

Background Document on Testing Strategy

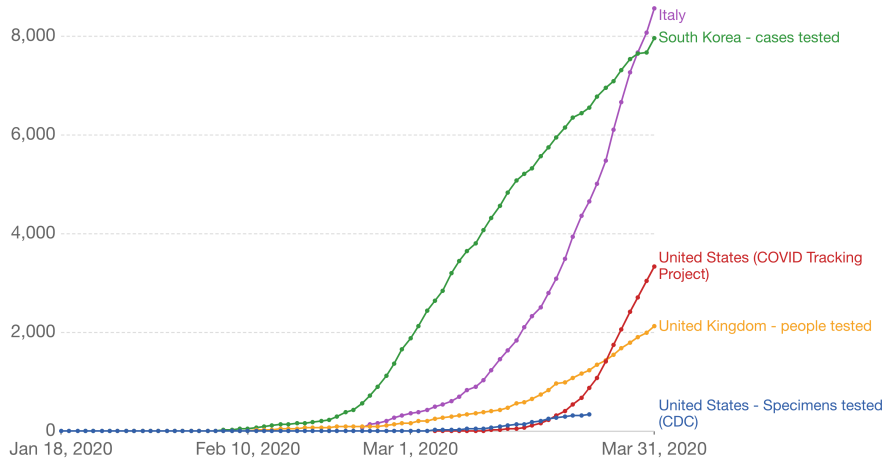
Draft, not for further circulation, prepared by the Global Health Governance Programme, Usher Institute, Edinburgh University.

Section 1: Extent of Testing: UK v. other countries

Total tests for COVID-19 per million people



Comparisons across the series are compromised for several reasons. See note below for more information about the series for the US and South Korea. For the UK and Italy only limited descriptions of the data are provided by the sources.

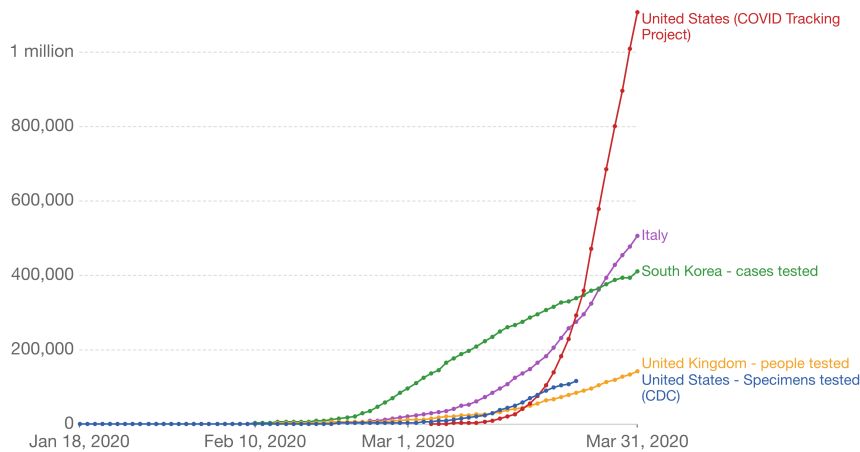


Source: US: CDC, COVID Tracking Project; South Korea: KCDC; UK: PHE/DHSC; Italy: Ministero della Salute
Note: 'Cases tested' is equivalent to the number of people tested. The COVID Testing Project aggregates figures for the number of tests and the number of people tested as reported by US states. US CDC figures do not include private labs; COVID Testing Project figures do so partially. OurWorldInData.org/coronavirus • CC BY

Total tests for COVID-19



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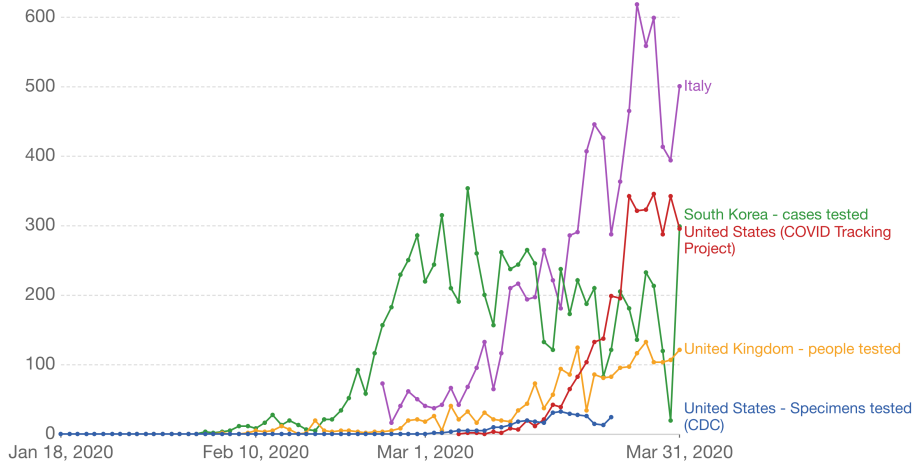


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Note: 'Cases tested' is equivalent to the number of people tested. The COVID Testing Project aggregates figures for the number of tests and the number of people tested as reported by US states. US CDC figures do not include private labs; COVID Testing Project figures do so partially. OurWorldInData.org/coronavirus • CC BY

Daily COVID-19 tests per million people

Our World
in Data

Comparisons across the series are compromised for several reasons. See note below for more information about the series for the US and South Korea. For the UK and Italy only limited descriptions of the data are provided by the sources.

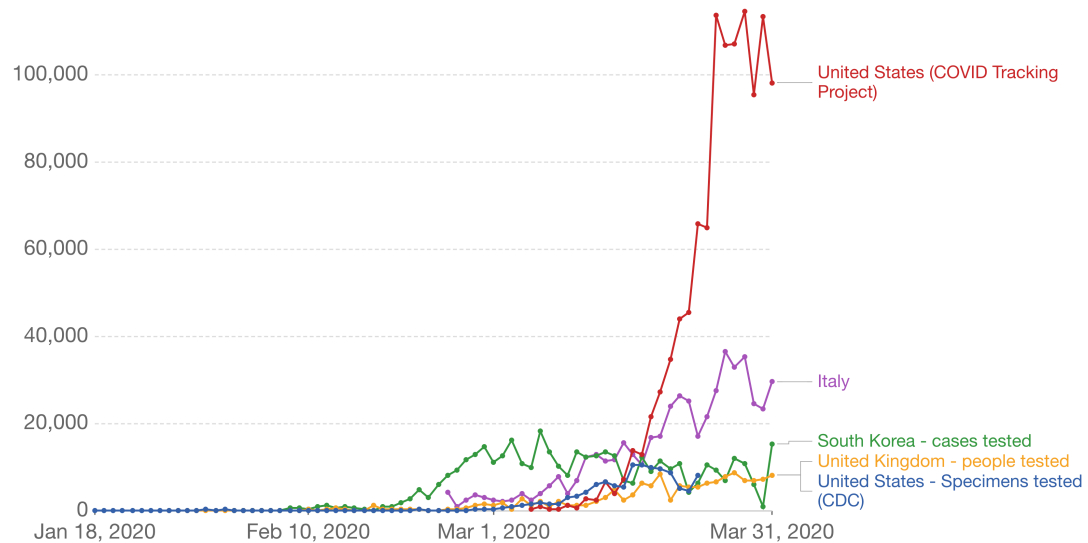


Source: US: CDC, COVID Tracking Project; South Korea: KCDC; UK: PHE/DHSC; Italy: Ministero della Salute
Note: 'Cases tested' is equivalent to the number of people tested. The COVID Testing Project aggregates figures for the number of tests and the number of people tested as reported by US states. US CDC figures do not include private labs; COVID Testing Project figures do so partially. OurWorldInData.org/coronavirus • CC BY

COVID-19 tests per day

Our World
in Data

Comparisons across the series are compromised for several reasons. See note below for more information about the series for the US and South Korea. For the UK and Italy only limited descriptions of the data are provided by the sources.



Source: US: CDC, COVID Tracking Project; South Korea: KCDC; UK: PHE/DHSC; Italy: Ministero della Salute
Note: 'Cases tested' is equivalent to the number of people tested. The COVID Testing Project aggregates figures for the number of tests and the number of people tested as reported by US states. US CDC figures do not include private labs; COVID Testing Project figures do so partially. OurWorldInData.org/coronavirus • CC BY

Testing Data Questions

The data above for the UK is pulled from the updated numbers from PHE/DHSC at the .gov website for the cumulative number of people tested.

- Is there similar data available for Scotland over time?
- Are there any issues of comparability in these published counts over time as well as lag between testing and reporting?
- Do the figures across the time series reflect the output of all labs/hospitals in the country?

- Is this aggregate figure the highest level of detail available, or can it be broken down by age, gender and region?

Testing Infrastructure Questions

- What is current testing capacity (PCR) in Scotland, and where are the testing locations?
- What are the key bottlenecks to increasing the number of tests, and how could these be overcome?
- What is the current testing strategy, and how could this be quickly extended to mass testing before first lockdown period ends on 13th April?
- How linked (or constrained) is Scottish testing strategy to UK-wide testing strategy?

Section 2: Closer Look at East Asian Countries Policy Strategies and Testing

GOVERNMENT APPROACH TO COVID-19 OUTBREAK

Country Profile: South Korea

Epidemiological situation

The first case of COVID-19 was reported in South Korea on 20 January 2020 [1]. As of 01 April 2020, the country has recorded 9887 confirmed cases, of which 5567 have recovered, with 165 deaths [1]. South Korea has tested 383,886 people, which amounts to more than 5200 tests per million inhabitants—more than any other country [1,2]. South Korea's policy measures of early and mass testing, rigorous contact tracing, and mandatory quarantine for anyone near a carrier of the virus, have been outlined as key reasons for its success in reducing the number of new cases of COVID-19 and the associated fatality rate [3, 4, 5].

Preparedness owing to MERS outbreak in 2015

South Korea identified three gaps from its experience of the Middle East Respiratory Syndrome (MERS) outbreak in 2015: ill-prepared hospitals, lack of early warning and transparent public communication, and slow diagnostic capacity [6]. Following the 2015 outbreak, the government implemented three measures to address these gaps and ensure disease outbreak preparedness. First, it invested heavily in infectious disease control demonstrated by its robust standard operating procedures, which essentially call for five steps: an aggressive and transparent information campaign, high volume testing, quarantine of infected individuals, treatment of those in need, and disinfection of contaminated environments [7]. Second, the government also invested in its research and development for PCR testing kits, creating financial incentive for competition among private biomedical companies to develop rapid diagnostic tools [9]. Third, soon after the MERS outbreak, South Korea passed laws that allow authorities to collect mobile phone, credit card, and other data from those who test positive to reconstruct their recent whereabouts for contact tracing, which, after being anonymised, can be shared on social media apps that also allow others to determine whether they may have crossed paths with a confirmed case [10].

Early, rapid and widespread testing

In late January, South Korean health officials convened a meeting with representatives from more than 20 medical companies, with a clear message that the country needed an effective test to detect the novel coronavirus, and promised swift regulatory approval [11]. A week later, the Korean Centers for Disease Control and Prevention approved one test and soon after another test approval followed, highlighting the partnership between the government and the robust biotechnology companies in South Korea [8]. The national testing capacity has reached a staggering 15,000 tests per day, as result of widespread testing implemented in the following ways: (i) sending government teams into rural areas, (ii) making testing available at public and private health centres, (iii) 'drive-through' test centres, and (iv) 'walk-through' test centres [2,7, 8,12]. Each

'drive-through' test centre is installed at the cost of \$11700 (£9900), operated through a process of 6 steps, serviced by 4 to 8 medical staff, collects 60 test each day, and is free at point of service [13]. Most importantly, drive-through test centres are timesaving and reduce the risk of cross-infections between patients and medical teams. The 'walk-through' test centre set up by the H Plus Yangji Hospital, a private facility in Seoul, has been running four booths and can test 10 patients in an hour [14]. Test results are delivered quickly, between 24 to 72 hours, via text messages or phone calls along with corresponding advice. This massive testing effort has helped government teams to identify and treat patients with critical symptoms as well as isolate several asymptomatic cases, which consist of 20% of all the confirmed cases, thereby breaking the chain of transmission [3, 6-8].

Rigorous contact tracing and mandatory quarantine

Under guidelines from the Korean Centers for Disease Control and Prevention, anyone who has come into contact with a confirmed coronavirus carrier is subject to a mandatory two-week self-quarantine. "Contact" is defined as having been within two meters of a confirmed carrier, or having been in the same room where a confirmed patient has coughed [15]. Since the first COVID-19 cases were confirmed, Korean public health authorities and local governments have collaborated for contact tracing through interviews, analysis of closed-circuit television, smartphone GPS data, and publicizing the so-called moving histories of Covid-19 patients on the Ministry of Health website (all of which are legally sanctioned by the government) [1, 6]. In mid-February, government teams identified a confirmed case linked to Shincheonji Church in Daegu city, and by March 10, had managed to investigate a cluster of more than 5000 cases (60% of nation's total) linked to the church [2,8].

South Koreans are encouraged by the government to download and use mobile based application for contact tracing and ensuring mandatory quarantine. First, the government-endorsed Corona 100m (Co100) application, launched on February 11, using government data, alerts users when they come within 100 metres of a location visited by a confirmed case [16]. Second, a self-diagnosis mobile application, launched on February 12, allows users to monitor health conditions and access readily available information on follow-up actions such as physical checkups, using helplines and finding clinics [8]. Third, a government GPS-based application named 'self-quarantine safety protection' launched on March 7, enforces self-quarantine measures [3, 8]. South Koreans are encouraged to download this application after getting tested. If they are advised to self-quarantine based on test results, then they have to input their symptoms into the mobile application twice a day for the period of the quarantine, and the application will monitor their locations and set off an alarm if they leave their designated quarantine location [8]. For those who do not use the application, a local monitoring team calls twice daily to make sure the quarantined stay put and check for symptoms.

Strategic treatment plans

After being tested, those with serious symptoms and with underlying illnesses are treated in hospitals, while patients with mild to moderate symptoms are referred to primary-level health treatment centres or repurposed corporate training facilities and spaces provided by public institutions, where they get basic medical support and observation [2]. Those who test negative are asked to self-quarantine at home for two weeks and update their health status using the self-quarantine mobile application [3]. Close contacts and those with minimal symptoms whose family members are free of chronic diseases and who can measure their own temperatures are ordered to self-quarantine for 2 weeks. All costs for Covid-19 related testing and treatment are borne by the government [17].

Recommended social distancing measures

South Korea has advised its citizens to follow a range of social distancing measures, however, these are recommendations and not mandatory as such. Wearing masks as an essential social distancing strategy is widely practiced in South Korea [18], as a result of heightened public information campaigns executed through television, newspaper, and internet ads. Since February 3, social welfare facilities including daycare centers, senior care facilities and disability facilities have been directed to temporarily close if they are informed of any occupants or visitors who test positive for COVID-19 or were in contact with individuals who tested positive. After reaching its peak of 909 COVID-19 cases on February 29, the Korea Centers for Disease Control and Prevention advised citizens to exercise social distancing and maintain personal hygiene until early March. In early March, the Ministry of Education postponed the start of the new school year for kindergartens and elementary, middle, and high schools [8]. On March 20, the government advised public facilities such as religious institutions, nightclubs and indoor gyms to close from March 22 to April 5 [19]. Most recently, on March 23, the government advised all individuals to observe enhanced social distancing from March 22 to April 5 by staying home other than going to work, visiting a healthcare provider, and purchasing necessities [8].

Legal sanctions

Quarantine violators face up to 3 million won (\$2500) fines. If a recent bill becomes law, the fine will go up to 10 million won and as much as a year in jail [2,8]. Further, the Seoul City government filed a lawsuit worth at least 300 million won (US\$247,000) against the Shincheonji Church, a religious sect widely blamed for accelerating the spread of the COVID-19 outbreak in South Korea, holding it responsible for hampering quarantine efforts through reluctance on revealing the names of its followers [19].

Border control measures

Since January 30, South Korea has stationed 250 staff from the Ministry of Health and Welfare, National Defense and National Police Agency at the Incheon International Airport for screening incoming passengers from Wuhan, extending this procedure to the whole of mainland China by February 4, and to the whole of Europe and U.S by March 25 [8,20]. As part of this screening, all incoming passengers

have to use the government-based self-diagnosis mobile application and report their diagnosis for 14 days after arrival [21,22]. Those who display symptoms must report to health centres for testing and receive treatment at health facilities if required, whereas those who are asymptomatic and test negative are required to self-quarantine at their domestic address for 14 days.

Fiscal relief

The government announced \$17 million for Covid-19 control on January 30, and a month later, on February 26, it budgeted \$42 million to 17 affected cities in the countries [8]. In March, a temporary government provision entailed a subsidy of 454,900 South Korean won (\$387) a month to cover basic living expenses to those who are self-isolating, regardless of whether they test positive for the virus [17].

Emerging concerns

Publicising people's movements has raised privacy concerns, to which the Korean Centers for Disease Control and Prevention have notified that such detailed location information should be released only when epidemiological investigations could not otherwise identify all the people with whom an infected person had been in contact before their diagnosis [9]. While revealing moving histories of people are meant to encourage citizens to avoid testing among citizens who may have come into contact with a confirmed case, it has had an unintended consequence on small businesses, as people are avoiding places that an infected person has visited [9]. Social distancing and mandatory quarantine have led to physical and mental hardships for vulnerable groups including the homeless and working class that live in small spaces [23]. Another major concern is the ongoing fatigue among health workers, which has resulted in a number of nurses serving their resignation in one province [24]. While the provincial government has announced additional wages, and the South Korean Defense Ministry has announced deployment of additional military medical staff to civilian hospitals [25], health worker fatigue is a factor that will need to be addressed by all the countries facing the COVID-19 outbreak.

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COVID-19 Testing Response: SOUTH KOREA

| | |
|---|--|
| <p>What is the population of the country?</p> | <p>51.47 million</p> |
| <p>When was the first case of COVID-19 reported?</p> | <p>South Korea began screening passengers from Wuhan at the Incheon International Airport from 2 January 2020, and as a result detected the first confirmed case through thermal screening and subsequent testing on 20 January 2020.ⁱ</p> |
| <p>What is the current epidemiological situation as of 1 April 2020?</p> | <p>South Korea has recorded 9786 confirmed cases, of which 5408 have recovered, with 163 deathsⁱⁱ</p> |
| <p>Who is tested for COVID?</p> | <p>All citizens and visitors are being tested for COVID-19, regardless of symptoms.</p> |
| <p>How was testing introduced?</p> <p>Key developments</p> | <p>January 2020: In response to the first confirmed COVID-19 case, in late January 2020, South Korean health officials convened a meeting with representatives from more than 20 medical companies, with a clear call for effective tests to detect the novel coronavirus, and promised swift regulatory approval.ⁱⁱⁱ</p> <p>4 February 2020: The Korean Centers for Disease Control and Prevention announced approval of rapid diagnostic test developed by Kogene Biotech Ltd.^{iv}</p> <p>7 February 2020: Newly developed test kits with capability to produce results in six hours become available at 50 health facilities. Private healthcare providers and city-and province-level public health and environment research institutes become designated as additional testing facilities.^v</p> <p>12 February 2020: Seegene Inc. becomes the second South Korean medical company to receive government approval for its test kits.</p> <p>13 February 2020: The Ministry of Health and Welfare announces that it will partner with companies producing test kits and private testing institutions to increase test kit supply and daily diagnostic test capacity to 10,000 tests.^{vi}</p> |

| | |
|--|--|
| | <p>23 February 2020: Kyungpook national university chilgok hospital begins operating the first drive-through testing site.^{vii}</p> <p>18 March 2020: Walk-through testing center set up by H Plus Yangji Hospital in Seoul.^{viii}</p> |
| Where is testing being conducted?^{ix} | <ol style="list-style-type: none"> 1. Primary health clinics and hospitals 2. Public health and environment research institutes 3. Private healthcare providers 4. Drive-through testing centres 5. Walk-through testing centers |
| Has the testing capacity changed over time? | <p>Daily testing capacity has increased over time^{xxi}</p> <ul style="list-style-type: none"> • 200 in January • 3000 from 7 February • 10,000 from 13 February • 20,000 since 12 March |
| How many people have been tested so far? | 3,83,886 ^{xii} |
| What is the role of testing within overall country response strategy? | <p>Early, rapid and widespread testing has been the government's central response strategy which is supplemented by rigorous contact tracing (aided by mobile-based applications) and mandatory self-quarantine for 14 days for anyone who has come into contact with a carrier of the virus.</p> <p>"Testing is central because that leads to early detection, it minimizes further spread and it quickly treats those found with the virus," Kang Kyung-wha, South Korea's foreign minister, told the BBC, calling the tests "the key behind our very low fatality rate as well."^{xiii}</p> |
| Who pays for testing? | COVID-19 testing and treatment borne by government. ^{xiv} South Korea has universal health coverage through its National Health Insurance System. |

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GOVERNMENT APPROACH TO COVID-19 OUTBREAK

Country Profile: Japan

Epidemiological situation

The first case of COVID-19 was reported in Japan on 16 January 2020 [1]. As of 01 April 2020, the country has recorded 2229 confirmed cases, of which 424 have recovered, with 66 deaths [1]. The low number of cases could be a result of Japan's strict testing criteria and subsequently limited testing, which in turn could mask the true scale of infection in the country.

Limited testing

Japan has conducted a total of 32,497 tests so far, and has a strict testing criteria that only offers test to people who have had a fever of greater than 37.5 Celsius (99.5 F) for more than four days, unless the patients are elderly, have other underlying health conditions, or are connected to a previously confirmed case [2]. The health ministry and doctors are asking individuals with mild symptoms to self-quarantine at home. Furthermore, those who call Japan's Novel Coronavirus Patient Consultation Call Center and are recommended for in-person outpatient consultation must then appear at the designated center and be examined. If the doctor suspects COVID-19, they can recommend a PCR (polymerase chain reaction) test, and seek approval from the National Institute of Infectious Diseases for it. In practice, the National Institute of Infectious Diseases is reportedly inundated with requests and it is often difficult for doctors to get through by phone. This system presents a strong bottleneck to testing [3]. In official documents, the Ministry of Health, Labor and Welfare confirms diagnostic capacity but attributes the targetted testing to focus on identifying clusters of the disease and efficiently allocate medical resources [4]. Despite ongoing contact tracing efforts, Health Minister Katsunobu Kato reported in late February 2020, that Japan had lost track of the route of some of the infections, alluding to the rising number of confirmed cases including those of Japanese officials who conducted assessments on the cruiseship 'Diamond Princess' (712 confirmed cases) [5].

Border control and quarantine

Japan's key response has included bans on the entry of travelers from hard-hit regions of China and quarantines for travelers arriving from other countries/regions with active COVID-19 outbreaks. Government teams have focused on identifying clusters and tracing contacts, rather than widespread community testing.

Social distancing

Social distancing is recommended but not mandatory in the country. Prime Minister Shinzo Abe recommended on Feb. 26 that organizers should cancel, scale back or postpone large events, and on Feb. 27, he recommended that schools across the country close until the end of spring break, in early April. While there have been notable social distancing, through the closure of schools and the

encouragement of working from home, there is significant evidence that despite the school closures and widespread cancellation of large events, social isolation is not being adhered to strongly in many places. Even now, bars, clubs, and restaurants are fairly full in Tokyo in the evening [6].

Fiscal measures

The emergency budget of US\$138 million is a significant step forward, helping to produce more testing kits, secure more beds in health facilities and fund research about the virus [7].

Issues

There seems to be a lack of leadership to combat COVID-19 in the country. Murukami writes that bureaucratic silos have resulted in parallel task forces and meetings convened by the Prime Minister's office, the Cabinet office, the Ministry of Health, Labour and Welfare and the Tokyo metropolitan government. Health experts and officials from various agencies debate the same topics repetitively in multiple meetings, while Abe has put no one in charge [8]. Arbitrary bureaucratic interference is preventing the authorities from implementing a desperately needed nationwide All-Japan efforts that include the best experts from academia, research centres and industry. The National Center for Global Health and Medicine – one of the main research centre for infectious diseases – was not invited to be part of a crucial task force. There have also been delays in rolling out favipiravir, the antiviral drug being developed by Fujifilm that's believed to be potentially effective against the virus, because it was approved only as a treatment for influenza, not COVID-19.

The absence of appropriate risk communication is feeding confusion and hysteria in the foreign media. The chain of command is vague and bureaucrats have incentives to cast-aside things that are not written in the rules, further delaying responses. While, the Japanese government has shifted its efforts to contain the spread of the virus from seaports and airports to focussing on communities and asking people to stay at home. But the messages have been mixed. The media remains optimistic, reporting that the virus is mild and will likely taper off as summer arrives. As a result, not all local communities are adhering to the Prime Minister's request to close schools. There is little detailed symptom data available from authorities and medical doctors. Only healthcare workers are voicing real concern, while the public struggles to judge how to protect itself from this 'very mild' yet deadly virus [8].

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Evidence for Testing for COVID-19: JAPAN

| | |
|--|--|
| What is the population of the country? | 126.8 million |
| When was the first case of COVID-19 reported? | A 30-year-old Chinese national who had previously travelled to Wuhan developed a fever on 3 January and subsequently returned to Japan on 6 January. He tested positive during a hospital admission on 16 January 2020. ⁱ |
| What is the current epidemiological situation as of 1 April 2020? | Confirmed: 2,229 ⁱⁱ Deaths: 66 Recovered: 424 |
| Who is tested for COVID? | Japan has a strict criteria for testing which requires patients to have had a fever of greater than 37.5 Celsius (99.5 F) for more than four days, unless the patients are elderly, have other underlying health conditions, or are connected to a previously confirmed case. ⁱⁱⁱ |
| Where is testing being conducted? | <p>PCR tests are required to be conducted at outpatient facilities for Japanese Returnees and Potential Contacts, to prevent in-hospital infection and ensuring the accuracy of the testing,^{iv}</p> <p>Specimens can also be tested at regional public health institutes and hospitals with sufficient infection control measures and pharmaceutical companies with necessary equipment. While the health ministry says about 860 hospitals across the country are capable of conducting COVID-19 tests, a number of them can only collect samples that need to be sent to separate facilities for analysis.^v</p> |
| Has the testing capacity changed over time? | <p>As of 18 March 2020, Japan's nationwide capacity for the polymerase chain reaction (PCR) test has grown to 7,500 a day, on track to reach an 8,000 a day target by the end of the month.^{vi}</p> <p>However, as per a government document released on 10 March 2020, actual daily testing figures ranged from a low of 513 tests (24 Feb) to a high of 1607 tests (21 Feb).^{vii}</p> |
| How many people have been tested | While Japan has conducted a total of 32,497 ^{viii} tests, only 16,484 people have actually been |

| | |
|--|--|
| so far? | tested, given that many are often tested multiple times. ^{ix} |
| What is the role of testing within overall country response strategy? | <p>The main features of Japan's strategy are bans on the entry of travelers from hard-hit regions of China and quarantines for travelers arriving from other countries/regions with active COVID-19 outbreaks.</p> <p>Japan has continued to focus on identifying clusters and tracing contacts, rather than widespread testing. Testing is limited and focused only on those who have had contact with confirmed cases and show serious symptoms. The health ministry and doctors are asking individuals with mild symptoms to self-quarantine at home.</p> <p>Despite the contact tracing efforts, Health Minister Katsunobu Kato reported in late February 2020, that Japan had lost track of the route of some of the infections, alluding to the rising number of confirmed cases including those of Japanese officials who conducted assessments on the cruiseship 'Diamond Princess'.^x</p> <p>Social distancing is recommended and not mandatory in the country. Prime Minister Shinzo Abe recommended on Feb. 26 that organizers should cancel, scale back or postpone large events, and on Feb. 27, he recommended that schools across the country close until the end of spring break, in early April.^{xi}</p> |
| Who pays for testing? | Tests have been covered under the national health insurance since 6 March 2020. ^{xii} |

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GOVERNMENT APPROACH TO COVID-19 OUTBREAK

Country Profile: Singapore

Epidemiological situation

Singapore reported its first case of Covid-19 on 23 January 2020 [1]. As of 01 April 2020, the country recorded 946 confirmed cases, 240 recovered cases, and 3 deaths [1], highlighting one of the lowest mortality rates in the world [2] [See Appendix 1]. So far, Singapore also appears not to have had a single recorded health-care-related transmission of Covid-19 [1, 3]. Until mid-March, the rate of confirmed cases and discharged cases was at an equilibrium, signalling a strong health care capacity and response.

A whole-of-government response

In response to the 2003 SARS epidemic, the government published its first Influenza Pandemic Preparedness and Response Plan in 2005 and has since honed it to a tee through regular capacity building of the health system and simulations of pandemic and terrorist attack-like scenarios played out in hospitals and observed by the Ministry of Health [4, 5]. This plan includes DORSCON i.e. Disease Outbreak Response System Condition, which is a colour-coded framework that follows a four step intensity scale (green, yellow, orange and red) signalling the current disease situation and the corresponding individual and corporate measures [6]. Singapore is currently at the orange level, which indicates that given the current epidemiological situation, schools and workplaces are still open [7]. On 22 January 2020, the government set up a Multi-Ministerial Committee, consisting of high-level policy makers from health, education, family and social welfare, transport, environment, trade, finance, and national development, reinforcing that Covid-19 is not just a public health crisis but a national threat [4].

Clinical readiness

First, a dedicated national-level hospital for disease outbreaks was set up in 2018, and all tertiary hospitals have been undergoing regular military-like outbreak simulation drills including protocol to gradually increase isolation capacity (i.e. free up intensive care units) [4]. Early on in the Covid-19 outbreak, hospitals notified staff to defer leave and travel plans after its first cases emerged, and also split their workforces into teams to ensure there were enough workers if the outbreak worsened, and to ensure workers got enough rest [8]. Second, enhanced measures were taken to protect health workers including stockpiling protective equipment and testing [4, 5], which has been the primary reason for no infections among health workers [9]. Third, primary health care response was activated. General Practitioners, who are the first point of contact for health care, are part of the government scheme of Public Health Preparedness (PHP) Clinics [10]. The government supports these clinics with training, timely information, guidelines, protective equipment and medical supplies. Through government mobile applications, people displaying respiratory symptoms can access the

nearest PHP clinic and get the required testing, treatment and advice [10]. All Covid-related testing and treatment costs for Singaporean residents and workers are borne by the government [11].

Persistent contact tracing and widespread testing

Public health staff have been working in partnership with police and detectives from the Criminal Investigation Department, in teams of 10, for 7 days a week, to trace, test and isolate contacts of patients with Covid-19 [4]. These teams have been using interviews, CCTV analysis, and the recently launched government mobile application 'Trace Together' for contact tracing [12]. The government encourages the public to download this application on their mobile phones, which then uses Bluetooth technology to track and identify close contacts of a patient with Covid-19, including timestamps. Individual patients can choose to allow the Ministry of Health to access the data in the application to identify close contacts [12]. Further, all high-risk patients in Singapore including those with pneumonia, are tested for coronavirus [8]. Additionally, with the integration between researchers, technology transfer offices, and industry, a rapid test kit for Covid-19 was created by 9 February [11].

Informed border control steps

Tracking imported cases i.e. source of travellers that tested positive for Covid-19, informed the government's border control measures. Incoming flights were restricted from provinces and countries based on their community transmission of Covid-19: Wuhan (23 January), China (1 February), Cheongdo and Daegu in South Korea (26 February), Iran and North Italy (4 March), Italy, France, Spain, and Germany (16 March). On 26 March, Singapore closed its borders for all short-term visitors except for its citizens and long-term pass holders [4].

Mandatory but nuanced social distancing measures

Since 27 January, people returning to Singapore from hot zones (countries with widespread community transmission) were given a 'leave of absence', where they don't go to work but can leave their homes for meals and necessities. From 28 January, suspected carriers are being given a 'quarantine order' (QO) and have to be isolated at home or a government facility. On 18 February, the government announced the 'stay at home notice' (SHN), wherein all Singaporeans have to stay at home for 14 days, and can leave their residence to purchase daily necessities and attend to important personal matters [4,13]. Those who flout SHN or the QO may face penalties and can be prosecuted under Section 21A of the Infectious Disease Act [13]. Singaporeans can also calculate the number of days of social distancing based on their arrival in the country, using a government-based website [14]. Additional social distancing measures were imposed in early February: large public gatherings were outlawed, restaurants imposed social distancing by spacing clients, individuals must sit and stand 1 metre apart in public spaces. From 25 February, the government also enforced closures of all entertainment outlets until the end of April [4].

Multi-layered public communication

The government implemented its public communication campaign for Covid-19 early on, through television and front-page newspaper

notices, daily updates on its WhatsApp channel, routine media monitoring and legal measures to counter fake news, and using celebrities and influential persons in public announcements [4]. The Ministry of Health maintains a public dashboard, which is updated each day, with a detailed description of the epidemiological situation [1]. The government also coordinates with university modellers to guide its policy response, and has put together a commission under Chief Medical Officer that publishes weekly syntheses of their work [4].

Timely economic relief measures

On 26 March, Singapore announced a \$48 billion relief package to offset the economic impact of Covid-19 on individuals and businesses [15]. Financial relief (\$100 Singapore dollars a day) is in place for all who stay at home as well as occasional one-off allowances or rental waivers for certain workers [4], to encourage testing and maintain social distancing. Small and medium-sized businesses including universities are implementing Business Continuity Plans, which is a government-developed framework for managing work during crisis, including measures such as remote work and teleconferencing [16].

Key lessons

Singapore is a small and rich country, with a high level of public trust in the government, which enhances its ability to control Covid-19. However, the country's success in containing the Covid-19 outbreak offers us several important lessons: extraordinary political leadership, planning and preparedness, multi-sectoral government response, protection of health workers, rigorous contact tracing and widespread testing, clear, timely and transparent communication for individuals and businesses, and financial protection for its citizens and workers.

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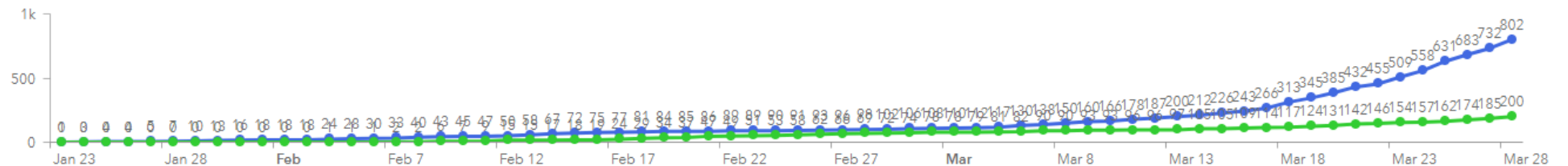
Appendix 1: Official Update of COVID -19 Situation in Singapore as per Ministry of Health. 28 March 2020

[<https://experience.arcgis.com/experience/7e30edc490a5441a874f9efe67bd8b89>]

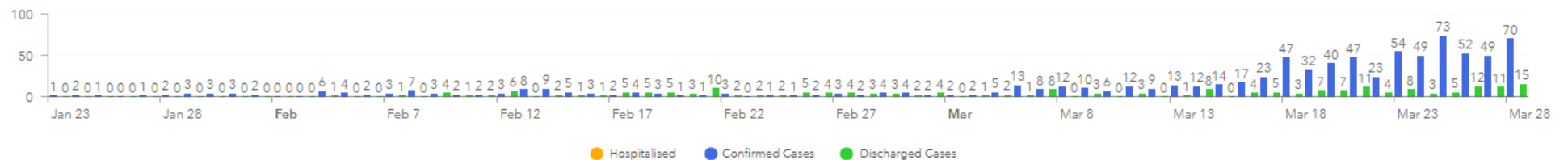
Hospitalised (Stable, Critical and Discharge to Isolation)



Cumulative Confirmed and Discharged Cases



Daily Confirmed and Discharged Cases



● Hospitalised ● Confirmed Cases ● Discharged Cases

COVID-19 Testing Response: SINGAPORE

| | |
|---|---|
| What is the population of the country? | 5.6 million |
| When was the first case of COVID-19 reported? | The first COVID-19 case in Singapore was confirmed on 23 January, involving a 66-year-old Chinese national from Wuhan who flew from Guangzhou. ⁱ |
| What is the current epidemiological situation as of 1 April 2020? | Confirmed: 926 ⁱⁱ Deaths: 3 Recovered: 240 |
| Who is tested for COVID? | <ul style="list-style-type: none"> • Anyone who had been in contact with a COVID-19 patient • Any citizen, immigrant worker, health staff or international visitors upon displaying symptoms • All high-risk patients including those with pneumonia regardless of symptoms |
| How was testing introduced? ⁱⁱⁱ | <ul style="list-style-type: none"> • January 2020: For the first week after the first confirmed case, only people from Wuhan or Hubei province were tested, followed by testing anyone who had been in China within the last 14 days. • 9 February 2020: Rapid diagnostic test kit for Covid-19 created • February 2020: Enhanced screening -anyone coming to a hospital with a respiratory illness and anyone who had been in contact with a COVID-19 patient. • March 2020: Testing expanded to include healthcare staff displaying symptoms • 31 March 2020: Singapore-listed medtech company Biolidics launched its rapid test kit for COVID-19. The first batch of Biolidics' rapid test kits is expected to be available in April 2020.^{iv} • March 2020: Ten companies received provisional government authorisation for COVID-19 tests that can be supplied to healthcare institutions, private hospitals, medical clinics and clinical laboratories in Singapore.^v |
| Where is testing being conducted? | <ul style="list-style-type: none"> • Public hospitals • Public Health Preparedness Clinics (GPs) |

| | |
|--|---|
| | |
| Has the testing capacity changed over time? | – |
| How many people have been tested so far? | As of 25 March 2020, Singapore has conducted around 39,000 Covid-19 tests, translating to 6,800 tests per million people in the country. ^{vi} |
| What is the role of testing within overall country response strategy? | <p>Singapore’s key response has been threefold:</p> <ol style="list-style-type: none"> 1. Preparedness in its hospitals and clinics (GPs) – by ensuring training, communication, PPE, rapid tests 2. Rigorous contact tracing and border controls 3. Social distancing enforced through clear messages, fines, and financial support for those in self-isolation <p>Testing plays a supporting role in the above strategy.</p> |
| Who pays for testing? | All Covid-related testing and treatment costs for Singaporean residents and workers are borne by the government. ^{vii} |

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GOVERNMENT APPROACH TO COVID-19 OUTBREAK

Country Profile: Taiwan

Epidemiological situation

The first case of COVID-19 was reported in Taiwan on 21 January 2020 [1]. As of 01 April 2020, the country has recorded 322 confirmed cases, of which 39 have recovered, with 5 deaths [1]. So far, Taiwan has tested 31,800 people, and has reported a daily testing capacity of 1000 [1]. Big data analytics, targeted testing and new technology are being touted as Taiwan's key strategies for reducing the number of new cases of COVID-19 and the associated fatality rate [2].

Preparedness after the SARS outbreak

On 31 December, the same day China notified the World Health Organization that it had several cases of an unknown pneumonia, Taiwan's Centers for Disease Control immediately ordered inspections of passengers arriving on flights from Wuhan. Despite poor relations with Beijing, Taiwan asked and received permission to send a team of experts to the mainland on a fact-finding mission 12 January. Shortly after the team returned, Taiwan began requiring hospitals to test for and report cases, which helped the government identify those infected, trace their contacts and isolate everyone involved, preventing the virus from spreading to the community [3]. The National Health Command Center (NHCC) was activated to respond to COVID-19 on 20 January 2020, a day before the first confirmed case [4]. In 2004, the year after the SARS outbreak, the Taiwan government established the National Health Command Center (NHCC). The NHCC is part of a disaster management center that focuses on large-outbreak response and acts as the operational command point for direct communications among central, regional, and local authorities. The NHCC unified a central command system that includes the Central Epidemic Command Center (CECC), the Biological Pathogen Disaster Command Center, the Counter-Bioterrorism Command Center, and the Central Medical Emergency Operations Center. The Central Epidemic Command Center has rapidly produced and implemented a list of at least [124 action items](#) including border control from the air and sea, case identification (using new data and technology), quarantine of suspicious cases, proactive case finding, resource allocation (assessing and managing capacity), reassurance and education of the public while fighting misinformation, negotiation with other countries and regions, formulation of policies toward schools and childcare, and relief to businesses [2].

Proactive case identification

Taiwan leveraged its national health insurance database and integrated it with its immigration and customs database to begin the creation of big data for analytics; it generated real-time alerts during a clinical visit based on travel history and clinical symptoms to aid case identification. It also used new technology, including QR code scanning and online reporting of travel history and health symptoms to classify travelers' infectious risks based on

flight origin and travel history in the past 14 days. Persons with low risk (no travel to level 3 alert areas) were sent a health declaration border pass via SMS (short message service) messaging to their phones for faster immigration clearance; those with higher risk (recent travel to level 3 alert areas) were quarantined at home and tracked through their mobile phone to ensure that they remained at home during the incubation period [2]. Home quarantines are monitored by the police and flouting these rules can result in heavy fines [5].

Targetted testing

Taiwan follows a targetted approach for testing and includes any individuals with foreign travel history to (designated countries with widespread transmission) in the past 14 days or any individuals who have had contact with foreign travelers with a fever or respiratory symptoms and highly suspected of having the said symptoms caused by COVID-19 by the physician in the past 14 days; and anyone categorized as highly vulnerable to COVID-19 (including patients with severe respiratory symptoms and healthcare workers with pneumonia) [6,7]. The toll-free number 1922 served as a hotline for citizens to report suspicious symptoms or cases in themselves or others; as the disease progressed, this hotline has reached full capacity, so each major city was asked to create its own hotline as an alternative [2].

Ensured availability of supplies

To ensure a steady supply of masks, the government quickly banned manufacturers from exporting them, implemented a rationing system and set a nominal price. It also set up new production lines and dispatched soldiers to staff factories, significantly increasing production and distribution to citizens [4].

Public Communication and Reassurance

In addition to daily press briefings by the minister of health and welfare and the Central Epidemic Command Center, the vice president of Taiwan, a prominent epidemiologist, gave regular public service announcements broadcast from the office of the president and made available via the internet. These announcements included when and where to wear a mask, the importance of handwashing, and the danger of hoarding masks to prevent them from becoming unavailable to frontline health workers. The CECC also made plans to assist schools, businesses, and furloughed workers. Most office buildings, schools and community sports center check temperatures and prevent anyone with a fever from entering. Apartment buildings also place hand sanitizer inside or outside elevators [4].

Border control

Measures have included screening of passengers from high alert areas followed by quarantine for high risk visitors; banning flights from China by end of January; and barring all foreign passengers from entry into Taiwan from 19 March 2020 [8].

Fiscal measures

The government allocated USD \$2 billion for businesses affected by the epidemic. Furthermore, the Ministry of Labor to provide

financial assistance to workers furloughed due to COVID-19 and receive up to USD \$630 in subsidies [2].

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COVID-19 Testing Response: TAIWAN

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| <p>What is the population of the country?</p> | <p>23.78 million</p> |
| <p>When was the first case of COVID-19 reported?</p> | <p>On 21 January, the first case in Taiwan was confirmed in a 50-year-old woman who just returned to Taoyuan International Airport from her teaching job in Wuhan.ⁱ</p> |
| <p>What is the current epidemiological situation as of 1 April 2020?</p> | <p>Confirmed: 322ⁱⁱ Deaths: 5 Recovered: 39</p> |
| <p>Who is tested for COVID-19?</p> | <p>Taiwan follows a targetted approach for testing and includes following groups under its mandated testing response:^{iiiiv}</p> <ul style="list-style-type: none"> • Any individuals with foreign travel history to (designated countries with widespread transmission) in the past 14 days or any individuals who have had contact with foreign travelers with a fever or respiratory symptoms and highly suspected of having the said symptoms caused by COVID-19 by the physician in the past 14 days • Anyone categorized as highly vulnerable to COVID-19 (including patients with severe respiratory symptoms and healthcare workers with pneumonia) |
| <p>How was testing introduced?</p> | <ul style="list-style-type: none"> • December 31: After China notified WHO about several cases of an unknown pneumonia, Taiwan's Centers for Disease Control began screening of passengers arriving on flights from Wuhan and testing symptomatic passengers.^v • January 5: Testing expanded to anyone with travel history to Wuhan and with symptoms • February 16: Testing expanded to individuals with foreign travel history in the past 14-days and those who had contact with travelers exhibiting fever or respiratory symptoms with suspected cause from COVID-19; clusters of cases with fever or respiratory symptoms; pneumonia cases with symptoms; and healthcare workers with pneumonia • March 9: Taiwanese genome researchers have developed a rapid COVID-19 diagnostic test, which reduces time to test from the current 4 hours to 15 minutes. Mass production expected |

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| | in 4 months based on approval from the Ministry of Health. ^{vi} |
| Where is testing being conducted? | Taiwan Centers for Disease Control and designated hospitals ^{vii} |
| Has the testing capacity changed over time? | - |
| How many people have been tested so far? | A total of 32,726, with a daily testing figure of 933 reported on 31 March 2020. ^{viii} Daily testing capacity for COVID-19 is approximately 1,300 samples ^{ix} |
| What is the role of testing within overall country response strategy? | <p>Taiwan relies heavily on responses including border control, case identification and targetted testing, mandatory quarantine for suspected cases, and hygiene measures: ^{xxix}^{xii}</p> <ol style="list-style-type: none"> 1. Border control: Measures include screening of passengers from high alert areas, banning flights from China by end of January, barring all foreign passengers from entry into Taiwan from March 19. 2. Case identification and mandatory quarantine: Taiwan merged its National Health Insurance and Immigration databases to identify and test anyone with recent travel history to alert areas. Incoming passengers have to fill forms to avail an entry pass into the country, and those who are at high risk are advised mandatory 14-day quarantine and tracked by GPS technology and enforced by the Police. Flouting quarantine can lead to heavy fines to tune of \$10,000. 3. Hygiene measures: Taiwan has ramped up its mask production and distribution, and all organisations and establishments have to maintain hand hygiene and check temperatures and report symptoms. <p>However, this approach may need modifications once community based transmission increase.</p> |
| Who pays for testing? | Testing and treatment costs are borne by the government, through its National Health Insurance system. ^{xiii} |

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COVID-19 Testing Response: HONG KONG

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| What is the population of the country? | 7.3 million |
| When was the first case of COVID-19 reported? | Hong Kong declared its first case of Covid-19 on 23 January. ⁱ |
| What is the current epidemiological situation as of 1 April 2020? | Confirmed: 714 ⁱⁱ Recovered: 128 Deaths: 4 |
| Who is tested for COVID? | <ul style="list-style-type: none"> • Anyone with travel history and symptoms • Anyone in contact with a confirmed case |
| How was testing introduced? | <p>Hong Kong developed diagnostic tests and rapidly deployed them to labs at major hospitals in the city.ⁱⁱⁱ</p> <p>The government has also set up a scheme where suspected patients can stay home, "emergency department will give a specimen tube to the patient", they spit into it, send it back and get a test result. This ensures that those who test negative will be kept away from the hospital system to reduce the load and avoid any cross-infection.^{iv}</p> |
| Where is testing being conducted? | Since the first week of March 2020, the government extended its enhanced laboratory surveillance scheme, already in effect at 17 public hospitals and 64 government-run outpatient clinics, to all of Hong Kong's private clinics and hospitals. Under this initiative, private GPs and family doctors can, based on their medical assessment, collect respiratory samples from patients with symptoms of infection. ^v |
| Has the testing capacity changed over time? | As of 26 March 2020, about 1,000 people undergo screens each day. ^{vi} |
| How many people have been tested so far? | The Controller of the Centre for Health Protection, Dr Wong Ka-hing, said as of 30 March 2020, Hong Kong has done about 90,000 coronavirus tests, or about 12,000 tests per 1 million people. ^{vii} |

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| <p>What is the role of testing within overall country response strategy?</p> | <p>Widespread testing has played a key role in mapping the trend in the infection rate and informing government response such as closures.</p> <p>An emergency was declared and more than five days after the first confirmed Covid-19 case, the government began putting some restrictions on travel from mainland China. Schools stayed out after the lunar new year break in January and people began working from home and avoiding social gatherings, restaurants, public transport. Borders partially closed with quarantine restrictions for travellers.^{viii} Hong Kong eventually closed some border crossings and from 8 February required all arrivals from China to undergo self-quarantine for 14 days. The government expanded the two-week quarantine to travelers from other hard-hit countries, including the United Kingdom, the United States, and much of Europe before it recently stopped all tourists and non-residents from entering.^{ix}</p> <p>Hong Kong has started seeing its second wave of infections in late March. In the last week of March, the government ordered all residents back home, and closed public sports facilities, museums, and libraries that had just reopened. The city stopped admitting visitors for two weeks. As an extra measure against socializing, the government demanded that bars stop serving alcohol.^x</p> |
| <p>Who pays for testing?</p> | <p>While the test is free in public hospitals, there is a consultation fee. Private facilities charge for the test.^{xi}</p> |

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