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nanced enquiries at country levels and to identify and address societal norms, economic systems, political processes, and threats to social justice that challenge the rights of young people to equitable access to health, education, employment, and meaningful social participation.

We declare no competing interests.

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Navigating from SARS-CoV-2 elimination to endemicity in Australia, Hong Kong, New Zealand, and Singapore



Elimination of COVID-19, broadly defined as no local SARS-CoV-2 transmission for more than 28 days, has been a target considered by Australia, Hong Kong, New Zealand, and Singapore since early in the pandemic. Their elimination strategies are based on earlier successes in interrupting SARS-CoV-2 transmission by using a mix of non-pharmaceutical interventions (NPIs) such as forced physical distancing (lockdowns), contact tracing and isolation, testing and quarantine at borders, travel restrictions, and mandatory use of face masks.¹ Elimination strategies have been reported to have contained the virus without severe economic fallout during the first year of the pandemic.² Despite their benefits, elimination strategies forestall the development of population immunity among populations with low risk of severe outcomes of infections through natural infection.^{3,4} Initially, elimination strategies were intended to provide time to develop COVID-19 therapies and vaccines, strengthen health systems, and for informed decision making, but some locations continue to adopt them as a long-term response.^{5,6} Yet there are concerns about

the sustainability of such strategies and the need to transition away from SARS-CoV-2 elimination.⁷ The current status and approaches of these four elimination locations (appendix) as of late September, 2021, are instructive for policy makers and researchers as the world navigates towards an endemic future.

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In July, 2021, the Singapore Government declared its intention to move away from a near elimination strategy towards endemicity.⁸ A central feature of this shift is the sustained deployment of first-year NPIs while new NPIs, such as distribution of SARS-CoV-2 self-test kits to households to facilitate early case detection, are undertaken to instil a common sense of social responsibility. Concomitantly and throughout the pandemic, the Singapore Government had earmarked about S\$100 billion through five budgets to provide targeted and universal relief, of which \$53.7 billion was drawn from its national reserves.^{9,10} On Sept 1, 2021, with more than 80% of the population fully vaccinated¹¹ and a strengthened health system with augmented contact tracing, testing, isolation, and treatment resources, Singapore adopted a middle course by increasing liberty of movement while remaining ready to tighten NPIs when needed.¹² In August, 2021, Singapore entered the first of its four-phase reopening roadmap.¹³ In this Preparatory Phase, selected NPIs are relaxed while others are expanded to permit increased social and economic activities, including international travel, albeit with a corresponding expectation of increased imported SARS-CoV-2 infections.¹⁴ Under this roadmap, differentiated measures are anticipated, whereby vaccinated individuals enjoy additional liberties and home-based recovery for fully vaccinated individuals with mild or no symptoms and no severe comorbidities is promoted to free up hospital resources. The second and third phases—Transition Stages A and B—foresee a further increase in personal liberties while minimising COVID-19 deaths and the risk of overwhelming Singapore's health system. The strength of NPIs and the rate of transition to these phases will depend on the number of severe COVID-19 cases, SARS-CoV-2 transmission trajectory, vaccination coverage, effectiveness of NPIs, and occupancy of Singapore's 1000 intensive care unit (ICU) bed capacity. A cautious stepwise approach with doorstep interventions for halting sudden spikes in infections ready at every stage is expected to serve as Singapore's guiding principle.

Australia has employed stringent quarantine for incoming international travellers and subnational (state) border closures to contain local outbreaks while retaining first-year NPIs. A national four-stage

plan for reopening when vaccination coverage reaches 70–80% of the population was adopted in August, 2021.¹⁵ However, this plan has been hampered by vaccination coverage that is one of the lowest among countries in the Organisation for Economic Co-operation and Development, with mRNA COVID-19 vaccines in short supply until September, 2021.¹⁶ The incursion of the SARS-CoV-2 delta variant highlighted the vulnerabilities of fairly low population vaccination coverage, prompting stricter NPIs such as extended or renewed lockdowns in various jurisdictions, including the Australian Capital Territory, which had held a zero-transmission status for more than a year.¹⁷ Although Australia has the ability to increase ICU bed capacity, there are concerns of a potential shortfall of trained ICU personnel and the country's hospital capacities will be monitored closely.^{18,19} ICU capacity partly guides the strength of NPIs. In a federation where states have constitutional responsibility for health and determine lockdown policies, there has been political tension in relation to abandoning elimination or maintaining zero transmission. For a country whose gross domestic product largely relies on economic income from education, tourism, and trade, reopening only after reaching high vaccination coverage is generally seen as the most practical exit strategy.²⁰ This approach has driven COVID-19 vaccine swap deals to overcome bottlenecks in vaccine supplies. In September, 2021, Australia was embarking on Phase A of its four-stage reopening roadmap, during which NPIs including lockdowns are enforced in outbreak areas while vaccination is accelerated. By Sept 28, 2021, 53% of people older than 16 years in Australia had been fully vaccinated.²¹ In anticipation of the 80% vaccine coverage for the population older than 16 years by the end of November, Australia announced the end of an 18-month travel ban and is working on a framework of testing and home quarantine upon arrival for returning fully vaccinated and unvaccinated Australians as it continues to widen its list of approved vaccines to prepare for increased international travel.²² The remaining phases of Australia's roadmap will be implemented as vaccine coverage increases.

New Zealand continues its elimination strategy guided by four Health Response Pillars: Keeping

it Out, Preparing for it, Stamping it Out, and Managing the Impact.²³ This strategy is achieved by strengthening NPIs and targeted lockdowns while reinforcing New Zealand's historically under-capacitated intensive care operations,²⁴ to prevent overwhelming the health system. Furthermore, COVID-19 has had a disproportionate impact among already disadvantaged Māori and Pacific populations, prompting an equity motivation to sustaining elimination.²⁵ To that end, New Zealand uses a four-level Alert System that triggered a nationwide lockdown (Alert Level 4) in August, 2021, after a single case was detected in Auckland, a first community infection identified in 6 months.²⁶ Vaccination coverage below 20% in August, 2021,²⁷ and the fast-spreading SARS-CoV-2 delta variant motivated the country to hasten its vaccinations during the lockdowns, including by securing additional COVID-19 vaccine doses from Spain and Denmark. Despite these measures, Auckland's lockdown was extended repeatedly in August and September as new SARS-CoV-2 infections emerged, only to have its Alert Level 4 status reduced on Sept 21 while other jurisdictions moved down to lower Alert levels even before that.^{28,29} If local vaccination is maximised by early 2022, New Zealand envisages a risk-based entry system to the country that subjects travellers to three entry pathways on the basis of vaccination status and country of departure.³⁰ The success of pilot programmes³⁰ such as home isolation and high vaccination coverage serve as key prerequisites for more domestic freedoms in New Zealand and reconnection with the world.

Hong Kong responded effectively to its four COVID-19 waves with decisive and strict NPIs without implementing lockdowns coupled with high levels of public compliance.³¹ The government disbursed four rounds of aid and a relief package from the Anti-epidemic Fund to individuals and businesses to support them through the prolonged NPIs.³² However, increasing vaccination coverage is currently a challenge in Hong Kong. There are adequate supplies of COVID-19 vaccines in Hong Kong but vaccine uptake has been slow. Vaccine hesitancy in Hong Kong is a concern, especially among the oldest age groups.^{33,34} In late September, 2021, about 62% of the eligible population in Hong Kong

was fully vaccinated, but among those older than 80 years coverage drops to only 14%.³⁴ To incentivise vaccination, Hong Kong has implemented a set of policies, including differentiated measures such as a vaccine bubble in food and beverage establishments, which regulates the number of patrons and opening hours based on the vaccination statuses of staff and customers. In September, 2021, Hong Kong reiterated its commitment to its elimination strategy with the explicit aim of reopening its borders with mainland China, which mandates zero tolerance towards the virus.³⁵ Hence, strict NPIs are expected to persist for the foreseeable future, despite increasing criticism from the international business community that the strict quarantine policies are hampering Hong Kong's position as a global business hub.³⁶ However, a daily quota of Hong Kong residents and other travellers are permitted to return from mainland China under its Return2hk and Come2hk schemes.^{37,38}

Lessons from these four locations, consistent with a growing body of medical literature,^{39,40} suggest that the social and economic stressors on populations as a result of elimination strategies that were feasible during the first year of the COVID-19 pandemic might not be sustainable in the future. Although elimination strategies averted a high COVID-19 death toll, especially among those with risk factors for serious illness after SARS-CoV-2 infection, nations that were successful in implementing these strategies develop low population immunity from natural infection and must now increase vaccination coverage to avoid high mortality and other consequences associated with the establishment of SARS-CoV-2 endemicity. To transition safely, we propose four key tenets. First, nations need to retain flexible and short-term NPIs based on the changing epidemiology and hospital capacities and be steadfast in implementing NPIs even when there is a rise in infections from reopening. Second, nations need to ensure maximum vaccination coverage while taking into account risk prioritisation, vaccine dose sparing, and equity principles. Third, the disparate impacts of the COVID-19 pandemic have highlighted the need for more targeted and commensurate relief, to shield to an extent industries and vulnerable groups from the unintended consequences resulting from sustained NPIs. Fourth, nations need to foster extensive surveillance

and stronger community social responsibility to detect and isolate COVID-19 cases quickly through more self-testing and home-based isolation while transferring risk assessment skills from institutions to individuals through codesigned risk communication and community engagement strategies, so communities can understand and mitigate their own risks. As places that were successful in early elimination come to terms with integrating into a world where SARS-CoV-2 is endemic, researchers and decision makers need to identify every opportunity to strengthen health system capacities, reduce inequities, and reinforce lasting pandemic preparedness.

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Bridging the evidence gap to achieve a healthy, net zero future



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The urgent challenge of achieving net zero carbon emissions by 2050 at the latest presents an opportunity to drive transformative changes in all sectors of society. Well designed actions to cut greenhouse gas (GHG) emissions could bring major benefits for health, by both reducing the health risks of climate change and delivering multiple benefits to human health and development (co-benefits).^{1,2} Modelling studies estimate that many millions of premature deaths could be prevented and GHG emissions greatly reduced by phasing out fossil fuels, thereby reducing air pollution,³ and by encouraging active travel, increasing use of public transport, and shifting to sustainable and healthy diets.^{1,4,5} Further benefits could accrue from efficient, well ventilated housing⁶ and from efforts to develop net zero health-care systems.^{7,8} There is also great potential to achieve health and climate benefits from nature-based solutions, including green space in cities, reforestation, and reduced deforestation and agroforestry.^{9,10} However, these potential benefits will only be realised by addressing key barriers and challenges.

First, standard approaches are inadequate to assess and quantify the health and GHG impacts of climate mitigation actions, including the use of different timescales and metrics of success.¹¹ This means the results of different studies, even in the same sector, are difficult to compare. The design of research is often weak, leading, for example, to a lack of data on baseline health status and GHG emission levels with

which to evaluate the effectiveness of mitigation actions. Second, many of the published studies model estimates of effect sizes that indicate the potential magnitude of benefits, but do not quantify the impacts of the implemented actions. Additionally, few studies document synergies and trade-offs between policies. Projected benefits may not be fully realised in implemented projects without rigorous evaluation. This failure to achieve maximum benefits for health and equity may partly be due to the unintended adverse consequences that result from poorly designed policies and from an absence of comprehensive policy packages to effectively transform systems. For example, higher carbon prices could increase poverty if issues around equity and distribution are not



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