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Institutional and behaviour-change interventions to support COVID-19 public health measures: a review by the Lancet Commission Task Force on public health measures to suppress the pandemic

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The Lancet COVID-19 Commission Task Force for Public Health Measures to Suppress the Pandemic was launched to identify critical points for consideration by governments on public health interventions to control coronavirus disease 2019 (COVID-19). Drawing on our review of published studies of data analytics and modelling, evidence synthesis and contextualisation, and behavioural science evidence and theory on public health interventions from a range of sources, we outline evidence for a range of institutional measures and behaviour-change measures. We cite examples of measures adopted by a range of countries, but especially jurisdictions that have, thus far, achieved low numbers of COVID-19 deaths and limited community transmission of severe acute respiratory syndrome coronavirus 2. Finally, we highlight gaps in knowledge where research should be undertaken. As countries consider long-term measures, there is an opportunity to learn, improve the response and prepare for future pandemics.

Keywords: behaviour change, COVID-19, pandemic, public health .

Introduction

The Lancet COVID-19 Commission Task Force for Public Health Measures to Suppress the Pandemic[1] was launched in September 2020 to identify critical points for consideration by governments on public health interventions to control coronavirus disease 2019 (COVID-19). As countries consider long-term measures, there is an opportunity to learn, improve the response

and prepare for future pandemics. In this paper, we review the evidence for two broad groups of public health interventions: institutional measures and behaviour-change measures. We define institutional measures as those strategies for pandemic control operationalised through four policy instruments: legal (e.g. acts and regulations); economic (e.g. public investment and subsidies); voluntary standards and guidelines; and information and education.[2] Behaviour-change measures are implemented and maintained by restriction and coercion; persuasion and incentivisation; education and training; modelling; enablement and environmental restructuring, and are influenced by factors operating at the individual, community and population level.[3] We cite examples of institutional and behaviour-change measures adopted by a range of countries, but especially jurisdictions that have, thus far, achieved low numbers of COVID-19 deaths and limited community transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).

Review criteria

To identify our main points, we drew on data analytics and modelling, evidence synthesis and contextualisation, and behavioural science evidence and theory on public health interventions. For the most current evidence syntheses of the effectiveness of institutional and behaviour-change measures, we searched the Cochrane Coronavirus Resources website (https://www.cochrane.org/our-evidence/coronavirus-covid-19-resources) and COVID-19 research published on health evidence (https://www.healthevidence.org/) then performed PubMed searches (without date specification) for evidence of measures drawn from studies of interventions used in other pandemics.

Institutional measures

In general, most countries with SARS and Middle East respiratory syndrome (MERS) experience were better prepared for using measures, such as isolation of people with infection or quarantine for interrupting disease transmission, than jurisdictions whose only recent experience was with pandemic influenza.[4] This experience, together with advances in the knowledge of virus transmission modes, generated some or all of the following institutional responses: government measures to minimise interpersonal contact and reduce person-to-person transmission; early well-coordinated and widespread community testing, contact tracing, supported quarantine of contacts and isolation of cases and vaccination; strengthening health systems, including systems for testing and vaccination, as well as services addressing other health needs of populations; and clear and consistent public communications and trusted political leadership.[5] Our points relate to these responses, in turn.

Government measures to minimise interpersonal contact and reduce person-to-person transmission

Until large-scale vaccination of populations and or herd immunity reduce virus transmission, governments must rely on the public health measures at their disposal to contain the spread within their populations. Early in the pandemic, virus transmission was known to be primarily via respiratory droplets spread during close physical contact. Airborne transmission of smaller droplets and particles suspended in the air and able to travel over longer distances and time than close-contact droplet transmission is another important but less common route.[6] The contribution of fomites to SARS-COV-2 transmission remains unclear.[7] Public health measures have, therefore, focused on minimising interpersonal contact to reduce the risks of person-to-person transmission. These include mobility restrictions, border restrictions, shutdowns of workplaces and all but essential facilities, limitations to the size of public gatherings, using barriers and visual prompts to facilitate physical distancing, screening for symptoms before entering indoor spaces, mandating mask-wearing[8] and personal and environmental hygiene measures (disinfecting surfaces, making handwashing facilities and masks readily available).[9] When combined, these measures appear to have been effective in reducing transmission in countries where they were implemented and adhered to by most people.[9]

A systematic review found that the introduction of cross-border travel restriction led to reductions in the number of imported/exported cases and in the number of new cases.[10] Another systematic review that included 29 studies (10 modelling studies on COVID-19, 4 observational studies and 15 modelling studies on SARS and MERS) reported that, when combined, prevention and control measures (school closures, travel restrictions and social distancing and quarantine) demonstrated a larger effect on the reduction of new cases, transmissions and deaths than individual measures alone.[11]

A cross-country analysis using documented cases from 20 countries found that venue closures were associated with a reduction by 36% in the number of new cases, closely followed by large gathering bans, work bans on non-essential business activities, then banning gatherings of more than 50 people.[12] Limiting small and large gatherings, border restrictions, limiting individual movement, national lockdowns and school closures are all effective in significantly reducing transmission.[13] Lockdowns in particular have a large effect on reducing transmission.[12] These measures are more effective the more strictly they are adhered to. Most countries have employed most of these measures to some degree, with policy, regulatory and legislative tools used to increase adherence.[14]

Early well-coordinated and widespread community testing, contact tracing, supported quarantine of contacts and isolation of cases

Testing, contact tracing, quarantining contacts and isolating infected people are fundamental to the public health response and will continue to be so for the foreseeable future, even as vaccines are being deployed. A systematic review concluded that quarantine measures could reduce the number of infected people and the number of deaths, the former by 44–81%, the latter by 31–63%.[11]

Population-wide antigen testing (testing an entire community or jurisdiction) has been adopted as an emergency response to newly detected clusters in some countries (e.g. China and Vietnam). The rationale has been to rapidly identify cases, link them

to isolation and contact tracing and thus prevent widespread transmission. A Cochrane rapid review found a limited evidence base for the effectiveness of community-wide testing and only low-certainty evidence that testing people at travel hubs (such as airports and train stations) may slightly reduce the importation of infected cases.[15] Furthermore, the usefulness of this approach diminishes if laboratory capacity is insufficient and overwhelmed, as in countries with widespread transmission. Where testing capacity is adequate, in addition to testing all suspected cases, countries may consider regular, community-based testing programmes of populations in high-risk settings (e.g. hospitals, long-term care facilities, school, prison, migrant detention and reception centres), at high occupational risk (e.g. healthcare and social workers, food packaging and processing plant workers) and in vulnerable communities, to identify and isolate any asymptomatic or early emerging cases of COVID-19. Testing should be carried out by trained, appropriately equipped staff, and adequately resourced to ensure convenient, free or low-cost access, minimal waiting, strong information infrastructure systems across the health systems and prompt communication of results to ensure rapid linkage of positive results to contact tracing and isolation.

Testing should be accompanied by rapid contact tracing (forward and retrospective), isolation and quarantine of close contacts, plus surveillance, outbreak investigation and healthcare and social-care system response, especially when testing capacity is limited. Contact tracing requires identifying persons who may have been exposed to COVID-19, assessing their exposure risk, arranging a test (routinely or symptom-based), and subsequent disposition to quarantine (if test-negative or asymptomatic) or isolation (if test-positive or symptomatic), within the evidence-based incubation period from the last point of exposure. When systematically applied, and in a context where there are high levels of public trust in the authorities leading the process, contact tracing has the potential to prevent up to 80% of all transmissions and break new transmission chains.[16,17] Because SARS-CoV-2 may spread through 'superspreading' events, where one person infects multiple people (as is especially the case with the more infective variant strains of concern), retrospective contact tracing is vital, to find when and where a person was infected and thus help identify who else might have been infected at the time.

During surges, countries have trouble keeping up with contact tracing. It is critical to implement the system early when cases are manageable.[17] In a setting of a young population, a large proportion of infections are asymptomatic with no identifiable positive contacts (who are likely also to be asymptomatic), making it more difficult to control infections without mass testing of asymptomatic cases. Countries should commit to supporting conventional contact tracing through training an additional skilled workforce able to be mobilised rapidly and flexibly to respond to surges and establishing a centrally coordinated contact tracing national database.[18] The cost of contact tracing systems is small relative to the economic and social cost of repeated shutdowns.

Contact tracing efforts may be complemented using digital tools, such as the voluntary use of QR codes to log locations visited over the previous 14 d (e.g. New Zealand and the Republic of Korea), or mobile phone Bluetooth apps that automatically log proximate encounters with others using the app (e.g. Singapore, New Zealand, many European countries), linkage of global positioning systems, credit card transactions and closed-circuit television databases to identify contacts (e.g. the Republic of Korea).[19,20] Uptake has been varied across countries because of accuracy and trust, influenced by privacy and data-safety concerns.[20,21] Different societies have different levels of tolerance for such digital tracking and some countries have data-protection rules that would not allow their implementation; therefore, a strong recommendation for them cannot be made. Where measures might involve intrusion into an individual's personal life, it is important that they are both necessary to achieve public goals and time bound (i.e. to the duration of the pandemic) to respect the fundamental rights of people.[21] However, there is currently only limited evidence for a reduction in secondary cases if digital contact tracing is used with other measures such as self-isolation, and weak evidence that digital contact tracing may produce more reliable counts of contacts and reduce time to complete contact tracing.[22]

The fact that COVID-19 patients can be infectious while asymptomatic or presymptomatic complicates efforts to reduce the virus's spread. Isolation of confirmed cases is a necessary step in the containment of the virus, but quarantine of close contacts of cases for an incubation period is also important. Elements of a quarantine and isolation policy include location, duration, support and protection. Either home (if single or if home configuration allows for physical distancing) or alternatives to home (e.g. hospitals, hotels, repurposed sport stadiums, convention centres or other venues) can be applied. To exit isolation, people should have had asymptomatic periods with consecutive negative test results. The individual being isolated should be provided with information about what worsening or urgent symptoms and signs to monitor. Whenever financially possible, the isolated individual should be provided with support: meals or food to prepare meals; personal care and homemaking supplies (e.g. soap, cleaning supplies); communication to be able to interact with family, friends, employer and banker, etc.); caregiving if not able to care for dependents (e.g. children or older parents) or pets; remote working support if able to work; paid leave if not able to work; job protection if not able to work; housing protection if not able to pay rent or mortgage and/or maintain property; exercise options; and healthcare (e.g. nursing care and physician visits) if their condition deteriorates or they have concurrent medical conditions. Because these support packages are expensive, it is critical to implement them early when the number of cases is low.

Strengthening health systems and services addressing other health needs of populations

The pandemic has highlighted weaknesses and strengths in health systems. Some countries responded rapidly and innovatively. For example, China built quasi-hospitals in a matter of days to care for mild to moderate patients who did not need oxygen therapy.[23] Attention has focused on the availability of acute and intensive care beds, but effective primary, community and social care are also crucial to provide care for infected people not needing hospitalisation and to ensure continuity of care for people with other care needs.[23,24] A WHO survey found that many countries have struggled to deliver essential health services, such as

routine vaccinations and screening programmes, and the care of people with cancer, mental health issues and addictions, as well as surgical needs, particularly in low-income countries.[25] Defining and protecting essential service delivery is critical to sustain good health outcomes and maintain the trust of communities in the health services and population health,[26] especially vulnerable groups such as indigenous peoples who generally have a lower standard of living, limited access to healthcare, including public health services, and who experience poorer health outcomes than the population overall.[27]

It is vital that contact tracing and social isolation measures build on existing community-based programmes with a geographical and health system reach with well-rehearsed systems for reaching the most remote, most in need, most vulnerable and people with disabilities.[28] Where they exist, such programmes (e.g. the neglected tropical disease programme in Africa) provide an excellent platform that other programmes can learn from and link to.[29]

Many countries have faced health professional shortages, with significant skill mismatches. The shortfall of health workers globally is estimated at 18 million, primarily in low- and middle-income countries, but many high-income countries also have shortages.[30] Countries with decentralised health systems have been able to tailor care to local needs and involve communities. For example, Rwanda used its community health workers and Ethiopia its health extension workers[31] to ensure communities had access to frontline healthcare services, laboratory and contact-tracing staff, as well as behavioural support. Unfortunately, coverage for high-quality services is limited in many low- and middle-income countries, as revealed by the reliance on community volunteers in the delivery of health interventions.[32]

Communication and leadership

Public communication allows those at risk to understand and adopt behaviours necessary to mitigate risks and harm and should be integrated as a critical element in pandemic preparedness and response activities. Communication must clearly establish the priorities and actions to be followed and facilitate appropriate actions and their consequences. Governments should establish strategies that control and coordinate the flow of information, linked to increasing people's motivation and confidence to act and promote actions that individuals can realistically take to protect their health and that of their families and communities. They should present the benefits of adhering to control measures at the individual, community and broader societal/national level.

Public communication should be tailored to target audiences by both message and medium; stakeholder engagement is important to identify the most appropriate message framing and medium of the message.[33] Positively framed messages emphasising a collective vs individual approach may be most effective.[33] Communication should be transparent, relying on the latest scientific evidence to counteract inaccurate and unverified information shared through social media or informal platforms such as word of mouth.[34–36]

Building trust with the public is vital to gain widespread cooperation and to avoid the need for coercion. New rules are more likely to be effective if communicated widely by trusted sources, enabled and enforced, and seen by the population as a valid need.[37] Effective public communications from governments and their agencies build and convey trust by being clear, repeated, action-oriented and delivered by a trusted leader (e.g. community leader, trusted public health professional).[33]

However, trust in government and state institutions varies widely between and within countries and could explain in part observed differences in effectiveness and adherence by the public to actions recommended by governments.[38] Trust in both the message and the person delivering the message can be enhanced by acknowledging uncertainty, changing recommendations and information or previous errors.[33]

Communication should also be pro-equity, prioritising the most vulnerable populations.[39] It should engage with these populations and involve local stakeholders to aid in decision-making and tailor communication and interventions to their unique needs.[39] It should protect groups that experience stigma and discrimination related to the pandemic.[40] Pandemic communication must be sensitive to the diversity of populations, especially language and culture, adjusting communication strategies for indigenous and ethnic minorities and low socioeconomic groups, utilising multiple platforms and channels, especially those preferred by vulnerable populations, to design appropriate communication strategies.[41]

Effective political and community leadership has emerged as a related critical component to controlling the spread of the virus. It requires innovation, a focus on learning and experimentation,[42] exploring alternative solutions grounded in solid evidence and timely data generation, and creative responses coupled with tried and tested measures to adequately manage risks.[43] Leaders should evaluate the public's response to their pandemic control measures, and act according to the findings to build and maintain trust.[43–46]

Leaders should develop and communicate clear objectives underpinning a strategy for tackling the pandemic.[47] Leaders of different countries have articulated different objectives: for example, while the UK has pursued the objective of 'mitigation' or 'suppression', the leaders of New Zealand, China, Taiwan and others have communicated the ambitious goal of eliminating community transmission to zero. They should model the behaviour that they want to see, because others will follow their lead.[47]

Even the strongest health measures are likely to be ineffective if the population does not embrace them. In the next section, therefore, we consider the role of behaviour change.

Enabling public behaviour change

We focus in this section on the behaviour of the public in communities. Until effective vaccines have been administered at a global scale, changes in public behaviours represent the primary defence mechanism against COVID-19.[48] Even highly effective vaccines are ineffective at the population level unless very large numbers of people assent to be vaccinated. Protective behaviours will still be required, given the possibility of only partial protection afforded by vaccination and the emergence of variant strains of the virus.[49] Thus, human behaviour is the key to managing the COVID-19 pandemic.[50] To date, there has been limited research investment, and therefore few empirical studies, on the evidence of effectiveness of behavioural interventions on

Table 1. Key behaviours according to different phases of the COVID-19 pandemic

Phase of pandemic	Key behaviours
Community transmission occurring	*Protective behaviours* Maintain safe physical and social distance, cover nose and mouth when coughing and sneezing, wear masks (especially indoors, on public transport or when in crowds), avoid touching eyes, nose and mouth, disinfect hands and surfaces, immediately isolate if a contact is symptomatic, ventilate indoor spaces, limit indoor gatherings, meet people out-doors, symptom checking. *Behaviours if symptomatic* Isolate immediately, get tested, isolate while awaiting the result, provide a list of close contacts. *Safe participation in health, social and economic systems* Work from home if required and feasible, use telehealth services, limit distances travelled, limit the number of places visited, download and use a contact tracing app if available or keep a diary of all premises visited, exercise locally in families or small groups, buy online and locally.
Vaccine available and accessible	*Vaccination uptake* Get vaccinated (especially the most vulnerable), support dependents to get vaccinated, encourage others to vaccinate.
Recovery	*Recovery behaviours* Build protective behaviours into routines and social norms, avoid crowded indoor spaces, create enabling environments (e.g. ventilated indoor spaces) to ensure protective behaviours can be maintained sustainably at scale.

COVID-19 infection rates. Despite understanding behaviour being vital to managing COVID-19, national pandemic responses have included ineffective and even counterproductive measures. For example, a lack of adherence to government advice may be assumed to stem from low motivation, when the real issue is a lack of opportunity and/or knowledge (e.g. knowledge of rules). Understanding public behaviours, their influences, and evidence of the effectiveness of different types of intervention, will also prove invaluable for future pandemics, increasing understanding about how and why populations within and between countries have reacted differently and about the impacts of these different approaches.[51]

Behaviours that can reduce COVID-19 transmission

Key behaviours drawn from case studies around the world and the WHO[51] can be grouped into five categories: protective behaviours; behaviours if symptomatic; safe participation in health, social and economic systems; vaccination uptake; and recovery behaviours. Table 1 shows these key behaviours grouped according to the phase of the pandemic (community transmission occurring, vaccine available and accessible, and the recovery phase).

Behaviour-change strategies to prevent viral transmission

Many types of intervention can be effective in changing behaviour, but the most effective strategies use several types of intervention simultaneously and maintain them over time. An integrative framework based on 19 frameworks identified in a literature review, the behaviour change wheel (BCW), identifies 9 broad intervention types (education, persuasion, incentivisation, coercion, training, restriction, environmental restructuring, modelling and enablement).[3] For simplicity, we group these functions into five groups: restriction and coercion (making new rules and enforcing them); persuasion and incentivisation (convincing people that behaviour will result in good outcomes); education and training (on how to perform); modelling; and enablement and environmental restructuring (making the behaviour easy to do).[52,53] In Table 2, we draw on several examples to illustrate interventions frequently used by governments according to these groups.[54,55]

According to the BCW approach, behavioural interventions likely to be effective should be selected based on understanding the nature of the target behaviour and its context. Depending on what needs to change—motivation and/or capability (e.g. knowledge and skills) and/or opportunity (physical and social)—different interventions should be selected. These interventions can be supported, implemented and maintained by one or more policy options: fiscal policy, legislation, regulation, environmental planning, communications, service provision and guidelines.[3,56]

Explanations for variation in behaviour within and between countries

Behaviour is influenced by factors operating at individual, community and population levels,[57] such as trust in government,[58–61]

Table 2. Interventions identified from published evidence and country examples, according to behaviours for reducing community transmission

Behaviour	Intervention types				
	New rules and enforcement (restriction/coercion)	Convince people behaviours will lead to positive outcomes (persuasion/incentives)	Education and training on how to do behaviours (education/training)	Modelling behaviour (modelling)	Make the behaviour easy (enablement/environmental restructuring)
Personal protective behaviour (handwashing, not touching face, covering coughs and sneezes)		Public facing campaigns, community-driven campaigns	Guidelines for correct handwashing, lists of recommended behaviours	Leaders/peers demonstrating and used in communication	Hand sanitiser is readily available
Mask-wearing	Mandating mask-wearing (in general or particular places), fines for not wearing masks, no entry to premises without mask	Public facing campaigns, bespoke audience-focused messaging, greater freedoms with masks	Make your own mask videos, information on how to wear, clean and dispose of masks	Leaders wearing masks, used in communication	Free mask availability
Limiting interactions (social distancing/physical distancing/stay at home when required/isolating when required)	Number limits at indoor and outdoor gatherings, limiting movement (e.g. 5 km or exclusion zones with checkpoints and fines for being out of zone), isolating when required (e.g. travelling or in hotspot) and fines for non-compliance, curfews and fines for breaches, closing/limiting businesses, requirements for COVID-19 plans, closing/limiting schools and public transport, greater policing	Public facing campaigns reinforcing collective efficacy, bespoke audience-focused messaging, payments to cover lost work opportunities and income, early access to retirement funds	Public/political announcements (about restrictions), guidelines, information for education	Leaders/peers staying at home and used in communication	Tables/chairs spaced in venues, limited numbers in venues, isolation facilities available, designation of responsible person in facility, markers on the ground to show distance, barriers between service employees and customers, purchase collection points near the front

Table 2. Interventions identified from published evidence and country examples, according to behaviours for reducing community transmission

Behaviour	Intervention types			
Getting tested	Limiting movement/ability to work without test results	Public facing campaigns, bespoke audience-focused messaging, community-driven communication, free testing, increased local services in response to cases	Leaders/peers getting tested, used in communication	Multiple test sites, free testing, readily accessible information on test site locations, speedy SMS notification of test results
Getting vaccinated	Limit movement/ability to work/access to venues without vaccination	Public facing campaigns, bespoke audience-focused messaging	Leaders/peers getting vaccinated, used in communication	Free vaccination, multiple vaccination sites (or mobile vaccination), reminders for boosters

the degree of inequality in a society,[62–66] culture and national history (including experience of pandemics),[67] health literacy,[68] values and personality traits,[69,70] opportunities to break rules,[70] population density and housing conditions,[71] as well as the quality and frequency of communication.[72] Because populations differ widely in the degree to which such factors are at play, modelling behavioural adherence by using other countries' experiences and data should be carried out with caution: there is no one-size-fits-all in government interventions to change COVID-19 behaviour.[54,73]

Driving behaviour change: the role of national governments

To deliver on the potential of behavioural science,[74] governments should identify key behaviours (depending on the stage of the pandemic); measure and monitor the behaviour of populations; co-create and evaluate interventions based on understanding drivers and barriers of key behaviours; and communicate effectively (highlighted here because of its widespread use and misuse). We consider each of these in turn.

Identifying key behaviours

Behaviours with high population impact (i.e. their collective performance will decrease community COVID-19 transmission) and high likelihood of being adopted (perceived as easy to do and effective by the target population) and adhered to are vital to focus on.[75] All too often adoption and adherence are addressed through rules, instead of enabling social norms and environmental support, which may have the added benefit of positive spillover effects on other behaviours.[76]

Measuring and monitoring behaviours

Once identified, governments should monitor behaviours for efficacy and reach, using objective measures rather than self-report, and in real time and everyday contexts. Data are needed on influences on behaviour, such as trust in government, knowledge, motivation (including risk perceptions), acceptance of recommended behaviours, misperceptions and stigma. These may serve as barriers or drivers to recommended behaviours. This information can assist in identifying resistance to change,[77] risk compensation (people may compensate for changes perceived as improving safety by adapting their behaviour[78]), such as could occur with wide vaccination coverage, and new ways to change behaviour. Monitoring behaviour may help identify groups where rule adherence and proactive behaviour change is lower than desired, to inform targeted interventions for additional support.

Co-creating and evaluating interventions based on understanding drivers and barriers of key behaviours

Governments should draw on insights from behavioural science into why people perform desirable and undesirable behaviours and co-create interventions with people from the target population who have relevant lived experience and can provide information about context. Models and theories of behaviour that summarise what is known about behaviour and how to change it can be useful for understanding what is likely to be effective for different behaviours and contexts.[3,79] Evaluations should be of both outcome (intervention effectiveness) and of process (how the intervention achieved its effects), to inform the design of better interventions in the future.

Effective communication

In Box 1, we propose a set of principles of effective communication for use by governments according to objective and context.[80–82]

Box 1. Principles of effective communication

- Communicate broadly and early to shaping public opinion
- Use trusted sources and networks to deliver localised messages, in addition to mass media
- Engage end-users in message design
- Emphasise positive descriptive norms
- Emphasise collective efficacy
- Highlight alternative behaviours (e.g. food delivery services)
- Use clear, concise, consistent and frequently repeated messages
- In multiethnic and multilingual countries, ensure that all population groups are reached through customised messages
- Be honest about uncertainty and failure
- Emphasise benefits to the recipient and others
- Align with the recipient's moral values
- Highlight the prospect of social group approval
- Avoid stigmatising groups for not adhering to recommendations.

Conclusions

An effective and equitable public health response should be grounded in iteratively revised institutional responses that draw on robust data analytics and modelling, strong evidence synthesis and contextualisation, in tandem with the thoughtful application of behavioural science evidence and theory.

However, there are many challenges and questions still to be answered about the effectiveness and equity of the public health measures, especially in the light of the emergence of SARS-CoV-2 variants of concern.[83] Even as vaccinations are being given to millions of people in many countries, research is urgently needed to answer questions on the current approach to vaccination (e.g. using vaccines that offer greater protection against variants, using different vaccines for first and second doses and/or re-vaccinating those initially vaccinated with vaccines with limited efficacy for new variants). There are gaps in knowledge to inform changes in policies on infection-prevention measures in the community (e.g. duration of handwashing, mask-wearing, as well as physical and temporal distancing); community infection-control procedures (the duration of quarantine of exposed or potentially exposed individuals, the duration for isolating suspected cases); the frequency of testing; and the approach to contact tracing and outbreak management. For health systems, there are many questions about the implications of SARS-CoV-2 variants of concern on capacity planning if re-infection and severe disease emerge as additional challenges, frequency of screening, personal protective equipment, cohorting patients based on variants, adjusting patient spaces and so on. From the perspective of behaviour change, it is crucial to understand if people are adequately prepared to cope long-term with both the demands and the consequences of living with essential public health measures.

To mitigate the negative impact of COVID-19 restrictions and build preparedness for future pandemics, political leaders at local, regional and global levels must weigh up the benefits and harms of restrictions on individual freedoms, tackle existing and emerging inequities, provide clear, consistent guidance to the public and strengthen capacity in research and the application of the analytical and behavioural sciences.[84] Despite the many challenges, there is an unprecedented window of opportunity for countries to work collectively to 'build back better', with more robust and equitable processes, policies, public health infrastructure and health systems.

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