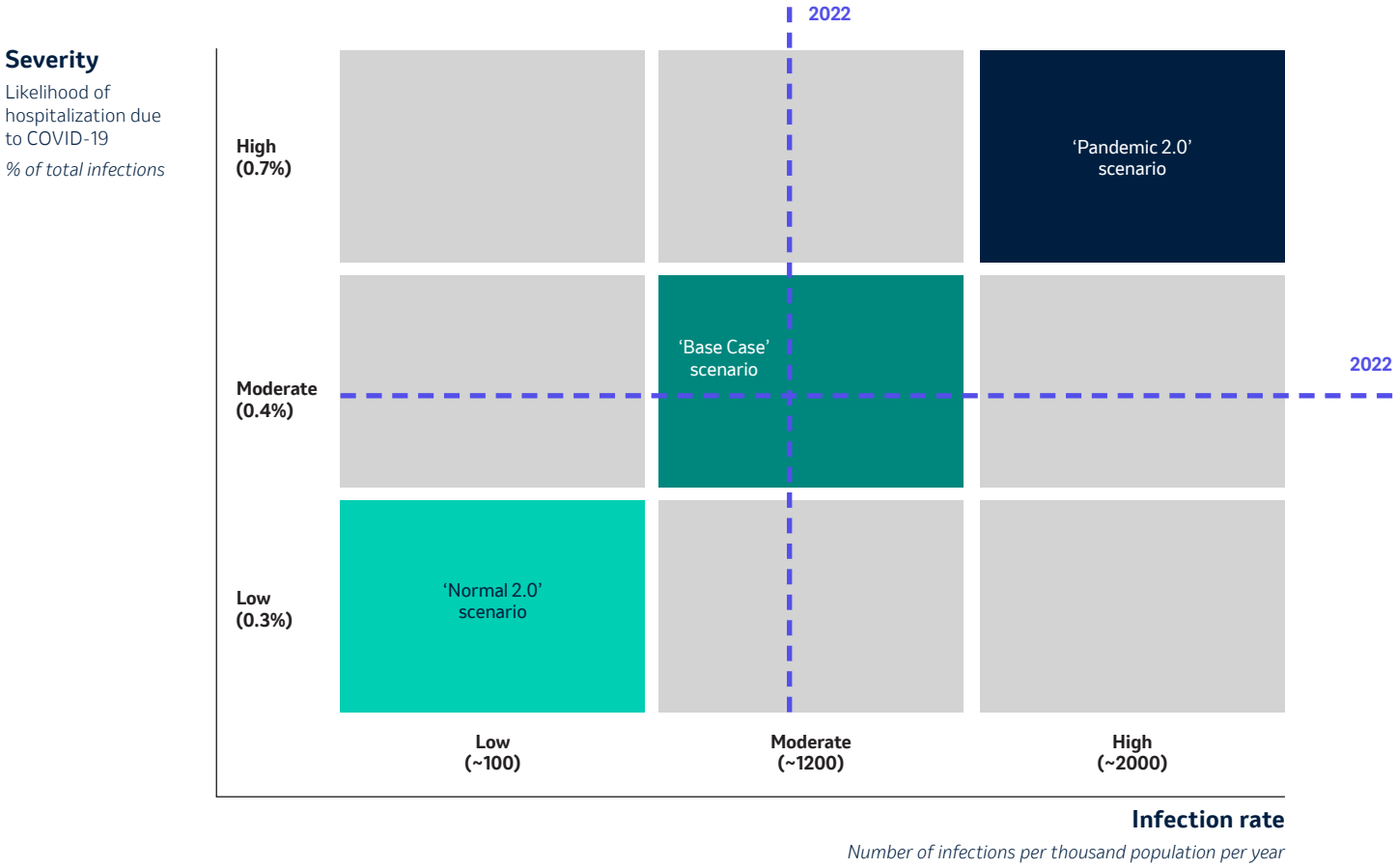
  - E.g., if total inpatient costs are $1.7b, and 36,000 patients are admitted, the cost per person is ~ $48,000

A full list of assumptions is given in the appendix.

MSD INVENTING FOR LIFE

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

Exhibit 2: Potential epidemiological scenarios



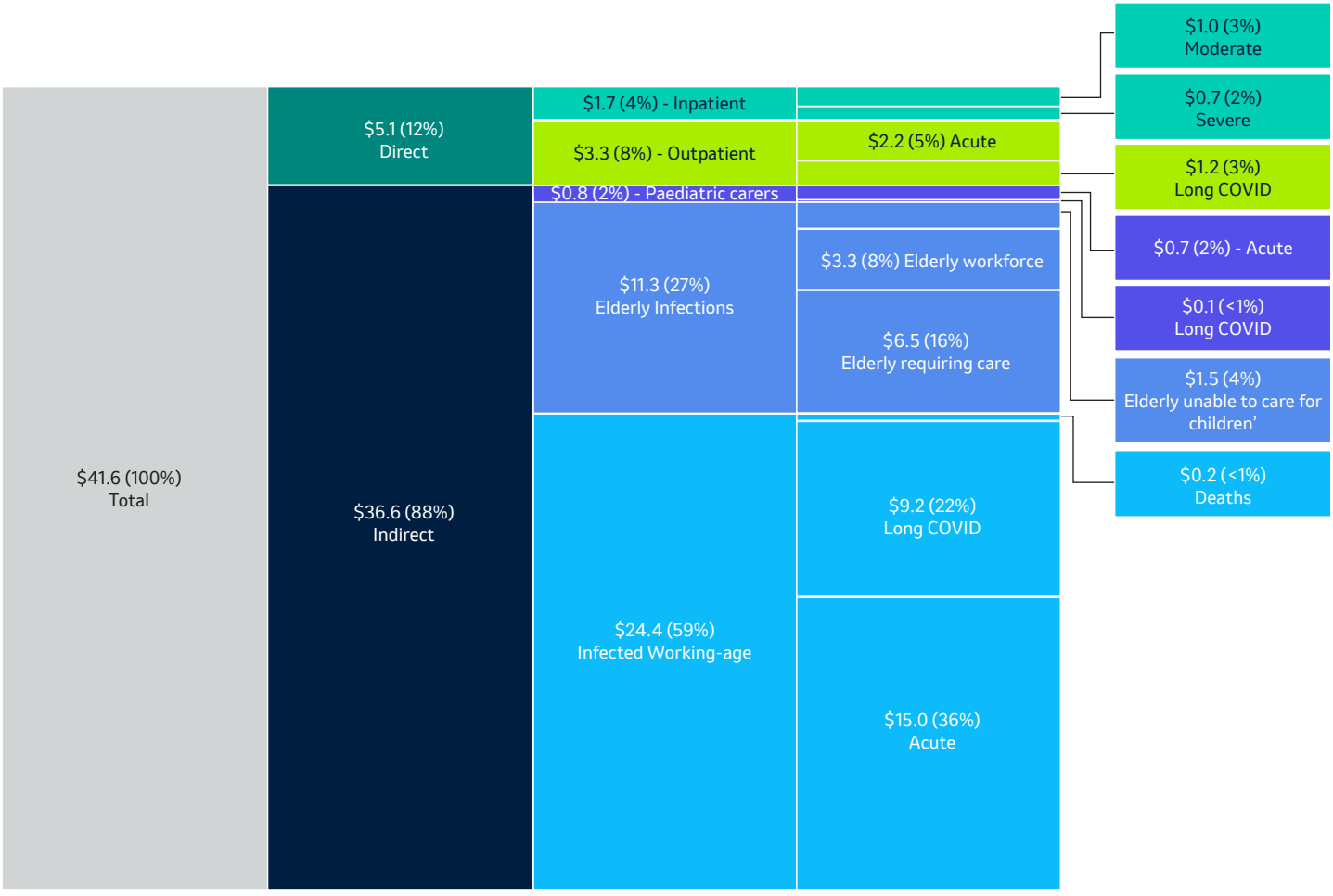
Scenarios are indicative only and based on the observed epidemiology of COVID-19 in Hong Kong in 2022.

As Exhibit 2 illustrates, Hong Kong could experience a range of cost scenarios:

- A base case, with an economic cost of HKD ~41.6 billion p.a. (~1.4% of GDP, in addition to the value of lost health such as that already considered in HTAs), which assumes a rate of infection (e.g., ~1.2 million infections per million population annually) and a viral severity driving ~36,000 hospital admissions annually, similar to that seen in late 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.
- A high or Pandemic 2.0 case, with an economic cost of HKD ~108.7 billion p.a. (~3.8% of GDP), which assumes a higher rate of infection (e.g., ~2.1 million infections per million population per year) and a higher viral severity driving ~108,000 hospitalizations annually, similar to that seen in the early part of 2022. A scenario of this type could result from a variety of circumstances, such as the emergence of a novel, more infectious variant, and could be exacerbated by the return of mass movement to and from Hong Kong, including the reopening of domestic and international borders.

- **A low or Normal 2.0 case, with an economic cost of HKD ~4.0 billion p.a. (~0.1% of GDP),** which assumes a lower rate of infection (e.g., ~120,000 infections per million population per year) and a viral severity driving ~2,500 hospitalizations, similar to that seen in mid-2022.

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

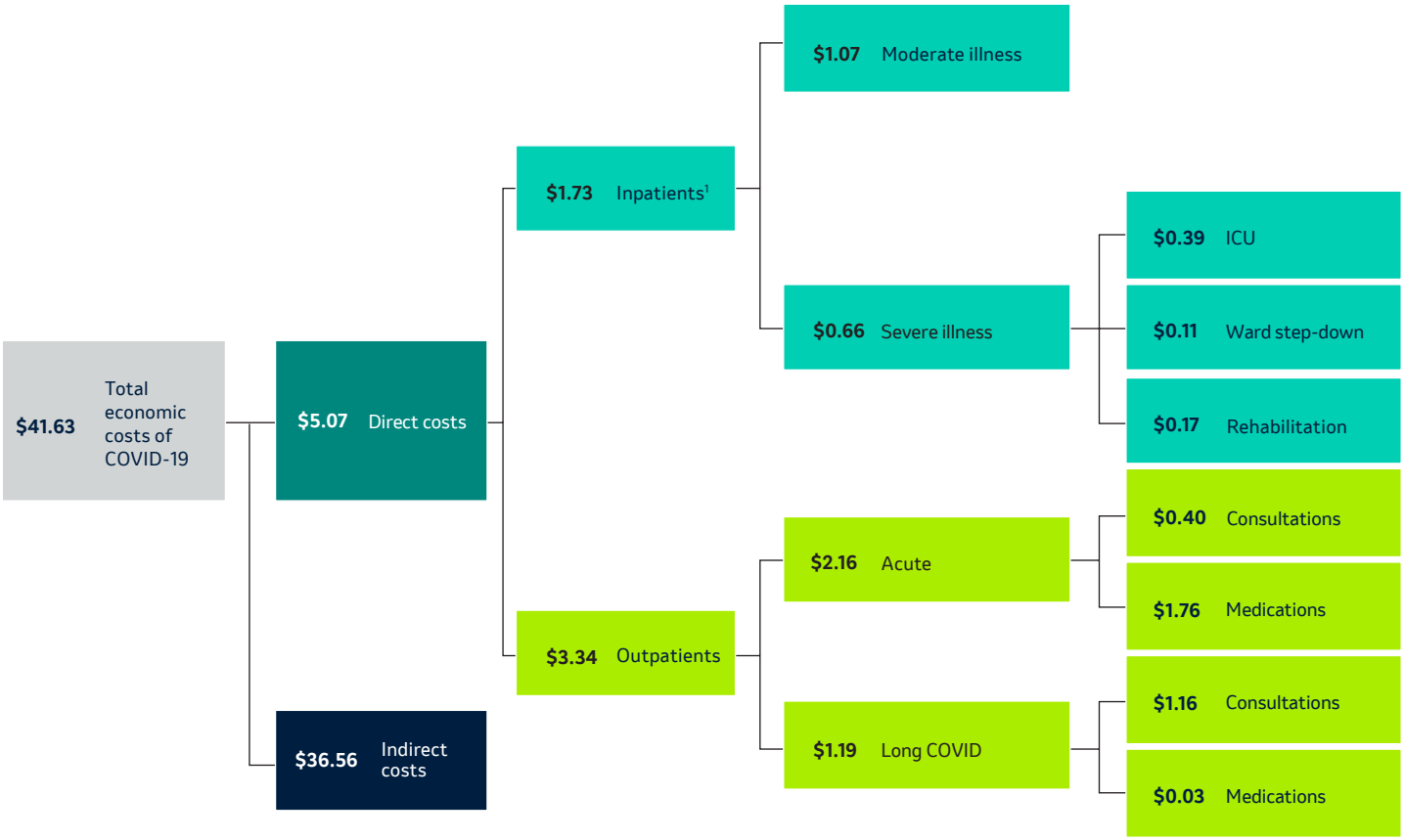


Proportion of costs borne by infected cohorts, HKD billion (% of total)"

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

Exhibit 3 maps out our base case scenario, which is designed to reflect a continuation of recent conditions. To create this scenario, infection volumes and the prevailing hospitalization rate from Q4 2022 have been drawn from the Institute of Health Metrics and Evaluation (IHME) model of COVID-19 (figures used with permission) and annualized.

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



1. Cost is 'all inclusive' (i.e., includes accommodation, all aspects related to medical care, and medications)
Note: Totals may not sum precisely due to rounding to 2 decimal places.

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

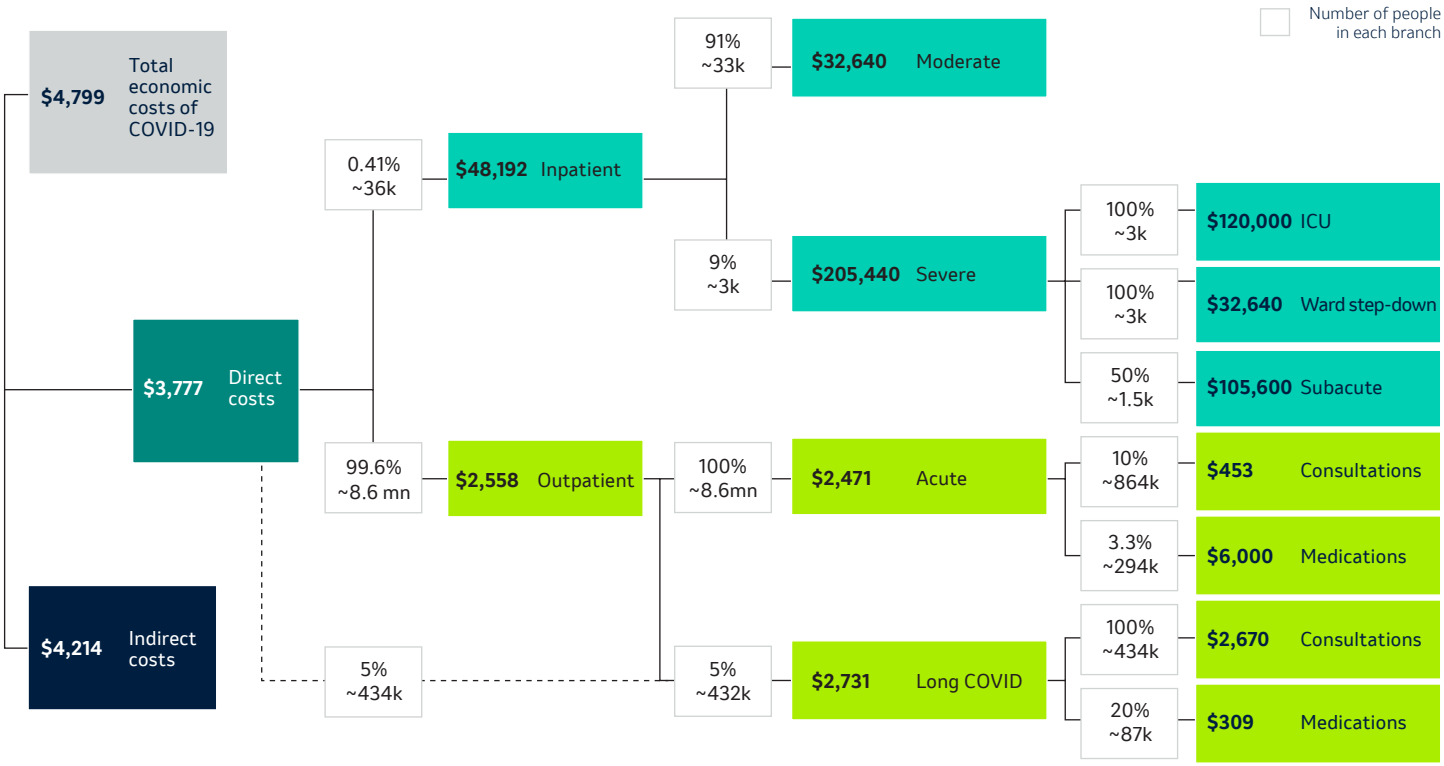
3.3.1 Direct costs to the health system

With ~36,000 hospital admissions (including ~3,000 to the ICU) and ~434,000 cases of long COVID in our base case scenario, preventing admissions (including to ICU), reducing lengths of stay, time to recovery, and/or the incidence of long COVID could significantly lower the direct costs imposed by COVID-19 on our health system. Given that those over 60 are over-represented in the COVID-19 inpatient population, preventing severe illness in this age group would likely be particularly impactful in reducing direct costs.

In the base case scenario (see Exhibit 5), COVID-19 could cost the Hong Kong health system HKD ~5.1 billion p.a. Despite the magnitude of this figure, direct costs in fact account for a minority of the total economic costs of COVID-19 in Hong Kong, at just ~12% of the total. The indirect cost of productivity losses due to missed work accounts for the remainder and could be HKD ~36.6 billion p.a. These indirect costs are discussed further in Section 3.3.2.

Despite the relatively minor scale of direct costs in the wider scheme of COVID-19's economic impact, they remain significant on a per-infection basis. As illustrated in Exhibit 5, each infection that necessitates some form of health service could impose an average cost of HKD

Exhibit 5: Direct economic costs from COVID-19, per person, base case, HKD 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 use a health service; 'Moderate illness' requires ward-based inpatient care and 'Severe illness' requires ICU-level care; 'Acute illness' refers to all infections not included in inpatient care, where ~10% visit a GP and 3.4% are prescribed medication; Long COVID refers to a small subset (~5%) of total infections and represents infections with symptoms lasting 12 weeks or more.

~3,777. The bulk of this cost is from inpatient care, where a single ward admission could cost HKD ~32,640 and a single ICU admission (with subsequent ward and rehabilitation stays) could cost HKD ~205,440.

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

- Inpatient (hospital-based) care (HKD ~1.7 billion p.a.; 34%; HKD ~48,192 per person)
- Outpatient (primarily GP-based) care (HKD ~3.3 billion p.a.; 66%; HKD ~2,558 per person)

The profile of inpatient care costs suggests that ameliorating the severity of illness acquired could have a significant impact on cost. Particularly in a reopened economy, where individuals at risk of severe disease are less protected from infection by community health 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 moderate infections requiring ward-based care (HKD ~1.1 billion p.a.; HKD ~32,640 per person) and severe infections requiring ICU treatment (HKD ~660 million p.a.; HKD ~205,440 per person). The higher overall cost of care for moderate infections is due to the greater volume of patients with moderate infections (33,000, compared to 3,000 patients with severe infections), while the cost of care for severe infections is principally due to high bed day costs (HKD ~24,000 per day in ICU), followed by substantial periods of inpatient rehabilitation.

Analysis of outpatient care costs indicates that limiting the incidence, duration, and/or severity of long COVID would have a substantial impact on

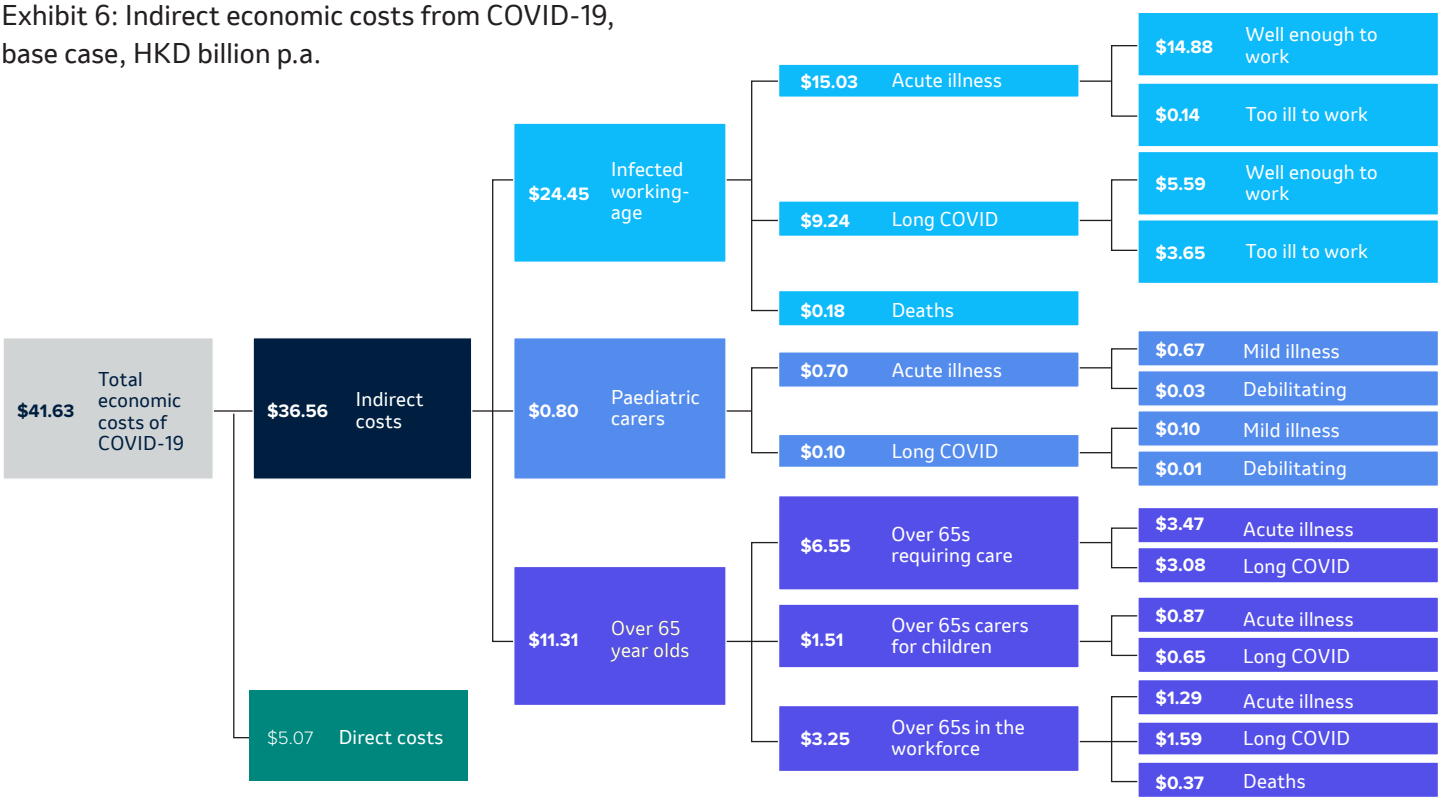
this portion of the cost burden. Outpatient care for COVID-19 infections adds HKD ~3.3 billion p.a. to the total economic costs incurred due to COVID-19. While seemingly less resource-intensive, outpatient infections that call for health services are also expensive on a per-person basis, costing HKD ~2,558 each.

Outpatient costs can be separated into acute outpatient care (consultations and medications: HKD ~2.2 billion p.a.) and chronic outpatient or Long COVID care (consultations and medications: HKD ~1.2 billion p.a.; see 3.4.4).

While the cost of acute outpatient care is largely due to the cost of medications (such as oral antivirals, HKD ~1.8 billion), it is only around 4% of the total economic cost. This seems a small investment for treatment that partially reduces the total economic costs associated with COVID-19 (HKD ~41.6 billion p.a.) and helps prevent them from spiraling. The remaining outpatient costs are from GP visits, which could exceed 3.5 million consultations per year assuming ~10% of those acutely infected seek care from their GP and ~5% develop long COVID (all of whom would have to seek primary care). The cost of these services is higher than inpatient costs (HKD ~1.7 billion p.a.) and represents a substantial added burden on the primary care system.

Together, direct costs from inpatients and outpatients amount to HKD ~5.1 billion p.a. While significant on their own, these costs should be seen together with the indirect costs to Hong Kong's economy (discussed below), the value of lost health, and ripple effects on the health system (such as its workforce) and other critical industries.

Exhibit 6: Indirect economic costs from COVID-19, base case, HKD 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 inpatient care; Long COVID refers to a small subset (~5%) of total infections where symptoms last 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 reducing the economic and societal costs of COVID-19.

In the base case scenario, and as Exhibit 6 illustrates, COVID-19 could cost the Hong Kong economy HKD ~36.6 billion p.a. in productivity losses if current epidemiological conditions and responses continue.[21] The impact could be larger if the city were to see a return to stricter isolation protocols. As with direct costs to the health system, this is a significant expense, equating to ~1.2% of GDP. 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 separable age groups:

- **Infections in working-age adults (20-59 year-olds) – HKD ~24.4 billion p.a.** (~67%; HKD ~4,626 per person)
- **Infections in the older population (60 year-olds and above) – HKD ~11.3 billion p.a.** (~31%; HKD ~5,147 per person)
- **Infections in children and adolescents (19 years old and below) – HKD ~800 million p.a.** (~2%; HKD ~698 per person)

Infections in working-age adults impose a significant economic burden on Hong Kong, through productivity losses valued at HKD ~24.4 billion p.a., which equates to ~0.8% of Hong Kong's GDP. An illness that is mild for most people but significant enough to last ~12 days and impairs productivity by ~35% for three-quarters of us has a major impact on the broader economy.[22]

Productivity loss according to working-age groups can be separated into two categories:

- Acute illness (HKD ~15.0 billion p.a.), chronic illness, or long COVID (HKD ~9.2 billion p.a.), and deaths (HKD ~0.2 billion p.a.)
- Infected adults with mild illness who are still well enough to work but with reduced capacity (HKD ~20.5 billion p.a.), and infected adults who are too ill to work (i.e., are hospitalized) (HKD ~3.8 billion p.a.)

Looking at these together, acute illness in those who can still work but at reduced capacity accounts for ~61% of productivity losses incurred by working-age adults. Even modest reductions in working capacity at the individual level have a substantial cost when the illness lasts several days and affects ~8.7 million infections in Hong Kong per year.

Infections in the older population impose an overall cost of HKD ~11.3 billion p.a. in productivity losses for the Hong Kong economy on top of the burden of infections in working-age adults. This underlines the fact that productivity losses are not limited to those borne by working-age adults, and that infections in younger and older people also bring an economic cost.

COVID-19 infections in older people can lead to loss of productivity in three main ways:

- **Older people with COVID-19 who require care from a working-age person** – ~1.9 million working-age carers, each incurring an HKD ~3,512 productivity loss – resulting in a total impact of HKD ~6.5 billion p.a.
- **Older people who directly participate in Hong Kong's labor force** – estimated to be 23% of those over 60. Infections in this group result in HKD ~3.3 billion in productivity losses.
- **Older people (e.g., grandparents) who care for children to enable parents to work** – one in three parents in Hong Kong report that their parents (i.e., the child's grandparents) have helped them raise their children. When this work-enabling care is disrupted, the productivity loss amounts to HKD ~1.5 billion.

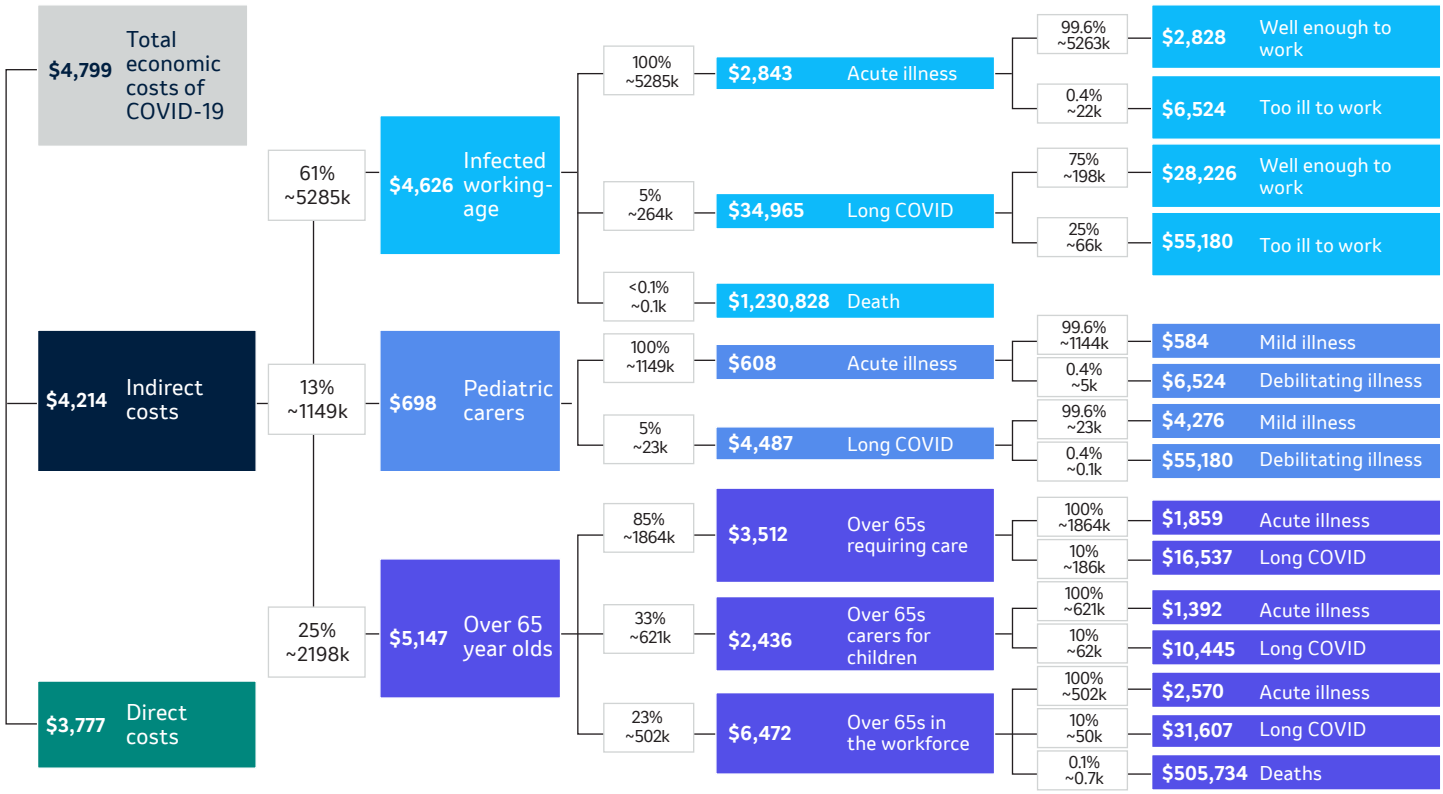
21. Based on a median monthly earnings figure of $18,700 as at 2021 May-Jun. Hong Kong SAR government press release [Internet]. Survey results of 2021 Annual Earnings and Hours Survey. Available from: https://www.info.gov.hk/gia/general/202203/21/P2022032000685.htm
22. Johnsen S. et al. ERJ Open Research [Internet]. Descriptive analysis of long COVID sequelae identified in a multidisciplinary clinic serving hospitalised and non-hospitalised patients.2021 Aug 2; 7: 00205-2021. Available from: https://openres.ersjournals.com/content/erjor/7/3/00205-2021.full.pdf

Infections in the older population account for HKD ~12.6 billion p.a., or ~30% of all direct and indirect costs combined, serving as a stark reminder of the need to address the cost of infections in the older population.

Finally, infections in children impose an additional economic cost of HKD ~802 million p.a. owing to productivity losses borne by adults who are absent from or less productive at work while caring for children. As with productivity losses from the older population, 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 (~96%) of productivity losses in adults caring for children with acute illness, is worth HKD ~670 million p.a. This cost is driven by care for ~234,000 mild but symptomatic infections in children, who despite having a mild illness require one parent to care for them at home. The remaining ~4% is driven by productivity losses from caring for children with debilitating infections. For parents who can work from home (~45%), productivity is estimated to halve, while parents who cannot (~55%) lose all productivity. This is a substantial cost driven more by lost work than the illness itself, another demonstration that the substantial cost of productivity losses is not limited to infections in working-age adults.

Exhibit 7: Indirect economic costs from COVID-19, per person, base case, HKD 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 inpatient care; Long COVID refers to a small subset (~5%) of total infections and represents infections with symptoms lasting 12 weeks or more.

Despite their seemingly lower resource intensiveness compared to direct healthcare costs, indirect costs from COVID-19 are nearly as expensive on a per-person basis (as indicated in Exhibit 7) due to the massive loss of productivity – with each infection costing HKD ~4,214 on average. This is concentrated in productivity losses resulting from infections in the working-age (HKD ~4,626 per person) and older population (HKD ~5,147 per person).

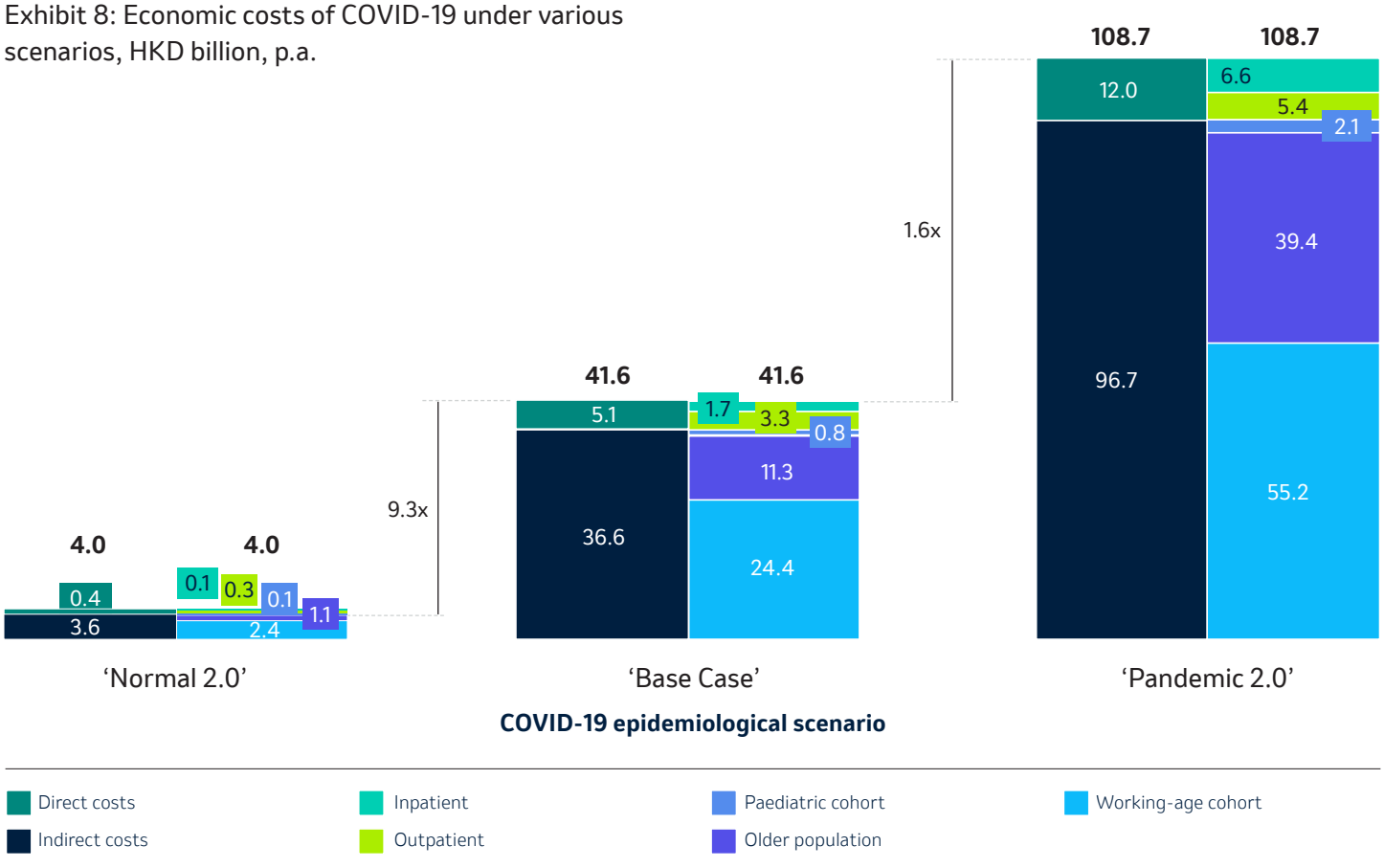
Together, economic costs arising from productivity losses in these age groups amount to HKD ~36.6 billion p.a. or ~1.2% of Hong Kong's GDP, which is in addition to the value of lost health and direct costs to Hong Kong's health system. Although already substantial, these costs likely underestimate the entirety of the burden imposed on society by COVID-19, including second-order impacts on health system capacity and ripple effects on the health workforce, supply chains, and other aspects of critical industry that all add measurable economic impacts.

In fact, the whole economic burden imposed by COVID-19 needs to be understood in the context of the prevailing epidemiological scenario, as the impacts and costs described can significantly increase in plausible scenarios where novel variants emerge. These scenarios 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.

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



Normal 2.0 refers to a scenario featuring ~120,000 infections per million population and ~2,500 hospitalizations, reflecting conditions observed in mid-2022; Pandemic 2.0 refers to a scenario featuring ~2.1 million infections per million population and ~108,000 hospitalizations, reflecting conditions observed in early 2022.

In a Pandemic 2.0 scenario, total economic costs could reach HKD ~108.7 billion p.a. Conversely, in the Normal 2.0 scenario, economic costs could drop to HKD ~4.0 billion p.a.

These scenarios represent two divergent but plausible epidemiological outcomes amid the evolving pandemic. Each scenario is theorized using two key features:

- Infection volume (driven by contagiousness; measured by cases per million people 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 ~2.1 million cases per million population per year (i.e., the entire population is infected twice on average) and a case severity where ~0.7% of all infected people are hospitalized. By comparison, the base case scenario assumes a case volume of ~1.2 million infections per million people and a hospitalization rate of 0.4%.

In the Pandemic 2.0 scenario, economic impacts from COVID-19 could increase to HKD ~108.7 billion p.a., equating to ~3.8% of GDP and HKD ~7,034 per person. Direct costs could be HKD ~12.0 billion p.a. (a 2.4X increase of HKD ~6.9 billion p.a.) and indirect costs could reach HKD ~96.7 billion p.a. (a 2.6 times increase of HKD ~60.1 billion p.a.). These increases would be driven by the higher case volume, increased hospitalization rates, longer lengths of stay, and exacerbated productivity losses due to an increased incidence of debilitating illness and longer periods of missed work.

The sharp rise in costs that could result from a plausible epidemiological scenario like this demonstrates the need for a range of preparedness settings, including options to limit impacts at every stage.

A Normal 2.0 scenario would feature a case volume of ~120,000 cases per million population per year and a hospitalization rate of 0.3%. Under a Normal 2.0 scenario, economic impacts from COVID-19 could diminish to HKD ~4.0 billion p.a., equating to ~0.1% of GDP and HKD ~4,323 per person. Direct costs could decrease to HKD ~400 million p.a. and indirect costs to HKD ~3.6 billion p.a. Decreases in costs would be driven by the lower case volume, 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 costs. Equally important to consider are the broader 'second order' impacts that COVID-19 could have on health system capacity and ripple effects on vulnerable populations and critical industries.

3.4 Considerations For Particular Cohorts And Industries

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

Interventions that protect health and avoid productivity losses in these critical industries and populations may yield similarly significant economic returns. Disruptions to these groups also cause significant economic and societal concern and may be worthy of closer focus when considering countermeasures 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 one industry in particular: healthcare.

The economic costs of COVID-19 borne by critical industries and their stakeholders may increase in a Pandemic 2.0 scenario. Critical workers who 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 1-2 workdays) than for individuals in desk jobs.

3.4.2 Healthcare

Hong Kong's health system serves as our first and last line of defense against COVID-19 and other health threats. Healthcare expenditure totaled HKD ~190 million in 2019/20[23] and ~117,000 healthcare professionals are currently employed in Hong Kong.[24]

At a potential minimum cost of HKD ~793 million p.a. (~1.9% of the combined total cost),[25] healthcare workers who catch COVID-19 represent a disproportionate slice of the impact on the economy. However, this is likely a significant underestimation of the total impact on the Hong Kong economy and citizens' welfare due to ripple effects on patient outcomes.

Frontline healthcare workers are at high risk of contracting COVID-19 due to their high exposure risk. At the Queen Mary Hospital during the fifth COVID-19 wave, 25% of healthcare workers tested positive, a significantly higher infection rate than the general population (16%).[26] Of those healthcare workers infected, 79% were symptomatic.[27] Productivity losses are not only incurred by sick workers but also by the remaining workers who are required to take up additional responsibilities.

The economic ripple effects of COVID-19 among healthcare workers are significant, as COVID-19 exacerbates (pre-existing) workforce shortages. In March 2022, waiting times for an ambulance rose to 39 hours, with only 30% of emergency calls being responded to within the target time of 12 minutes.[28] During December 2022, Hong Kong residents faced emergency department wait times of at least 8 hours and up to 20 hours.[29] Such reductions in the availability and timeliness of medical care may subsequently lead to prolonged illness or recovery times for patients, many of whom lose productivity in the process.

Additionally, during the COVID-19 pandemic, high levels of workforce anxiety and burnout have been seen.[30] Although the initial response to the COVID-19 pandemic has subsided, global talent shortages and mobility challenges are ongoing challenges.

---

23. Hong Kong Health Bureau [Internet]. Domestic Health Accounts, June 2021. Available from: https://www.healthbureau.gov.hk/statistics/en/dha/dha_summary_report.htm
24. Department of Health [Internet]. Health Facts of Hong Kong, 2022 edition. Available from: https://www.dh.gov.hk/english/statistics/statistics_hs/files/2022.pdf
25. Based on a median monthly earnings figure of $19,900. Hong Kong Census and Statistics Department [Internet]. Report on Annual Earnings and Hours Survey 2021. 2022 Mar. Available from: https://www.censtatd.gov.hk/en/data/stat_report/product/B1050014/att/B10500142021AN21B0100.pdf
26. Wong SC et al. Infection of healthcare workers despite a high vaccination rate during the fifth wave of COVID-19 due to Omicron variant in Hong Kong. Infection Prevention in Practice. 2023 Mar; 5(1): 100261. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9705264/
27. As above.
28. Wong N. South China Morning Post [Internet]. Coronavirus: Hong Kong residents wait up to 39 hours for ambulance as health care system buckles under strain of COVID-19 cases. South China Morning Post [Internet]. 2022 Mar 1. Available from: https://www.scmp.com/news/hong-kong/society/article/3168736/coronavirus-hong-kong-residents-wait-39-hours-ambulance
29. Chan K, Cheung L. South China Morning Post [Internet]. COVID-19 patient waits 20 hours in A&E as Hong Kong hospitals become overwhelmed. South China Morning Post [Internet]. 2022 December 27. Available from: https://www.scmp.com/video/coronavirus/3204671/COVID-19-patient-waits-20-hours-ae-hong-kong-hospitals-become-overwhelmed
30. Yeung N. et al. Feeling anxious amid the COVID-19 pandemic: Factors associated with anxiety symptoms among nurses in Hong Kong. Frontiers in Psychology. 2021 October 1; 12: 748575. Available from: https://www.frontiersin.org/articles/10.3389/fpsyg.2021.748575/full#:~:text=facilitate%20well%2Dbeing.-,Conclusion,anxiety%20symptoms%20among%20those%20nurses.

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

3.4.3 Vulnerable populations

COVID-19 illness in Hong Kong's vulnerable populations represents a minimum impact of HKD ~16.1 billion p.a. on Hong Kong'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 60 years old and those with comorbidities.

COVID-19 in Hong Kong's older population (60 years old and above) could have an economic impact of HKD ~12.6 billion p.a. (~30% of the combined annual impact). This is significant on a per-person basis too, at HKD ~5,732. Despite representing ~25% of confirmed cases, the older population represents a significantly higher proportion of deaths, with ~96% of deaths due to COVID-19 occurring in people over 60 years old.[31] This is unsurprising, as the prevalence of comorbidities is particularly high in this age group. 70% of the elderly in Hong Kong have at least one chronic disease.[32]

Costs from those with comorbidities in the younger, working-age population could also have a disproportionate impact of HKD ~3.5 billion p.a. Just one comorbidity doubles the risk of severe COVID-19,[33] subsequently increasing the likelihood of hospitalization and prolonging time off work to recover. This could be a reality for ~24% of people in Hong Kong.[34]

Given that ~39% of combined direct and indirect costs are borne by these vulnerable populations, countermeasures that reduce the duration of illness and/or time to recovery for this group alone could significantly mitigate the costly impacts of COVID-19. Countermeasures may include ongoing vaccination, community measures, and/or the use of oral antivirals. Indeed, infections in individuals eligible for oral antivirals account for HKD ~16.1 billion p.a. in economic costs or ~39% of the total economic costs to Hong Kong.

3.4.4 Long COVID

Long COVID[35] has a potential minimum impact of HKD ~15.9 billion p.a. on Hong Kong's economy. Individuals who develop this condition experience prolonged productivity losses (increasing 'indirect costs') and rely on health services (increasing 'direct costs').

Direct costs due to long COVID collectively amount to at least HKD ~1.2 billion (HKD ~2,731 per person), which is largely the cost of consultations. This figure is driven by the incidence, relative complexity, and duration (90 days) of long COVID. When case complexity and duration are factored in, this could mean ~2.6 million healthcare consultations are required for this cohort alone.[36] Therefore, long COVID represents a substantial burden on the health system, both in terms of capacity requirements and economic costs.

31. Coronavirus website of the Hong Kong authorities (figures from the Centre for Health Protection of the Department of Health; and the Hospital Authority). Statistics on 5th Wave of COVID-19 [Internet]. 2023 Jan. Available from: https://www.coronavirus.gov.hk/pdf/5th_wave_statistics/5th_wave_statistics_20230129.pdf
32. Hong Kong SAR Department of Health, Elderly Health Service. Coping with Chronic Illness [Internet]. 2023 Feb. Available from: https://www.elderly.gov.hk/english/healthy_ageing/mental_health/coping_with_chronic_illness.html
33. Liu B. et al. High risk groups for severe COVID-19 in a whole of population cohort in Singapore. BMC Infectious Diseases. 2021 July 16; 21(1): 685. Available from: https://bmcinfectdis.biomedcentral.com/articles/10.1186/s12879-021-06378-z
34. Hong Kong SAR Census and Statistics Department [Internet]. Special Topics Report, Report No. 63: Persons with disabilities and chronic diseases. December 2021. Available from: https://www.censtatd.gov.hk/en/EIndexbySubject.html?pcode=C0000055&scode=380
35. 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.
36. Estimating ~432,000 long COVID cases, where each case could require 6 consultations on average over the 90-day period of long COVID illness.

Productivity losses from long COVID could amount to HKD ~14.7 billion p.a. (HKD ~33,799 per person and ~40% of all indirect costs). By a significant margin, the largest contributor is productivity losses arising from long COVID in the working-age population (HKD ~9.2 billion p.a. or ~63% of indirect costs from long COVID). To illustrate this further, an adult with long COVID, despite being well enough to work, could still lose the equivalent of 46 work days over a three-month period of illness while their productivity is impaired.[37]

Given the large share (~38%) of total economic costs that long COVID imposes on the Hong Kong economy, any countermeasures that can reduce the incidence and/or duration of this condition would contribute a great deal to mitigating economic costs associated with the pandemic. As evidence surrounding the incidence and course of long COVID is nascent, with conservative estimates placing incidence at 5% and duration at 90 days, it may emerge that these impacts are underestimates.

37. Based on an average of nine days of sick leave and reported reductions in productivity while working, due to long COVID.

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.

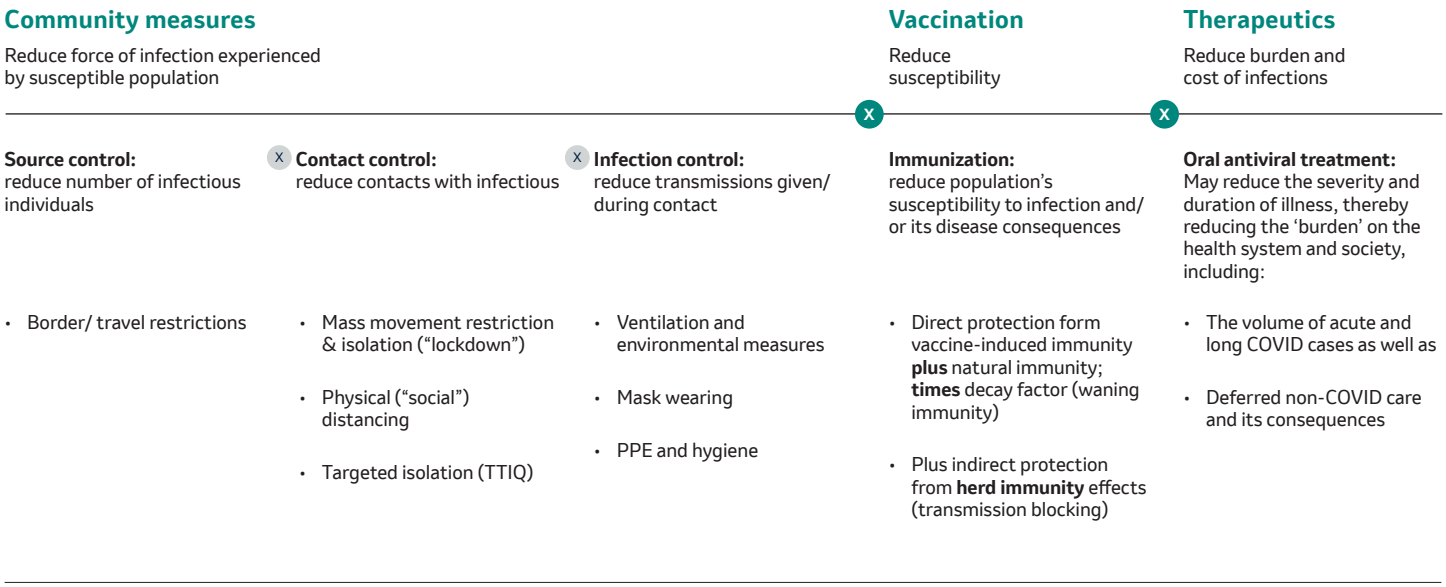
However, despite significant ongoing economic costs, uptake of these countermeasures has been incomplete. Examples of incomplete uptake include waning uptake of booster vaccination doses, and variable awareness and availability of oral antivirals. There is an opportunity for policymakers to consider 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 Hong Kong, 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 Hong Kong were among the lowest in the developed world. 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. The resulting reduced population immunity has been challenging, as novel variants have emerged, including Omicron.

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 the Hong Kong 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.

4.1.2 Vaccines – reducing population susceptibility

COVID-19 vaccines have had a significant benefit to economies, in addition to health outcomes for individuals. Hong Kong has achieved high rates of vaccination relative to international peers, with 93% of the population having received two doses.[38] By reducing the population's susceptibility (both directly for the recipient of the vaccine and indirectly by reducing the risk of onward transmission),[39] 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.

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.[40]

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.[41]

There may be an opportunity to broaden the use of therapeutics. Currently, populations that are eligible for oral antivirals could represent ~39% of the economic impact of COVID-19 in Hong Kong, assuming high levels of uptake. Given the challenges associated with community measures, and that Hong Kong has already achieved high vaccination coverages, investment in therapeutics for a broader population, if found to be efficacious for a wider cohort in reducing time to symptom resolution, could be a subsequent consideration in Hong Kong's response.

38. Government of Hong Kong Special Administrative Region [Internet]. Hong Kong Vaccination Dashboard. 2023 Feb 5. Available from: https://www.covidvaccine.gov.hk/en/dashboard
39. 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
40. 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/
41. 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 Hong Kong

Exhibit 10: Summary of countermeasures in Hong Kong

	Community measures	Vaccination	Therapeutics
2022	• **Mask wearing** - remains compulsory in both indoor and outdoor settings • **Isolation** - mandated isolation lifted January 2023 - Previously required for positive cases either in hospital or at community isolation facilities - Close contacts required 14 days of home quarantine (February 2022) • **Social distancing** - As at December 2022, maximum group gathering size of 12 people	• Two vaccinations available - Comirnaty and CoronaVac - Three doses recommended: additional fourth dose recommended for >50 years old and immunocompromised • 93% of the population have had two vaccine doses; 84% have received three doses	• Hospital Authority has made available nirmatrelvir/ritonavir and molnupiravir in February 2022 - Eligibility criteria include ≥60 years old, or at high risk of medical illness. or with chronic illnesses
2020-21	• **Border restrictions** - international borders closed for 2020-21, only opened to passengers from Mainland China, Taiwan or Macao in March 2022 • **Contact tracing** - LeaveHomeSafe app launched in November 2020 for contact tracing	• Secretary for Food and Health authorized Fosun Pharma/BioNTech (Comirnaty) and Sinovac Biotech Limited (CoronaVac) vaccines in Hong Kong on 25 January and 18 February 2021 respectively	

As of February 6, 2023.[42,43,44,45,46,47]

42. The Government of the Hong Kong Special Administrative Region [Internet]. COVID-19 Thematic Website. Available from: https://www.coronavirus.gov.hk/eng/index.html
43. Ancheta T. Timeout [Internet]. Things you need to know about Hong Kong's social distancing restrictions. 2023 Mar 3. Available from: https://www.timeout.com/hong-kong/things-to-do/things-you-need-to-know-about-hong-kongs-social-distancing-restrictions
44. Cheung E, Heung S. South China Morning Post [Internet]. Exodus of COVID-19 patients from isolation centres as Hong Kong ends compulsory isolation. 2023 Jan 30. Available from: https://www.scmp.com/news/hong-kong/health-environment/article/3208447/private-doctors-prepare-surge-covid-19-patients-hong-kong-ends-mandatory-isolation
45. The Government of the Hong Kong Special Administrative Region [Internet]. Government relaxes certain social distancing measures. Available from: https://www.info.gov.hk/gia/general/202212/20/P2022122000646.htm
46. The Government of the Hong Kong Special Administrative Region [Internet]. COVID-19 Vaccination Programme. Available from: https://www.covidvaccine.gov.hk/en/dashboard
47. News.gov.hk [Internet]. COVID-19 antiviral eligibility relaxed. Available from: https://www.news.gov.hk/eng/2022/07/20220729/20220729_170528_537.html

5. Conclusion

After implementing strict and long-standing anti-pandemic measures,[48] Hong Kong lifted its last major COVID-19-related restrictions in early 2023.[49] Nevertheless, the city's crowded conditions, aging population, and role as an international travel hub mean that COVID-19 (like other communicable diseases) continues to pose a heightened risk.[50,51,52] There is also a danger that the full economic impact of COVID-19 can get lost in the gap between yesterday's health emergency and today's desire to return to life as usual.

Indeed, the ongoing economic cost of COVID-19 on Hong Kong could range from a most optimistic HKD ~4.0 billion p.a. (~0.1% of GDP) to a worst-case scenario of HKD ~108.7 billion p.a. (~3.8% of GDP). In a base case scenario, where current conditions prevail, the economic costs could be HKD ~41.6 billion p.a. (~1.4% of GDP).

The findings in this report shed light on the many factors and considerations that have contributed to Hong Kong's COVID-19 response, and are intended to help policymakers plan better for that future.

5.1 Economic costs

In our base case scenario, the total economic cost of COVID-19 is HKD ~41.6 billion p.a. or ~1.4% of GDP, with:

- Direct costs to the health system accounting for 12% of the total economic cost. Health system costs could amount to HKD ~5.1 billion p.a., driven by an estimated ~36,000 hospitalizations and ~434,000 cases of long COVID.
- The remaining 88% of costs due to productivity losses through missed work by both working-age adults as a result of their own illness or while caring for dependents (children and over-60-year-olds); as well as elderly people in the workforce affected by COVID-19. These indirect costs could cost the Hong Kong economy HKD ~36.6 billion p.a.
- COVID-19 illness in Hong Kong's vulnerable populations, which includes those over 60 years old and those with comorbidities, representing a minimum impact of HKD ~16.1 billion p.a. to Hong Kong's economy. Of this cost estimate, infections in elderly Hong Kong residents alone could account for HKD ~12.6 billion p.a.

In the 'Pandemic 2.0' scenario, economic costs could reach up to HKD ~108.7 billion p.a., or ~3.8% of GDP. This assumes transmission rates that could result in ~15.5 million infections p.a. (instead of ~8.7 million in the base case) and a severity that could result in ~108,000 hospitalizations p.a. (compared with ~36,000 in the base case). At the lower end of the spectrum, a 'Normal 2.0' scenario might see ~928,000 infections over the course of a year with ~2,500 hospitalizations, which would translate to a total economic cost of HKD ~4.0 billion p.a. Regardless of the epidemiological scenario, COVID-19 will continue to have a major impact, both on those who need medical care and on the wider economy.

48. Master, F. Reuters [Internet]. Analysis: Hong Kong's 'zero-COVID' success now worsens strains of Omicron spike. 2022 Feb 21. Available from: https://www.reuters.com/world/china/hong-kongs-zero-covid-success-now-worsens-strains-omicron-spike-2022-02-19/
49. Cheung E., Yiu W., Ng K. South China Morning Post [Internet]. Smiles in the street once again: Hong Kong scraps Covid mask rule after nearly 3 years. 2023 Feb 28. Available from: https://www.scmp.com/news/hong-kong/health-environment/article/3211759/hongkongers-have-reason-smile-city-scrap-indoor-outdoor-covid-mask-rules-after-3-years?module=inline&pgtype=article
50. Wang V., May T. New York Times [Internet]. In 'Coffin Homes' and 'Cages,' Hong Kong Lockdown Exposes Inequality. 2021 Jan 26. Available from: https://www.nytimes.com/2021/01/26/world/asia/hong-kong-coronavirus-lockdown-inequality.html
51. Wong K., Yeung M. Population ageing trend of Hong Kong. Office of the Government Economist. 2019 Jan. Available from: https://www.hkeconomy.gov.hk/en/pdf/el/el-2019-02.pdf
52. Hong Kong government policy address. Factsheet: International Aviation Hub. 2021 Oct. Available from: https://www.policyaddress.gov.hk/2021/eng/pdf/publications/14-5/05_Factsheet-Intl-Aviation-Hub.pdf

Health system capacity

While an ongoing direct cost of HKD ~5.1 billion p.a. may seem small against the indirect cost of HKD ~36.6 billion p.a., this can be a considerable burden when looked at on a per-person basis. For instance, a single ward admission costs HKD ~32,640, while an ICU admission costs HKD ~205,440. In contrast, the cost of outpatient care is substantially lower, at just HKD ~2,558 per person. This reinforces the need to continue testing and ameliorate the severity of the illness to reduce dependency on services.

Similarly, long COVID also places further demand on Hong Kong's health system. Our analysis finds that direct costs due to long COVID amount to at least HKD ~1.2 billion (HKD ~2,731 per person), driven by the expected ~2.6 million additional healthcare consultations that will be required to care for this cohort alone. While millions of people in Hong Kong are estimated to have experienced long COVID to date, clinicians agree that early treatment will remain critical to reducing onset of severe illness and easing demand on health services.[53]

Workers and critical industries

Within Hong Kong's economy, there is an unequal distribution of the impact of COVID-19. Some critical industries experience disproportionate workforce productivity losses. In this report, we focus on the challenges that the health workforce faces. Indeed, Hong Kong's health workforce faces staff shortages and a high risk of infection, thus affecting health system capacity and quality of care.

According to our base case scenario, economic costs arising from these disruptions to the health workforce could total HKD ~793 million p.a. However, as this report points out, the cost could be significantly higher due to the ripple effect that workforce shortages have on health service provision and patient outcomes.

High levels of workforce burnout and anxiety have already been reported in Hong Kong throughout the pandemic. Both these workforce challenges are expected to persist to certain degrees under all future scenarios.

Vulnerable populations

Regardless of the epidemiological scenario, the economic costs of COVID-19 fall unevenly on the community's most vulnerable.

Hong Kong's vulnerable populations, which include those over 60 years old and working-age adults with comorbidities, stand to be among the most severely impacted by COVID-19's ongoing cost. Under the base case scenario, they account for HKD ~16.1 billion p.a., or ~39% of total economic costs. This is largely due to their heightened susceptibility to COVID-19 and higher dependence on health services.

Amongst the vulnerable populations, older people are heavily impacted, accounting for HKD ~12.6 billion p.a. Likewise, younger, working-aged people with comorbidities account for another HKD ~3.5 billion p.a. It is worth noting that the presence of just one comorbidity doubles the risk of severe COVID-19, raising the likelihood of severe illness, hospitalization, and time off work.

There is also a flow-on cost for families, particularly those with elderly relatives. Many Hong Kong families rely on the older generation (e.g., grandparents) to care for children, enabling parents to work. However, when this work-enabling care is disrupted, the productivity loss amounts to HKD ~1.5 billion.

53. Heung S. More than 2 million people in Hong Kong may have suffered from long Covid, ongoing study finds. South China Morning Post. 2022 Oct 16. Available from: https://www.scmp.com/news/hong-kong/health-environment/article/3196145/2-million-people-hong-kong-may-have-suffered-long

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 Hong Kong's 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 Hong Kong in February 2022, have the potential to further curb the economic impact of COVID-19 by helping to reduce the disease burden. There may also be an opportunity to broaden the use of therapeutics, given that the cost of medications (such as oral antivirals, HKD ~1.8 billion p.a.) equates to just 4% of total economic costs, representing a small investment towards partially reducing a large burden of direct and indirect costs. Enabling a broadened use of therapeutics could aid in reducing the severity of COVID-19 symptoms, thereby softening its blow to productivity.

As has been described, the costs of the pandemic on Hong Kong 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

Hong Kong

Exhibit A1: Key overall assumptions

3rd Level	4th/5th Level	Value	Source	Commentary
Total	Total COVID-19 infections	8,676,159	The Institute for Health Metrics and Evaluation (IHME) (released December 16, 2022)	• ~Q4 2022 annualized • Note: IFR ratio is 0.04%. IHME corrects to ensure reported deaths reflect actual deaths due to COVID-19
	Total COVID-19 cases (detected)	2,867,629		
	Total COVID-19 deaths	3,373		

Exhibit A2: Key direct cost assumptions

3rd Level	4th/5th Level	Parameter Name	Value	Source	Commentary
Inpatient		Hospitalization rate	0.41%	Institute for Health Metrics and Evaluation	• Rolling average hospitalization rate for Q4 2022
		Number of admissions	35,882	Calculation	• Total infections (~8.68mn) multiplied by hospitalization rate
	Moderate	Ward admission rate	91%	Institute for Health Metrics and Evaluation	• IHME-modelled number of required hospital beds versus number of required ICU beds
		Ward length of stay	6.4 days	Hong Kong Hospital Authority	• Average length of stay of 6.4 days for inpatients of general specialties over 2021-2022
		Ward bed day cost	HKD 5,100	Hong Kong Hospital Authority	• Daily un-subsidized cost for inpatient (general hospitals) – cost is all inclusive
	Severe	ICU admission rate	9%	Institute for Health Metrics and Evaluation	• Modelled number of required ICU beds as proportion of required hospital beds
		ICU length of stay	5 days	Journal of Emergency and Critical Care Medicine Queen Elizabeth Hospital, Hong Kong	• Mean ICU length of stay – assessment of 8,037 records over an 8 year period
		ICU bed day cost	24,000	Hong Kong Hospital Authority	• Daily un-subsidized cost for intensive care ward/ unit – cost is all inclusive

Exhibit A2: Key direct cost assumptions (continued)

3rd Level	4th/5th Level	Parameter Name	Value	Source	Commentary
Inpatient	Severe (cont.)	Proportion of ICU admissions requiring subacute care	50%	Annals of Intensive Care British Medical Journal	• 45-50% of COVID patients admitted to ICU required rehabilitation or subacute care
		Subacute length of stay	17.6 days	Hong Kong Hospital Authority	• Average length of stay for public inpatient rehabilitation services over a one year period
		Subacute bed day cost	HKD 6,000	Australian Independent Hospital Pricing Authority	• Hospital pricing authority data form comparable health system (Australian independent hospital pricing authority) indicates subacute bed day costs are approximately 1.2 times ward bed day costs

Exhibit A2: Key direct cost assumptions (continued)

3rd Level	4th/5th Level	Parameter Name	Value	Source	Commentary
Outpatient	Acute	Number of acute outpatient infections	8,640,277	Calculation	• Total infections (~8.68mn) minus number of hospital admissions
		Proportion of total infections that visit an Emergency Department	0.1%	Institute for Health Metrics and Evaluation Australian Institute of Health and Welfare	• Very limited data for Hong Kong; assumption based on triangulation of two sources in Australia
		Number of ED visits per year for COVID	9,151	Calculation	• Number of acute outpatient infections multiplied by 0.1%
		Cost per Emergency Department visit	HKD 1,230	Hong Kong Hospital Authority	• Full/un-subsidized cost per accident and emergency attendance
		Proportion of infections prescribed OAV	3.4%	Hong Kong Legislative Council	• Known ~300k prescriptions in 2022, divided by number of annual infections (~8.68mn)
		Proportion of total infections that visit a GP	~10%	Hong Kong Legislative Council Calculation based on known volumes of OAV prescriptions	• Assumes approximately 1 in 3 primary care visits for COVID results in an OAV prescription
		Cost per GP visit	HKD 445	Hong Kong Hospital Authority	• Full/unsubsidized cost per primary care visit
		Number of infections prescribed medication	293,769	Calculation	• Number of outpatient infections (~8.64mn) multiplied by the proportion of infections prescribed OAV (3.4%)

Exhibit A2: Key direct cost assumptions (continued)

3rd Level	4th/5th Level	Parameter Name	Value	Source	Commentary
Outpatient	Chronic	Incidence of Long COVID	5%	National Centre for Infectious Diseases	• Estimates incidence of long COVID to be ~5% among vaccinated population and ~10% among unvaccinated population
		Average duration of Long COVID	12 weeks	World Health Organization	• Globally accepted consensus on duration of Long COVID of 12 weeks
		Average number of clinic visits per Long COVID patient	6	Calculation	• Very limited data; 1 clinic visit per fortnight over 12-week illness

Exhibit A3: Key indirect cost assumptions

Parameter		Value	Source	Commentary
Age distribution of infections	Working-age	61%	• Statistics on 5th Wave of COVID-19 – Centre for Health Protection of the Department of Health, and the Hospital Authority	• Time period: 31 Dec 2021 to 29 Jan 2023
	Pediatric carers	13%		
	Elderly	25%		
Cross-cutting assumptions	Acute illness	100%		• Assume all COVID-19 infections experience short-term 'illness' which can be symptomatic or asymptomatic
	Long COVID – for working-age population	5%	• 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
	Detected	33%	• The Institute for Health Metrics and Evaluation (IHME) (released December 16, 2022)	• Calculated based on cases divided by total infections for comparable timeframe as infections assumption
	Proportion of people who isolate while symptomatic	32%	• Bupa Hong Kong – Wellness@Work Research (2016)	• 68% of respondents who were sick in the past year still went into work while ill

Exhibit A3: Key indirect cost assumptions (continued)

Parameter			Value	Source	Commentary
Specific to working-age and elderly	Acute - well enough to work	Proportion of acute infections well enough to work	99.6%	• The Institute for Health Metrics and Evaluation (IHME)	• Modelled based on infection to hospitalization rate – assumes well enough to work if not hospitalized
		Proportion of people who can work from home	45%	• South China Morning Post (2022)	• "Only 45 per cent have that option to work from home"
		Duration of acute illness	12 days	• Medline (2022)	• 10-14 days for mild to moderate illness
		Average number of days too ill to work / fully taken off work with COVID-19	3 days	• The Straits Times (2013) and Channel News Asia (2022) – extrapolated from Singapore sources	• "Employees use up, on average, only about four days of their outpatient sick leave" but "68% did not take any leave for 12 months" • Assumes not all sick leave would typically be used in one illness, but residents may be more likely to take sick leave for COVID-19 • 3 days of 0% work (e.g. sick leave taken and/or too sick to work at all) assumed for each acute COVID-19 infection – in line with Australia's model also
		Productivity loss on days worked while ill	35%	• European Respiratory Society	• Cross-Sectional study of positive COVID-19 diagnosis. 3 months after discharge or resolution of acute disease. Uses WPAI. 35% work impairment for non-hospitalized and 10% for hospitalized, 20% overall; make conservative estimate that long-COVID symptoms cause same level of productivity loss as when working with acute illness.
		Median monthly earnings	$18,700	• Census and Statistics Department	• Median monthly wage May-Jun 2021
	Acute – too ill to work	Duration of acute debilitating (inpatient) illness	10.6 days	• See direct cost length of stay assumptions	• Weighted average LOS from direct model: 7.6 days • + Recovery time at home (off work) assumed to be ~3 days (same as outpatient)
	Long COVID – well enough to work	Average # of days taken as sick leave from work	9 days	• European Respiratory Society	• 2021 Cross Sectional study of patients at 3 months who had missed 10% of work time due to health if non-hospitalized

Exhibit A3: Key indirect cost assumptions (continued)

Parameter		Value	Source	Commentary
Specific to working-age and elderly	Proportion of elderly receiving / requiring care from a working-age adult who is not employed as their carer	85%	• Asian Education and Development Studies (Lam et al, 2021) • Research Office Legislative Council Secretariat – Research Brief 2016-2017	• 6.8% of elders institutionalized – 93.2% are not • Of those 93.2%, 9% have Foreign Domestic Workers who can care for them
	Proportion of elderly providing childcare while parents work	33%	• Environmental Research and Public Health (Chen et al, 2022)	• One in three parents in Hong Kong reported that their parents had helped them raise children; 25% of families received intensive childcare from parents, who were the principal child caregivers during the daytime • Assume 33% care for on average 2 days a week
	Proportion of elderly participating in the workforce	23%	• Census and Statistics Department • Research Office Legislative Council Secretariat – Research Brief 2016-2017	• Participation rate for >=65 years old is 13.8% (Oct-Dec 2022) • Participation rate for 60-64 years old is 45.5% • Assumption of 23% of 60+ years old participating in labor force based on weighted average as per population age demographics
	Median monthly income of elderly	$16,904	• Paylab	
Specific to pediatric	Average duration of acute illness	6 days	• Illness duration and symptom profile in symptomatic UK school-aged children tested for SARS-CoV-2 (2021)	• Mean duration of illness is 5-7 days • Assumed to be applicable across all markets (same virus)
	Average productive loss due to providing care for a child with acute mild / outpatient illness	25%	• Macquarie University (2021)	• Australian study of lockdown care coverage used as a p proxy and applicable across markets due to limited availability of data • Survey respondents spent 10.7 hours per week home-schooling (including feeding meals etc.) children, and one or more other adults spent an average of 3.4 hours with the same child = 14.1 hours total (2 hours on average per day)


MSD
INVENTING FOR LIFE