



# A Neglected Burden: The Ongoing Economic Costs of COVID-19 in South Korea

June 2023

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

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# Preface

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

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

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 South Korea's economy. It is inspired and informed by efforts to estimate the economic impact of COVID-19 in other economies.<sup>1,2</sup>

The discussion that follows is based on information available at the time of writing, and sources are provided throughout the text. Estimates are based on epidemiological scenarios that extrapolate market-specific hospitalization and transmission rates observed

in South Korea during various periods between February 2020 and early 2023. All content and estimates have been reviewed for validity and accuracy at the end of February 2023.

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

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

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

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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 South Korea's economy, with a more thorough assessment of the hidden economic costs to Korean society than has previously been available. Due to a range of factors including its health system, impacts on workforce and business, and demographics, South Korea finds itself susceptible to the ongoing economic toll of COVID-19. As South Korea 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 South Korea 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 the indirect costs of COVID-19's economic impact in South Korea have provided widely varying assessments depending on the type of research carried out, from an estimated cost of USD ~400 million p.a. (taking into account only inpatient costs) to USD ~64 billion p.a. (gauging the net impact on the economy).<sup>3</sup> 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 a base case scenario, the annual economic costs of COVID-19 could reach about KRW 36.2 trillion in South Korea, representing around 1.6% of GDP. In a worst-case Pandemic 2.0 scenario, KRW 122.0 trillion would be lost, around 5.5% of GDP.

We study the direct costs of the disease, such as healthcare costs, as well as indirect costs – i.e., productivity losses due to missed work. Our findings show that indirect costs far outweigh direct costs, accounting for 96% of South Korea's total ongoing economic cost of COVID-19 in the base case scenario. Across all three scenarios, the indirect costs remain the bulk of the economic burden well into the endemic phase of COVID-19.

One important example of such ensuing costs is in the health workforce, which was impacted by high levels of absenteeism and continues to experience a greater risk of infection compared to the wider community. This susceptibility has significant consequences for health system capacity, efficiency, and quality of care. Likewise, South Korea's economically important logistics, as well as travel and tourism sectors, have also been heavily impacted by workforce shortages.

The report 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<sup>4</sup> and working-age adults with one or more comorbidities (such as high blood pressure, cancer, and/or diabetes) are likely to be disproportionately impacted. Meanwhile, individuals affected by long COVID experience prolonged productivity losses, which increase indirect costs and reliance on health services, and this in turn escalates 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

3. These studies had been conducted in USD currency.

4. Older adults refers to those aged 60 and above.

value of lost work and use of health systems due to long COVID is KRW ~12.5 trillion p.a., which amounts to 34% of South Korea's total economic cost of COVID-19.

Part of South Korea's ongoing endemic response may include the strengthening of existing systems and protocols, whether that be community measures such as contact tracing and mask-wearing mandates, other infection control strategies, or medical responses like vaccines and therapeutics. Such efforts can help to ensure that South Korea's population and economy are better prepared for future challenges to the healthcare system, ranging from mild endemics 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 South Korean 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 South Korea'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 South Korea 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 (~1.6% of GDP) and need to be better recognized.

The remainder of this chapter provides an overview of the existing estimates of costs in South Korea, 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 South Korea

### Range of existing estimates of the cost of COVID-19:

**USD ~400 million to USD ~64 billion p.a.** Existing estimates of the costs imposed by COVID-19 in South Korea are limited, with values depending on widely varying methodologies and epidemiological contexts.

**Lower estimate: USD ~400 million.** This estimate reflects only the annualized costs of inpatient care that would arise from the spread of the Omicron variant in late 2021 and early 2022, when the nation was still subject to the majority of response measures employed prior to reopening.<sup>5</sup>

**Higher estimate: USD ~64 billion.** By contrast, this estimate reflects the net impact on national GDP that COVID-19 could have on the South Korean economy, in the context of the earlier variants prevalent in 2020.<sup>6</sup> It also takes into account the change in real value-added growth rates of each industry in the economy, acknowledging that some will contract (e.g., transport, hospitality) while others may in fact grow (e.g., biotech, semiconductors). The net impact, however, is ~3.7% of GDP, which equates to USD ~64 billion.

The disparity in existing estimates of COVID-19's cost impact underscores the conclusion that a more consistent and comprehensive approach to evaluating the costs of the pandemic's impact is required.

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

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

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

5. Jo Y., Kim S., Radnaabaatar M., Huh K., Yoo J., Peck K., Park H., Jung J. Model-based cost-effectiveness analysis of oral antivirals against SARS-CoV-2 in South Korea. *Epidemiology and Health*. 2022 Mar 12; 44: e2022034

6. Kang et al. Bank of Korea, National Statistics Office [Internet]. The Impact of the Covid-19 Pandemic on the Korean Economy and Industry: An Interim Assessment One Year after the Outbreak. 2023 Jan 10. Available from: [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=4192204](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4192204)



# 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 South Korea. 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 South Korea 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,<sup>7</sup> 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.<sup>8</sup> 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.

7. 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>

8. 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 (South Korea) 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 South Korea



In South Korea, the future economic cost of COVID-19 could range from KRW ~7 trillion p.a. (~0.3% of GDP) to KRW ~122 trillion p.a. (~5.5% of GDP), depending on the scenario that evolves. These are far greater costs than commonly recognized. COVID-19 not only inflicts health losses through illness and death but also imposes substantial economic costs, including a direct strain on the healthcare system and productivity losses from missed work.

As a society, South Korea has largely accepted the reality of living with ongoing transmission of the virus and the disease burden this incurs. However, the tools available to reduce this burden have been taken up incompletely. To better inform the ongoing discussion on COVID-19's impacts and the benefits of addressing them, it is fruitful to 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.<sup>9</sup> This is reflected in the wide range of existing estimates for the economic costs resulting from COVID-19 (which also vary depending on the types of interventions studied and the scope of costs included). Possible epidemiological scenarios include a base case, where current conditions prevail, and alternative scenarios that differ in the volume of infections and their severity (driven, for example, by the interplay between variants and the level of immunity maintained in the population).

In the base case scenario, total economic costs could be KRW ~36 trillion p.a. (~1.6% of GDP), with:

- The majority (KRW ~35 trillion p.a., ~96%) due to productivity losses (indirect costs) through missed work by both working-age adults and elderly in the workforce, either during their own illness or while caring for dependents (children and over 60-year-olds) affected by COVID-19;
- A minority (KRW ~1.5 trillion p.a., ~4%) borne by the health system (direct costs), in both the inpatient (KRW ~540 billion p.a.) and outpatient (KRW ~1 trillion p.a.) settings.

In a Pandemic 2.0 scenario, economic costs could reach as high as KRW ~122 trillion p.a. (~5.5% of GDP). (This assumes transmission rates that result in ~103 million infections per year (instead of ~52 million in the base case) and a severity that results in ~1,000,000 hospitalizations (compared with ~155,000 in the base case). In contrast, at the lower end of the spectrum, a Normal 2.0 scenario could result in just ~12 million infections over the course of a year with only ~23,000 hospitalizations, which would translate to direct and indirect costs of KRW ~7 trillion p.a.

9. Institute of Health Metrics and Evaluation [Internet]. COVID-19 Results Briefing - The Western Pacific Region. 2022 Nov 17. Available from: [https://www.healthdata.org/sites/default/files/files/Projects/COVID/2022/44568\\_briefing\\_the\\_Western\\_Pacific\\_Region\\_8.pdf](https://www.healthdata.org/sites/default/files/files/Projects/COVID/2022/44568_briefing_the_Western_Pacific_Region_8.pdf)



**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, economic costs in the health workforce total KRW ~1 trillion p.a. This is driven by high levels of absenteeism and a likelihood of infection that is higher than the wider community, with consequences for health system capacity and quality of care. Those affected by long COVID are impacted most significantly, with the value of lost work and health system utilization totaling KRW ~12.5 trillion p.a. (~0.6% of GDP) or a third of all economic costs. Finally, COVID-19 in vulnerable populations contributes KRW ~18 trillion p.a. (~0.8% of GDP). Almost all of the costs in this category (KRW ~17.4 trillion p.a.; ~48% of total economic costs and ~0.8% of GDP) result from infections in individuals who are eligible for oral antivirals.<sup>10,11</sup>

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

10. Assumes ~19.5% infections are >60 and eligible; assumes ~57.4% infections are aged 19-60 years, of which ~36.5% have a comorbidity and are eligible.

11. Eul H. Journal of Health Informatics [Internet]. Analysis of multiple chronic disease characteristics in South Koreans by age groups using association rules analysis. Journal of Health Informatics [Internet]. 2022 Jan 17. Available from: <https://journals.sagepub.com/doi/full/10.1177/14604582211070208#bibr5-14604582211070208>

## 3.1 Context: The Situation In South Korea

**Today, South Korea is relatively free of restrictive measures.** Most of the community measures employed earlier in the pandemic, such as case isolation, lockdowns, and social distancing have been pared back. In their place, South Korea now has wide vaccine availability and uptake, while other therapeutics such as antivirals are also being used, having been made available to a subset of the South Korean population deemed to be at high risk of developing severe disease, based on their age or other eligibility criteria.

**As of early December 2022, South Korea experienced a reduction in the volume of infections** following its second Omicron wave. With ~20,000 new infections per day on average, and an effective transmission number<sup>12</sup> of ~0.97, infection volumes have been

stabilizing. At the height of South Korea's Omicron wave in March 2022, however, there were ~385,000 new infections per day on average and an effective transmission number of ~1.43 in the month preceding this. By contrast, in October 2021 there were just ~5,300 infections per day,<sup>13</sup> at a time when the nation was still subject to wide-ranging response measures, and before the emergence of the Omicron variant. The

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

13. Directional estimates based on Institute of Health Metrics and Evaluation (IHME; used with permission), 2022 Reference Scenario. Available from: <https://www.healthdata.org/covid/data-downloads>

change in South Korea's pandemic response is both a reaction to the volume of infections, as well as a driver itself of the subsequent infection volume.

**South Korea's initial measures were very effective at containment and suppression of the virus.** By international standards, the countermeasures employed during the first phase of the pandemic (2020 to 2021) were successful. The number of reported cases (~635,000) and deaths (~5,720) were among the lowest in the OECD.<sup>14</sup> However, border closures, social-distancing requirements, strict contact tracing, and mask-wearing mandates still imposed significant hardships on the community and the economy. The successful rollout of vaccines<sup>15</sup> afforded a gradual easing of many restrictions from February 2022 onwards, although the immunity conferred was found to wane over time.

**Oral antivirals have been added to South Korea's response toolkit.** The short-term nature of restrictive community measures and the remaining health threat from COVID-19 led South Korea to broaden its approach to include oral antivirals, which became available in South Korea in January 2022.<sup>16</sup>

**Nevertheless, the health and economic outcomes of the reopening phase have been mixed.** The vast majority (>98%) of South Korea's infections occurred in 2022.<sup>17</sup> While the severity of infections remained relatively mild compared to that seen early in the pandemic, the high volume of infections nevertheless made 2022 the busiest year for the hospital system during the pandemic so far, with an average of ~362 hospital admissions per day, compared to 76 in 2021 and just 26 in 2020. This also translated into the number of deaths increasing significantly, to ~25,770 in 2022 compared to ~4,708 in 2021 and just 917 in 2020.<sup>18</sup>

The high volume of infections has also wrought an economic impact, both in direct costs borne by the health system in addressing COVID-19, and indirect economic losses borne by society in the form of absenteeism and productivity declines. While vaccination coverage has remained widespread, the

use of antivirals has tended to track infection waves, with overall usage remaining relatively uncommon at a prescription rate of ~1.9% of all infections.

Direct and indirect costs will be explored in detail in Sections 3.3.1 and 3.3.2. South Korea's reopening experience has illustrated that the costs of COVID-19 borne by South Korean society extend beyond the value of health losses calculated merely by traditional health technology assessments. Indeed, productivity losses driven by infections across all age groups constitute a major economic cost.

**A better understanding of the economic costs of the pandemic may allow for a more accurate assessment of the costs and benefits of various measures to address COVID-19.**

14. Mathieu E, Ritchie H, Rodés-Guirao L, Appel C, Gavrillov D, Giattino C et al. Our World in Data [Internet]. South Korea: Coronavirus Pandemic Country Profile. 2023 Apr 13. Available from: <https://ourworldindata.org/coronavirus/country/south-korea>

15. As in many international jurisdictions, a vaccine rollout strategy was adopted in 2021 as a conduit for an easing of various restrictions. The resulting population-wide vaccination program (excluding ineligible children) delivered a double-dose national vaccination rate of >80% by January 2022. Lim S, Sohn M. The Lancet Regional Health Western Pacific [Internet]. How to cope with emerging viral diseases: lessons from South Korea's strategy for COVID-19. 2022 Sep 4. Available from: [https://www.thelancet.com/journals/lanwpc/article/PIIS2666-6065\(22\)00196-1/fulltext](https://www.thelancet.com/journals/lanwpc/article/PIIS2666-6065(22)00196-1/fulltext)

16. They are currently available for all COVID-19 positive patients over the age of 12 who are at high risk of severe disease, to be taken within 5 days of symptom onset.

17. There have been ~28 million infections in Korea this year, compared to ~635,000 in 2020-21.

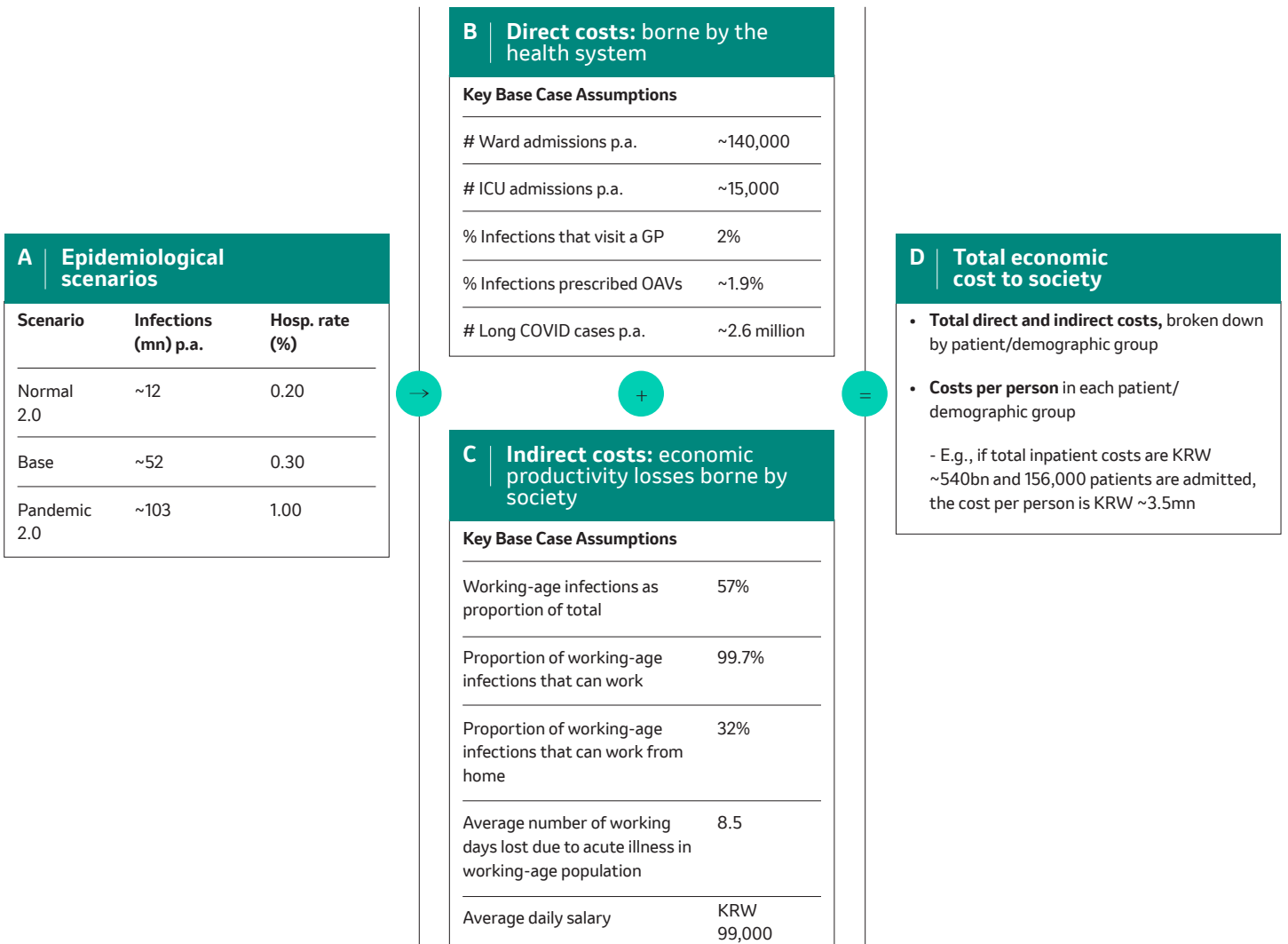
18. Mathieu E, Ritchie H, Rodés-Guirao L, Appel C, Gavrillov D, Giattino C et al. Our World in Data [Internet]. South Korea: Coronavirus Pandemic Country Profile. 2023 Apr 13. Available from: <https://ourworldindata.org/coronavirus/country/south-korea>

## 3.2 Key Assumptions In The South Korean Context

A range of informed assumptions is used to derive estimates for the economic costs in South Korea as a result of COVID. Exhibit 1 illustrates how these

assumptions are used and provides a list of key assumptions used, while a full list of assumptions is given in the Appendix section.

Exhibit 1: Use of assumptions in the South Korean context

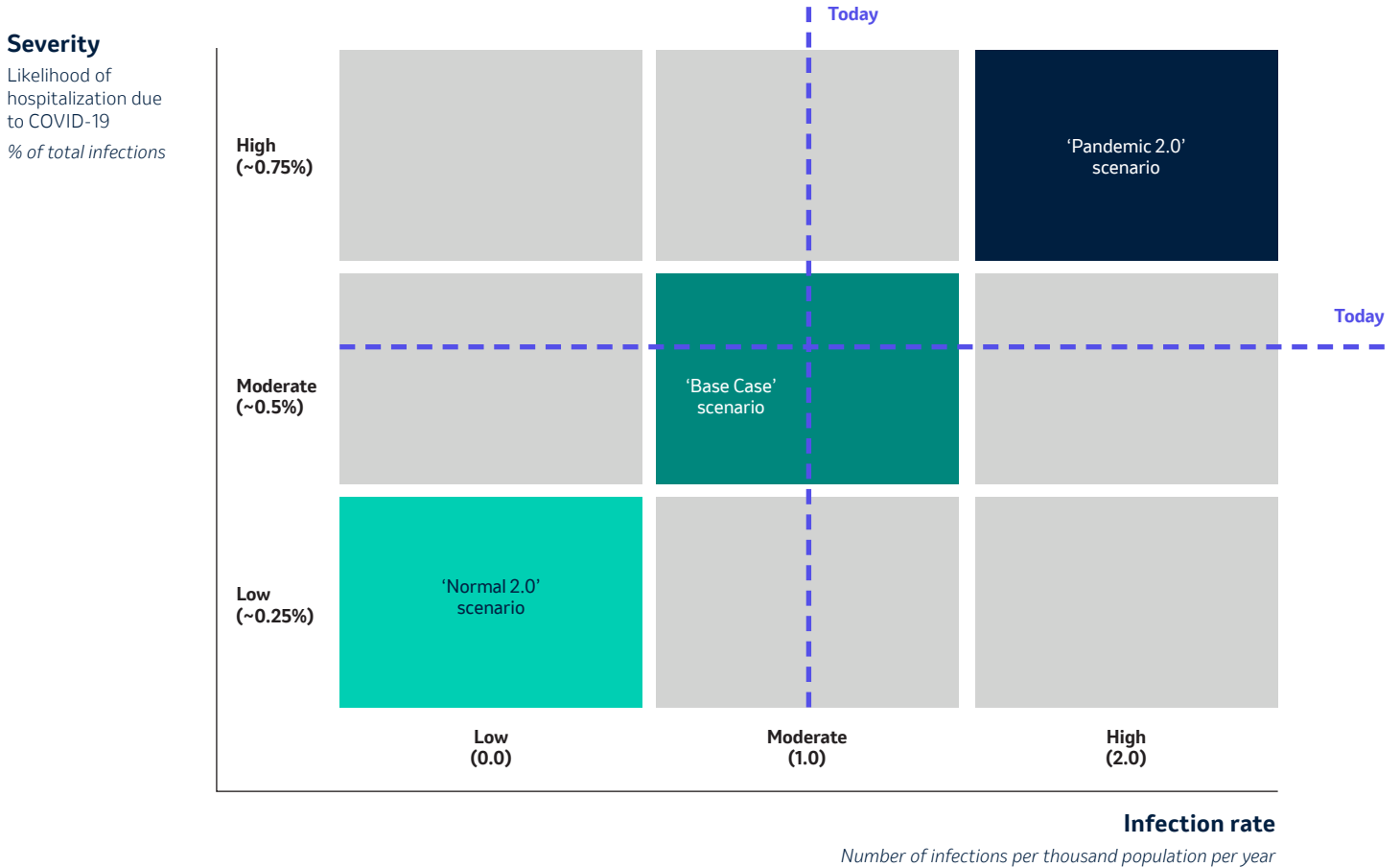


A full list of assumptions is given in the appendix.



# 3.3 Future: Scenario-Based Estimates Of The Economic Costs Of COVID-19 In South Korea

Exhibit 2: Potential epidemiological scenarios



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

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

As illustrated by Exhibit 2, in the South Korean context this could mean:

- A base case, with an economic cost of KRW ~36 trillion p.a. (~1.6% of GDP, and in addition to the value of lost health, such as that already

considered in HTAs), which assumes a rate of infection and a viral severity similar to that seen in Q3-4 2022, i.e., ~1,000,000 infections per million population annually, driving ~155,000 hospital admissions.<sup>19</sup> 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.

19. Infection numbers and hospitalization rates are sourced from modelling of COVID-19 infections in Korea by the Institute of Health Metrics and Evaluation (IHME; used with permission). In Korea, infection numbers are ~twice the number of reported cases, recognizing the volume that is not detected by the testing process.

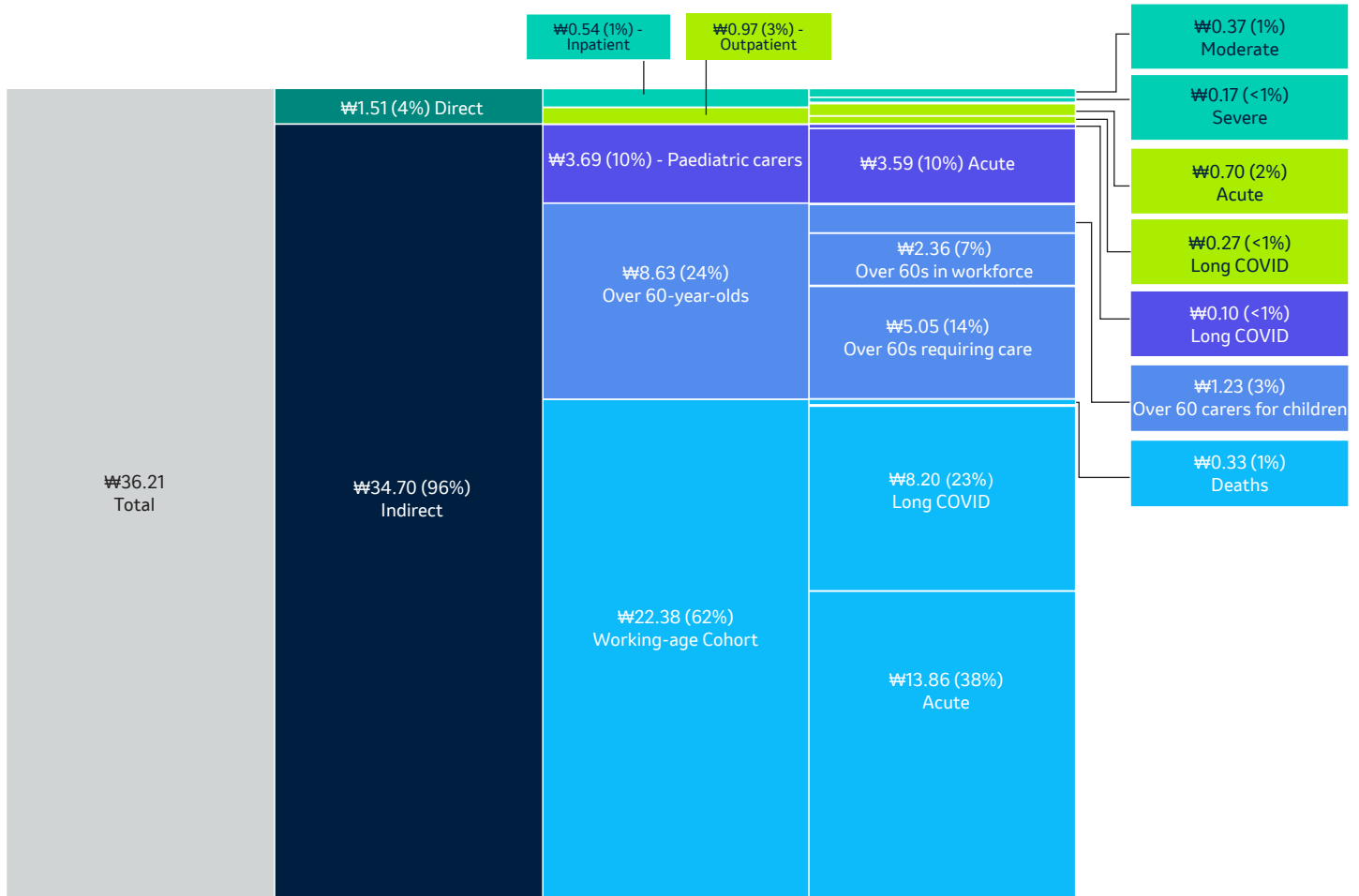
This base case scenario reflects the current COVID-19 isolation mandate of 7 days. If this assumption were to be reduced to just 3 days, the economic impact would be KRW ~32 trillion p.a. (an ~11% reduction).

■ **A high or Pandemic 2.0 case, with an economic cost of KRW ~122 trillion p.a. (~5.5% of GDP)**, which assumes a higher rate of infection and a higher viral severity, reflecting a scenario where each individual contracts the virus twice per year, i.e., 2 million infections per million population per year, driving ~1,000,000 hospitalizations annually.

■ **A low or Normal 2.0 case, with an economic cost of KRW ~7 trillion p.a. (~0.3% of GDP)** which assumes a lower rate of infection and lower viral severity, similar to that seen in June 2022, whereby ~230,000 infections per million population per year result in ~23,000 hospitalizations.

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

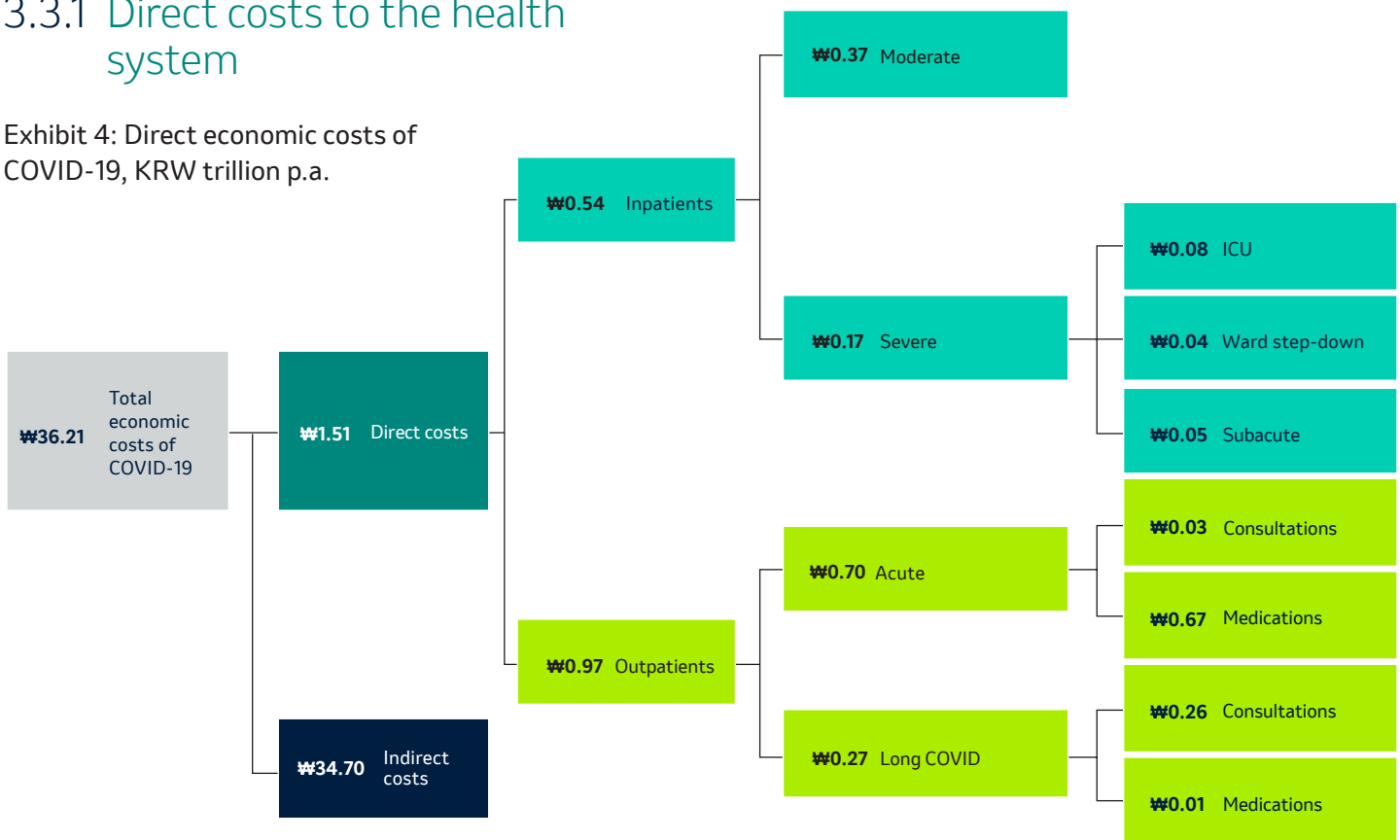
Exhibit 3: Direct and indirect costs of COVID-19 to South Korea’s economy in a base case scenario, KRW trillion p.a.



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

### 3.3.1 Direct costs to the health system

Exhibit 4: Direct economic costs of COVID-19, KRW trillion p.a.



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.

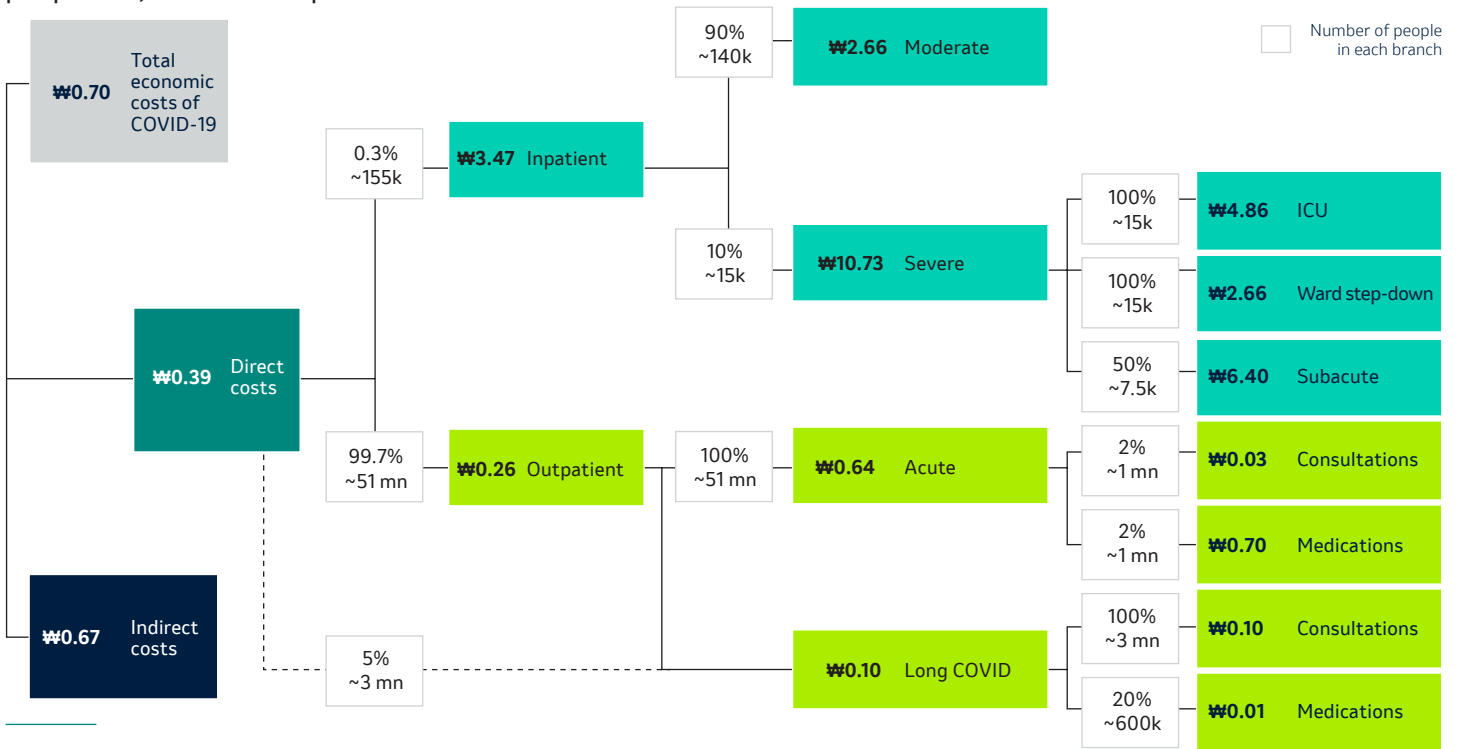
With ~155,000 hospital admissions (including ~15,000 ICU admissions) and ~2.6 million cases of long COVID in the base case scenario, a number of variables could have a significant cumulative impact in reducing the direct costs imposed by COVID-19 on the health system, namely limiting hospital admissions and reducing lengths of stay, as well as differences in recovery times and/or the incidence of long COVID. Given that ~40% of admissions and ~60% of inpatient costs are borne by patients >60 years of age<sup>20</sup> preventing moderate to severe illness in this cohort would have a particularly impactful role in mitigating costs. More broadly, the magnitude of COVID-19's ongoing impact on the health system underscores the importance of continuing to test for and treat the disease, despite potentially changing societal attitudes towards the pandemic.

In this scenario, as displayed in Exhibit 4, COVID-19 could cost the South Korean health system KRW ~1.5 trillion p.a. This is a significant expense, equating to ~0.1% of South Korea's GDP. Despite the magnitude of this figure, direct costs are still a minority of the total economic costs of COVID-19 in South Korea, accounting for only ~4% of the overall total. Indirect costs, comprising productivity losses due to missed work, account for the remainder and could add up to KRW ~35 trillion p.a. (~1.5% of GDP). These are discussed further in Section (3.3.2). While together these amount to a significant expense, they still do not put an accurate value on the damage to health caused by COVID-19, nor the secondary effects to critical industries and vulnerable populations such as the health workforce.

20. HIRA and NHIS [Internet]. 2021 National Health Insurance Statistical Yearbook. 2021 Dec 17. Available from: <https://www.hira.or.kr/bbsDummy.do?pgmid=HIRAJ030000007001&brdScnBltNo=4&brdBltNo=3>



Exhibit 5: Direct economic costs from COVID-19, per person, KRW million p.a.



Costs per person for each segment are calculated by dividing the total cost of that segment by the number of individuals in that segment that utilize a health service; '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.

Despite the relatively minor weighting of direct costs within the wider economic impact of COVID-19, they remain significant on a per-infection basis. As illustrated in Exhibit 5, each infection that uses some form of health service could impose an average cost of KRW ~390,000. This is concentrated in the costs of inpatient care, where a single ward admission could cost up to KRW ~2.7 million and a single ICU admission (with subsequent ward and rehabilitation stays) could cost as much as KRW ~10.7 million.

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

- Inpatient (hospital-based) care (KRW ~540 billion p.a.; 35%; KRW ~3.47 million per person)
- Outpatient (primarily clinic-based) care (KRW ~970 billion p.a.; 65%; KRW ~260,000 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 measures, the extent of ongoing costs to the health system underscores the importance of continuing to test for and treat the disease.

Costs in this category comprise those arising from moderate infections requiring ward-based care (KRW ~370 billion p.a.; KRW ~2.7 million per person) and severe infections requiring ICU (KRW ~170 billion p.a.; KRW ~10.7 million per person). The more costly care for moderate infections is driven largely by length of stay on the ward (~10 days on average), while the cost of care for severe infections is driven mostly by higher bed day costs (KRW ~650,000 per day in ICU), followed by substantial periods of inpatient rehabilitation (a median stay of 20 days).

The profile 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 KRW ~970 billion p.a. to the total economic costs incurred due to COVID-19. While seemingly less resource-intensive,

outpatient infections are not inexpensive on a per-person basis, each costing KRW ~260,000. Outpatient costs can be separated into acute outpatient care (consultations and medications; KRW ~700 billion p.a.) and chronic outpatient or long COVID care (consultations and medication; KRW ~270 billion p.a.; see also Section 3.4.6).

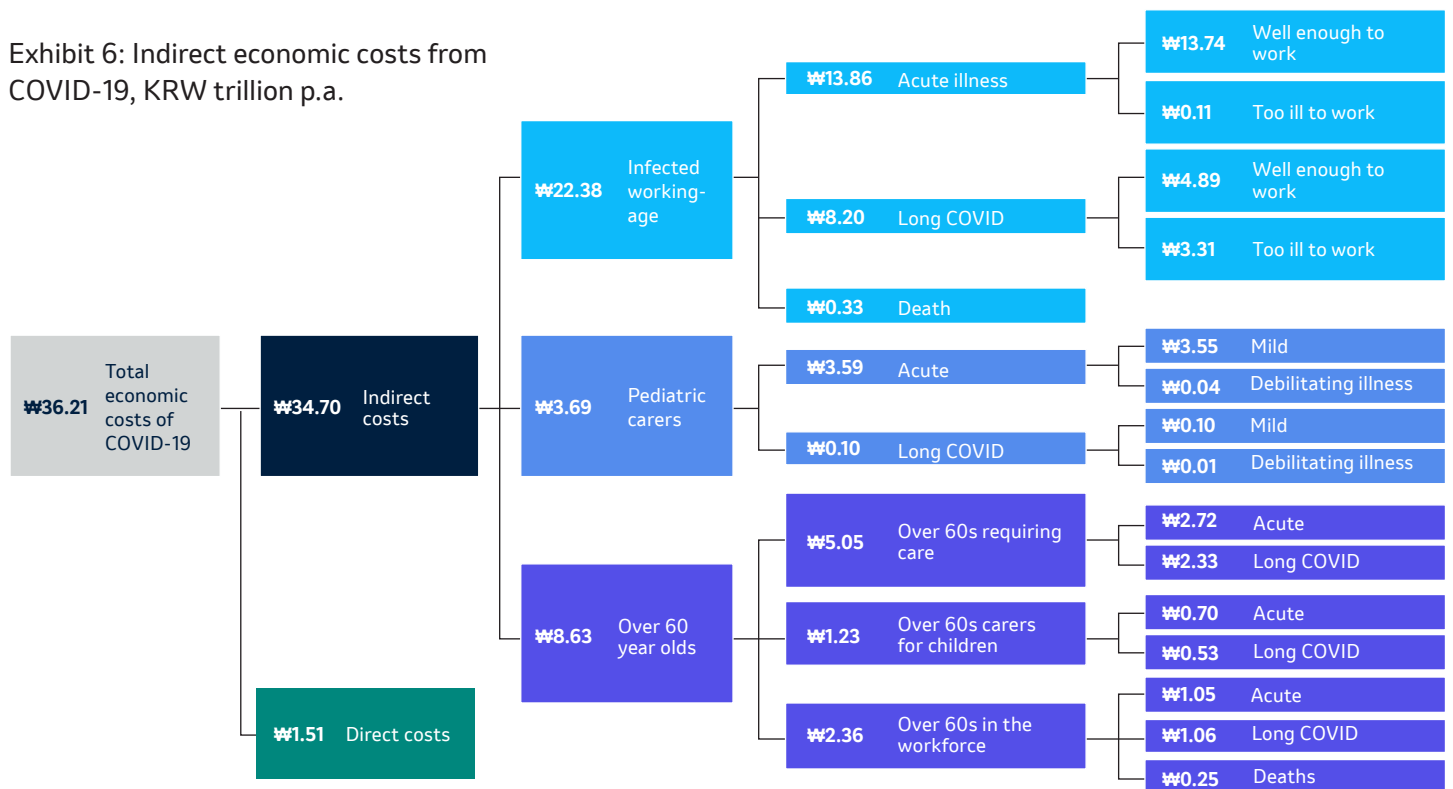
The figures for acute outpatient care are driven largely by the cost of medication (such as oral antivirals, KRW ~670 billion p.a.<sup>21</sup>), which equates to ~2% of total economic costs, representing a small investment toward partially reducing a much larger burden of direct and indirect costs (KRW ~36 trillion p.a.). Additionally, it is important to recognize the healthcare labor costs associated with prescribing medications. For example, a complex treatment regimen that requires comprehensive checks or reviews would incur an additional cost of KRW~ 2,000 for every extra 10-minute period of healthcare worker labor is worth,<sup>22</sup> without accounting for the opportunity cost of servicing other patients, which is imposed by this burden. Aggregate consultation costs in this cohort are lower because there

are fewer of them – it is estimated that 2% of all infections visit a clinic<sup>23</sup> (~1 million visits p.a.).

**Together, direct costs from the inpatient and outpatient cohorts amount to KRW ~1.5 trillion p.a. or 0.1% of South Korea’s GDP.** While significant on their own, these costs are in addition to the indirect costs to South Korea’s economy (discussed below in Section 3.3.2), the value of lost health they represent, and the secondary effects on the health system (such as its workforce) and other critical industries (discussed below in Section 3.4).

21. ‘일동제약 코로나19 치료제 허가 가시권, 유통업 확이자 MSD와 승부 앞뒤’. Business Post [Internet]. 2022 Nov. Available from: [https://www.businesspost.co.kr/BP?command=article\\_view&num=299133](https://www.businesspost.co.kr/BP?command=article_view&num=299133).
22. Based on a median weekly earnings figure of ₩693,000. Statista [Internet]. Average monthly salary of employees in South Korea from 2010 to 2021. 2022 Jun 29. Available from: <https://www.statista.com/statistics/689751/south-korea-average-wage/>
23. Goldstein EV, Seiber EE et al. Journal of Primary Care & Community Health [Internet]. Early Data on Predictors of COVID-19 Treatment Frequency at Community Health Centers. 2021 Dec 23. Available from: <https://journals.sagepub.com/doi/full/10.1177/21501319211069473>

**Exhibit 6: Indirect economic costs from COVID-19, KRW trillion p.a.**



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.

### 3.3.2 Indirect costs to the economy

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

In the base case scenario, and as Exhibit 6 illustrates, COVID-19 could cost the South Korean economy KRW ~35 trillion p.a. (~1.5% of GDP) in productivity losses if current epidemiological conditions and response settings continue.<sup>24,25</sup> As with direct costs to the health system, this is a significant expense, equating to ~1.5% of GDP. When discounting for productivity losses due to potential changes in isolation mandates (which may be reduced in the future), indirect costs would remain significant at KRW ~31 trillion p.a.<sup>26</sup> While these costs are significant, as with direct costs, they still do not put an accurate value on the damage to health due to COVID-19, nor on the secondary effects to critical industries and vulnerable populations, such as the health workforce.

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

- **Infections in working-age adults (19 to 59 years old) – KRW ~22.4 trillion p.a.** (~62%; KRW ~750,000 per person)
- **Infections in the older population (60 years old and above) – KRW ~8.6 trillion p.a.** (~24%; KRW ~860,000 per person)
- **Infections in children and adolescents (18 years old and under) – KRW ~3.7 trillion p.a.** (~10%; KRW ~370,000 per person)

**Infections in working-age adults impose a significant economic burden on South Korea, with productivity losses valued at KRW ~22.4 trillion p.a. (~1.0% of GDP).**

This burden highlights the broader economic impact that can be inflicted by an illness that, although mild for most, can be significant enough to last ~12 days and impair productivity by ~35% on days worked while unwell (an average of ~10).

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

- Acute illness (KRW ~13.9 trillion p.a.), chronic illness or long COVID (KRW ~8.2 trillion p.a.), and deaths (KRW ~330 billion p.a.);
- Infected adults still well enough to work, but with reduced capacity (KRW ~18.6 trillion p.a.), and infected adults who are too ill to work (KRW ~3.4 trillion p.a.).

**Taking these together, acute illness in those who can still work but at reduced capacity accounts for ~60% of productivity losses incurred by working-age adults.**

The magnitude of this cost illustrates that, despite the mildness of the illness for most, when modest reductions in working capacity are multiplied across a multi-day illness affecting ~33 million people in South Korea, the result is a substantial cost impact for the whole market.

**Infections in the older population impose KRW ~8.6 trillion p.a. (~0.4% of GDP) in costs on the South Korean economy from productivity losses,** adding to the burden from working-age adults. This highlights that productivity losses are not limited to those borne by the working-age population alone and that adjacent cohorts are of proportional importance.

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

- **Older people with COVID-19 who require care from a working-age person** – 9 million working-age adults incurring a KRW ~560,000 productivity loss – resulting in a total impact of KRW ~5.1 trillion p.a.
- **Older people who directly participate in South Korea's labor force** – ~19% of those over 60.<sup>27</sup> Infections in this group result in KRW ~2.4 trillion p.a. of productivity losses.

24. Based on a median weekly earnings figure of ₩693,000. Based on a median weekly earnings figure of ₩693,000. Statista [Internet]. Average monthly salary of employees in South Korea from 2010 to 2021. Available from: <https://www.statista.com/statistics/689751/south-korea-average-wage/>

25. As of December 2022, the isolation mandate for an individual who becomes infected with COVID-19 is 7 days.

26. Assumes that individuals infected by COVID-19 do not isolate unless they voluntarily take sick absence from work.

27. Wise Person [Internet]. 65세 이상 취업자 345만명, 45%는 근로소득 100만원 미만. 2022 Sep 20. Available from: <http://www.wiseperson.co.kr/news/articleView.html?idxno=2039>

Older people (e.g., grandparents) who care for children to enable parents to work – one survey found that ~30% of grandparents (including in multi- and single-generation households) provided care for grandchildren.<sup>28</sup> When this work-enabling care is disrupted, the productivity loss amounts to KRW ~1.2 trillion p.a.

Infections in the older population account for KRW ~9.0 trillion p.a., or ~25% of all direct and indirect costs combined, serving as a stark reminder of the need to address costly infections in cohorts adjacent to working-age adults.

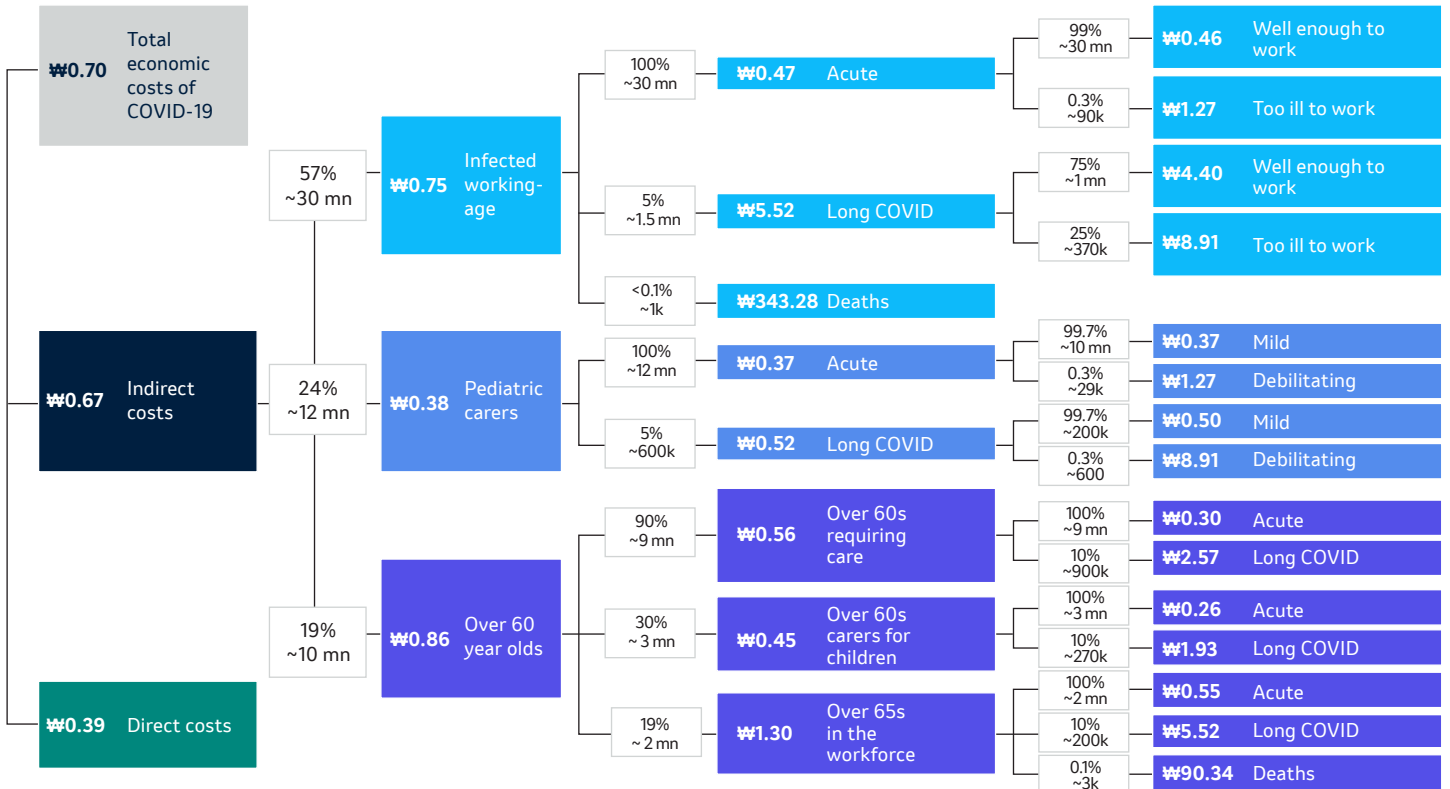
Finally, infections in children impose an additional economic cost of KRW ~3.7 trillion p.a. (~0.2% of GDP), owing to productivity losses borne by adults who are absent from or less productive at work while

caring for children. Along with those from the older population, productivity losses arising from infections in children can be difficult to recognize in advance, but are significant when they emerge.

Productivity losses arising from infections in children are predominantly driven by adults caring for children with acute, mild illness. The cohort of infected children, which constitutes the majority (~99%) of productivity losses in adults caring for children with acute illness, is worth KRW ~3.55 trillion p.a. This cost is driven by care for ~6.9 million mild infections in children, who despite having a mild illness require one parent to

28. Stuck AE, Tuckett AG. International Journal of Environmental Research and Public Health [Internet]. Longitudinal Patterns of Grandchild Care in South Korea. 2022 Jan 20. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8834307/>

Exhibit 7: Indirect economic costs from COVID-19, per person, KRW million 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.



care for them at home. The remaining ~1% is driven by productivity losses from caring for children with debilitating infections. For parents who can work from home (~32%), productivity is estimated to halve, while all productivity is foregone by parents who cannot (~68%).<sup>29</sup> This is a substantial cost driven more by lost work than the illness itself, reiterating that significant costs imposed by productivity losses are not limited to infections in working-age adults.

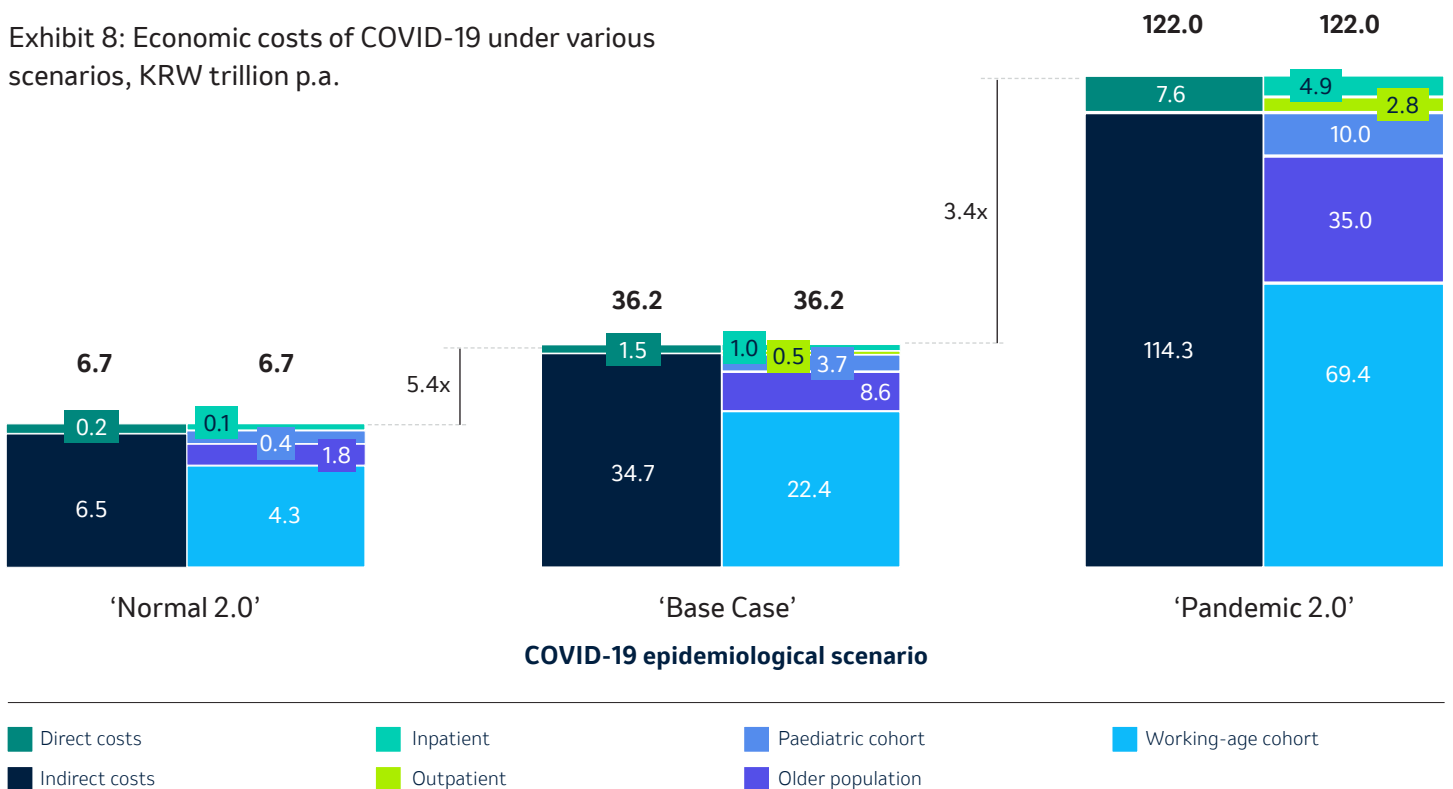
Despite the apparent reduction in resource intensiveness compared to direct healthcare costs, the magnitude of productivity losses imposed by COVID-19 means indirect costs are actually more expensive on a per-person basis (as indicated in Exhibit 7), with each infection costing KRW ~670,000 (versus KRW ~390,000 for direct costs) on average. This is concentrated in productivity losses resulting from infections in working-age (KRW ~750,000 per person) and older populations (KRW ~860,000 per person).

Together, economic costs arising from productivity losses in these groups amount to KRW ~34.7 trillion p.a. or ~1.5% of South Korea's GDP and are in addition to the value of lost health and direct costs to South Korea's health system. Although already substantial, these costs are likely to underestimate the entirety of the burden imposed on society by COVID-19, including second-order impacts on health system capacity and knock-on effects on the health workforce, supply chains, and other aspects of critical industry; all of these factors contribute to directly measurable economic impacts.

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

29. Statista [Internet]. Remote work in South Korea. Available: <https://www.statista.com/study/105361/remote-work-in-south-korea/>

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



Normal 2.0 refers to a scenario featuring ~230,000 infections per million population and ~23,000 hospitalizations. Pandemic 2.0 refers to a scenario featuring ~2 million infections per million population (i.e., 2 infections per person per year) and ~1,000,000 hospitalizations, reflecting conditions observed in March and August of 2022, annualized.

### 3.3.3 Alternative scenarios: costs of Pandemic 2.0 and Normal 2.0

In addition to the base case, two further scenarios are considered, as illustrated in Exhibit 8.

**In a Pandemic 2.0 scenario, total economic costs could reach KRW ~122 trillion p.a. (~5.5% of GDP).**

Conversely, in the Normal 2.0 scenario, economic costs could be reduced to KRW ~7 trillion p.a. (~0.3% of GDP).

**The two example scenarios represent divergent epidemiological outcomes, both of which are plausible as the pandemic evolves.** Each theoretical scenario is constructed with two key features:

- Infection volume (driven by contagiousness, measured by cases per million population per year);
- 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 million cases per million population per year** (i.e., the entire population is infected twice, on average) and a case severity that drives a hospitalization rate of ~1% of all infections. This is in comparison to the base case scenario, where a case volume of ~1 million infections per million population and a hospitalization rate of 0.3% is assumed.<sup>30</sup>

**In this scenario, economic impacts from COVID-19 could increase to KRW ~122 trillion p.a.,** equating to ~5.5% of GDP and KRW ~1.3 million per person. In this scenario, direct costs could be KRW ~7.6 trillion p.a. (i.e., KRW ~6 trillion p.a. higher than the base case, or a five-fold increase), while indirect costs could reach KRW ~114 trillion p.a. (i.e., KRW ~80 trillion p.a. higher than the base case, or a more than three-fold increase). These increases would be driven by an uptick in hospitalization rates and longer periods of stay, as well as augmented productivity losses, caused by a more prevalent incidence of debilitating illness and longer periods of missed work.

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

**By contrast, a Normal 2.0 scenario would feature a case volume of ~320,000 cases per million population per year** and a hospitalization rate of 0.2%. These thresholds represent the lowest recorded levels for each measure observed in South Korea during the pandemic. Under a Normal 2.0 scenario, economic impacts from COVID-19 could reduce to KRW ~6.7 trillion p.a. (~0.3% of GDP) and KRW ~577,000 per person. Direct costs could decrease to KRW ~200 billion p.a. and indirect costs to KRW ~6.5 trillion p.a. Decreases in costs would be driven by lower hospitalization rates and diminished productivity losses owing to reduced periods of missed work.

**While these different scenarios help us to consider potential trajectories that the COVID-19 pandemic may take in the future,** their scope is largely restricted to the consideration of quantifiable economic costs. Equally worthy of consideration are the second-order impacts that COVID-19 could exert on health system capacity and the knock-on effects that this would have on vulnerable populations and critical industries. This aptly demonstrates the broad economic and societal impacts of the pandemic.

30. Infection numbers and hospitalization rates are sourced from modeling of COVID-19 infections in South Korea by the Institute of Health Metrics and Evaluation (IHME; used with permission). Available from: <https://www.healthdata.org/covid/data-downloads>

## 3.4 Considerations For Critical Cohorts And Industries

The economic costs of COVID-19 described will impact different populations and industries disproportionately. This includes cohorts that play a critical economic or societal role (e.g., logistics workers, health care workers), those that are particularly vulnerable to severe disease (e.g., people with comorbidities), and those that go on to develop long COVID. These groups may be worthy of additional focus when considering countermeasure approaches to mitigate the impacts of COVID-19.

Specifically, interventions that protect health and productivity losses in these critical industries and populations may yield corresponding, disproportionate economic returns.

### 3.4.1 Critical workers and industries

As outlined above, some critical industries experience disproportionate indirect costs (i.e., productivity losses) that generate significant public concern.

Here, the focus is on three industries in particular – healthcare, logistics, and travel and tourism.

The economic costs of COVID-19 borne by critical industries and their stakeholders may increase under a Pandemic 2.0 scenario. In this scenario, workforces that are largely unable to work from home may be required to isolate while they recover. The resulting loss of productive time can be 50% greater (up to the equivalent of ~3 workdays) than that of individuals in desk-based jobs who are able to perform work tasks in their home environment.

### 3.4.2 Healthcare

South Korea's health system serves as the market's first and last line of defense against COVID-19 and other health threats. Medical services are a KRW ~127 trillion industry, employing ~780,000 healthcare practitioners.<sup>31</sup>

At a potential minimum cost of KRW ~1 trillion p.a. (~3% of combined total cost),<sup>32</sup> healthcare workers who become infected with COVID-19 represent a disproportionate slice of the impact that this disease exerts on the economy. However, this is likely to significantly underestimate the total cost to the South Korean economy and citizens' welfare, as it would also translate into secondary impacts on patient outcomes.

Health service employers typically experience higher rates of absenteeism due to COVID-19 compared with other industries. A root cause of these inflated figures is the heightened risk of severe COVID-19 that healthcare workers are exposed to, due to their frequent contact with infectious patients.<sup>33</sup> Productivity losses are not only incurred by sick workers but also by the remaining workers who are required to take up additional responsibilities. This extra workload reduces their capacity for completing non-patient care tasks and contributes to exhaustion, diminished empathy, and an increased risk of mistakes.<sup>34</sup>

31. Korean Health Industry Development Institute [Internet]. 2021 Market Overview. Available from: <https://www.khidi.or.kr/board?menuId=MENU00793&siteId=SITE00012>

32. Based on the proportion (3%) of the workforce represented by healthcare workers. This figure is an underestimate as healthcare workers are likely to represent a disproportionate number of infections due to increased exposure.

33. Kim S, Kang H, Jeong H, Jang S, Lee J, Kim D et al. Journal of Korean Medical Science [Internet]. Vaccination in Healthcare Workers: 3-Dose Versus 2-Dose Vaccination. 2022 Sep 5. Available from: <https://jkms.org/pdf/10.3346/jkms.2022.37.e267>

34. Docdocdoc [Internet]. "국립대병원 의료인력 부족으로 의료 붕괴 위기 직면" ("Facing the crisis of medical collapse due to lack of medical personnel at national university hospitals"). 2022 Mar 28. Available from: <http://www.docdocdoc.co.kr/news/articleView.html?idxno=2021244>

**The second-order economic impacts of COVID-19-related absenteeism among healthcare workers are significant.** COVID-19 has exacerbated pre-existing workforce shortages, resulting in poorer quality and safety of healthcare provision. Shortages have the potential to exacerbate ambulance wait times, for example, which have reached up to six hours in some hospitals.<sup>35</sup> Such reductions in the availability and timeliness of medical care may subsequently lead to prolonged illness or recovery times for patients, who in turn accumulate their own additional productivity losses.

**Additionally, during the COVID-19 pandemic, unprecedented levels of workforce burnout and attrition have been seen.**<sup>36</sup> Although the initial response to the COVID-19 pandemic has subsided, global talent shortages and mobility challenges are an ongoing concern.

**A countermeasure approach that targets healthcare workers could have a significant effect** in mitigating overall economic costs, as well as the impacts of COVID-19 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 Logistics

**COVID-19 has caused unprecedented disruption to South Korea's logistics sector,** which delivers vital goods and services across the nation. It is a KRW ~114 trillion industry, with a workforce of ~750,000 people.<sup>37</sup> During the pandemic, the sector experienced a disproportionate impact of productivity loss from workers, which has snowballed to disrupt local and global supply chain networks.

**South Korea has experienced significant workforce shortages in the logistics sector due to the COVID-19 pandemic.**<sup>38</sup> Among this workforce are warehouse staff, forklift drivers, unloading crews, and technicians, who are unable to complete their tasks at home while ill, isolating, or caring for others who have been infected with COVID-19. Taking on the workload of sick colleagues adds to high levels of pressure on the logistics workforce, which has led to collective strikes.<sup>39</sup>

**Workforce shortages have downstream consequences for end-point retailers, users, and customers too.**

Disruptions have the dual effect of driving inflation in the costs of goods and services while impeding the ability of businesses, and their workers, to deliver them. Among these, there are necessities of particular public concern – life-changing medicines, gas, and oil.<sup>40</sup>

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

35. "Docdocdoc [Internet]. "응급환자 이송 지연 해결하려면 '수용 거부' 제재해야" ("In order to solve the delay in transporting emergency patients, 'acceptance refusal' should be sanctioned). 2021 Aug 19. Available from: <http://www.docdocdoc.co.kr/news/articleView.html?idxno=2013637>
- Medical Times [Internet]. Infinite waiting at ambulance due to lack of corona confirmed paediatric and maternal wards. 2022 Aug 27. Available from: <https://www.medicaltimes.com/Main/News/NewsView.html?ID=1149116>
36. Keimyung University Sleep Centre [Internet]. 코로나19 대응 의료진 정신 건강 '적신호' (Mental health red flag for medical staff responding to COVID-19) 2021 Apr 12. Available from: <http://www.docdocdoc.co.kr/news/articleView.html?idxno=2009575>. IHME [Internet]. Worldwide shortage of health workers threatens effective health coverage IHME. 2022 May 23. Available from: <https://www.healthdata.org/news-release/worldwide-shortage-health-workers-threatens-effective-health-coverage>
- Seoul Economic Daily [Internet]. 코로나 2년 사투에 '번아웃'... 의료진이 떠난다 ('Burnout' in the 2-year struggle with Corona... medical staff leave). 2021 Dec 14. Available from: <https://www.sedaily.com/NewsView/22VAGVCHRT>
37. Statistics Korea [Internet]. Transport Survey. Available from: <https://kostat.go.kr/anse/?bmode=read&aSeq=417098&pageNo=&rowNum=10&amSeq=&sTarget=&sTxt=>
38. Shin J. The Korea Herald [Internet]. Korea struggles to respond to labor shortage amid pandemic. 2021 Mar 28. Available from: <https://www.koreaherald.com/view.php?ud=20210328000132>
39. Crossing [Internet]. 韓國物流業大罷工——快速便利的電商文化背後，是過勞的惡性循環 ('Strike in South Korea's logistics industry—Behind the fast and convenient e-commerce culture is a vicious cycle of overwork'). 2021 Jul 9. Available from: <https://crossing.cw.com.tw/article/15025>
40. Lee Y, Cha S. Bloomberg [Internet]. South Korea Plans to Order Fuel, Steel Truckers Back to Work. 2022 Dec 4. Available from: <https://www.bloomberg.com/news/articles/2022-12-04/south-korea-to-order-fuel-steel-truckers-to-return-to-work?leadSource=verify%20wall>



### 3.4.4 Travel and tourism

Despite a strong recovery since the re-opening of borders in October last year, South Korea's travel and tourism sector continues to face headwinds due to workforce shortages. Representing a major portion of the South Korean economy, the sector's contribution to GDP had been projected to reach KRW ~73 trillion and support ~1.3 million jobs in 2022.<sup>41</sup> Prior to last year, the impact of the pandemic could be observed through the steep decline in visitor volumes and spending, due to border restrictions, isolation orders, and general hesitancy among travelers.

COVID-19-related absenteeism has wreaked havoc across airports and accommodation services. Staff shortages (coupled with demand surges as travel restrictions ease) have forced flight cancellations with passengers waiting 2 to 7 days, rather than 24 hours, for the next available option.<sup>42</sup> Flight disruptions can impede the productive work time of corporate travelers and impact the consumer spending of holidaymakers. On the flights themselves, as few as six flight attendants are being assigned, compared to the usual nine crew members, leading to concerns around safety and workforce fatigue.<sup>43</sup>

Countermeasures that are targeted specifically at South Korea's travel and tourism workforce may help the sector fully overcome any remaining hurdles in its recovery from the COVID-19 pandemic.

### 3.4.5 Vulnerable populations

COVID-19 illness in South Korea's vulnerable populations – those over 60, or over 18 with a comorbidity – represents a minimum impact of KRW ~18 trillion p.a. (~0.8% of GDP) to South Korea's economy. These populations are at greater risk of severe COVID-19 disease and are more heavily reliant on the healthcare system than others. Vulnerable populations that have received particular attention throughout the pandemic include those over 60 years old and those with comorbidities. Almost all (KRW ~17.4 trillion p.a.; ~48% of total economic costs and ~0.8% of GDP) of the costs in this category result from infections that are eligible for oral antivirals.<sup>44,45</sup>

COVID-19 illness in South Korea's older population (60 years and over) could have an economic impact of KRW ~9.0 trillion p.a. (~25% of annual economic costs).

This is significant on a per-person basis too, at KRW ~896,000. Despite representing just ~12% of confirmed cases, the older population accounts for a higher proportion of COVID-19 hospitalizations, at ~40%.<sup>46</sup> This is unsurprising when one considers that the prevalence of comorbidities (predominantly high blood pressure, cancer, and diabetes) is particularly high in this age group, reaching ~71% for those over 65 years old.<sup>47</sup>

41. World Travel and Tourism Council [Internet]. South Korea's tourism to create nearly half a million jobs. 2022 Jul 7. Available from: <https://insights.ehotelier.com/global-news/2022/07/07/south-koreas-tourism-to-create-nearly-half-a-million-jobs/>

42. Yoo H. The Korea Herald [Internet]. Damage claims surge over frequent flight cancellations. 2022 Jul 18. Available from: <https://www.koreaherald.com/view.php?ud=20220718000652>

43. Park T. Hankyoreh [Internet]. 코로나19 끝나니 '일터 지옥'... "항공사들이 노동력 쥐어짜" ('Corona 19 is over, 'workplace hell'... Airlines squeeze the labour force'). 2022 Aug 23. Available from: <https://www.hani.co.kr/arti/society/labor/1055895.html> Assumes ~19.5% infections are >60 and eligible; assumes ~57.4% infections are aged 19-60 years, of which ~36.5% have a comorbidity and are eligible.

44. Assumes ~19.5% infections are >60 and eligible; assumes ~57.4% infections are aged 19-60 years, of which ~36.5% have a comorbidity and are eligible.

45. Eul, H. Journal of Health Informatics [Internet]. Analysis of multiple chronic disease characteristics in South Koreans by age groups using association rules analysis. 2022 Jan 17. Available from: <https://journals.sagepub.com/doi/full/10.1177/14604582211070208#bibr5-14604582211070208>

46. Calculated based on age distribution of inpatients. Specific data related to COVID-19 or similar respiratory illnesses was unavailable. HIRA and NHIS [Internet]. National Health Insurance Statistical Yearbook, 2021. Available from: <https://www.hira.or.kr/bbsDumy.do?pgmid=HIRAJ030000007001&brdScnBltno=4&brdBltno=3>

47. Eul, H. Journal of Health Informatics [Internet]. Analysis of multiple chronic disease characteristics in South Koreans by age groups using association rules analysis. 2022 Jan 17. Available from: <https://journals.sagepub.com/doi/full/10.1177/14604582211070208#bibr5-14604582211070208>

**Comorbidities in the younger, working-age (19-59 years) population could also have a disproportionate impact of KRW ~8.7 trillion p.a.**<sup>48</sup> one comorbidity doubles the risk of severe COVID-19,<sup>49</sup> subsequently increasing the likelihood of hospitalization and prolonging recovery time away from work. This could be a reality for ~39% of adults in South Korea.<sup>50</sup>

**With vulnerable populations bearing ~50% of combined direct and indirect costs,** countermeasures that reduce their duration of illness and/or recovery time could significantly mitigate the costly impacts of COVID-19. Countermeasures may include ongoing vaccination,<sup>51</sup> community interventions, or the use of oral antivirals.<sup>52</sup> Oral antivirals were introduced in South Korea in the second quarter of 2022 to provide an additional option for protection against COVID-19.

### 3.4.6 Long COVID

**Long COVID<sup>53</sup> has a potential minimum impact of KRW ~12.5 trillion p.a. (~0.6% of GDP and KRW ~4.8 million per person p.a.) on South Korea's economy.**

Individuals who develop this condition experience prolonged productivity losses (increasing indirect costs) and reliance on health services (increasing direct costs).

**Direct costs due to long COVID collectively amount to at least KRW ~268 billion** (KRW ~103,00 per person), largely driven by the need for ongoing medical consultations. This higher figure results from the incidence and the relative complexity and duration (90 days) of long COVID illness. When case complexity and duration are factored in, this could mean ~15 million healthcare consultations are required for this cohort alone.<sup>54,55</sup> Long COVID, therefore, represents a substantial burden on the health system, both in terms of capacity requirement and economic cost.

**Indirect costs/productivity losses arising from long COVID could amount to at least KRW ~12.2 trillion p.a.** (KRW ~4.7 million per person p.a. and ~35% of all indirect costs). By a significant margin, the largest contributors are productivity losses arising from long COVID in the working-age population (KRW ~8.2 trillion p.a. or ~67%). To illustrate this case, an adult with long COVID could still lose an aggregate of 44

workdays over a three-month period, despite being well enough to work.<sup>56</sup>

**Given the large share (~34%) of total economic costs that long COVID imposes on the South Korean economy,** any countermeasure that is able to reduce the incidence and/or duration of this condition would contribute a great deal to mitigating economic costs associated with the pandemic. Current conservative estimates suggest that the incidence and course of long COVID are at 5% and 90 days respectively; however, the evidence is still nascent, and these impacts may yet be shown to be underestimates.

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48. Calculated based on age distribution of inpatients. Specific data related to COVID-19 or similar respiratory illnesses was unavailable. HIRA and NHIS [Internet]. National Health Insurance Statistical Yearbook, 2021. Available from: <https://www.hira.or.kr/bbsDumy.do?pgmid=HIRAJ030000007001&rdScnBltno=4&brdBltno=3>
49. Liu B, Spokes P, He W, Kaldor J. BMC Infectious Diseases [Internet]. High risk groups for severe COVID-19 in a whole of population cohort in Australia. 2021 Jul 16. 685(2021). Available from: <https://bmcinfectdis.biomedcentral.com/articles/10.1186/s12879-021-06378-z>
50. Proportion of total population with chronic diseases, including hypertension, diabetes, heart disease, and cerebrovascular disease. Age distribution was unavailable. HIRA and NHIS [Internet]. Available from: <https://www.hira.or.kr/bbsDumy.do?pgmid=HIRAJ030000007001&brdScnBltno=4&brdBltno=3>
51. KDCA [Internet]. 누가 먼저 코로나19 예방접종을 하나요? (Who gets vaccinated against COVID-19 first?). Available from: <https://ncv.kdca.go.kr/menu.es?mid=a10117010000>
52. Oral antivirals are indicated for over 18-year-olds with COVID-19 confirmed with severe risk factors within 5 days of onset. Risk factors include being over 65 years of age or having cardiovascular disease, high blood pressure, or chronic lung disease. KDCA [Internet]. 코로나19 치료제 및 치료제 지침 (COVID-19 Treatment and Treatment Guidance). Available from: <https://ncv.kdca.go.kr/hcp/page.do?mid=030301>
53. 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.
54. Kim, Y., Bitna-Ha, Kim, SW. et al. BMC Infectious Diseases [Internet]. Post-acute COVID-19 syndrome in patients after 12 months from COVID-19 infection in Korea. 2022 Jan 27. 93(2022). Available from: <https://bmcinfectdis.biomedcentral.com/articles/10.1186/s12879-022-07062-6>
55. Each case could require 6 consultations on average over the 90-day period of long COVID illness.
56. Based on an average of 6 days of sick leave and reported reductions in working hours 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 variable adherence to isolation requirements, 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 South Korea, 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 South Korea 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 South Korea’s 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

Community measures			Vaccination	Therapeutics
Reduce force of infection experienced by susceptible population			Reduce susceptibility	Reduce burden and cost of infections
<p><b>Source control:</b> reduce number of infectious individuals</p> <ul style="list-style-type: none"> <li>• Border/ travel restrictions</li> </ul>	<p><b>Contact control:</b> reduce contacts with infectious</p> <ul style="list-style-type: none"> <li>• Mass movement restriction &amp; isolation (“lockdown”)</li> <li>• Physical (“social”) distancing</li> <li>• Targeted isolation (TTIQ)</li> </ul>	<p><b>Infection control:</b> reduce transmissions given/ during contact</p> <ul style="list-style-type: none"> <li>• Ventilation and environmental measures</li> <li>• Mask wearing</li> <li>• PPE and hygiene</li> </ul>	<p><b>Immunization:</b> reduce population’s susceptibility to infection and/ or its disease consequences</p> <ul style="list-style-type: none"> <li>• Direct protection from vaccine-induced immunity <b>plus</b> natural immunity; <b>times</b> decay factor (waning immunity)</li> <li>• Plus indirect protection from <b>herd immunity</b> effects (transmission blocking)</li> </ul>	<p><b>Oral antiviral treatment:</b> May reduce the severity and duration of illness, thereby reducing the ‘burden’ on the health system and society, including:</p> <ul style="list-style-type: none"> <li>• The volume of acute and long COVID cases as well as</li> <li>• Deferred non-COVID care and its consequences</li> </ul>

### 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. South Korea has achieved high rates of vaccination relative to international peers, with ~50% of the economic impact of COVID-19 in South Korea, having received two doses.<sup>57</sup> By reducing the population's susceptibility (both directly for the recipient of the vaccine and indirectly by reducing the risk of onward transmission),<sup>58</sup> 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.<sup>59</sup>

**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.<sup>60</sup>

**There may be an opportunity to broaden the use of therapeutics.** Currently, populations that are

eligible for oral antivirals could represent ~50% of the economic impact of COVID-19 in South Korea, assuming high levels of uptake. Given the challenges associated with community measures, and that South Korea 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 South Korea's response.

57. Holder J. New York Times [Internet]. COVID Vaccinations tracker. 2023 Mar 13. Available from: <https://www.nytimes.com/interactive/2021/world/covid-vaccinations-tracker.html>

58. 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>

59. 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/>

60. 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 South Korea

Exhibit 10: Summary of countermeasures in South Korea

	Community measures	Vaccination	Therapeutics
<b>2022</b>	<ul style="list-style-type: none"> <li>• <b>Isolation</b> - there is a 7-day mandatory isolation period for those who test positive for COVID-19 (although this is likely to be reduced in 2023)</li> <li>• <b>Mask wearing</b> - masks are required to be worn indoors</li> <li>• <b>Social distancing</b> - as of April 2022, all social distancing restrictions have been lifted</li> <li>• <b>Border restrictions</b> - until October 2022, inbound travelers were required to quarantine for 2 weeks</li> </ul>	<ul style="list-style-type: none"> <li>• Population aged 12 or more have access to vaccination.</li> <li>• Since August, the second COVID booster shot available for people aged 50 or more, as well as immunosuppressed individuals from 18 or more, from 4 months after the last booster shot</li> <li>• As of December, ~130 million doses have been administered with ~86% of population receiving 2 doses and ~80% receiving 3</li> </ul>	<ul style="list-style-type: none"> <li>• 3 antivirals are approved by South Korea MFDS (Remdesivir, Paxlovid, and Molnupiravir)</li> <li>• Eligible cohorts include those 60+ years old and 18+ year olds at high risk of severe illness</li> </ul>
<b>2020-21</b>	<ul style="list-style-type: none"> <li>• Border restrictions - South Korea maintained testing and quarantining procedures at its border.</li> <li>• TTIQ: South Korea implemented a national program of testing, contact tracing and quarantining of positive cases that was underpinned by its Epidemic Intelligence Service.</li> </ul>	<ul style="list-style-type: none"> <li>• Roll-out commenced in February 2021 with vulnerable and highly exposed groups</li> <li>• By October 2021, 70% of all citizens were vaccinated &gt; 5,000 nursing home residents and workers younger than 65 would receive the AstraZeneca vaccines on Feb 26, 2021</li> </ul>	

As of December 23, 2022.<sup>61,62,63,64</sup>

61. KDCA [Internet]. Report on 2 years of COVID-19 in South Korea, 2022 Jan. Available from: [https://www.kdca.go.kr/board/board.es?mid=a20602010000&bid=0034&list\\_no=718713&act=view](https://www.kdca.go.kr/board/board.es?mid=a20602010000&bid=0034&list_no=718713&act=view)

62. Ministry of Health and Welfare [Internet]. 2022 Apr. Available from: [https://www.mohw.go.kr/react/al/sal0301vw.jsp?PAR\\_MENU\\_ID=04&MENU\\_ID=0403&page=1&CONT\\_SEQ=371078](https://www.mohw.go.kr/react/al/sal0301vw.jsp?PAR_MENU_ID=04&MENU_ID=0403&page=1&CONT_SEQ=371078)

63. South Korea MFDS press release [Internet]. 2022 Aug. Available from: <https://www.medifonews.com/mobile/article.html?no=169660>

64. Google News [Internet]. COVID-19 map. Available from: <https://news.google.com/covid19/map?hl=en-AU&mid=%2Fm%2F06qd3&gl=AU&ceid=AU%3Aen&state=7>

# 5. Conclusion

While South Korea was internationally recognized for its effective containment of COVID-19 in the early stages of the pandemic in 2020, achieving among the lowest number of cases and deaths in the OECD, 2022 proved more difficult – with a surge of infections occurring after restrictions were lifted in April of that year.<sup>65</sup> Looking into the endemic period ahead, our analysis indicates that South Korea will continue to be impacted by both direct and indirect costs of COVID-19, ranging from a more optimistic KRW ~7 trillion p.a. (~0.3% of GDP) to KRW ~122 trillion (~5.5% of GDP) in a worst-case Pandemic 2.0 scenario.

South Korea's health system will likely bear significant direct costs from COVID-19 moving forward. At the same time, a substantial indirect toll will arise from the country's working-age adults, many of whom will either contract the virus or have to forgo work to care for someone infected. Infections among older people, vulnerable populations, and children will continue to cause productivity losses among working-age adults and certain cohorts, such as workers in critical industries (healthcare, logistics, and travel and tourism). As it stands, indirect costs due to productivity losses account for 96% of the future economic cost for South Korea in a base case scenario.

The findings in this report shed light on the many factors and considerations that will inevitably contribute to South Korea overcoming COVID-19 and are intended to help policymakers plan for that future.

## 5.1 Economic costs

In our base case scenario, the total economic cost of COVID-19 is KRW ~36.2 trillion p.a., which is equivalent to ~1.6% of GDP, with:

- direct costs to the South Korean health system at KRW 1.5 trillion p.a. in both inpatient and outpatient settings, a significant direct expense equating to ~0.1% of South Korea's GDP and ~4% of the total economic costs.
- the remaining 96% of costs due to productivity losses through missed work by both (i) adults as a result of their own illness or while caring for dependents (children and over-60-year-olds); as well as (ii) elderly in the workforce affected by COVID-19.
- COVID-19 infections in the older population (60 years-old and above) representing a minimum impact of KRW ~8.6 trillion p.a. in productivity losses, and infections in children and adolescents (18 years-old and younger) costing KRW ~3.7 billion p.a.

In the Pandemic 2.0 scenario, economic costs could reach KRW ~122 trillion p.a. (~5.5% of GDP). This assumes a higher rate of infection of ~2 million cases per million population and a higher viral severity that could result in a hospitalization rate of 1% of all infections. At the lower end, a Normal 2.0 scenario might impose an economic cost of KRW ~6.7 trillion p.a. with 320,000 infections per million population.

## Health system capacity

In a base case scenario, with current conditions prevailing, South Korea can expect KRW ~1.5 trillion p.a. worth of direct costs to its health system, fueled by ~155,000 hospital admissions, including ~15,000 in ICU. This equates to ~0.1% of the market's GDP. When considering the incidence, complexity, and duration (90 days) of long COVID, its impact could result in an additional 15 million healthcare consultations to address the impact alone.

65. Mathieu E, Ritchie H, Rodés-Guirao L, Appel C, Gavrilov D, Giattino C et al. Our World in Data [Internet]. South Korea: Coronavirus Pandemic Country Profile. 2023 Apr 13. Available from: <https://ourworldindata.org/coronavirus/country/south-korea>

Of the direct impact, inpatient care poses the most significant cost. According to our analysis under a base case scenario, inpatient care in South Korea could cost KRW ~3.47 million per person, while outpatient care could cost KRW ~260,000 per person.

Given these expenses and the further consideration that ~60% of inpatient costs are borne by patients aged over 60 years old, it is apparent that testing, treating, and ameliorating the severity of illness – especially among vulnerable populations – remains just as important during the current endemic phase of COVID-19.

## Workers and critical industries

South Korea's healthcare workers remain at the frontlines of this ongoing health crisis. Despite the magnitude of direct costs imposed on the health system as discussed above, indirect costs in the health workforce (productivity losses due to missed work) create an additional burden on South Korea's economy.

The healthcare system employs ~780,000 people and represents a disproportionate slice of the COVID-19 impact.<sup>66</sup> Over the past three years, health service employers have seen higher rates of absenteeism due to greater exposure and susceptibility to COVID-19, exacerbating workforce shortages and burnout, and resulting in poorer quality and safety of care. Looking ahead, this issue is likely to continue, accounting for KRW ~1 trillion p.a under a base case scenario.

However, other key industries such as logistics, as well as travel and tourism, also face significant ongoing impacts. South Korea's KRW ~114 trillion logistics sector delivers vital goods and services across the country.<sup>67</sup>

During the pandemic, the sector was significantly impacted by productivity losses from workers who were either ill themselves, isolating, or caring for others who have been infected with COVID-19. South Korea's travel and tourism industry likewise experienced absenteeism linked to COVID-19, exacerbating flight disruptions and workforce shortages.

Despite signs of recovery, critical industries are likely to experience ongoing impacts from COVID-19 throughout the endemic phase.

## Vulnerable populations

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

South Korea's older population (over the age of 60) and those with comorbidities are especially susceptible to COVID-19 and severe illness, which places greater demands on health services. Together, they represent a minimum impact of KRW ~18 trillion p.a. (~0.8% of GDP) on the market's economy.

While South Korea's older population represent only ~12% of confirmed cases, they account for ~40% of related hospitalizations.<sup>68</sup> For younger people with comorbidities, the risk of severe illness and therefore hospitalization is double that of the wider population.<sup>69</sup>

Given this disproportionate impact, policymakers in South Korea may seek to strengthen countermeasures, including bolstering vaccination, community interventions, or the use of oral antivirals to reduce the duration and severity of illness in these groups.

66. Korean Health Industry Development Institute [Internet]. 2021 Market Overview. Available from: <https://www.khidi.or.kr/board?menuId=MENU00793&siteId=SITE00012>

67. Statistics Korea [Internet]. Transport Survey. Available from: <https://kostat.go.kr/anse/?bmode=read&aSeq=417098&pageNo=&rowNum=10&amSeq=&sTarget=&sTxt=>

68. Calculated based on age distribution of inpatients. Specific data related to COVID-19 or similar respiratory illnesses was unavailable. HIRA and NHIS [Internet]. National Health Insurance Statistical Yearbook, 2021. Available from: <https://www.hira.or.kr/bbsDummy.do?pgmid=HIRAJ030000007001&brdScnBitNo=4&brdBitNo=3>

69. Liu B, Spokes P, He W, Kaldor J. BMC Infectious Diseases [Internet]. High risk groups for severe COVID-19 in a whole of population cohort in Australia. 2021 Jul 16. 685(2021). Available from: <https://bmcinfectdis.biomedcentral.com/articles/10.1186/s12879-021-06378-z>



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

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

### Keep community measures on the table and keep innovating

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

### Continue vaccinating and developing new vaccines

By reducing individuals' susceptibility to the virus, COVID-19 vaccines have provided a significant benefit to the South Korean 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 South Korea in January 2022, have the potential to further curb the economic impact of COVID-19 by playing a role in reducing the burden of disease. There may also be an opportunity to broaden the use of therapeutics, given that the cost of medications (such as oral antivirals, KRW ~670 billion p.a.) equates to 2% of total economic costs, representing a small investment toward partially reducing a large burden of direct and indirect costs. With South Korea now increasingly accepting COVID-19 as endemic along with the rest of the world, there is an opportunity to reduce the severity of its symptoms and thereby soften its blow to productivity.

As has been described, the large and wide-ranging costs of the pandemic on South Korea are 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

## South Korea

### Exhibit A1: Key overall assumptions

3 <sup>rd</sup> Level	4 <sup>th</sup> /5 <sup>th</sup> Level	Value	Source	Commentary
Total	Total COVID-19 infections	51,740,000	World Bank (population data) The Institute for Health Metrics and Evaluation (IHME) (released November 18, 2022)	• Assume a rate of 1 infection per person per year (average of last 6 months in South Korea)
	Total COVID-19 cases	10,348,000	The Institute for Health Metrics and Evaluation (IHME) (released November 18, 2022)	• Assume case detection rate continues from Q4 2022 - 20%
	Total COVID-19 deaths	15,522	The Institute for Health Metrics and Evaluation (IHME) (released November 18, 2022)	• Assume infection fatality rate continues from Q4 2022 - 0.03%

## Exhibit A2: Key direct cost assumptions

3 <sup>rd</sup> Level	4 <sup>th</sup> /5 <sup>th</sup> Level	Parameter Name	Value	Source	Commentary
Inpatient	Acute	Hospitalization rate	0.3%	Institute for Health Metrics and Evaluation	• Reflects infection and hospitalization rates in Q3-4 2022
		Number of admissions	155,220	Calculation	• Total infections (~51.7m) multiplied by hospitalization rate
	Moderate	Ward admission rate	90%	Institute for Health Metrics and Evaluation	• IHME-modelled number of required hospital beds versus number of required ICU beds
		Ward length of stay	10 days	South Korea National Assembly Budget Office	• Average COVID LOS Q1-2 2020; revised down from 13 to account for ICU admissions and variant severity
		Ward bed day cost	₩265,909	South Korea National Assembly Budget Office	• Total cost per inpatient day (borne by NHI and government under infectious diseases control and prev. act)
	Severe	ICU admission rate	10%	Institute for Health Metrics and Evaluation	• Modelled number of required ICU beds as proportion of required hospital beds
		ICU length of stay	7.5 days	Hospital Insurance Review and Assessment Service report	• Average ICU LOS at 17 university hospitals 7.43 days
		ICU bed day cost	₩650,000	National Health Insurance Service	• Total daily inpatient treatment costs per severe COVID cases ₩650,000

## Exhibit A2: Key direct cost assumptions (continued)

3 <sup>rd</sup> Level	4 <sup>th</sup> /5 <sup>th</sup> Level	Parameter Name	Value	Source	Commentary
Inpatient	Severe (cont.)	Proportion of ICU admissions requiring subacute care	50%	Annals of Intensive Care, published journal article	<ul style="list-style-type: none"> <li>Modelled number of required ICU beds as proportion of required hospital beds</li> </ul>
		Subacute length of stay	20 days	Calculation (2 x 10 days)	<ul style="list-style-type: none"> <li>Ratio of rehabilitation to ward LOS in comparable markets is ~2</li> </ul>
		Subacute bed day cost	¥320,000	Calculation (1.2 x ¥266,000)	<ul style="list-style-type: none"> <li>Ratio of rehabilitation to ward LOS in comparable markets is ~1.2</li> </ul>

## Exhibit A2: Key direct cost assumptions (continued)

3 <sup>rd</sup> Level	4 <sup>th</sup> /5 <sup>th</sup> Level	Parameter Name	Value	Source	Commentary
Outpatient	Acute	Number of acute outpatient infections	51,584,780	Calculation	• Total infections (~51.74mn) minus number of hospital admissions
		Number of visits to the ECU per 1,000 infections (~500 reported infections)	1	Australian Institute of Health and Welfare report on the impact of COVID-19 on 2020 emergency department activity	• Limited RWE; figure from comparable population and health system can be applied
		Number of Emergency Department visits per year for COVID	54,637	Calculation	• Number of acute outpatient infections multiplied by (~1/1000)
		Cost per Emergency Department visit	₩204,752	2021 Annual survey of Emergency Medical Service Users (MOHW)	
		Proportion of total infections that visit a primary care clinic	2%	Journal of Primary Care and Community Health	• Study of visits to ~1,200 primary care centers across the US in 2020 for treatment of COVID illness; divided by number of infections
		Cost per Clinic visit	₩16,970	National Health Insurance Corporation report on COVID-19 costs, 2020-22	• Cost of a basic COVID-19 consultation, excluding testing costs
		Proportion of infections prescribed OAV	1.9%	Internal MSD – South Korea team Institute for Health Metrics and Evaluation	• Calculated using known 2022 OAV prescription volumes and infections
		Number of infections prescribed medication p. a.	959,477	Calculation	• By comparison, 852,000 OAV prescriptions have been written in 2022



## Exhibit A2: Key direct cost assumptions (continued)

3 <sup>rd</sup> Level	4 <sup>th</sup> /5 <sup>th</sup> Level	Parameter Name	Value	Source	Commentary
Outpatient	Chronic	Incidence of Long COVID	5%	South Korean Long COVID study published in BMC Infectious Diseases	• Gives estimate of Long COVID incidence of 5%
		Average duration of Long COVID	≥12 weeks	World Health Organization	• Globally accepted consensus on duration of Long COVID being symptoms that persist ≥12 weeks
		Average number of clinic visits per Long COVID patient	6	Calculation	• 1 clinic visit per fortnight over 12-week illness

## Exhibit A3: Key indirect cost assumptions

Parameter		Value	Source	Commentary	
Age distribution of infections	Infected working-age	57%	• South Korea Disease Control and Prevention Agency (KDCA)	• Based on age distribution of cumulative cases until November 22, 2022 which are used as a proxy for infection proportions	
	Pediatric carers	24%			
	Elderly	19%			
Cross-cutting assumptions	Acute illness	100%		• Assume all COVID-19 infections experience short-term 'illness' which can be symptomatic or asymptomatic	
	Long COVID	5%	• Australian National University Evidence from the COVID-19 Impact Monitoring Survey Series, August 2022	• Estimate of incidence in Australia of 4.7% • Consistent across multiple global sources (with estimates ranging from 5-50%)	
	Persistently asymptomatic	25%	• Magnitude of asymptomatic COVID-19 cases throughout the course of infection: A systematic review and meta-analysis (2021)	• March 2021 Systemic Review - 6071 cases, weighted pooled proportion of asymptomatic cases throughout course of infection was 25% (95% CI)	
	Detected	20%	• The Institute for Health Metrics and Evaluation (IHME) (released November 18, 2022)	• Calculated based on cases divided by total infections for December 2022	
	Proportion of people who will isolate for full time period (7 days)	100%		• Assume 100% adherence to national mandate of 7 day isolation period (if detected and/or symptomatic)	
Specific to working-age and elderly	Acute - well enough to work	Proportion of acute infections well enough to work	99.7%	• The Institute for Health Metrics and Evaluation (IHME)	• Proportion of people who are outpatients used as proxy • Based on Q4 2022 hospitalization rate; no inclusion of HITH as community service centers have all closed down

## Exhibit A3: Key indirect cost assumptions (continued)

Parameter		Value	Source	Commentary	
Specific to working-age and elderly	Acute - well enough to work	Proportion of people who can work from home	32%	<ul style="list-style-type: none"> <li>Statista (combination of sources) (2021)</li> </ul>	<ul style="list-style-type: none"> <li>Around half the value for Taiwan and Australia</li> <li>Other sources quote 4-12% (even lower)</li> <li>Aligned to culture of small business in South Korea</li> </ul>
		Duration of acute illness	12 days	<ul style="list-style-type: none"> <li>Medline (2022)</li> </ul>	<ul style="list-style-type: none"> <li>10-14 days for mild to moderate illness; assumed consistent across all markets</li> </ul>
		Average # of days taken as sick leave from work	2 days	<ul style="list-style-type: none"> <li>Hankyoreh 'South Koreans take the fewest number of sick days among OECD markets' (November 2020)</li> </ul>	<ul style="list-style-type: none"> <li>In a survey conducted by OECD, South Korea workers reported just 2 days taken off sick in a year. This was lowest among member OECD markets (e.g., in US and UK it is 4 and 4.4 days respectively)</li> <li>The assumption used for Australia is 3 and Taiwan is 2.4</li> </ul>
		Productivity loss on days worked while ill	35%	<ul style="list-style-type: none"> <li>European Respiratory Society</li> </ul>	<ul style="list-style-type: none"> <li>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.</li> </ul>
Acute - too ill to work	Duration of acute debilitating (inpatient) illness	12.88 days	<ul style="list-style-type: none"> <li>See direct cost length of stay assumption</li> </ul>	<ul style="list-style-type: none"> <li>10 days on ward (95%) and (5% severe) 17.5 ICU + Ward stepdown + 10 subacute (50% of severe for 20 days) = weighted average of ~10.875 days</li> <li>+ Recovery time of assumed ~2 days (same as outpatient) = ~12.88 days</li> </ul>	
Long COVID - well enough to work	Average # of days taken as sick leave from work	6 days	<ul style="list-style-type: none"> <li>European Respiratory Society</li> </ul>	<ul style="list-style-type: none"> <li>2021 Cross Section study of patients at 3 months who had missed 10% of work time due to health if non-hospitalized.</li> <li>Reduce to 2/3 of 10% of working days, proportional to the assumption for acute illness.</li> </ul>	

## Exhibit A3: Key indirect cost assumptions (continued)

Parameter	Value	Source	Commentary	
Specific to elderly	Proportion of elderly receiving / requiring care from a non-health professional working-age adult	90%	<ul style="list-style-type: none"> <li>Medical World News – OECD health statistics analysis (2022)</li> </ul>	<ul style="list-style-type: none"> <li>Long-term care recipients refer to those aged 65 or older who receive paid long-term care services (facility services or home-based services) in South Korea.</li> <li>In home long-term care 7.4% and in facility 2.6% (total 10%) which was lower than OECD average (in home 10.4%, facility 3.6%)</li> </ul>
	Proportion of elderly providing childcare while parents work	30%	<ul style="list-style-type: none"> <li>Longitudinal patterns of grandchild care (2022)</li> </ul>	<ul style="list-style-type: none"> <li>Approximately 30% of South Korean grandparents who have adult children going to their places of employment have provided grandchild care at some point in their lives, and South Korean grandparents who provide care for their grandchildren report doing so for an average of 52 h per week</li> </ul>
	Proportion of elderly participating in the workforce	19%	<ul style="list-style-type: none"> <li>Wise Person Article (2021)</li> <li>KOSIS (2022)</li> </ul>	<ul style="list-style-type: none"> <li>By job status, 54.1% of workers aged 65 or older were temporary workers, 28.1% were full-time workers, and 17.7% were daily workers.</li> <li>60+ in November 2022 was 6,189 of 28,421 thousands employed persons</li> <li>Total population 60+ is ~15.4 million</li> <li>Calculation = <math>(0.281 \times 6.19 \text{ million} + 0.25 \times 0.719 \times 6.19 \text{ million}) / 15.4 \text{ million} = \sim 19\%</math> participation rate (compared to 10 to 15% in Australia and Taiwan)</li> </ul>
Specific to pediatric	Average duration of acute illness	6 days	<ul style="list-style-type: none"> <li>Illness duration and symptom profile in symptomatic UK school-aged children tested for SARS-CoV-2 (2021)</li> </ul>	<ul style="list-style-type: none"> <li>Mean duration of illness is 5-7 days</li> <li>Assumed to be applicable across all markets (same virus)</li> </ul>
	Average productive loss due to providing care for a child with acute mild / outpatient illness	50%	<ul style="list-style-type: none"> <li>Macquarie University (2021)</li> </ul>	<ul style="list-style-type: none"> <li>Australian study of lockdown care coverage used as a proxy and applicable across markets due to limited availability of data</li> <li>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)</li> <li>Assume double care coverage is required for sick child</li> </ul>

