



Using Risk Analysis to Shape Border Management

A Review of Approaches during the COVID-19 Pandemic

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INTERNATIONAL PROGRAM

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Executive Summary

Evidence shows that, since the onset of the pandemic, travel measures have been used effectively by some countries to reduce or slow the importation and onward transmission of SARS-CoV-2, the virus that causes COVID-19. These travel measures were used for border management to govern the movement of people, goods, and services into and out of jurisdictions, ranging from advisories and screening to quarantine, testing, immunity certification, and restrictions on entry. However, the overall application of such measures worldwide has been highly varied, changeable, and poorly coordinated. Many measures have also been applied for prolonged periods, causing substantial social and economic impacts on individuals, communities, and key economic sectors. Moreover, the rationale for such measures, the evidence underpinning them, and their role in pandemic response strategies has often not been communicated clearly to the public. Policymakers are thus faced with two key challenges: how to use travel measures to mitigate public-health risks most effectively while limiting secondary harms to individuals and societies; and how to communicate in ways that foster public trust and understanding of the need for travel measures for responding to the potential or actual spread of dangerous pathogens.

To address the problematic and inconsistent uses of travel measures for border management during COVID-19, there has been growing discussion among governments, international organizations, and private-sector actors of risk-based approaches to decision-making during public-health emergencies of international concern. A clear and agreed framework for risk analysis would allow governments to assess emerging threats posed by spreading pathogens in real time, and then support decision-making on whether, what, and how travel measures should be implemented. By integrating evolving scientific evidence about an emerging disease event with transparent policymaking, an agreed travel-related risk analysis framework can support border management that is more consistent, coherent, and harmonized within and across jurisdictions. As World Health Organization (WHO) Member States seek to negotiate a legal instrument for future global pandemics and amend the International Health Regulations (the WHO instrument for controlling the international spread of disease), an important opportunity exists to learn lessons from the COVID-19 pandemic to advance consensus on a travel-related risk analysis framework.

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Different travel-related risk analysis methodologies have been put forth in guidelines or policy documents by countries, regional bodies, and international organizations during this pandemic. A comparative analysis of 11 publicly available methodologies—from Hong Kong, New Zealand, South Korea, Taiwan, the United Kingdom, the United States, the International Civil Aviation Organization, the International Air Transport Association, WHO, the Organization for Economic Cooperation and Development, and the European Union—along the six key features described below reveals both commonalities and differences.

- 1 **Hazard identification (what is the source of hazard?):** All of the methodologies start with the pathogen as the potential hazard source, but they vary by which individual travelers (e.g., inbound versus all travelers) and geographical areas (e.g., departure versus destination country) are seen as risk sources. Not all government methodologies differentiate threats posed by mode of transportation (i.e., relative risk from air, land, and sea travel), but the United States' methodology provides some risk assessment of individual cruise ships, and Hong Kong applies different entry requirements to crew depending on mode of entry.
- 2 **Hazard characterization (what is the nature of the hazard?):** Most methodologies are concerned primarily with virus importation and onward transmission that lead to increased illness and death. WHO and ICAO guidance also covers the risk of case *exportation*, when an infected traveler might bring the virus to and spread it within other countries. In addition, New Zealand, the United Kingdom, and WHO identify disruption to health-care systems as a secondary hazard, and WHO considers social and economic impacts beyond public health.
- 3 **Exposure assessment (who is at risk?):** All methodologies focus on risks to domestic populations, with limited consideration of spread beyond national borders. Certain methodologies specify risks for different subpopulations (e.g., border staff, airline or ship crew).
- 4 **Risk characterization (how is level of risk calculated?):** All 11 methodologies consider epidemiological data, but New Zealand, South Korea, Taiwan, and WHO are the most comprehensive, considering variables under four categories: evolving science, epidemiological data, health system indicators, and jurisdictional context. However, the specific variables considered under each category differ for each methodology.
- 5 **Risk evaluation (what level of risk is tolerated?):** Risk tolerance is based on objective criteria (e.g., health-care system capacities) and subjective criteria (e.g., normative frameworks, trade-offs). The 11 methodologies differ in the criteria applied. The European Union, United Kingdom, and United States rank countries by risk level and apply more stringent measures on countries deemed high-risk. Hong Kong applies thresholds based on the proportion or number of inbound travelers who test positive arriving on any flight.
- 6 **Option assessment (how are mitigation measures chosen?):** Few methodologies tie different risk levels to specific mitigation measures. The European Union recommends that travelers from low-risk countries face no restrictions (and leaves Member States to determine measures for travelers from countries deemed higher-risk). South Korea, however, assigns different measures (visa restrictions, quarantine and testing requirements, and flight caps) to three risk levels.

Despite these differences, the methodologies reviewed share two common challenges. First, there is a need for appropriate, timely, and reliable data that are harmonized across jurisdictions. Currently, data are not collected and shared across jurisdictions in agreed and standardized ways that would facilitate systematic and coordinated travel-related risk analysis. This is due to variations in terminology, practice, capacity, and data management protocols. For example, data on test positivity of in-bound travelers vary because national governments use different sampling methods, test types, and testing protocols that have also changed over time. Limited testing capacity in many countries throughout the pandemic, and in all

countries since Fall 2021 due to the overwhelming surge in infections from the Omicron variant of concern, further undermines travel-related case counts for surveillance.

A second challenge is the need for greater transparency. Building toward more harmonized use of travel measures globally requires greater openness about what risk analysis methodologies were applied during COVID-19. This in turn will support ongoing evaluation and, in time, consensus on the appropriate and effective use of such methodologies. Improved transparency regarding the science and policy underpinning travel measures will also build public trust in what has become a controversial policy area.

This report proposes a decision instrument for policymakers that outlines key steps to applying risk analysis in the use of travel measures during future public-health emergencies. In this approach, policymakers would begin by assessing the threat in relation to the pathogen (e.g., is there human-to-human transmission, how is the pathogen transmitted, how severe are the impacts on illness and deaths) and the jurisdiction's characteristics (e.g., is the pathogen already present, what is the capacity for health care and border management, how susceptible is the population). Policymakers must then decide on priority policy objectives (i.e., trade-offs among public-health, social, and economic impacts) and the commensurate response strategy (e.g., eradicate versus mitigate the pathogen). Once these steps are completed, to decide whether travel measures should be used and for what purpose, policymakers can apply the six risk analysis parameters discussed above to inform how travel measures should be used. Once these are applied, real-time monitoring and reviewing should provide ongoing feedback on the effectiveness at achieving priority objectives, along with changes in the pathogen (e.g., variants of concern, waning effectiveness of vaccines), scientific knowledge (e.g., transmission dynamics, effectiveness of vaccines and treatments), jurisdictional characteristics (e.g., increased vaccination), priority policy objectives (e.g., increased priority to economy), and response strategy (e.g., shift from elimination to mitigation).

Overall, this report concludes that risk analysis can support more systematic, evidence-informed, and harmonized use of travel measures during public-health emergencies. This begins with agreed methodologies underpinned by appropriate, timely, and reliable data. It recommends that risk analysis be conducted as a decision instrument that brings together science and policy considerations. Doing so will improve transparency and, ultimately, strengthen preparedness for future public-health emergencies including those which may require effective border management.

1 Introduction

Border management concerns the policies, procedures, and processes governing the movement of traffic (people) and trade (goods and services) into and out of a jurisdiction. These practices can occur before, at, or within the border, and they can take place at regional (e.g., European Union, African Union), national, or subnational (e.g., provincial or state) levels. Travel measures concern the management of traffic (human mobility) and, when used for border management purposes, span a broad range of practices, including advisories, screening, quarantine, health certification, and restrictions on entry.

The near universal adoption of travel measures by governments to control the spread of SARS-CoV-2 has proved controversial during the COVID-19 pandemic. Previous major outbreaks of infectious diseases

suggest that restrictions on travel are generally of limited value to public-health goals or may even be counterproductive if they hinder prompt disclosure of information or limit the ability of health-care workers and essential supplies to reach affected areas.¹ Yet travel measures including restrictions were adopted by virtually all countries, and many subnational authorities, by April 2020. Because SARS-CoV-2 was a novel pathogen, and understanding of its nature and spread was evolving, authorities made decisions amid considerable uncertainty and rapid change. This contributed to highly varied, frequently changing, and poorly coordinated use of travel measures across jurisdictions, creating chaos for travelers and the travel sector, and causing significant economic and social harms. In most cases, governments did not follow the temporary recommendations issued by the director-general of the World Health Organization (WHO) in relation to the public-health emergency of international concern (PHEIC), pursuant to the International Health Regulations (IHR; the WHO-administered international legal instrument for controlling the international spread of disease). They also failed to clearly communicate the rationale for such measures, the evidence underpinning them, and their role within overall pandemic response strategies.

Despite this problematic use of travel measures, there is now substantial evidence that their early and stringent use by some governments during the initial stages of the COVID-19 pandemic slowed SARS-CoV-2 importation and reduced onward transmission.² There is also growing recognition of weaknesses in the quality of available evidence informing the use of travel measures.³ This includes varied and inconsistent terminology, contributing to confusion and undermining the ability to draw comparative lessons across jurisdictions.⁴ Importantly, the basis for real-time decisions about the use of travel measures remains unclear. Frameworks for assessing travel-related risks existed before the COVID-19 pandemic, but these methodologies remain underdeveloped. Governments have often justified their use of travel measures during the pandemic as evidence-informed, but in most cases, they have not made the methodologies and data sources underpinning their decisions publicly available. In some cases, governments have published this information, but only partially or only long after implementing travel measures. Regional and international bodies have developed other methodologies, though these were not adopted widely. Overall, it remains unclear what methodologies have been used, how they have informed the use of travel measures, and to what effect.

Evaluating the appropriateness of travel measures and applying them effectively during future public-health emergencies, including PHEICs, thus depends upon international consensus on methodologies that

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- 1 Timothy C. Germann, Kai Kadau, Ira M. Longini Jr., and Catherine A. Macken, "Mitigation Strategies for Pandemic Influenza in the United States," *Proceedings of the National Academy of Sciences* 103, no. 15 (2006): 5935–5940; Lawrence O. Gostin and Rebecca Katz, "The International Health Regulations: The Governing Framework for Global Health Security," *Milbank Quarterly* 94, no. 2 (2016): 264–313.
 - 2 Nina Haung et al., "Ranking the Effectiveness of Worldwide COVID-19 Government Interventions," *Nature Human Behaviour* 4, (2020): 1303–1312; Nicholas Steyn et al., "Managing the Risk of a COVID-19 Outbreak from Border Arrivals," *Journal of the Royal Society Interface* 18, no. 177 (2021): 20210063; Sheng-Chia Chung et al., "Lessons from Countries Implementing Find, Test, Trace, Isolation, and Support Policies in the Rapid Response of the COVID-19 Pandemic: A Systematic Review," *BMJ Open* 11, no. 7 (2021); Lama Bou-Karroum et al., "Public Health Effects of Travel-Related Policies on the COVID-19 Pandemic: A Mixed Methods Systematic Review," *Journal of Infection* 83, no. 4 (2021): 413–423; Hasan Muhammad Baniamin, Mizanur Rahman, and Mohammad Tareq Hasan, "The COVID-19 Pandemic: Why Are Some Countries Coping More Successfully than Others?" *Asia Pacific Journal of Public Administration* 42, no. 3 (2020): 153–169; Michael G Baker, Amanda Kvalsvig, and Ayesha J. Verrall, "New Zealand's COVID-19 Elimination Strategy," *The Medical Journal of Australia* 213, no. 5 (2020): 198–200.
 - 3 Jacob Burns et al., "International Travel-Related Control Measures to Contain the COVID-19 Pandemic: A Rapid Review," *Cochrane Database of Systematic Reviews* 3, no. 3 (2021).
 - 4 Kelley Lee et al., "Managing Borders during Public Health Emergencies of International Concern: A Proposed Typology of Cross-Border Health Measures," *Globalization and Health* 17, no. 62 (2021).

lead to a more harmonized and coordinated approach. This, in turn, will support public trust and encourage compliance with necessary public-health orders. Toward this purpose, this report begins by outlining key elements of risk analysis. It then compares 11 publicly available travel-related risk analysis methodologies put forth during COVID-19 and compares them along six parameters. It concludes with lessons and recommendations, including a proposed decision instrument, for advancing the use of risk analysis for border management during future public-health emergencies.

2 Travel-Related Risk Analysis Methodologies

Risk⁵ analysis can be broadly structured into three main parts: risk assessment, risk management, and risk communication. During an outbreak event, *risk assessment* assigns a level of risk to the pathogen (as the hazard or threat), *risk management* weighs the options for managing public-health risks (including mitigation measures), and *risk communication* supports informed decision-making by members of society, positive behavior change, and public trust. This report focuses on methodologies that inform risk assessment and management, focusing on the four parameters listed under “risk assessment” in Figure 1 as well as the first two under “risk management.” The remaining features (option implementation, monitoring and review, and risk communication) are critically important in an overall risk analysis framework. However, available methodologies give limited attention to these remaining parameters. An assessment would involve searching and reviewing a broader range of additional guidelines and policy documents that lie beyond the scope of this review.

FIGURE 1
Structure of Risk Analysis



Source: Based on Figure 1 from A.M. Fazil, “A Primer on Risk Assessment Modelling: Focus on Seafood Products” (Fisheries Technical Paper No. 462, UN Food and Agriculture Organization, Rome, 2005).

5 The World Health Organization (WHO) defines risk as “the likelihood of the occurrence and the likely magnitude of the consequences of an adverse event during a specified period.” See WHO, *Rapid Risk Assessment of Acute Public Health Events* (Geneva: WHO, 2012), 4. Emergency or disaster risk is defined more specifically as “the potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society, or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability, and capacity.” See WHO, *Health Emergency and Risk Management Framework* (Geneva: WHO, 2019), 3.

Risk analysis has long been applied in travel medicine and other fields concerned with human mobility. Travel medicine assesses potential health risks in different destinations to provide care to outbound travelers (e.g., vaccination, advisories).⁶ Risk assessment is also used in immigration processes whereby inbound migrants from certain regions may be required, for example, to provide a personal health history (e.g., immunization record or vaccine certificate), proof of health insurance, or undergo health screening.⁷

As the world has become more globally interconnected, with higher volumes and greater diversity in forms of human mobility, individual traveler-based risk assessment has become more complex.

As the world has become more globally interconnected, with higher volumes and greater diversity in forms of human mobility, individual traveler-based risk assessment has become more complex.⁸ Given major public-health events over the past two decades—including SARS-CoV-1, responsible for the SARS outbreak in 2002–04; the MERS outbreak that began in 2012; the Zika virus epidemic in 2015–16; and H5N1 avian influenza virus (popularly known as “bird flu”) as an ongoing challenge—there has been greater attention to assessing travel-related risks, including the risks of pathogen or vector importation (i.e., introduction through international traffic or trade),⁹ transmission in transit,¹⁰ and cost-benefit analysis of preventing travel-related importations.¹¹ It is

notable that for several such events prior to the COVID-19 pandemic (e.g., the SARS outbreak [2002–04]; H1N1 influenza also known as the “swine flu” pandemic [2009], Ebola virus epidemic in West Africa [2013–16]), government and public perceptions *overestimated* travel-related risks.

For SARS-CoV-2, as a new pathogen, many parameters (and the corresponding data) required to predict the probability of associated travel-related risks and the varied outcomes from those risks have been either unknown or remained uncertain. Several of the risk methodologies examined in this report were adopted several months into the COVID-19 pandemic, once data on cases, transmission dynamics, and testing had become more widely available. Thus, one critical challenge to comparing (and improving) assessments of

6 Peter A. Leggat, “Risk Assessment in Travel Medicine,” *Travel Medicine and Infectious Disease* 4, no. 3–4 (2006): 127–134; Stephen Toovey, “Travelling to Africa: Health Risks Reviewed,” *Travel Medicine and Infectious Disease* 4, no. 3–4 (2006): 147–158.

7 U.S. Centers for Disease Control and Prevention (CDC), “Immigrant, Refugee, and Migrant Health,” updated June 16, 2022; Government of Canada, “Medical Inadmissibility,” updated January 4, 2022.

8 Karin Leder, Robert Steffen, Jakob P. Cramer, and Christina Greenaway, “Risk Assessment in Travel Medicine: How to Obtain, Interpret, and Use Risk Data for Informing Pre-Travel Advice,” *Journal of Travel Medicine* 22, no. 1 (2015): 13–20.

9 See, for example, Annelies Wilder-Smith, Kee Tai Goh, and Nicholas I. Paton, “Experience of Severe Acute Respiratory Syndrome in Singapore: Importation of Cases and Defense Strategies at the Airport,” *Journal of Travel Medicine* 10, no. 5 (2003): 259–262; U.S. CDC, “Lessons Learned, Supplement E: Managing International Travel-Related Transmission Risk,” updated May 3, 2005; Tianmu Chen et al., “Risk of Imported Ebola Virus Disease in China,” *Travel Medicine and Infectious Disease* 12, no. 6 Part A (2014): 650–658; Shiori Otsuki and Hiroshi Nishiura, “Reduced Risk of Importing Ebola Virus Disease Because of Travel Restrictions in 2014: A Retrospective Epidemiological Modeling Study,” *PLoS One* 11, no. 9 (2016): e0163418.

10 See, for example, Sonja J. Olsen et al., “Transmission of the Severe Acute Respiratory Syndrome on Aircraft,” *New England Journal of Medicine* 349, no. 25 (2003): 2416–2422; Annelies Wilder-Smith, Nicholas I. Paton, and Kee Tai Goh, “Low Risk of Transmission of Severe Acute Respiratory Syndrome on Airplanes: The Singapore Experience,” *Tropical Medicine and International Health* 8, no. 11 (2003): 1035–1037; Michael G. Baker et al., “Transmission of Pandemic A/H1N1 2009 Influenza on Passenger Aircraft: Retrospective Cohort Study,” *BMJ* 340 (2010): c2424; Isaac I. Bogoch et al., “Assessment of the Potential for International Dissemination of Ebola Virus via Commercial Air Travel during the 2014 West African Outbreak,” *Lancet* 385, no. 9962 (2015): 29–33.

11 See, for example, Annelies Wilder-Smith, “The Severe Acute Respiratory Syndrome: Impact on Travel and Tourism,” *Travel Medicine and Infectious Disease* 4, no. 2 (2006): 53–60; Ronald K. St. John et al., “Border Screening for SARS,” *Emerging Infectious Diseases* 11, no. 1 (2005): 6–10.

travel-related risks during the COVID-19 pandemic is understanding how and to what extent precautionary approaches apply (that is, actions taken in response to serious threats, despite scientific uncertainty).

BOX 1

Precautionary Approaches, Uncertainty, and Travel-Related Risk

A precautionary approach means acting preemptively, in the absence of full scientific certainty, in response to an identified hazard or threat that potentially poses the risk of severe or irrevocable harm. The concept originates in Swedish policy to address environmentally hazardous activities. Historically, the burden of proof required policymakers to demonstrate with scientific certainty that harm had been caused by that activity. The legislation adopted in 1969 shifted the burden of proof to enable preventative action to mitigate the risk of environmental harm. The precautionary principle has since been widely adopted into international environmental law (e.g., the 1982 World Charter for Nature, the 1985 Vienna Convention for the Protection of the Ozone Layer). For example, Principle 15 of the Rio Declaration on Environment and Development (1993) requires that “lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.”

The precautionary approach has since been extended to other policy areas, including public health. Bringing together environmental policy and the important role of prevention in public-health action, a gathering of scientists, lawyers, policymakers, and environmentalists in 1998 issued what became known as the Wingspread Statement, which stated: “When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically.” The varied legal interpretations of the precautionary principle, need to advance methodologies to operationalize them, and opposition to their application by vested interests have led to ongoing contestation.

In the context of future public-health emergencies and the use of travel measures, the COVID-19 pandemic suggests that robust risk analysis methodologies may need to integrate a precautionary approach. The IHR (2005) requires that states parties apply “additional health measures” based on existing scientific evidence and principles. However, amid scientific uncertainty about SARS-CoV-2, evidence now shows that travel measures implemented early in the pandemic response were most effective. This points to inherent challenges concerning how and when travel measures should be used in response to public-health threats. WHO can only issue temporary recommendations once a PHEIC is declared, thus possibly delaying government responses. If governments are compelled to act in advance of WHO recommendations out of precaution, they may undermine collective commitments to efficient disease reporting and avoiding unnecessary interference with international trade and mobility. Efforts to reach consensus on more harmonized approaches to travel-risk methodologies must therefore consider uncertainty and define conditions under which precautionary approaches might be warranted.

Sources: Andrew Stirling, “Risk, Precaution and Science: Towards a More Constructive Policy Debate. Talking Point on the Precautionary Principle,” *EMBO Reports* Talking Point 8, no. 4 (2007): 309–315; Wingspread Conference Participants, “Wingspread Statement on the Precautionary Principle,” January 1998; Jose Felix Pinto-Bazurco, “The Precautionary Principle,” *International Institute for Sustainable Development*, October 23, 2020.

3 Comparing Travel-Related Risk Analysis during the COVID-19 Pandemic

COVID-19 has accelerated efforts to advance travel-related risk analysis methodologies, in differing forms and with varied standing, as guidelines, protocols, or policy documents.¹² Among the 11 publicly available methodologies that this report examines, 6 were developed by governments (Hong Kong, New Zealand, South Korea, Taiwan, the United Kingdom, and the United States), 4 were developed by international organizations (the International Air Transport Association [IATA], the International Civil Aviation Organization [ICAO], the Organization for Economic Cooperation and Development [OECD], and WHO), and 1 was developed by the European Union (see Appendix B for additional information on each methodology). These 11 methodologies, which emerged between the start of 2020 and early 2022, can be compared along the following first six parameters of the risk analysis framework (also shown in Figure 1), which is widely used by WHO, the Food and Agriculture Organization, and other organizations.

- 1 **Hazard identification:** what is the source of hazard (i.e., pathogen, individual traveler, mode of transportation, geography)?
- 2 **Hazard characterization:** what is the nature of the hazard (e.g., illnesses, deaths, disruption to health-care system)?
- 3 **Exposure assessment:** who is at risk (e.g., domestic population, traveler, flight crew)?
- 4 **Risk characterization:** how is level of risk calculated (e.g., total case numbers in traveler's country of origin, testing capacity)?
- 5 **Risk evaluation:** what level of risk is tolerated (e.g., proportion of passengers testing positive upon arrival, total number of cases)?
- 6 **Option assessment:** how are mitigation measures chosen? What mitigation measures are deemed appropriate to the level of risk assessed (e.g., predeparture test for all arrivals from a selected country, mandatory quarantine for all arrivals, flight ban for designated airline)?

A. *Hazard Identification: What Is the Source of Hazard?*

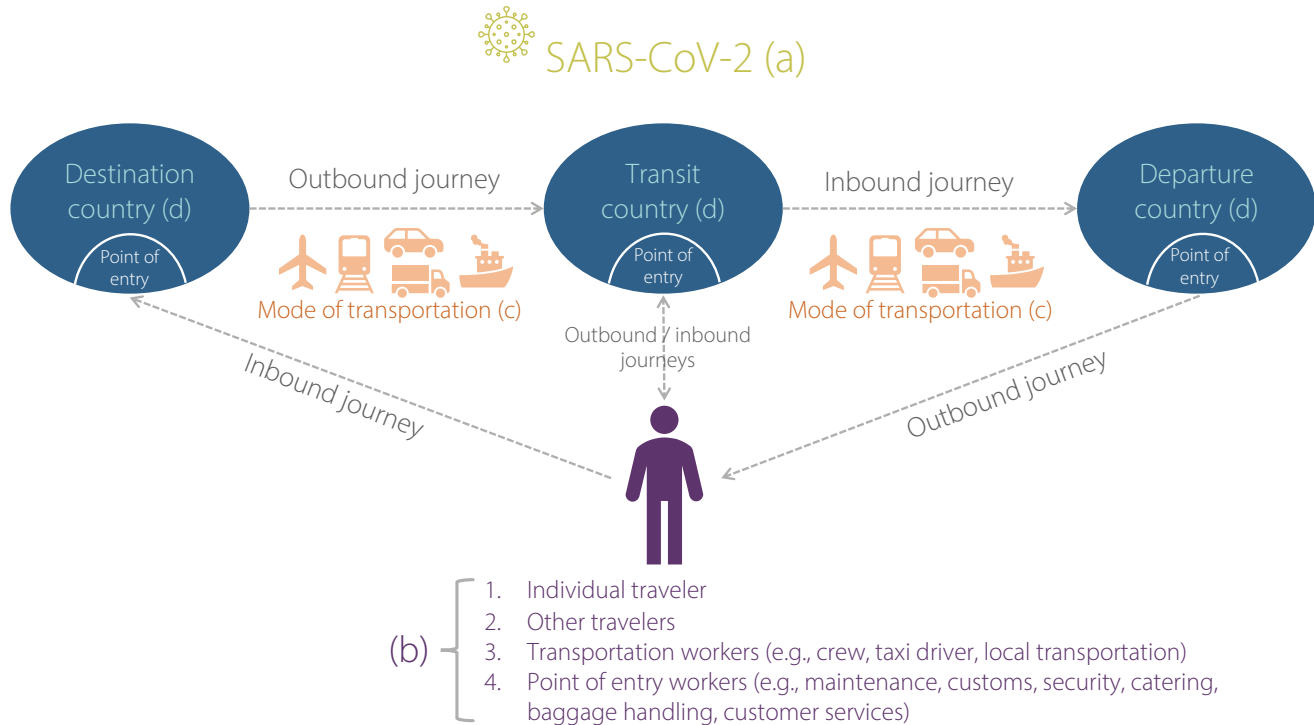
Travel-related hazards during COVID-19 have come from four sources (see Figure 2).¹³ All of the methodologies reviewed consider the evolving science on SARS-CoV-2. Beyond that, however, they focus on different hazard categories.

12 Online searches were conducted during January–May 2022 using the keywords travel* AND risk AND assessment OR analysis OR management AND COVID-19. Documents that claim use of risk analysis but do not provide their methodology were excluded.

13 A fifth category might be transported goods, including baggage, trade products, animals and pests, and containers. See Shilian Han and Xinwang Liu, "Can Imported Cold Food Cause COVID-19 Recurrent Outbreaks? A Review," *Environmental Chemistry Letters* 20, no. 1 (2022): 119–129.

FIGURE 2

Potential Sources of International Travel-Related Risk during the COVID-19 Pandemic



Source: Graphic created by the authors.

- a) The pathogen (included in all 11 methodologies):** Pathogens as a hazard pose different degrees of travel-related risk depending on their transmissibility, virulence (severity of disease caused), case fatality rate, incubation period, and duration of immunity bestowed. SARS-CoV-2 is a highly transmissible virus, is capable of human-to-human spread, can be spread across international borders by symptomatic and asymptomatic travelers, and can cause widespread and severe illness. It is thus considered a risk in all methodologies.
- b) The individual traveler (included in all 11 methodologies):** Travelers as a hazard may pose different degrees of risk depending, for example, on their travel history, itinerary, behaviors, and health and immunity status (e.g., if they have recovered from prior infection or are fully vaccinated). All 11 methodologies consider individual travelers (and their direct contacts, such as crew or other passengers) as potential hazards, but the criteria used to assess this risk varies. The European Commission, for example, proposes that travelers with proof of vaccination or recovery from prior infection pose a lower risk and thus should be allowed to enter the European Union. By contrast, during the first two and a half years of the pandemic, Hong Kong and New Zealand mainly excluded all non-nationals and nonresidents, treating them all as potentially high risk. Except for WHO, the methodologies do not mention or account for the risk posed by travelers considered essential or otherwise exempt from travel measures. There is also a lack of agreement about exemption categories, that is, what is deemed “essential” versus “nonessential” travel, contributing to varying practices in border management by countries and preventing comparisons if based on risk analysis methodologies.

- c) The mode of transportation (included in 7 of the 11 methodologies: OECD, IATA, ICAO, WHO, Hong Kong, Taiwan, and United States):**¹⁴ Air, land, or sea travel can pose different degrees of risk depending, for example, on conditions of travel (e.g., volume and proximity of passengers, capacity to social distance, amount of ventilation), length of journey, and adherence to public-health measures (e.g., mask and vaccination mandates). While some governments have applied different mitigation measures to different modes of transportation during COVID-19 (e.g., different testing and quarantine requirements for air versus land arrivals in Canada), most of the methodologies do not set out how risk analysis can inform such decisions (e.g., why air travel is riskier than land travel). One exception is the WHO’s methodology, which notes the need to take account of air, land, and sea route-specific volume of travel when assessing risk from inbound travel.¹⁵ There are also protocols for assessing and managing risks for selected modes of transportation such as commercial airlines¹⁶ or cruise ships.¹⁷ For example, the United States supported a Cruise Ship Status Database that ranked risks by individual ship based on data such as reported COVID-19 cases and the proportion of passengers vaccinated. Up to July 2022, a Cruise Ship Status Dashboard was publicly available to provide individual travelers with “information they can use to make informed decisions before choosing to travel.”¹⁸
- d) The geographical area (included in 8 of 11 methodologies, all except for IATA, ICAO, and OECD):** The hazard posed by different geographical areas can differ depending on the presence and number of identified infections, trends in new infections, testing and vaccination capacity, health-care capacity, and volume of travel to and from each location. A traveler’s country of origin or destination is the most common unit of geography used by 8 methodologies, although risk rankings have been applied to subnational regions (e.g., the travel bubble between New Zealand and the Australian states of New South Wales, Victoria, and South Australia). New Zealand, the United Kingdom, and the United States have ranked travel source countries by risk level during COVID-19 to guide the use of travel measures, including restricting travel from high-risk countries. This focus on individual countries largely ignores the porous nature of some borders or the level of global interconnectivity whereby some travelers transit through multiple countries.

B. Hazard Characterization: What Is the Nature of the Hazard?

All 11 methodologies characterize the primary travel-related hazards posed by SARS-CoV-2 as virus importation and onward transmission, contributing to increased illness and death in domestic populations. Given a strong focus on domestic populations, virus exportation is not addressed directly except for the WHO and ICAO methodology. Three methodologies consider the potential to disrupt and overwhelm health-care systems (New Zealand, the United Kingdom, and WHO), although ICAO considers this a potential secondary impact. Most methodologies do not consider non-public-health hazards. The main exception is WHO (which identifies the need to consider “vulnerable groups” and “contextual factors,” including

14 OECD notes that its blueprint is applicable to air, rail, coach, and ship travel, but the methodology remains the same for each mode of transportation. The United States has a specific methodology for cruise travel.

15 WHO, *Technical Considerations for Implementing a Risk-Based Approach to International Travel in the Context of COVID-19* (Geneva: WHO, 2021).

16 International Civil Aviation Organization (ICAO), “Aircraft Module,” accessed September 15, 2022.

17 Transport Canada, “Preventing or Limiting the Spread of COVID-19 on Cruise Ships,” updated March 31, 2022; U.S. CDC, “Technical Instructions for CDC’s COVID-19 Program for Cruise Ships Operating in U.S. Waters,” accessed May 5, 2022.

18 U.S. CDC, “Cruise Ship Color Status,” accessed May 5, 2022.

“economic impact, human rights, and feasibility of applying measures”),¹⁹ and New Zealand (the importance of equity considerations).

C. *Exposure Assessment: Who Is at Risk?*

In early 2020, governments were understandably focused on the risks to specific populations linked to hotspots where the first COVID-19 cases were reported (e.g., Wuhan, China, and cruise ships).²⁰ They were concerned with citizens requiring government-facilitated repatriation from these locations; noncitizen arrivals from these locations and their close contacts; and crews and other transportation workers, border officials, and health workers in direct contact with travelers journeying from these locations.

As SARS-CoV-2 spread worldwide, governments shifted concern from the risk of individual travelers’ exposure in hotspot locations to protecting domestic populations from infection risks posed by inbound travelers. Despite the potential for exposures throughout a journey, nine methodologies did not apply risk analysis to outbound travelers or the potential risk exposure exported by them to populations in other countries. Predeparture testing, for example, has been driven by the requirements of destination countries (rather than departure countries). Only the WHO and ICAO methodologies support exposure assessment for both outbound and inbound travel.

As SARS-CoV-2 spread worldwide, governments shifted concern from the risk of individual travelers’ exposure in hotspot locations to protecting domestic populations from infection risks posed by inbound travelers.

Governments have primarily been concerned with risks to domestic populations. This includes the European Union, which adopted a dual approach of securing external borders with non-EU countries against the threat of virus importation, while maintaining openness of internal borders among EU Member States.²¹ There is limited consideration by government methodologies, for example, of the porousness of some borders, transiting of travelers through other countries, or close mixing of populations of many nationalities at a destination or along a journey. By contrast, the WHO, IATA, and ICAO methodologies recognize the need to mitigate exposure risks during a journey for crew and other transportation workers,²² including in aircraft and airports.²³

Importantly, the focus on individual-level risk exposure overlooks population-level differences in vulnerability to travel-related hazards, but also the unanticipated impacts of travel measures adopted.

¹⁹ WHO, *Technical Considerations for Implementing a Risk-Based Approach*.

²⁰ The exceptions are countries that adopted an aggressive suppression (COVID Zero) strategy in early 2020.

²¹ European Union, “Council Recommendation (EU) 2021/119 of 1 February 2021 Amending Recommendation (EU) 2020/1475 on a Coordinated Approach to the Restriction of Free Movement in Response to the COVID-19 Pandemic,” *Official Journal of the European Union* 2021 L36/1, February 2, 2021.

²² A UK study comparing Biobank and SARS-CoV-2 test results found that transportation workers were at highest risk of severe COVID-19 among essential workers. See Miriam Mutambudzi et al., “Occupation and Risk of Severe COVID-19: Prospective Cohort Study of 120,075 UK Biobank Participants,” *Occupational and Environmental Medicine* 78, no. 5 (2020): 307–314.

²³ International Air Transport Association (IATA), “Vaccination of Aviation Workers” (position paper, IATA, Montreal, Quebec, December 2020); IATA, “Crew Testing: Safely Enabling the Global Air Transport Supply Chain during the COVID-19 Pandemic” (position paper, IATA, Montreal, Quebec, December 2020).

This, in turn, obscures associated health and social inequities. While three methodologies recommend analysis of risk exposure for some occupations (e.g., flight crew), overall there is a lack of consideration for how different segments within and across national populations may face differential risks (e.g., different categories of workers, women, refugees and asylum seekers). Furthermore, variations in the definition and application of exemption categories for essential travelers are likely to have further influenced the distribution of travel-related risks and benefits. These exemptions determine who is allowed to travel and conditions that either mitigate or heighten risk.

D. Risk Characterization: How Is the Level of Risk Calculated?

The 11 methodologies calculate level of travel-related risk using four categories of variables:

- ▶ **epidemiological data:** morbidity and mortality rates, disease prevalence, transmission rates, vaccination rates, and so on; considered by 10 methodologies (all except for IATA).
- ▶ **health system indicators:** hospital and intensive care unit beds, testing and quarantine capacity, vaccination capacity, surveillance and reporting capacity, and so on; considered by 8 methodologies (all except for Hong Kong, IATA, and OECD).
- ▶ **jurisdictional context:** social and economic impacts, travel and trade volumes, information transparency, and so on; considered by 7 methodologies (all except for IATA, OECD, United Kingdom, and United States).
- ▶ **evolving science:** emerging evidence on SARS-CoV-2 and its real-world impacts, including transmission, incubation period, symptoms, severity, duration of immunity, vaccine effectiveness against new variants, and so on; considered by 7 methodologies (all except for the European Union, IATA, United Kingdom, and United States).

Of the methodologies reviewed, only IATA does not identify any specific variables when calculating risk. The remaining ten methodologies all consider epidemiological data in their risk assessments. New Zealand, South Korea, Taiwan, and WHO consider variables under all four of the categories listed above when calculating risk. Importantly, the specific variables considered under each category differ for each methodology. For example, on health system indicators, Taiwan considers local surveillance capacity, South Korea considers domestic response capacities and supply of vaccines, and the United Kingdom considers testing capacity. Variables to calculate risk using jurisdictional context were the most varied, including volume of travel and trade (Hong Kong, New Zealand, and WHO), existing bilateral or multilateral agreements (WHO), readiness to accommodate increased passenger flow (ICAO), reciprocity (European Union), public perception (South Korea), information transparency (Taiwan), and political, social, and economic factors (Taiwan).

BOX 2**World Health Organization Risk Characterization for Inbound Travelers**

WHO's guidance on a risk-based approach to international travel offers a broad range of potential variables for risk characterization. The general factors that determine this approach for inbound travel are:

- ▶ local epidemiology in departure and destination countries;
- ▶ volume of travelers between countries;
- ▶ existing bilateral and multilateral agreements between countries to facilitate free movement;
- ▶ public health and health services performance and capacity to detect and care for cases and their contacts in the destination country, including among vulnerable travelers such as refugees, migrants, and temporary or seasonal workers whose livelihoods depend on cross-border activities; and
- ▶ contextual factors, including economic impact, human rights, and feasibility of applying measures.

WHO guidance on risk characterization is relatively broad to allow adaptation for specific contexts. For example, most methodologies consider local epidemiological conditions in destination countries, but vary in how this is calculated (e.g., Hong Kong considers the number of passengers per inbound flight who test positive upon arrival; the United States measures how quickly cases numbers are increasing or decreasing by cumulative new cases over 28 days; and the United Kingdom includes weekly case load data, number of arrivals testing positive and with variants, and vaccination rates). An agreed and fuller set of basic indicators to characterize risk would enable countries to better share data and monitor rapidly changing risk over time.

Source: WHO, *Technical Considerations for Implementing a Risk-Based Approach to International Travel in the Context of COVID-19* (Geneva: WHO, 2021).

E. Risk Evaluation: What Level of Risk Is Tolerated?

Each country must decide upon a level of risk beyond which mitigation measures should be applied. Importantly, risk tolerance comes from objective criteria such as health-care and other capacities (e.g., how many hospital beds and intensive care unit beds before a health-care system is in crisis, what volume of travelers can border services manage), as well as subjective criteria such as normative frameworks (e.g., how much disease and death is acceptable, what interests are deemed to be most important) and trade-offs made among different policy goals (e.g., what is the appropriate balance between public-health and economic goals). This combination of objective and subjective criteria may explain why IATA, ICAO, and WHO do not set out specific thresholds for risk tolerance in their methodologies but rather leave it to governments to develop their own ranking systems.

For the methodologies that did set risk levels (the European Union, OECD, United Kingdom, and United States), the thresholds for tolerated risk differ. Most commonly, source and destination countries are graded from high to low risk (see Section 3.D on risk characterization). Stringency of mitigation measures is then aligned with these rankings. The criteria and thresholds to rank relative risk, and the appropriate mitigation measures thus deemed necessary, vary by methodology. These have also varied over time. For example, in December 2021 the U.S. Centers for Disease Control and Prevention shifted from a three-level

to a four-level notice system along with updated criteria to determine Travel Health Notices for destination countries. Rankings take account of population size, testing rate, and incidence rate. Destinations that have a population of more than 100,000, that conduct more than 1,500 tests per 100,000 people over 28 days, and that have more than 500 positive cases per 100,000 over 28 days are ranked as Level 4 risk (avoid travel to this destination).²⁴ By contrast, the United Kingdom's traffic light system "does not use a mechanical quantitative approach to assessment with hard thresholds" but instead brings together "a range of qualitative and quantitative indicators to provide an overall judgement on risk" and risk categories, including red (high-risk) countries.²⁵

Other methodologies do not set risk tolerance by traveler's country of origin (Hong Kong, New Zealand, and Taiwan). Non-nationals were restricted from entering these jurisdictions for much of the pandemic. All three apply the same mitigation measures to all inbound travelers (notably testing, quarantine, and later vaccination), and level of risk tolerated is determined not by country rankings but by characteristics of individual travelers (e.g., nationality, purpose of travel). New Zealand's level of risk tolerated is determined by domestic case counts, citizenship, and purpose of travel (applied to noncitizens as restrictions eased). Hong Kong applies thresholds based on the number of travelers testing positive per inbound flight. Arriving flights exceeding this threshold (e.g., five inbound travelers or greater than 5 percent of total passengers) result in the suspension of flights of the relevant airline.²⁶ This is because the risk tolerance threshold is set at zero imported cases under the territory's elimination strategy. By contrast, higher test positivity rate thresholds for inbound travelers are supported under suppression or mitigation strategies. For example, in October 2021 the IATA director-general called for the removal of testing requirements and reducing the number of countries on the red list (high risk) on the basis of a lower PCR test positivity rate among inbound travelers to the United Kingdom (1 percent) compared to the general population (7 percent).²⁷ The capacity to administer mitigation measures has also been used as a threshold to determine acceptable level of risk (i.e., use of arrival volume quotas).

F. Option Assessment: How Are Risk Mitigation Measures Chosen?

While the overall goal of risk analysis is to enable authorities to assess and then mitigate travel-related hazards, the methodologies reviewed generally lack detail on how to make choices regarding the selection of appropriate and effective mitigation measures. International organizations (IATA, ICAO, and WHO) provided general guidance along with updates on available evidence regarding specific travel measures. Differences in how governments conducted risk assessments were accompanied by differences in what measures were chosen to mitigate assessed travel-related risks. Some countries (Hong Kong, New Zealand, and Taiwan) choose to restrict certain categories of travelers (i.e., non-nationals and nonresidents), and then apply relatively strict measures (e.g., PCR testing, quarantine) to all permitted inbound travelers. Other methodologies (European Union, United Kingdom, and United States) seek to match specific mitigation measures of varying stringency to inbound travelers assessed as posing different levels of risk. This suggests

24 U.S. CDC, "How CDC Determines the Level for COVID-19 Travel Health Notices," accessed December 6, 2021.

25 UK Health Security Agency, "Risk Assessment Methodology to Inform International Travel Traffic Light System," updated October 29, 2021.

26 Government of Hong Kong, "Government Suitably Adjusts Inbound Control Measures on Risk-Based Principle" (press release, April 22, 2022).

27 IATA, "Simple Testing, Affordability and Sustainability Keys to Restoring UK Aviation" (press release, October 13, 2021).

a substantial and dynamic effort conducted over a sustained period of time. However, these methodologies lack details on *how* or *why* specific measures are chosen to be applied based on risk analysis. For example, the European Union's traffic light system leaves Member States to decide upon which mitigation measures to apply by risk level.

There are two notable exceptions. South Korea ranks countries as safe, average risk, or high risk and sets out mitigation measures for each level of risk. Travelers from safe countries have no visa restrictions, and vaccinated travelers have eased quarantine and testing requirements. Average risk means visa restrictions are reimposed, but vaccinated travelers still have quarantine exemptions. High risk means restrictions are imposed, and the number of flights is limited. Even then, the methodology does not explain the rationale for how specific mitigation measures are matched to each risk level.

Similarly, the OECD blueprint suggests specific mitigation measures for particular levels of risk.²⁸ It classifies countries, based on epidemiological data (testing rates, test positive rates, and case rates), using a traffic light color system. Unlike the European Union, IATA, ICAO, or WHO, the OECD proposes to peg these risk levels to specific mitigation measures. Travelers from the lowest-risk countries (green) could be required to provide a negative test result and not quarantine, while those from medium (yellow) to high-risk (red) countries could be required to test after arrival and quarantine for five to ten days, depending on level of risk. Travelers from highest risk (dark red) countries could enter only if they are essential travelers, citizens, or residents. The OECD blueprint is a more ambitious proposal methodologically than those of most other organizations but remains nonbinding.

Decision-making on whether and which mitigation measures to apply goes beyond evidence of their effectiveness at achieving public-health goals and requires consideration of their broader societal impacts.

Evidence to inform choices regarding different measures to mitigate travel-related risk continues to emerge. During the initial phase of the pandemic, there was evolving scientific knowledge about the virus and lack of precedence in the large-scale and prolonged use of travel measures. Even now, “[w]ith much of the evidence derived from modeling studies, notably for travel restrictions reducing or stopping cross-border travel and

quarantine of travelers, there is a lack of ‘real-world’ evidence.”²⁹ Importantly, decision-making on whether and which mitigation measures to apply goes beyond evidence of their effectiveness at achieving public-health goals and requires consideration of their broader societal impacts. There is now evidence of the benefits of travel measures on reducing virus importation and slowing onward transmission, but more limited evidence to understand the social and economic costs of such measures (see Box 3).

28 OECD, *OECD Initiative for Safe International Mobility during the COVID-19 Pandemic (Including Blueprint)* (Paris: OECD Publishing, 2021).

29 Burns et al., “International Travel-Related Control Measures.”

BOX 3**Evidence on the Use of Mitigation Measures to Manage Travel-Related Risks during COVID-19**

A study by Jacob Burns et al. reviewed 62 unique studies: 49 modeling studies and 13 observational studies. The authors concluded the following:

“With much of the evidence derived from modeling studies, notably for travel restrictions reducing or stopping cross-border travel and quarantine of travelers, there is a lack of ‘real-world’ evidence. The certainty of the evidence for most travel-related control measures and outcomes is very low and the true effects are likely to be substantially different from those reported here. Broadly, travel restrictions may limit the spread of disease across national borders. Symptom/exposure-based screening measures at borders on their own are likely not effective; PCR testing at borders as a screening measure likely detects more cases than symptom/exposure-based screening at borders, although if performed only upon arrival this will likely also miss a meaningful proportion of cases. Quarantine, based on a sufficiently long quarantine period and high compliance, is likely to largely avoid further transmission from travelers. Combining quarantine with PCR testing at borders will likely improve effectiveness. Many studies suggest that effects depend on factors, such as levels of community transmission, travel volumes and duration, other public-health measures in place, and the exact specification and timing of the measure. Future research should be better reported, employ a range of designs beyond modeling, and assess potential benefits and harms of the travel-related control measures from a societal perspective.”

Source: Excerpt from Jacob Burns et al., “[International Travel-Related Control Measures to Contain the COVID-19 Pandemic: A Rapid Review](#),” *Cochrane Database of Systematic Reviews* 3, no. 3 (2021).

4 Lessons from the COVID-19 Pandemic

This comparative analysis of publicly available methodologies to assess travel-related risks during the COVID-19 pandemic offers important lessons that could support more systematic, evidence-informed, and harmonized use of such measures during public-health emergencies. It should be noted that this review cannot evaluate the effectiveness of each methodology in achieving its stated goals. This would require detailed case studies of how each was operationalized over time and the extent to which decisions about the use of travel measures were informed by the methodology. It is also worth noting that the methodologies reviewed are unlikely to cover all that were applied, as not all have been publicly disclosed. Risk analysis methodologies not used for COVID-19 may offer additional insights. Nonetheless, this comparison of 11 publicly available methodologies points to common challenges and limitations.

A. Methodologies Were Not Sufficiently Transparent

While most jurisdictions have claimed that decision-making on the use of travel measures during COVID-19 has been evidence-informed, publicly available methodologies remain limited. Methodologies used by the private sector are also not widely available.³⁰ Lack of transparency during the early phase of the pandemic

³⁰ Kearney, “[What the COVID-19 Outbreak Reveals about Airlines’ Approach to Risk](#),” updated March 20, 2022; Michel Bielecki et al., “[Air Travel and COVID-19 Prevention in the Pandemic and Peri-Pandemic Period: A Narrative Review](#),” *Travel Medicine and Infectious Disease* 39 (2021): 101915.

is perhaps understandable, given the evolving science concerning SARS-CoV-2 as a novel pathogen, limited precedent from previous outbreaks, and precautionary use of travel measures (see Box 1). However, greater transparency became critical as time went on because many measures remained in place for prolonged periods, with significant social and economic impacts.

To strengthen future pandemic prevention, preparedness, response, and recovery, there is need for improved transparency that enables the evaluation of decision-making processes. This, in turn, will support fuller understanding of how risk-based approaches can support policymakers as well as recognition of the limitations of such approaches. More transparency would also support public understanding of and, hence, trust in public-health measures.³¹ In this, transparency would enable governments to explain to the public the rationale behind their policy decisions, communicate risk and uncertainty more effectively, and invite feedback from affected groups.³² The latter is especially important to prevent or mitigate inequities associated with travel and travel measures during a public-health emergency.

B. *Use of Risk Analysis and Pandemic Response Strategies Were Closely Linked*

Governments have adopted three main response strategies during the COVID-19 pandemic (see Box 4). Their methodologies for travel-related risk analysis and the ways they have approached the six parameters have been closely linked with the chosen response strategy. For example, risk evaluation (what level of risk is tolerated) is shaped directly by the case counts deemed appropriate within a country's response strategy.

Jurisdictions that adopted an aggressive containment strategy, such as Hong Kong, New Zealand, and Taiwan, applied risk analysis in a precautionary way. For example, hazard identification categorized all inbound travelers as the source of travel-related risk, regardless of individual characteristics (e.g., citizenship, vaccination status), mode of transportation, source country, or purpose of travel. Hazard characterization assessed all inbound arrivals as potentially high risk and thus subject to stringent mitigation measures on an ongoing basis. The methodologies for these jurisdictions were the simplest and easiest to apply because there was no need to

BOX 4

Three Main Response Strategies to the COVID-19 Pandemic

Aggressive containment: Countries aim to eliminate community transmission and achieve elimination status for 28 consecutive days by implementing public-health interventions.

Suppression: Countries aim to suppress and minimize community infections by implementing public-health interventions.

Mitigation: Countries aim to avoid overwhelming health systems by flattening the epidemic curve or achieving herd immunity in the population. The public-health interventions focus on protecting vulnerable and high-risk groups while allowing transmission among low-risk groups.

Source: Shishi Wu et al., "Aggressive Containment, Suppression, and Mitigation of COVID-19: Lessons Learnt from Eight Countries," *BMJ* 375 (2021): e067508.

31 Tayla Porat et al., "Public Health and Risk Communication during COVID-19—Enhancing Psychological Needs to Promote Sustainable Behavior Change," *Frontiers in Public Health* 8 (2020).

32 Nirosha Varghese et al., "Risk Communication during COVID-19: A Descriptive Study on Familiarity with, Adherence to and Trust in the WHO Preventive Measures," *PLoS One* 16, no. 4 (2021): e0250872.

continually apply and reapply risk analysis (to different categories of travelers or countries, for example). The capacity to apply such measures was enabled by restricting inbound travel largely to citizens and residents. As these countries move away from aggressive containment to suppression or mitigation strategies, the safe resumption of travel will require more complex use of risk analysis.

By contrast, jurisdictions adopting suppression or mitigation strategies needed more sophisticated risk analysis methodologies. The lack of pre-existing methodologies to inform the large-scale and prolonged use of travel measures led to wide variation in methodologies used by these jurisdictions. South Korea has followed a suppression strategy, initially adopting measures similar to aggressive containment (i.e., test, trace, and treat all inbound travelers) but then moving to a system based on country risk levels. Jurisdictions adopting a mitigation strategy (e.g., United Kingdom, United States) have relied on risk analysis that balances epidemiological dynamics with various social and/or economic policy objectives. Risk tolerance for case counts and transmission rates has changed as the pandemic has evolved, meaning that these countries have needed to conduct risk assessments on an ongoing basis to match travel measures with the pandemic's progression nationally, regionally, and globally, along with potential changes in social or economic policy objectives. For example, as vaccination rates rose, the European Council's recommendation changed to allow vaccinated travelers to enter the European Union, even if arriving from medium- and high-risk countries.

There are additional challenges for risk analysis under a mitigation strategy because the virus is difficult to manage without stringent mitigation measures. The virus's mean incubation period and high proportion of asymptomatic transmission has meant that low-cost mitigation tools (e.g., testing) have often missed significant proportions of infectious travelers. Risk tolerances have needed to be high to lift stricter mitigation measures such as quarantine. Overall, jurisdictions require significant analytical and operational capacities and higher risk tolerance to use risk analysis effectively under a mitigation strategy.

C. Travel-Related Risk Analysis Requires Better-Quality and Timely Data

Given the unprecedented nature of the COVID-19 pandemic, evidence available to support decision-making on travel measures has been largely limited to modeling studies (see Box 3). Available data are largely aggregated nationally, which prevents exposure assessment and risk mitigation for subpopulations or subregions.³³ The COVID-19 pandemic has disproportionately affected vulnerable populations, with the risks and outcomes of both illness and deaths distributed inequitably in ways that epidemiological data often do not capture.³⁴ To date, studies have been time limited, and there are currently no longitudinal studies to understand how travel measures should be adapted to changing risks over time during the pandemic. Finally, the lack of standardized datasets prevents cross-national comparisons using risk analysis.

The available data are also produced by health systems with diverse capacities and priorities for data collection and dissemination, with differing and often unknown data reliability, accuracy, and

33 Michele Tizzoni et al., "Addressing the Socioeconomic Divide in Computational Modeling for Infectious Diseases," *Nature Communications* 13, no. 2897 (2022).

34 Efrat Shadmi et al., "Health Equity and COVID-19: Global Perspectives," *International Journal for Equity in Health* 19, no. 1 (2020): 1–16.

comprehensiveness. For example, testing regimes in different countries have been reduced over time and varied widely, producing a range of different data qualities. In many countries, health system management and therefore responsibility for data falls to subnational governments, which can further complicate consistency and timeliness in reporting at national and international levels and force governments to compile data from a wide range of sources.³⁵ In this context, ensuring that risk analyses are using the most recent and best available data from each jurisdiction can be a complex and cumbersome process.

The global nature of travel requires improved capacity to collect, summarize, and share standardized data in real time across all countries.

The effective use of risk analysis in the future will depend on timely availability of appropriate and reliable epidemiological and other data. The global nature of travel requires improved capacity to collect, summarize, and share standardized data in real time across all countries, which necessitates capacity-building and resources in low- and middle-income countries that may lack (though not always) such capacities. Where such data are limited or do not exist, proxy indicators may support risk-based approaches. For example, volume and patterns of population mobility can be estimated using mobile telephone data.³⁶

5 Toward a Decision Instrument for Pandemic Travel Measures

The purpose of a decision instrument is to guide policymakers in asking key questions when developing and implementing policies. An internationally agreed decision instrument for travel-related risk analysis during evolving public-health events would also enable policymakers to better coordinate their use of travel measures. Two existing decision instruments relevant to risk analysis during international disease outbreaks are:

- ▶ The IHR (the WHO instrument of international law for controlling the international spread of disease) uses a decision instrument for the assessment and notification of events that may constitute a PHEIC. This tool helps governments decide whether they need to notify the WHO of public-health events. The decision points include whether an event is “unusual or unexpected,” is of “unknown causes or sources,” poses a potentially serious public-health impact, and can “spread rapidly internationally.”³⁷ This instrument provides useful questions for the initial characterizing of a pathogen as posing a potential travel-related risk.
- ▶ ICAO sets out a basic decision aid that “can support the development of operationally viable inter-agency risk management processes” for cross-border commercial airline travel.³⁸ It sets out a risk analysis approach that informs the implementation of risk management measures in four steps to achieve a state of “residual risk.” Guidance on *what* analysis should be conducted at each stage is

35 European Centre for Disease Prevention and Control (ECDC), “How ECDC Collects and Processes COVID-19 Data,” updated June 23, 2022; U.S. CDC, “COVID-19 Travel Health Notices,” accessed March 25, 2022.

36 Nishant Kishore, “Mobility Data as a Proxy for Epidemic Measures,” *Nature Computational Science* 1, no. 9 (2021): 567–568.

37 See Annex 2 of WHO, *International Health Regulations (2005)*, 3rd ed. (Geneva: WHO, 2016), 43.

38 See ICAO, *Manual on COVID-19 Cross-Border Risk Management*, 3rd ed. (Montreal: ICAO, 2021), Att C-1 and Att C-2.

provided (e.g., draft scenarios, assess the likelihood of scenarios, select mitigation measures) but not *how* this analysis should be conducted (i.e., methodology).

Building on these examples, Figure 3 sets out an initial framework for a decision instrument that applies risk analysis to decision-making on the use of travel measures during a potentially unfolding PHEIC. The instrument identifies seven main decision points that would follow the issuing by WHO of a Disease Outbreak News report.³⁹ These reports notify Member States of a confirmed or potential public-health event of international concern. The steps below should be considered as an initial proposal to encourage discussion about the framework's usefulness, appropriateness, and feasibility, rather than a final proposal of a decision instrument. Further refinement, informed by emerging evidence, and piloting with decisionmakers are needed but beyond the scope of this report. The seven decision points are as follows:

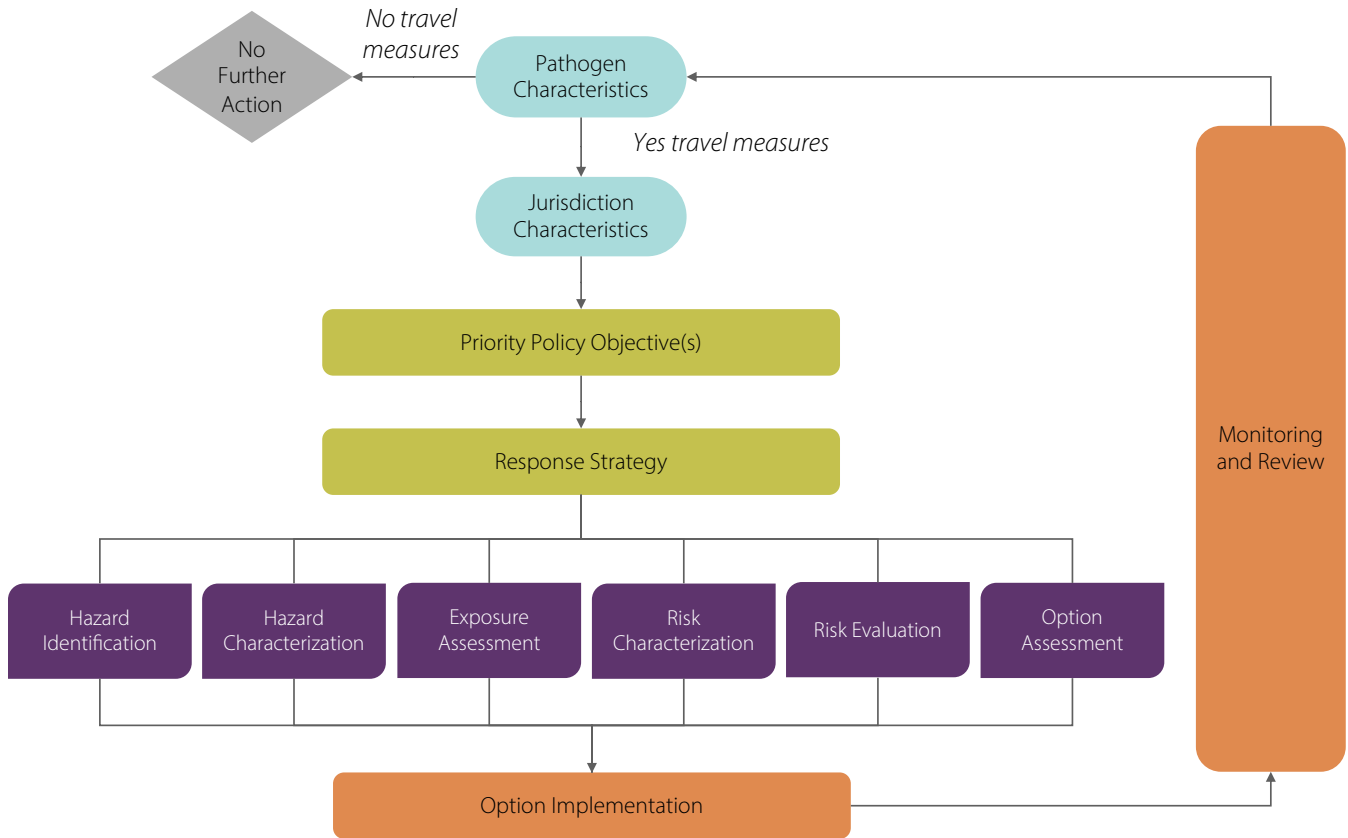
- 1 Policymakers should consider **pathogen characteristics** and whether they warrant the potential use of travel measures. These characteristics may include virulence (capacity to cause disease), severity (capacity to cause serious illness), transmissibility (human-to-human transmission, degree of transmissibility, potential for international spread), novelty (what is known and not known), and other relevant factors (e.g., mutability).⁴⁰ Because SARS-CoV-2 emerged as a new and virulent pathogen, capable of rapid and widespread human-to-human transmission, without treatment or vaccine options at the time of emergence, and causing substantial levels of severe illness and death, consideration of the use of travel measures to slow its global spread was warranted.
- 2 Policymakers should next consider key **jurisdiction characteristics** that will enable assessment of the importance of travel, and whether travel is more or less likely to contribute to the importation and onward transmission of the pathogen. Factors that may be considered are the geographical features of a jurisdiction (e.g., size, length of borders, nature/number of points of entry), demography (e.g., susceptibility to pathogen, large diaspora populations likely to engage in higher volume of international travel), and political economy (e.g., importance of trade relations, degree of global interconnectedness, international alliances). The relative capacities of a jurisdiction (e.g., health-care system) to mitigate the hazards associated with a major disease event may indicate whether travel measures are warranted. Moreover, the capacities to apply travel measures (i.e., border services) could be considered. Finally, if the pathogen is already substantially present in the country (e.g., endemic, significant community transmission), travel measures are unlikely to be as useful to control case numbers or transmission dynamics.
- 3 After taking account of pathogen and jurisdictional characteristics, policymakers should decide on **priority policy objectives**. What should border management policy seek to achieve? Whose wellbeing and interests should be protected through the use (or nonuse) of travel measures? Whose should not? These decisions should ideally be informed by consultative processes with experts, stakeholders, and affected communities. These choices would ultimately be based on normative frameworks, ideological factors, and chosen trade-offs among different interests, values, and outcomes.

39 Under Annex 2 of the International Health Regulations (2005), Member States are required to notify WHO of certain types of public-health events. After review, WHO may issue a Disease Outbreak News to notify all Member States of a confirmed acute public-health event or potential events of concern. See WHO, "Disease Outbreak News," accessed September 15, 2022.

40 This list is based on an initial consultation with experts on emerging pathogens with characteristics posing travel-related risks. The authors are conducting research to develop a fuller list of agreed characteristics that warrant the use of travel measures.

- 4 Policymakers should then seek to understand the available **response strategy** options for the emerging public-health event (given certain pathogen and jurisdictional characteristics), aligning their choice of strategy with the chosen priority policy objectives. During the COVID-19 pandemic, there have been three broad response strategies: aggressive elimination, suppression, and mitigation. If the agreed priority policy objectives change over time, or there are changes to the pathogen or jurisdictional characteristics, policymakers should shift strategy accordingly. In doing so, policymakers should understand how travel measures would be used differently under each of these strategies.
- 5 The four steps described above serve as the preliminary risk analysis to understand the nature of the emerging threat, the jurisdictional context, and the policy goals to be given priority when considering responses to the potential threat. The four steps bring together consideration of both scientific evidence and politics. Once this preliminary risk analysis is undertaken, policymakers should then apply the **six risk assessment and management parameters** used in this report's comparative analyze of the 11 methodologies. These six parameters inform the decisions about what specific travel measures should be used and how they should be applied for risk mitigation. While further research is needed to refine each of these parameters, it is important to recognize that the technical and operational choices to be informed by them will invariably be shaped by evolving science and politics. For example, a jurisdiction heavily dependent on the tourism industry, with strong public-health and health-care capacities, that decides to protect its economy as the priority policy objective may seek to do so through a mitigation strategy. The choices made under the six parameters would be different from a jurisdiction that is less economically dependent on international travel, has weaker capacities, that decides to protect public health as a priority, and thus pursues an elimination strategy.
- 6 Once the six parameters are applied, including option assessment, policymakers can move to **option implementation**, putting into place the chosen travel measure(s) for the jurisdiction to manage risk to the level deemed tolerable. Travel measures would range from advisories to restrictions and even border closures. The planning and operationalizing of these measures, including the design of risk communication, are outside the scope of the report but could be added as additional steps to refine this decision instrument. This step should be informed by evolving evidence regarding the effective use of travel measures in different contexts.
- 7 Finally, policymakers should **monitor and review** their use of travel measures on a continuous basis, taking account of their public-health and wider impacts, along with any evolving evidence about the pathogen or changes in the jurisdiction. For example, the COVID-19 pandemic has been a rapidly evolving disease event that includes the emergence and spread of (sub- and recombinant) variants of concern and shifting degrees of immunity due to mass vaccination and waning immunity. The significant economic impacts evident from the prolonged use of travel measures may become a higher priority consideration for policymakers. Alternatively, the emergence of variants of concern may warrant temporary use of increased testing and quarantine of inbound travelers to slow the variants' importation and onward transmission. Once community transmission reaches a given level, the benefit from these travel measures may be lessened and their use no longer warranted. These examples demonstrate the importance of a continuous monitoring and review feedback loop, reapplying the decision instrument to inform any necessary adaptations to the use of travel measures.

FIGURE 3
Example of a Decision Instrument for Using Travel Measures during Potential Public-Health Emergencies of International Concern



Source: Graphic created by the authors.

Overall, this proposed risk analysis instrument sets out suggestions for key decision points, and the inputs and outputs to be considered, when contemplating the use of travel measures. Importantly, for each of the seven steps, the risk analysis needs to be supported by various types of data and analysis. Alongside epidemiological surveillance, genomic and clinical data, the steps draw upon such analyses as policy mapping, focus groups, stakeholder analysis, impact assessment (e.g., environmental, equity, or economic), and public opinion polls to inform choices. Effective decisions on border management, in short, should be guided by insights from both science and politics, and any internationally agreed risk analysis methodology must therefore integrate a broad range of expertise and evidence. Policymakers should especially ensure that the use of a decision instrument is accompanied by a relevant range of expertise and evidence far beyond the limited types and sources used to date.

6 Recommendations

There is a strong case for agreed methodology to support more systematic, evidence-informed, and harmonized use of travel measures during public-health emergencies, integrated into a decision instrument applying risk analysis. This would also require standardized terminology, definitions, and data. The wide

variation in available methodologies partly explains the wide variation in the use of travel measures during the COVID-19 pandemic. Harmonized data in particular are needed as a starting point. Datasets should be agreed, created, and made openly available in real time across jurisdictions, including public-health and other data (or proxy data and indicators when necessary). Limitations in data quality and timely access have undermined the ability to apply risk analysis effectively, so the improved use of digital platforms for this purpose should be explored—the advancement and availability of new technologies need to be leveraged creatively to increase the quality, consistency, and speed with which data critical to risk analysis are gathered and shared across governments. Additionally, there is a demonstrated need for broader and more in-depth research on the use and effectiveness of specific travel measures, beyond modeling studies, which are currently the predominant evidence base available to support policymakers on these issues.

The proposed decision instrument is an initial starting point based on lessons drawn from travel-related risk analysis methodologies publicly available during the COVID-19 pandemic. Methodologies developed and used but not yet publicly available should be put into the public domain and integrated into future analysis. This will provide the basis of further comparative analysis that advances development of, and international agreement on, appropriate methodologies.

Policymakers and experts seeking to strengthen risk analysis methodologies may consider the following recommendations related to the six key parameters:

- ▶ **Hazard identification (what is the source of risk?):** Policymakers should initially consider all four categories of potential risk identified in this review—nature of pathogen, individual traveler (all persons traveling inbound, outbound, and transit), mode of transportation (air, land, and sea), and geography—when conducting future risk analysis. Other categories may be developed and applied such as the nature of transported goods. While not all categories may prove relevant, authorities should begin by considering all of them to support fuller and more standardized understanding of the risk source. Partial or varied identification of risk sources has resulted in different approaches to risk mitigation.
- ▶ **Hazard characterization (what is the nature of the hazard?):** Policymakers should expand the collection and use of indicators beyond public-health risks (e.g., pathogen importation, morbidity and mortality, impacts on health-care systems) when characterizing travel-related risks. Border management involves consideration of trade-offs among a broad range of risks posed by the pathogen itself and the measures taken to mitigate pathogen risks (i.e., travel measures). Although policymakers worldwide are likely to have made such trade-offs, the evidence base for doing so has been largely untransparent. A holistic approach to risk analysis, which takes account of impacts on public health and beyond (i.e., social and economic impacts), is recommended.
- ▶ **Exposure assessment (who is at risk?):** Policymakers should consider the travel-related risks posed to a fuller range of individuals and populations, beyond just citizens, residents, and other domestic populations. Effective mitigation of travel-related risks from public-health events such as the COVID-19 pandemic requires recognition of the porousness of some borders, transiting behaviors of many travelers, close mixing of populations along a journey, and the complexity of population mobility dynamics globally. Policymakers should also consider specific at-risk populations (e.g., crew and

transportation workers) and apply an equity lens (by considering disproportionate impacts on some groups, such as migrant workers and refugees) during exposure assessment.

- ▶ **Risk characterization (how is the level of risk calculated?):** Policymakers should adopt a more holistic approach to assessing risk level by considering the evolving science, epidemiological data, health system indicators, and jurisdictional context. Among the methodologies examined, only those of New Zealand, South Korea, Taiwan, and WHO considered variables under all four categories when assessing risk. In order to more closely harmonize risk analysis methodologies, agreed variables are needed for each category.
- ▶ **Risk evaluation (what level of risk is tolerated?):** Policymakers should be more transparent about the objective and subjective criteria used to set the level of travel-related risk tolerated. Thresholds should also be stated more explicitly. The factors shaping risk tolerance will vary across jurisdictions, and thus methodologies for setting the level of risk tolerated will differ (e.g., ranking of countries, test positivity rates, purpose of travel). However, a lack of transparency about the criteria used and thresholds applied, along with limited public discussion about their appropriateness, undermines public support for mitigation measures. Detailed case studies should be conducted to document the process by which criteria and thresholds have been applied to set the level of risk tolerated. Future processes to set risk thresholds should explain how those thresholds align with a jurisdiction's characteristics, capacities, and normative frameworks.
- ▶ **Option assessment (how are risk mitigation measures selected?):** Policymakers should develop clear methodology and decision-making processes for using risk assessment to inform choices about mitigation measures. South Korea and the OECD provide examples linking risk rankings with mitigation measures. This should be refined using emerging evidence on the effective use of travel measures to achieve public-health and wider policy goals.

This report concludes that risk analysis can support more systematic, evidence-informed, and harmonized use of travel measures across jurisdictions during public-health emergencies. This begins with agreed methodologies underpinned by appropriate, timely, and reliable data. The proposed decision instrument is presented to prompt initial discussion on this agreed methodology and will need much further development. Risk analysis should be integrated within a decision instrument that brings science and policy considerations together. This will improve transparency and, ultimately, strengthen preparedness for future public-health emergencies requiring effective border management.

Risk analysis can support more systematic, evidence-informed, and harmonized use of travel measures across jurisdictions during public-health emergencies.

Appendices

Appendix A. Glossary

Exposure assessment—The qualitative or quantitative (or both) evaluation of likely exposure to the hazard

Hazard—Biological, chemical, and physical agents capable of causing adverse health effects

Hazard characterization—The qualitative or quantitative (or both) evaluation of the nature of the hazard's adverse effects

Hazard identification—The identification of the biological, chemical, and physical agents capable of causing adverse health effects

Incidence rate—The number of new cases of a disease within a specific at-risk population, expressed per unit of time

Option assessment—The process of weighing and selecting measures in light of the risk assessment to mitigate the risk to an acceptable level

Prevalence—The number of existing cases in a defined population at a given point in time expressed as a percentage or rate (with the total population as the denominator)

Relative risk—A measure of the increased or decreased risk of an event occurring relative to current circumstances (e.g., risk of infection with no travel versus risk with travel)

Risk—The likelihood of the occurrence and the likely magnitude of the consequences of an adverse event during a specified period

Risk assessment—The systematic process for gathering, assessing, and documenting information to assign a level of risk

Risk characterization—The qualitative or quantitative (or both) estimation, including attendant uncertainties of the probability of occurrence and severity of known or potential adverse effects in a given population based on hazard identification, hazard characterization, and exposure assessment variables to measure risk

Risk communication—The range of communication principles, activities, and exchange of information required through the preparedness, response, and recovery phases of a serious event among responsible authorities, partner organizations, and communities at risk to encourage informed decision-making, positive behavior change, and the maintenance of trust

Risk evaluation—The setting of thresholds indicating the level or levels of risk deemed acceptable or unacceptable

Risk management—A systematic approach to setting the best course of action under uncertainty by identifying, assessing, understanding, making decisions on, and communicating risk issues

Risk mitigation—The reduction of the impact of a risk by addressing its likelihood, magnitude, or both

Risk perception—An individual's or population's beliefs, based on subjective judgement, about the characteristics and severity of a risk (i.e., potential for harm or possibility of loss)

Risk scenario—A description of the possible risk event and the potential positive and negative impacts from the risk should it occur

Risk tolerance/risk aversion—The willingness of an individual or organization to accept or reject a given level of residual risk

Appendix B. Case Studies of Risk Assessment by Selected International Organizations, Regions, and Countries

World Health Organization

Upon declaring a public-health emergency of international concern (PHEIC) on January 30, 2020, the World Health Organization (WHO) recommended against adopting travel and trade restrictions. By May 2020, WHO was recommending that Member States “implement appropriate travel measures with consideration of their public-health benefits”⁴¹ and released interim guidance on “implementing a risk-based approach to international travel in the context of COVID-19” in December 2020. The guidance provided national authorities with an initial “step-by-step approach to decision-making for calibrating risk mitigation measures and establishing policies for international travel.”⁴² In July 2021, WHO issued updated guidance in light of the availability of effective vaccines, emergence of variants of concern, and “evidence on the effectiveness and broader impact of risk mitigation measures implemented in the context of international travel during the COVID-19 pandemic.”⁴³

WHO recommends considering the risk posed by travel for the importation (inbound) and exportation (outbound) of cases. For both:

- ▶ **Hazard identification:** The source of hazard is the individual traveler.
- ▶ **Hazard characterization:** The nature of the hazard is the infections and deaths from SARS-CoV-2, with recognition of the need to take account of wider societal impacts.

41 WHO, “Statement on the Third Meeting of the International Health Regulations (2005) Emergency Committee Regarding the Coronavirus Disease (COVID-19) Pandemic” (statement, WHO, May 1, 2020).

42 WHO, *Considerations for Implementing a Risk-Based Approach to International Travel in the Context of COVID-19, Interim Guidance* (Geneva: WHO, 2020).

43 WHO, *Technical Considerations for Implementing a Risk-Based Approach*.

- ▶ **Exposure assessment:** The population at risk for inbound travel is the population of the destination country. For outbound travel, the at-risk population is the individual traveler.
- ▶ **Risk characterization:** variables to calculate the level of risk are:
 - local epidemiology in departure and destination countries;
 - volume of travelers between countries and existing bilateral or multilateral agreements between countries to facilitate free movement;
 - public health and health services performance and capacity to detect and care for cases and their contacts in the destination country, including among vulnerable travelers such as refugees, migrants, and temporary or seasonal workers whose livelihoods depend on cross-border activities; and
 - contextual factors, including economic impact, human rights, and feasibility of applying measures.
- ▶ **Risk evaluation:** No thresholds for tolerated risk are provided. The data sources are national authorities, which are encouraged “to publish in the public domain up-to-date data on COVID-19 incidence, public health and health services capacity and implemented public-health and social measures.”⁴⁴
- ▶ **Option assessment:** Key questions to guide implementation of risk mitigation measures are provided. For inbound travel, “Will the number of cases to be imported from the country of departure likely have a significant impact on the current transmission level in the country of destination?” For outbound travel, “How likely are travelers to be infected in the country of destination compared with their likelihood of getting infected in the country of departure, taking into consideration the potential circulation of VOIs [variants of interest] and/or VOCs [variants of concern] in the country of destination?” (that is, relative risk).⁴⁵

International Air Transport Association

The lack of consistency and frequently changing rules across countries has posed major challenges for International Air Transport Association (IATA) member airlines. IATA has called for “simplified risk management...to manage the risks of COVID-19.”⁴⁶ IATA has issued position papers on the use of a broad range of travel measures to mitigate risks during COVID-19, including vaccination of aviation workers, crew testing, vaccine certification, testing, quarantine, and contact tracing.

IATA summarizes the available evidence related to “assessing risk related to air travel during COVID-19” and supports national governments to determine “how much risk, related to importing cases of COVID-19, can be accepted,”⁴⁷ but IATA does not set out methodology per se.

44 WHO, *Technical Considerations for Implementing a Risk-Based Approach*, 3.

45 WHO, *Technical Considerations for Implementing a Risk-Based Approach*, 3-4.

46 IATA, “Re-Open Borders with Simplified Risk Management” (press release, October 4, 2021).

47 IATA, “COVID-19: Air Travel, Public Health Measures and Risk: A Brief Summary of Current Medical Evidence” (IATA Medical Advisor/Medical Advisory Group, Montreal, Quebec, February 1, 2022).

- ▶ **Hazard identification:** The source of hazard is inbound travelers arriving by air (importation risk), with recognition that risks should take account of the “entire journey including not only aircraft but also surface transport (road/rail etc.) and airports.”⁴⁸
- ▶ **Hazard characterization:** The nature of the hazard is virus importation and onward transmission within the domestic population of the destination country.
- ▶ **Exposure assessment:** The populations at risk are the individual travelers, transportation workers with whom they come into contact along their entire journey, and populations in the destination countries.

As an evidence review, IATA does not identify specific **risk characterization** variables to measure the level of risk, but there is acknowledgement that any **risk evaluation** (risk tolerance thresholds) should take account of the state of the public-health system to detect and manage cases, along with “political considerations.”⁴⁹ No **option assessment** is provided on how risk analysis should be used to inform decision-making on mitigation measures.

International Civil Aviation Organization

The methodology of the International Civil Aviation Organization (ICAO) is in the form of a decision aid to support analytical and operational steps for travel-related risk management, including risk assessment and mitigation. Although this framework identifies tasks to define and evaluate risks toward “probabilistic estimation,” such as the need to “assess the likelihood of the risk scenario” and “assess the impacts of the risk scenario and its context,” it does not offer a specific methodology for these tasks.⁵⁰

- ▶ **Hazard identification:** The source of the hazard is individuals traveling by commercial air transportation.
- ▶ **Hazard characterization:** The nature of the hazard is illness and death caused by virus transmission during a commercial air transport operation. Secondary impacts on health-care systems and wider society are also considered.
- ▶ **Exposure assessment:** The populations at risk are commercial airline passengers and crew who may subsequently pose an infection risk to populations in destination countries.
- ▶ **Risk characterization:** ICAO recognizes that “there is no single measure that can be deemed as a definitive solution”⁵¹ but offers variables to calculate the level of risk, including:
 - disease incidence and prevalence;
 - new variants;
 - disease trajectory;

48 IATA, “COVID-19: Air Travel, Public Health Measures and Risk,” 3.

49 IATA, “COVID-19: Air Travel, Public Health Measures and Risk,” 1.

50 ICAO, *Manual on COVID-19 Cross-Border Risk Management*.

51 ICAO, *Manual on COVID-19 Cross-Border Risk Management*, 3-1.

- national testing strategy;
 - screening capabilities;
 - capabilities to identify, diagnose, and treat COVID-19 cases;
 - status of health-care system (hospital capacity);
 - robustness of contact tracing;
 - status of national vaccination strategy; and
 - readiness to accommodate increased passenger flows.
- ▶ **Risk evaluation:** Thresholds for tolerated risk are left to each jurisdiction. The data sources are national authorities.
 - ▶ **Option assessment:** ICAO recommends that states should “share risk assessments with other States and begin to discuss developing bilateral or multilateral agreements.”⁵²

Organization for Economic Cooperation and Development

The Organization for Economic Cooperation and Development (OECD) was called upon to develop an international framework for safe global mobility in December 2020, driven by the significant social and economic costs of COVID-19-related restrictions on international mobility.⁵³ The OECD’s blueprint was developed to “promote greater certainty, safety, and security in travel as re-opening takes place” during the COVID-19 pandemic.⁵⁴ The blueprint aligns itself with existing approaches to risk assessment and travel, including recommendations put forth by the European Union, ICAO, and WHO. The central aim of this blueprint is stronger international coordination and consistency in travel-related risk assessment and mitigation.

- ▶ **Hazard identification:** The source of the hazard is the pathogen, including new variants of concern, spread by individual travelers on all modes of transportation (air, rail, coach, and ship).
- ▶ **Hazard characterization:** The OECD acknowledges national characterizations of hazards, including the importation of COVID-19 cases and variants into countries, and severe illness and death.
- ▶ **Exposure assessment:** The populations at risk of exposure are not defined explicitly. The blueprint implies reference to national populations and suggests that exposure concerns may be lower for countries with high levels of vaccination coverage, higher overall population immunity levels, or both.
- ▶ **Risk characterization:** The blueprint relies on the following epidemiological criteria:⁵⁵
 - notification rate, or the total number of newly notified cases per 100,000 population in the previous 14 days at national or subnational levels;

52 ICAO, *Manual on COVID-19 Cross-Border Risk Management*, 4-1.

53 OECD, *OECD Initiative for Safe International Mobility*.

54 OECD, *OECD Initiative for Safe International Mobility*, 8.

55 OECD, *OECD Initiative for Safe International Mobility*, 12.

- test positivity rate, which is the percentage of positive tests among all tests for COVID-19 carried out in the previous week; and
 - testing rate, which is the number of tests for COVID-19 infection per 100,000 population carried out in the last week.
- ▶ **Risk evaluation:** While risk tolerance is determined by individual country governments, the blueprint delineates the following categories of risk, calculated every two weeks:
- Green: A country or region is green if the notification rate is less than 25, and the test positivity is less than 4 percent.
 - Orange: The notification rate is less than 50, but test positivity is 4 percent or more, or if the notification rate is 25–150 but test positivity is less than 4 percent.
 - Red: The notification rate is 50 or more, and the test positivity rate is 4 percent or more, or if the notification rate is more than 150.
 - Dark red: A country or region is dark red if the notification rate is 500 or if there is high prevalence of new variants of concern.
 - Gray: A country or region is gray if insufficient information is available, or if the testing rate is 300 or less.

The blueprint also offers a separate schematic of color coding to provide a warning system of potential change in risk level. It is not included here because it serves primarily as a communication tool, rather than an element of risk analysis. While not outlined specifically, there is noted need to “identify criteria for taking into account the prevalence and risk associated with SARS-CoV-2 variants of concern.”⁵⁶

- ▶ **Options assessment:** The blueprint outlines protocols for two situations, subject to a country’s “own considerations of risk associated with importation of cases of COVID-19, local rates of vaccination, and other elements of national context”⁵⁷: Travel Protocol A, when potential health impact of importation is high, and countries are keen to prevent the importation of COVID-19 through international travel; and Travel Protocol B, when countries accept some risk of importation, given a lowered probability of affecting community transmission (e.g., when immunity levels are higher). The blueprint does not prescribe thresholds to determine which situation applies but instead defers to individual countries to determine the scenario to follow. Within each travel protocol, four levels of traveler requirements (e.g., testing, quarantine, vaccine requirements, etc.) are outlined corresponding to the color coding of departure and arrival countries.

European Union

The European Commission first adopted a Communication to the European Parliament, European Council, and the Council on March 16, 2020, calling for restrictions on nonessential travel to the European Union

⁵⁶ OECD, *OECD Initiative for Safe International Mobility*, 12.

⁵⁷ OECD, *OECD Initiative for Safe International Mobility*, 13.

in light of COVID-19.⁵⁸ Despite recognition of the need for a coordinated approach across the external border of the European Union as an important measure of security and to minimize disruptions to internal movements within and across Member States, European countries had differing approaches to assessing and mitigating travel-related risks, with dynamic and inconsistent travel measures applied both at Europe's external borders and internally. By June 15, 2020, the Commission recommended that Member States lift any internal border restrictions, in addition to considering "that the travel restrictions at the external borders no longer need to apply to all third countries but could start to be gradually lifted. This process would need to be based on clear criteria and be subject to constant monitoring."⁵⁹ On October 13, 2020 (updated on February 1, 2021, and June 14, 2021), the Council adopted a recommendation on a coordinated approach to the restriction of free movement in response to the COVID-19 pandemic, establishing common criteria and a common framework for possible measures for travelers.⁶⁰

- ▶ **Hazard identification:** The source of the hazard was focused initially on both the importation and exportation of SARS-CoV-2 through international travel but shifted throughout 2020 to focus more on the importation of cases through travelers from non-EU countries.
- ▶ **Hazard characterization:** The nature of the hazard recognized the role of human mobility in global transmission of the virus and COVID-19 as a "serious cross-border threat to health."⁶¹
- ▶ **Exposure assessment:** The population at risk was indicated as EU Member States' citizens.
- ▶ **Risk characterization:** Variables to calculate the level of risk, proposed initially in October 2020⁶² include:
 - the 14-day cumulative COVID-19 case notification rate (that is, the total number of newly notified COVID-19 cases per 100,000 population in the last 14 days at the regional level);
 - the test positivity rate (that is, the percentage of positive tests among all tests for COVID-19 infection carried out during the last week); and
 - the testing rate (that is, the number of tests for COVID-19 infection per 100 000 population carried out during the last week).

EU communications and criteria focused on restricting travel from non-EU countries (or "third countries")⁶³ emphasized the importance of availability and reliability of data from third countries. Alongside new cases per 100,000, criteria for the assessment of approximation of the epidemiological situation and response

58 European Commission, "Communication from the Commission: COVID-19: Temporary Restriction on Non-Essential Travel to the EU" (COM [2020] 115 final, March 16, 2020).

59 European Commission, "Communication from the Commission to the European Parliament, the European Council and the Council on the Third Assessment of the Application of the Temporary Restriction on Non-essential Travel to the EU" (COM [2020] 399 final, June 11, 2020).

60 European Commission, "Council Recommendation (EU) 2020/1475 of 13 October 2020 on a Coordinated Approach to the Restriction of Free Movement in Response to the COVID-19 Pandemic," *Official Journal of the European Union* 2020 L337/3, October 13, 2020.

61 European Commission, "Council Recommendation (EU) 2020/1475 of 13 October 2020."

62 European Commission, "Council Recommendation (EU) 2020/1475 of 13 October 2020."

63 European Commission, "Communication... on the Third Assessment of the Application of the Temporary Restriction on Non-Essential Travel to the EU."

to COVID-19 in third countries included the trend in new infection rate and the country's overall response to COVID-19, taking into account available information on aspects such as testing, surveillance, contact tracing, containment, treatment, and reporting, and eventually reciprocity and travel advice.

Risk evaluation: (risk thresholds) for travel within the European Union mapped countries by color coding based on the following framework:⁶⁴

- ▶ Green: The 14-day cumulative COVID-19 case notification rate is less than 25, and the test positivity rate of tests for COVID-19 infection is less than 4 percent.
- ▶ Orange: The 14-day cumulative COVID-19 case notification rate is less than 50, but the test positivity rate of tests for COVID-19 infection is 4 percent or more, or if the 14-day cumulative COVID-19 case notification rate ranges from 25 to 150, but the test positivity rate of tests for COVID-19 infection is less than 4 percent.
- ▶ Red: The 14-day cumulative COVID-19 case notification rate is 50 or more, and the test positivity rate of tests for COVID-19 infection is 4 percent or more, or if the 14-day cumulative COVID-19 case notification rate is more than 150 per 100,000 population.
- ▶ Gray: This rating is given if insufficient information is available to assess the criteria in the first three bulleted points or if the testing rate is 300 or less COVID-19 tests for infection per 100,000 population.

The specific numerical thresholds of each of these categories were adjusted based on the pandemic trajectory at various points. On February 1, 2021, an additional category, dark red, was introduced and created the following distinction:⁶⁵

- ▶ Red: The 14-day cumulative COVID-19 case notification rate ranges from 50 to 150 and the test positivity rate of tests for COVID-19 infection is 4 percent or more, or the 14-day cumulative COVID-19 case notification rate is more than 150 but less than 500.
- ▶ Dark red: The 14-day cumulative COVID-19 case notification rate is 500 or more.

Consideration for immunity status and vaccination rates were eventually included, and nonessential travel for fully vaccinated travelers was recommended as of May 20, 2021.⁶⁶ By January 25, 2022, the European Council announced an agreement that COVID-19 measures should no longer be applied based on region of origin but instead on individual traveler situation (i.e., immunity status).⁶⁷ **Options assessment** (how mitigation measures are chosen) was left to Member States, as EU policy on risk assessment and travel measures was to be adopted on a voluntary basis by national governments.

64 European Commission, "Council Recommendation (EU) 2020/1475 of 13 October 2020."

65 European Commission, "Council Recommendation (EU) 2021/119 of 1 February 2021."

66 European Commission, "Statement by Commissioners Kyriakides and Reynders on the Council Agreement to Strengthen Coordination of Safe Travel in the EU" (news release, January 25, 2021).

67 European Commission, "A Common Approach to Travel Measures in the EU," accessed September 15, 2022.

Hong Kong

Initiating “serious response level” under its *Preparedness and Response Plan for Novel Infectious Disease of Public Health Significance 2020* on January 4, 2020,⁶⁸ Hong Kong’s response to COVID-19 has been criticized as slow and lagging behind other governments in the region. Border management responses—including the entry ban for residents of Hubei, China, closure of border control points, health screening, and quarantine requirements—were introduced after COVID-19 cases had already been imported to Hong Kong. The government’s “dynamic zero” approach has been said to be one of the strictest around the world, essentially closing off the former international hub, stranding even its own residents overseas.

- ▶ **Hazard identification:** The source of the hazard targeted by early border measures was inbound, nonresident travelers from affected areas. Crew members and local residents traveling abroad were also included at a later stage.
- ▶ **Hazard characterization:** The nature of the hazard was primarily concerned with preventing the importation of cases because of Hong Kong’s geographical proximity and the volume of travel and trade with mainland China.
- ▶ **Exposure assessment:** The population at risk is residents of Hong Kong.
- ▶ **Risk characterization:** Hong Kong’s *Preparedness and Response Plan for Novel Infectious Disease of Public Health Significance 2020* considers the following variables to calculate levels of risk:
 - clinical severity,
 - trajectory of epidemic,
 - transmissibility,
 - geographical spread of infection,
 - global distribution of affected areas and volume of travel and trade with Hong Kong,
 - availability of preventive measures (vaccines, treatments), and
 - recommendations by international health authorities (e.g., WHO).

A unique feature of Hong Kong’s response to COVID-19 is its flight suspension mechanism, which allows for the suspension of specific flights in violation of Hong Kong’s pandemic control measures for a duration of five days.⁶⁹ The threshold is defined as having more than five inbound travelers or greater than 5 percent of total passengers who test positive upon arrival, or at least three inbound travelers who test positive upon arrival, one of whom is noncompliant with local disease control regulations.

68 Government of Hong Kong, Centre for Health Protection, *Preparedness and Response Plan for Novel Infectious Disease of Public Health Significance (2020)* (Hong Kong: Government of Hong Kong, Centre for Health Protection, 2020).

69 Government of Hong Kong, “Government Suitably Adjusts Inbound Control Measures on Risk-Based Principle.”

Under the government’s Suppress and Lift strategy,⁷⁰ various measures have been implemented to limit the importation of cases to Hong Kong, including the closure of all but two land boundary control points and suspension of ferry services to and from mainland China beginning on February 4, 2020. Entry restrictions to Hong Kong, or **option assessment**, varies depending on **risk evaluation** of local risk levels:

- ▶ high-risk areas: entry permitted for fully vaccinated Hong Kong residents only
- ▶ medium risk: entry permitted for fully vaccinated Hong Kong and non-Hong Kong residents
- ▶ low risk: entry permitted for Hong Kong and non-Hong Kong residents

Air and sea crew members are another group included under **hazard identification** and must undergo stringent testing and quarantine measures. Exemptions are available under various programs, such as Return2hk (for Hong Kong residents) and Come2hk (for residents of Guangdong province and Macao). In a bid for “gradual return to normalcy,” Hong Kong has started to lift flight restrictions for select countries since April 2022.⁷¹ On May 1, 2022, two more major changes occurred: the global outbound travel alert (in place since March 17, 2020) was lifted,⁷² and entry to Hong Kong was reopened to all non-Hong Kong residents from overseas.⁷³

New Zealand

The government has maintained border restrictions as one of its “primary defenses to restrict the entry of COVID-19 into New Zealand.”⁷⁴ The Keep It Out pillar has been core to the country’s Elimination Strategy. This involved reduced volumes and then screening and mandatory quarantine for all inbound travelers. In July 2021, a new category of countries (very high risk) was introduced “to manage the risk of high numbers of positive COVID-19 cases arriving in New Zealand.”⁷⁵ As vaccination rates increased, in July 2021, the government proposed a Reconnecting New Zealanders strategy “to reconnect with the world and reopen our borders to some countries.”⁷⁶ This led to a different framework for assessing travel-related risks during the COVID-19 pandemic.

Under the Keep It Out pillar:

- ▶ **Hazard identification:** The source of hazard is any inbound travelers arriving in New Zealand, regardless of nationality or residence.
- ▶ **Hazard characterization:** The nature of the hazard is the direct impacts on morbidity and mortality from SARS-CoV-2.
- ▶ **Exposure assessment:** The at-risk population is residents of New Zealand.

70 Government of Hong Kong, “COVID-19: Hong Kong’s Multipronged Response” (fact sheet, September 2021).

71 Carrie Lam, “Charting a Path to Normalcy” (news release, April 28, 2022).

72 Government of Hong Kong, “Outbound Travel Alert to be Lifted” (news release, April 28, 2022).

73 Government of Hong Kong, “Inbound Travel Measures Adjusted” (news release, April 22, 2022).

74 New Zealand Office of the Minister for COVID-19 Response, “Creating a Risk Responsive Border: Proposed Risk Assessment Framework for Very High Risk Countries and Jurisdictions” (cabinet paper, July 10, 2021, published September 10, 2021), 1.

75 New Zealand Office of the Minister for COVID-19 Response, “Creating a Risk Responsive Border,” 3.

76 New Zealand Office of the Minister for COVID-19 Response, “Creating a Risk Responsive Border,” 1.

- ▶ **Risk characterization** is conducted upon arrivals based on:
 - multiple testing of all inbound travelers,
 - mandatory and supervised quarantine of all inbound travelers, and
 - equity considerations.

Under the Reconnecting New Zealanders⁷⁷ strategy, the government modified the following parameters focused on “very high risk” countries and jurisdictions:

- ▶ **Hazard identification:** The source of hazard was changed to “assessment of the COVID-19 situation within the [source] country, rather than arrivals data only.” The source of risk thus shifted from all inbound travelers to “travelers arriving from very high risk countries.” This approach required the introduction of a “country risk assessment framework,” which was intended to allow “a more nuanced understanding of the risk that travelers from each country or jurisdiction pose to New Zealand.”
- ▶ **Risk characterization:** Variables seek to “categorize country risk...based on the overall level and nature of the risk” based on “a broader range of public-health factors.” The factors to determine if a traveler poses a very high risk are:
 - potential volume and flow of travelers that may arrive from the country or jurisdiction
 - number of tests per positive COVID-19 case (indicating insufficient testing or underreporting);
 - case fatality rate (indicating likelihood of undetected cases);
 - weekly new cases per one million population;
 - estimated dissemination ratio (how quickly case numbers are decreasing or increasing);
 - vaccination rates (and type of vaccine) in the country;
 - confidence in the capacity and capability of the country’s health system to effectively manage a new spike in cases or a larger outbreak;
 - confidence in data received from the country;
 - confidence in predeparture testing measures in the country or jurisdiction; and
 - country strategies for managing outbreaks.

⁷⁷ New Zealand, Ministry of Health, “Country Risk Assessments: ‘Very High Risk’ Countries and Jurisdictions” (briefing paper of the Reconnecting New Zealanders Ministerial Group, 8 July 2021). See also New Zealand Office of the Prime Minister, “Reconnecting New Zealanders with the World” (memorandum of the Social Wellbeing Committee, September 8, 2021).

- ▶ **Risk evaluation:** Thresholds of tolerated risk use a traffic light system, ranging from green (quarantine-free travel) to very high risk to indicate severity of the in-country situation.
- ▶ **Option assessment:** Risk mitigation measures for inbound travelers are then based on the ranking of the source country.

In November 2021, the New Zealand cabinet endorsed a three-step approach to reopening travel along a “medium risk” pathway.⁷⁸

South Korea

South Korea’s response to COVID-19 has largely been informed by its experiences with the MERS outbreak in 2015, the botched handling of which led to reforms of the nation’s public-health emergency response system, including risk communication.⁷⁹ The reforms included the introduction of event-based surveillance and increased funding for digital health infrastructure and epidemiological intelligence, among others. These efforts ultimately allowed for an early national response to COVID-19. South Korea’s national alert system was activated on January 20, 2020, and included the implementation of emergency response measures such as contact tracing.

- ▶ **Hazard identification:** South Korea’s first border measure banned the entry of foreign nationals from Hubei Province, China. At this stage, the source of the risk focused on residents at the outbreak epicenter. The approach soon shifted by applying special entry measures comprising temperature screening, health questionnaires, and quarantine declaration to all incoming travelers, regardless of country of origin, nationality, and COVID-19 status by March 19, 2020.⁸⁰ Hazard identification thus shifted from residents of specific areas to include all incoming travelers.
- ▶ **Hazard characterization:** The nature of the hazard is the importation of disease. Symptomatic travelers are tested at the point of entry and are either treated at hospitals or advised to self-isolate, depending on test results. A mandatory 14-day quarantine was introduced shortly after on April 1, 2020.⁸¹
- ▶ **Exposure assessment:** The population at risk is residents of Korea.

The Korea Disease Control and Prevention Agency leads South Korea’s risk assessment through the Division of Risk Assessment and International Cooperation. The risk assessment framework is adapted from the European Centre for Disease Prevention and Control and identifies four different levels of likelihood of risk and four levels of potential impacts. The overall risk is categorized as very low, low, moderate, high, or very

78 New Zealand, Office of the Minister for COVID-19 Response, “Reconnecting New Zealanders to the World: Further Advice on Opening the Medium-Risk Pathway” (memorandum to the Cabinet, June 2, 2022).

79 OECD, *OECD Reviews of Public Health: Korea—A Healthier Tomorrow* (Paris: OECD Publishing, 2020).

80 Hyunjin Kang, Soonman Kwon, and Eunkyong Kim, *COVID-19 Health System Response Monitor: Republic of Korea* (New Delhi: WHO Regional Office for Southeast Asia, 2020).

81 Republic of Korea Ministry of Health and Welfare, “Korean Government’s Response System,” accessed September 15, 2022.

high and is assigned using matrix analysis.⁸² Variables to calculate levels of risk for **risk characterization** include:

- ▶ epidemiological data,
- ▶ domestic response capacities (response system, laboratory diagnostics),
- ▶ supply of vaccines, and
- ▶ public perception.

The first risk assessment was conducted on January 8, 2020, with continued risk assessment exercises following epidemiologically significant events as the pandemic evolved.

Korea's COVID-19 response has been based on “up-to-date scientific evidence and risk assessment,”⁸³ focused on the three Ts: test, trace, and treatment. While its first travel-related border measures were targeted at the country of origin (China), the approach soon shifted to testing all incoming travelers, regardless of travel history and nationality—a practice that persists to this day. The government's approach to border controls and risk management has changed with the pandemic's progression. *Roadmap for Gradual Recovery to a New Normal*, released in November 2021, for example, introduced **risk evaluation** based on a three-tiered categorization of nations, each with corresponding border control measures for **option assessment**:⁸⁴

- ▶ high risk: visa restrictions, limited number of flights
- ▶ average risk: visa restrictions, quarantine exemptions for vaccinated travelers
- ▶ safe: visa restrictions lifted, quarantine exemptions and PCR testing requirements eased for vaccinated travelers

The *Roadmap for Gradual Recovery to a New Normal* sets out the goal for border control measures to “better reflect the changing reality of the global pandemic...shifting toward greater international engagement.”⁸⁵ Other travel measures (e.g., quarantine exemptions and testing requirements) began to be introduced in 2022, based on the risk levels posed by specific countries as determined by epidemiological indicators and level of importation.⁸⁶ Further relaxing of public-health measures is expected, associated with COVID-19's reclassification as a class 2 notifiable infectious disease, down from class 1, which has less stringent reporting and monitoring requirements. The eventual goal stated in the post-Omicron response plan is to “ensure a safe and sustainable transition to a healthy new normal.”⁸⁷

82 Inho Kim et al., “KCDC Risk Assessments on the Initial Phase of the COVID-19 Outbreak in Korea,” *Osong Public Health and Research Perspectives* 11, no. 2 (2020): 67–73.

83 Republic of Korea Ministry of Health and Welfare, “Post-Omicron Response Plan: Toward a Safe, Sustainable New Normal” (press release, April 15, 2022).

84 Republic of Korea Ministry of Health and Welfare, “Roadmap for Gradual Recovery to a New Normal” (press release, November 29, 2021).

85 Republic of Korea Ministry of Health and Welfare, “Roadmap for Gradual Recovery to a New Normal.”

86 Republic of Korea Ministry of Health and Welfare, “KDCA Lifts Entry Restriction on Inbound Travelers from Abroad” (press release, April 3, 2022).

87 Republic of Korea Ministry of Health and Welfare, “Post-Omicron Response Plan.”

Taiwan

Taiwan initially opted for a zero-COVID approach, first barring residents of Wuhan from entry and then eventually those from the rest of China. The measure was expanded to include countries with active outbreaks, eventually restricting entry to all foreign nationals and nonresidents by mid-March 2020.⁸⁸ Taiwan started to reopen for essential travel in June 2022. The risk-based approach is based on lessons learned from previous infectious disease outbreaks, such as SARS, H1N1, and MERS.

Taiwan's public-health system introduced swift responses as soon as China announced an outbreak of pneumonia of unknown origins, made possible by the nation's own intelligence-gathering through real-time, event-based surveillance.⁸⁹ Taiwan started screening all arriving travelers from Wuhan for fever and pneumonia-like symptoms on December 31, 2019, and activated its Central Epidemic Command Centre on January 20, 2020.⁹⁰

Taiwan used WHO and European Centre for Disease Prevention and Control risk-assessment frameworks to conduct daily assessments in three aspects:

- ▶ risk of disease importation,
- ▶ risk of community outbreak, and
- ▶ impact on the country.

Each aspect is categorized as low, moderate, or high risk, and an overall risk level ranging from I to IV is assigned at the end, also considering political, social, and economic factors. Different levels of the overall risk assessment have a corresponding command unit, ranging from a contingency team (level IV risk) to the premier (level I risk).⁹¹

Under the *Preparedness and Contingency Planning in Response to COVID-19 Epidemic*:

- ▶ **Hazard identification:** The source of the hazard focuses on inbound travelers from “epidemic regions” and crew members.
- ▶ **Exposure assessment:** The population deemed at risk is the entire nation.
- ▶ **Risk characterization:** Countries of origin are categorized as low or intermediate risk, using the following variables:⁹²
 - epidemiological data, including daily COVID-19 cases;

88 Jennifer Summers et al., “Potential Lessons from the Taiwan and New Zealand Health Responses to the COVID-19 Pandemic,” *Lancet Regional Health—Western Pacific* 4 (2020): 100044.

89 Shu-Wan Jian et al., “Risk Assessment for COVID-19 Pandemic in Taiwan,” *International Journal of Infectious Diseases* 104 (2021): 746–751.

90 C. Jason Wang, Chun Y. Ng, and Robert H. Brook, “Response to COVID-19 in Taiwan: Big Data Analytics, New Technology, and Proactive Testing,” *JAMA* 323, no. 14 (2020): 1341–1342.

91 Taiwan Ministry of Health and Welfare and Taiwan Centers for Disease Control, *Preparedness and Contingency Planning in Response to COVID-19 Epidemic* (Taiwan: Ministry of Health and Welfare and Taiwan Centers for Disease Control, 2020).

92 Jian et al., “Risk Assessment for COVID-19 Pandemic in Taiwan.”

- epidemic magnitude;
- epidemic trends;
- local surveillance capacity;
- broader regional situation; and
- information transparency.

In the early days of the pandemic, risk from China was assessed at the provincial level, with travel restrictions imposed on each province.

Hazard characterization initially focused on importation and onward transmission of disease and later also took other factors into account, such as purpose of travel and risk based on the country of origin. Limited information is available on **risk evaluation** thresholds:

- ▶ low risk: less than ten daily new cases and less than one average daily new case per million in the past 14 days; and
- ▶ low-intermediate risk: ten to 100 daily new cases and one to five average daily new cases per million in the past 14 days.⁹³

Information on corresponding **option assessment** measures is similarly limited, and it is only known that entry and a shortened quarantine is in place for certain travelers from low or low-intermediate risk countries.

United Kingdom

The United Kingdom's approach to risk embodied an overarching strategy of mitigation, with early 2020 risk assessments underpinned by perspectives that widespread exposure in the United Kingdom may be inevitable, and that restrictions on international arrivals to the United Kingdom would serve at best to delay the risks of case importation and onward transmission of the virus.

A two-tiered, country-specific categorization of risk was introduced, with guidance determined based on travel history and symptoms. However, as of March 13, 2020, all COVID-19-related guidance specific to international arrivals was lifted on the basis that measures concurrently in place domestically were of similar nature and scope. The mandatory 14-day quarantine requirement came into effect June 8, 2020, followed shortly by a system of country-specific exemptions or "travel corridors." Travel corridors were created (whereby arrivals from designated countries were exempt from certain travel measures, e.g., quarantine), with risk determined based on "an estimate of the proportion of the population that is currently infectious in each country, virus incidence rates, trends in incidence and deaths, transmission status and international epidemic intelligence as well as information on a country's testing capacity and an assessment of the quality of the data available."⁹⁴

⁹³ Jian et al., "Risk Assessment for COVID-19 Pandemic in Taiwan."

⁹⁴ Grant Shapps, UK Secretary of State for Transport, "Travel Corridors" (statement, July 6, 2020).

On January 15, 2021, the government announced a suspension of all travel corridors because of the increased risk of emerging new variants. From May 17, 2021, international travel to and from the United Kingdom was permitted again under a new traffic light system that categorized country-level risk as green, amber, or red, based on both epidemiological and other factors. This traffic light system remained in effect until October 2021, when border management shifted to a single “red list” of countries, with measures for travelers from any other country based on the immunity status of individual travelers.

- ▶ **Hazard identification:** The source of hazard is travelers visiting or returning to the United Kingdom from areas with high transmission and low vaccination rates, particularly areas with variants of concern.
- ▶ **Hazard characterization:** The nature of the risk was focused on the importation of cases and subsequent impact on population health. This was framed in early 2020 discussions in terms of ensuring that the National Health Service was adequately prepared and equipped to respond.
- ▶ **Exposure assessment:** The population at risk was initially evaluated as highest for those traveling in hotspot regions and airline crew and border staff but was later expanded to include the general UK population. Under the travel corridor system in Summer 2020, for example, a government statement was issued in response to questions about why the government did not advise against travel to certain areas of Spain, yet returning UK citizens from these areas were still required to quarantine in late July 2020. The statement explained that travel advice “is based on the risk to the individual traveler and COVID-19 infection rates are lower [in the Balearic and Canary Islands] than mainland Spain,” whereas “self-isolation arrangements are put in place on the basis of risk to the UK as a whole.”⁹⁵ The traffic light system was later introduced as necessary “to keep our fortress [against COVID-19], built at such huge cost to us all, secure.”⁹⁶
- ▶ **Risk characterization:** The UK traffic light system primarily considered the following variables to calculate risk:⁹⁷
 - genomic surveillance capability,
 - COVID-19 transmission risk, and
 - variant of concern transmission risk.
- ▶ **Risk evaluation:** The UK Health Security Agency, responsible for determining whether a country was listed as green, amber, or red and the associated health measures required, states that it “does not use a mechanical quantitative approach to assessment with hard thresholds. Instead, a framework is used to consider countries in a consistent way, bringing together a range of qualitative and quantitative indicators to provide an overall judgement on risk categories.”⁹⁸ However, it also notes that under the traffic light system, countries are assumed to be medium public-health risk unless there is specific

95 UK Home Affairs Committee, “The Introduction of Border Quarantine Requirements,” Home Office Preparedness for COVID-19 (Coronavirus): Management of the Borders, August 5, 2021.

96 Grant Shapps, UK Secretary of State for Transport, “Transport Secretary’s Statement on Coronavirus: Friday 7 May 2021” (speech, May 7, 2021).

97 UK Health Security Agency, “Risk Assessment Methodology to Inform International Travel Traffic Light System.”

98 UK Health Security Agency, “Risk Assessment Methodology to Inform International Travel Traffic Light System.”

evidence to suggest that they are either specifically low or high risk to the United Kingdom, including from known variants of concern.

- ▶ **Options assessment:** There have been certain discussions of which mitigation measures to use in the public domain (through, for example, parliamentary records and government statements), but there has been limited transparency linking or explaining decision-making processes and policy choices, particularly in relation to risk methodologies or data.

United States

On February 2, 2020, the United States diverted all flights from China and all passengers who had traveled to China within the previous 14 days, routing them through selected U.S. airports with enhanced screening and quarantine capacity. Arriving foreign nationals who had traveled to China within 14 days were denied entry. U.S. nationals who traveled to Hubei Province within 14 days were subject to mandatory quarantine, and U.S. nationals traveling to other parts of China were subject to “proactive entry health screening and up to 14 days of self-quarantine with health monitoring.”⁹⁹

On March 23, 2020, the United States moved to “temporarily restrict all nonessential travel across the U.S.-Canada land border.” This was initially applied for 30 days and to be “subject to re-evaluation and further extension in light of the fluid nature of the coronavirus pandemic.”¹⁰⁰ Renewals and revisions to this policy were adopted throughout the pandemic.

While references have frequently been made to risk analysis in the United States’ use of travel measures, there has been limited information about the U.S. government’s methodology. In November 2020, the U.S. Centers for Disease Control and Prevention issued a “framework of considerations for ministries of health and their partners [beyond the United States] to use while designing and implementing travel-related intervention strategies...based on individual-level risk assessment of potential infection of arriving travelers to mitigate the spread of coronavirus disease 2019 (COVID-19).” The framework focuses on “public-health measures to mitigate risks of COVID-19 spread among those crossing international borders and for communities through which they travel.” The document is “not intended for risk assessment and management of persons traveling into and within the United States.”¹⁰¹

In January 2021, the U.S. Department of Homeland Security issued an *Overview of the Travel Risk Assessment Process* with the goal “to keep Americans safe” from travel-related “threats to the United States Homeland,” including terrorism.¹⁰² Led by a travel risk assessment team within the department’s Office of Strategy, Policy, and Plans, the risk assessment process was strongly informed by the Trump administration’s national security policy. Within this framing, the document sets out baseline criteria on “what additional information

99 U.S. Department of Homeland Security, “DHS Issues Supplemental Instructions for Inbound Flights with Individuals Who Have Been In China” (news release, February 2, 2020).

100 U.S. Department of Homeland Security, “DHS Measures on the Border to Limit the Further Spread of Coronavirus” (fact sheet, October 19, 2020).

101 U.S. CDC, *Developing a Framework for Assessing and Managing Individual-Level Risk of Coronavirus Disease 2019 (COVID-19) Exposure in Mobile Populations* (Washington, DC: U.S. Department of Health and Human Services, 2020), 2.

102 U.S. Department of Homeland Security, *Overview of the Travel Risk Assessment Process* (Washington, DC: U.S. Department of Homeland Security, 2021).

was required from each foreign country to adequately assess whether their nationals seeking to enter the United States posed a security or safety threat.” Criteria in this document include:

- ▶ **Hazard identification:** The primary source of travel-related risk is identified as travelers from foreign countries.
- ▶ **Hazard characterization:** The nature of the risk is focused on importation of infections and onward transmission, resulting in increased morbidity and mortality.
- ▶ **Exposure assessment:** The at-risk population is U.S. citizens (as travelers, Transportation Security Administration employees, and U.S. residents). The role of the Office of Strategy, Policy, and Plans is described as “to assess in real time the risk of COVID-19 infection from travelers arriving from foreign ports and make appropriate recommendations.”¹⁰³ However, the risk assessment methodology for issuing a Travel Health Notice is set out by the Centers for Disease Control and Prevention using a four-level system to rank international destinations.
- ▶ **Risk characterization:**
 - The primary variables to calculate levels of risk are:
 - case counts (cumulative new cases over the past 28 days)
 - new case trajectory (increase, decrease, or stable over the past 28 days)
 - The secondary variables to measure risk are:
 - population testing rate (number of tests conducted per 100,000 people over 28 days)
 - test-to-case ratio (number of tests conducted for each case reported during the same 28-day period)
- ▶ **Risk evaluation:** The guidelines provide thresholds for ranking a country of more and less than 100,000 people from Level 1 to 4. For countries with more than 100,000 population, incidence rate is the primary criteria. For countries of less than 100,000 population, case counts are the primary criteria.
- ▶ No information is given on **option assessment**.

103 U.S. CDC, *Developing a Framework for Assessing and Managing Individual-Level Risk*.

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