Flattening the COVID-19 peak: Containment and mitigation policies

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COVID-19 cases have grown rapidly in a growing number of countries, triggering bold policy responses. This document focuses on containment and mitigation measures to flatten the peak of COVID-19 and thus decrease as much as possible its huge strain on health care systems. The brief explains what containment and mitigation measures are, why there is a need to adopt a package of measures to enhance their overall impact, and then presents evidence on the relative effectiveness of each main measure, drawing from previous episodes of epidemic outbursts, largely to inform on a possible exit strategy once the virus is under control.

Key Findings

- COVID-19 cases have grown rapidly in a growing number of countries, triggering bold policy responses. This document aims at presenting evidence on the effectiveness of non-medical prevention policies from previous epidemics to help countries adjust their policy responses to this top global health threat.
- Four interconnected factors have contributed to the **rapid rise in the number COVID-19 cases**, namely:
  - A **high reproduction number** (that is, the number of other people infected by one infected person) of 2-2.6, with some estimates to up to 3.9 (seasonal influenza in comparison has an estimated reproduction number of approximately 1.3);
  - The **large number of asymptomatic or mild symptom cases**;
  - The relatively long **incubation period**, whereby most symptomatic infected individuals experience symptoms by the 11th or 12th day;
  - The **capacity of the coronavirus (SARS-CoV-2) responsible for COVID-19 to last on surfaces for up to three days**, in the case of plastic and steel.
- The **response to a new pandemic**, such as COVID 19, is typically based on **four key pillars**: 1) surveillance and detection; 2) clinical management of cases; 3) prevention of the spread in the community; and 4) maintaining essential services. Actions across the four pillars complement and closely interact and support one another. For example, containment measures based on identification of cases and contact tracing heavily depend on excellent surveillance and detection infrastructures.
- Given the relatively high reproduction number, the **eradication of the COVID-19 epidemic can be expected when at least 50%-60% of the population acquires immunity to the virus**, although this may go up to almost 75% in the case of a higher reproduction number. In principle if the virus is left to infect people without any containment measure, the population may acquire immunity relatively quickly. For example, a modelling study calculated that COVID-19 would self-eradicate in about five to six months in the United Kingdom and the United States. However, given its clinical characteristics and the lack of a vaccines or treatment, the same study also concludes that hospital intensive care services would lack the capacity to deal with the sudden, large inflow of severely ill people resulting in a very large number of deaths.
- In the absence of effective drugs and vaccines, **containment and mitigation measures are the key public health interventions currently available** to minimise the dramatic health consequences caused by COVID-19. More specifically:
  - ***Containment strategies*** aim to minimise the risk of transmission from infected to non-infected individuals in order to stop the outbreak. This may include actions to detect cases early on and trace an infected individual's contacts, or the confinement of affected persons;
  - ***Mitigation strategies*** aim to slow the disease, and to reduce the peak in health care demand. This may include policy actions such as social distancing, including a full society 'lock-down', and improved personal and environmental hygiene.
- Data from Hubei (China) suggests that the **implementation of a comprehensive package of containment and mitigation policies can be effective in suppressing the epidemic in the short-term**, but it is unclear whether the effect can last in the longer term. If the epidemic is not completely eradicated, one option would be to maintain such policies until a vaccine or an effective treatment become available. Otherwise, the number of infected persons would start growing again after the relaxation of the policy. In order to minimise the negative economic and

social consequences of strong social-distancing policies, an alternative, is to **alternate periods in which containment measures are in place, with periods in which some of these measures are relaxed**.

- Without strong containment and mitigation measures, the health care systems will not cope with the high number of patients. Approximately one in five infected persons develop severe symptoms possibly requiring intensive care. One of the biggest challenges caused by COVID-19 is health care system overloading, in particular, the insufficient number of ventilators and beds in intensive care units. Strong containment and mitigation measures are needed to **reduce the peak of COVID-19 cases and thus decreasing as much as possible its huge strain on health care systems**.
- **Modelling studies consistently conclude that packages of containment and mitigation measures, as opposed to individual policies are the most effective approach to reduce the impact of an epidemic**. Depending on the methodology and the policy package evaluated, studies generally conclude that comprehensive packages can reduce the attack rate (i.e. the proportion of individuals in a population who contract the disease) by at least 40%, and possibly more.
- The effectiveness of containment and mitigation depends on limiting the number of social contacts, but also the duration of each contact. Information on the effectiveness of individual policies is less relevant when a disease needs to be brought under control and taking all available measures is the best practice. Nevertheless, it may be particularly useful when considering **which measures to relax once the disease is being managed**. In this context, best evidence available on the effectiveness of individual containment and mitigation measures from modelling studies, studies from previous epidemic outbreaks, and selected case studies suggest the following:
    - **Workplace social distancing** is the most effective measure for both reducing the attack rate as well as delaying the disease peak. Workplace social distancing measures, such as working from home and workplace closures, can reduce the disease attack rate by between 23-73%, with lower values for highly infectious diseases, and where there is lower compliance. There are, however, significant economic consequences.
    - **School closures** can reduce transmission, i.e., the reproduction number, by 7-15% and the attack rate at the peak of the outbreak by about 40%. This intervention is most effective for infections with limited rate of spread, when implemented in the early phases of an outbreak and when attack rates are higher in children than in adults – some of these conditions do not apply for COVID-19. School closures have significant economic and social effects. Evidence shows that 16-45% of parents would need to take leave to supervise children at home; 16-18% of parents would lose income, and about 20% of households would have difficulty arranging childcare.
    - **Banning mass gatherings** has a smaller effect than many other forms of social distancing on the proportion of the population infected. This is because ‘contact time’ tend to be shorter than in other forms of social interaction such as at work or in schools. Nevertheless, it does have some positive effect in reducing the number of people who get sick, particularly if implemented alongside other policies.
    - **Several challenges are associated with social distancing**. Salient examples include reduced economic activity and reduced social interaction; neglect of vulnerable populations, such as the elderly; as well as psychological damage such as acute distress disorder, anxiety and insomnia.

- A systematic review concluded that **travel restrictions** delay but do not prevent influenza pandemics – e.g. by 3-4 weeks when 90% of air travel is restricted in affected countries, or by two months if more restrictive measures are introduced.
- **Household quarantine** can be the most effective measure to reduce attack rates in the community, but only if compliance is high. Voluntary quarantine of infected people is moderately effective due to lower compliance. For instance, voluntary quarantine of households with an infected individual may delay the peak of influenza by two to 26 days, and reduce the peak daily attack rate by at least 30%. Modelling work concludes that about 70% of COVID-19 cases have to be traced and quarantined to successfully contain the epidemic.
- **Effective communication** is crucial and has to strike a balance between preventing panic and encouraging action. During epidemic outbreaks, convincing the public that the threat is real may be a more pressing task for public authorities than providing reassurance. For example, a study of the public perception of influenza in the United Kingdom found that few people changed their behaviour because they believed that the outbreak, and its consequences, had been exaggerated.
- **Personal hygiene measures** have been shown to reduce the risk of getting infected. During the SARS outbreak in Hong Kong, China, in 2002-2004, people who got infected were less likely to frequently have worn a face mask in public (odds ratio 0.36) or to have washed their hands 11 or more times per day. A study during the influenza A(H1N1) pandemic of 2009 showed a 35% to 51% reduction in the incidence of influenza-like illness when using masks, proper hand hygiene practices and cough etiquette. Similarly, a meta-analysis found that combining masks and hand hygiene reduced the risk of influenza infection by 27%.

COVID-19 is now the top public health threat at the global level

In December 2019, Wuhan, located in the Hubei province of China, experienced an outbreak of pneumonia from a novel virus - severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (Chen et al., 2020[1]). SARS-CoV-2 can lead to the coronavirus disease 2019 (i.e. COVID-19), which has symptoms ranging from a cough or fever, to more severe illnesses such as to pneumonia and respiratory stress, which may result in death (World Health Organization, 2020[2]). A complete clinical picture of COVID-19 is not yet available, however, the majority of people who contract the disease will experience no or mild symptoms (Center for Disease Control and Prevention, 2020[3]; European Centre for Disease Prevention and Control, 2020[4]).

Since the initial cases in Hubei, the number of confirmed COVID-19 cases has grown rapidly and spread to countries across the world. Four interconnected factors have contributed to the rapid rise in the number COVID-19 cases, namely:

- The large number of asymptomatic or mild symptom cases (Xu et al., 2020[5]);
- The relatively long incubation period whereby most symptomatic infected individuals experience symptoms by the 11th or 12th day (Lauer et al., 2020[6]; Baum, 2020[7]; World Health Organization, 2018[8]);
- A high reproduction number (see Box 1) of 2-2.6, with some estimates to up to 3.9 (seasonal influenza in comparison has an estimated reproduction number of approximately 1.3) (Biggerstaff et al., 2014[9]; World Health Organization, 2020[10]; Wang et al., 2020[11]);
- The capacity of the coronavirus responsible for COVID-19 to last on surfaces for up to three days, in the case of plastic and steel (van Doremalen et al., 2020[12]).

Specifically, the first two points indicate infected individuals may not know they have the disease and therefore continue to interact in society where they infect a larger number of people (Anderson et al., 2020[13]).

Box 1. What is the reproduction number and why is it so important?

The reproduction number is the key epidemiological dimension determining the spread of an infection and the appropriate policy response by countries.

The reproduction number indicates the number of secondary infections from one infected individual. In the case of COVID-19, the reproduction number has generally been estimated between 2.0 to 2.6 indicating that, on average, every infected person spreads the infection to another 2 to 2.6 persons. In some cases, much higher reproduction numbers have been reported, for example up to 3.9 (Biggerstaff et al., 2014[9]; World Health Organization, 2020[10]; Wang et al., 2020[11]). The higher the reproduction number, the more quickly the infection spreads and the more stringent policies must be to tackle the outbreak.

Depending on the type of virus, many factors may affect the reproduction number including:

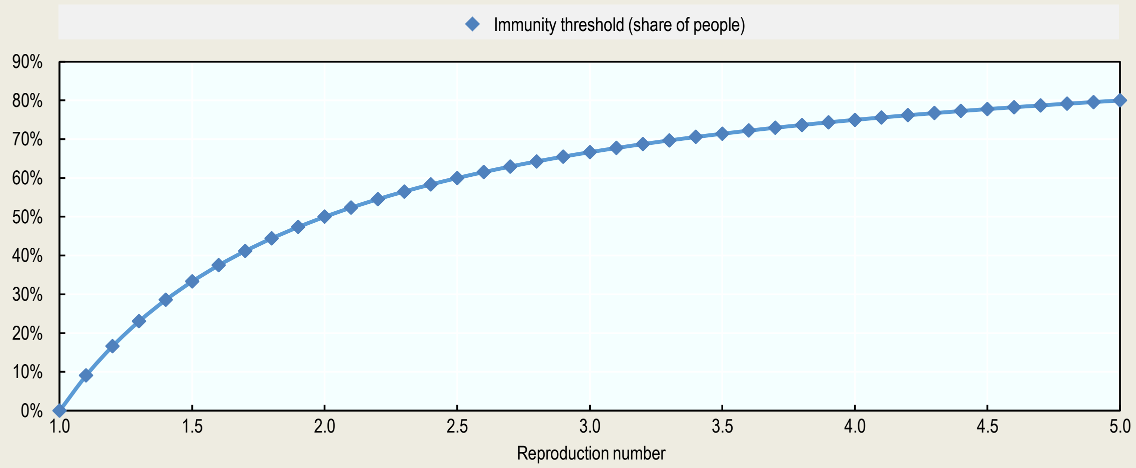
- The duration of the infectivity of patients and whether patients may be infectious when asymptomatic;
- The number or susceptible people in the population;
- Environmental factors, such as population density, population mobility and the temperature;
- The implementation of public health actions, including both medical and non-medical countermeasures.

The reproduction number may also change across different settings – e.g. by country or by area within a country – depending on the local characteristics.

The objective of prevention interventions, such as vaccination policies or containment interventions, is to get the reproduction number to below 1, that is, when the spread of the virus stops and the outbreak is eradicated.

The reproduction number naturally decreases over time until it falls below 1. Even in the absence of prevention policies, the outbreak may self-limit when a sufficient number of people acquire immunity. The minimum number of people with immunity needed to eradicate an epidemic (i.e. the critical vaccination level) depends on the reproduction number (Fine, Eames and Heymann, 2011[14]). In the case of COVID-19, at least 50% to 60% of the population need to be immune to the virus, when assuming a reproduction rate of 2.0 to 2.6 (Figure 1). A higher reproduction number would entail a higher minimum threshold. Immunity is acquired naturally, when people recover from the infection. Vaccination programmes speed up this process by training the immune system to recognise and combat the virus.

Figure 1. Reproduction number and associated immunity threshold

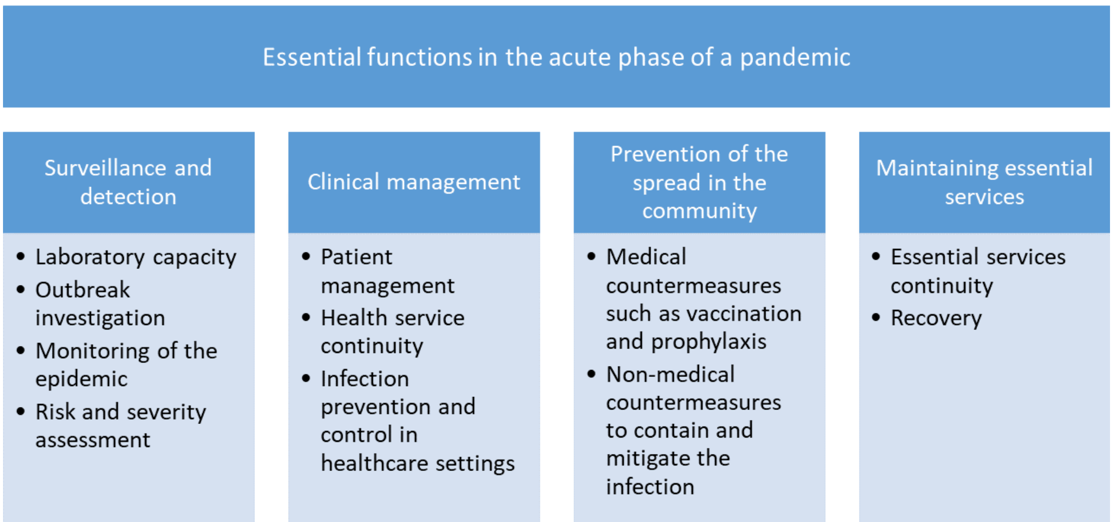


Source: OECD analyses.

A multi-pronged approach, with strong containment and mitigation actions, is needed to effectively combat COVID-19

The response to a new pandemic, such as COVID-19, is typically based on four key pillars: surveillance and detection; clinical management of cases; prevention of the spread in the community; and maintaining essential services (see Figure 2) (World Health Organization, 2005[15]). Actions across the four pillars complement and closely interact and support one another. For example, containment measures based on identification of cases and contact tracing heavily depend on excellent surveillance and detection infrastructures.

Figure 2. Essential functions to tackle COVID-19



Source: Prepared by OECD based on World Health Organization (2005[15]) "WHO checklist for influenza pandemic preparedness planning", .https://www.who.int/csr/resources/publications/influenza/WHO_CDS_CSR_GIP_2005_4/en/.

Non-medical containment and mitigation actions are the only policy tools countries currently have to prevent the further spread of the pandemic. In principle, a number of options are available to eradicate the coronavirus, however, due to the characteristics of the COVID-19 pandemic, the only option available is the implementation of non-medical public health measures. More specifically:

- Relying exclusively on the natural development of immunity may cause many deaths. In the case of COVID-19, the eradication of the epidemic is reached when at least 50%-60% of the population acquires immunity to the virus (see Box 1), although up to almost 75% of the population may have to acquire immunity in the case of a higher reproduction number. Therefore, in principle if the virus is left to infect people without any containment measures, the population may acquire immunity relatively quickly. For example, it was calculated that, under this scenario, COVID-19 would self-eradicate in about five to six months in the United Kingdom and the United States (Ferguson et al., 2020[16]). However, given its clinical characteristics, the same study also concludes that 510 000 in the United Kingdom and 2.2 million people in the United States may die.
- Medical countermeasures such as vaccination and prophylaxis will require several months to become readily available. Research and development activities for vaccination and treatment have surged significantly since the outbreak of COVID-19 (OECD, 2020[17]). However, it is generally believed that it will take at least 12-18 months before a new vaccine will be available on the market. Similarly, a number of drugs already on the market, such as chloroquine, seem to show promising outcomes in the treatment of COVID-19 and in the reduction of its infectiousness, but more studies and longer testing is needed before their utilization can be scaled up (Touret and de Lamballerie, 2020[18]). Therefore, at least in the short- to medium-term, medical countermeasures should not be considered an option in the fight against COVID-19.

Therefore, in practice, and until effective vaccines and drugs become available, countries are implementing a policy response which relies on non-medical countermeasures to contain and mitigate the epidemic. More specifically:

- *Containment strategies* aim to minimise the risk of transmission from infected to non-infected individuals in order to stop the outbreak – i.e. reducing the reproduction number to below one. This may include actions to detect cases early on and trace an infected individual's contact with other people, or the confinement of affected persons. Containment strategies are particularly effective in the initial phase of an outbreak when the number of infected people is relatively small.
- *Mitigation strategies* aim to slow the disease, and, where the disease has occurred, to lessen its impact or to reduce the peak in health care demand – i.e. getting the reproduction number as close as possible to one. Mitigation strategies are typically enforced in the more advanced stages of an outbreak and include policy actions such as social distancing, including a full society 'lock-down', and improved personal and environmental hygiene.

In practice, containment and mitigation actions largely overlap and are often implemented concurrently. In fact, containment and mitigation policies may even be considered as a continuum with gradual increments of the same strategy; with mitigation that could go to the extreme level of a full lock-down of a city, such as what happened in Hubei (Box 2) and, more recently, in some European countries such as in France, Italy and Spain (Paterlini, 2020[19]; Tanne et al., 2020[20]).

Together, containment and mitigation strategies can slow the spread of the infection and delay the impact of an outbreak. The spread of viruses generally follow a Sigmoid curve, with the number of infections growing slowly at the beginning of an outbreak, accelerating exponentially in its central phase when a critical mass of people are infected, and many others are still susceptible, and slowing down in its final phase when a significant number of individuals in the community are immunised. The central phase of this cycle corresponds to the peak of the infection, with the highest number of daily-infected persons. Containment and mitigation strategies both act to impede the speed of the virus: the former by suppressing the outbreak and the latter by slowing down the disease. As a result, the number of cases are spread over a longer period of time, which reduces the epidemic's peak.

In certain cases, if containment interventions are particularly effective – for example, if they are implemented as comprehensive packages of interventions – they can eradicate the outbreak. For example, the 2003 SARS outbreak in China was effectively contained and eradicated by the strong implementation of non-medical public health measures (Ahmad, Krumkamp and Reintjes, 2009[21]). Similarly, early analyses on the outbreak in Hubei suggest that the implementation of a comprehensive package of containment and mitigation policies would be effective in suppressing the SARS-CoV-2 epidemic in the short-term (see Box 2). However, it is still unclear whether similar containment measures are sufficient to produce a prolonged effect in the medium- and long-term. If the epidemic was not completely eradicated and, for example, if the virus became endemic (i.e. a baseline level of infection is constantly maintained in the population), containment and mitigation policies would have to be maintained until a vaccine, or an effective treatment for those affected, was made available. Otherwise, the number of infected persons would start growing again after the relaxation of the containment and mitigation policies. A modelling study suggests that an alternative viable option, in order to minimise the negative economic and social consequences of a continuous implementation of strong social-distancing policies, could be to alternate periods in which containment measures are in place, with periods in which these measures are relaxed (Ferguson et al., 2020[16]). For example, policies could be strengthened again, when a threshold number of cases are detected in the population.

Box 2. A policy package to contain and mitigate the outbreak is effective, but its impact may not be immediately observed: an early analysis on data from Hubei (China)

The Hubei province, which includes the city of Wuhan, was the epicentre of the Chinese COVID-19 outbreak. As of the 16 March 2020, 84% of China's 80 000 cases were in Hubei (Johns Hopkins University, 2020[22]). To control the spread of the virus in this area, a number of containment measures were put in place and strongly enforced after the first cases were identified late December 2019 (Wu and McGoogan, 2020[23]; World Health Organization, 2020[24]):

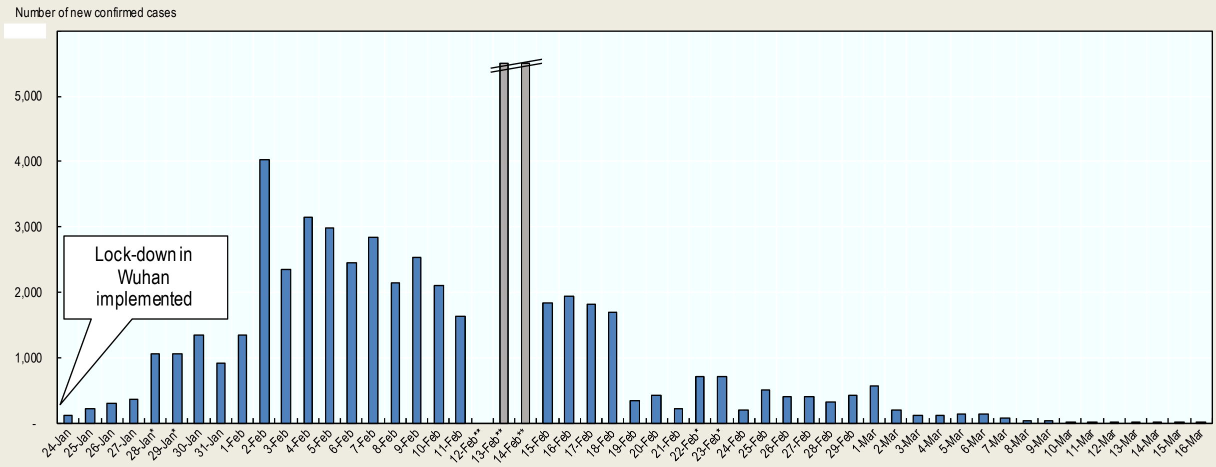
- 30 December 2019: active case finding begins in Wuhan City
- 1 January 2020: the Huanan Seafood Market (where the outbreak is assumed to have started) is closed
- 20 January 2020: COVID-19 is included in the statutory reporting of infectious diseases and plans are formulated to strengthen diagnosis, monitoring and reporting
- 23 January 2020: The city of Wuhan is put on lock-down when the statistics reported a total number of 444 cases in the province. The lock-down was mandatory and applied at the strictest level.
- 24 January 2020: Another 15 cities in Hubei province are put on lock-down.

Other measures included the extension of the Spring Festival holiday and strict traffic restrictions to reduce the movement of people, border temperature checks, cancellation of mass gatherings, public risk communications, contact tracing and quarantine, and school closures (World Health Organization, 2020[24]).

The effects of the containment and mitigation package took some weeks to be visible in statistics. While the decrease in the contagion started right after the implementation of the strategy, official statistics captured improvements some weeks later. This is due to the lag between the time patients fall ill and the time they actually are diagnosed and reported (The Novel Coronavirus Pneumonia Emergency Response Epidemiology Team, 2020[25]). In Hubei, the official reported cases continued growing until 4 February, one and a half weeks after the implementation of the lock-down, to decrease thereafter (Figure 3). Note that the peak on 13-14 February 2020 is a methodological artefact, as Hubei started including cases that were previously clinically-diagnosed in the total count around those dates, whereas earlier numbers only included laboratory-confirmed cases (World Health Organization, 2020[26]). On 19 February – 27 days after the lock-down of Wuhan – Hubei reported 349 new cases, with the number of new infections further decreasing more recently.

While the package proved to be effective in the short-term, its medium- and long-term effectiveness need to be confirmed over time, particularly after that the implementation of the containment and mitigation policies is relaxed.

Figure 3. New cases of COVID by date of diagnosis in Hubei (China)



Note: * Average calculated over two days; ** a change in case confirmation methodology caused a spike after the 12 February.
Source: OECD analysis of data collected by Johns Hopkins University (2020[22]) "Novel Coronavirus (COVID-19) Cases, provided by JHU CSSE", https://github.com/CSSEGISandData/COVID-19.

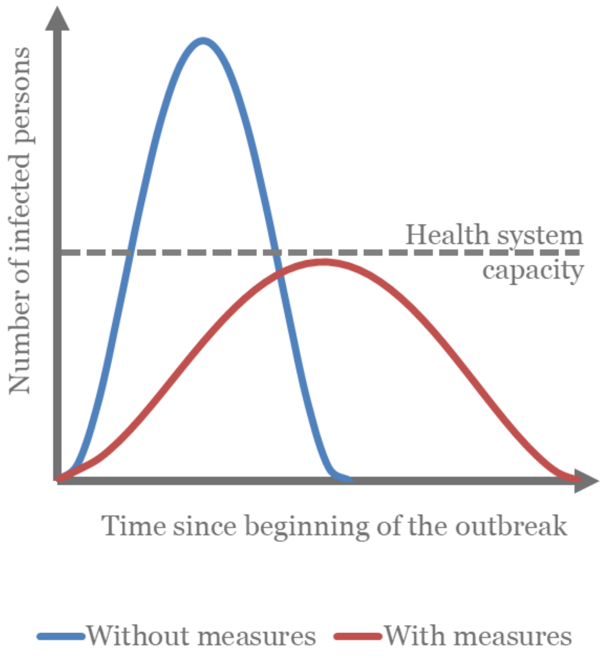
Containment and mitigation policies buy time for the health care system to adapt to COVID-19 and treat patients

A reduction in the peak of COVID-19 cases would lessen the burden placed on health care systems. While the majority of persons infected by the disease will develop no or mild symptoms, approximately one in five infected persons will develop severe symptoms possibly requiring access to hospitals (Wu and McGoogan, 2020[23]). Among those with severe symptoms, up to 25% may need advanced care, largely to support ventilation in intensive care units. Indeed, one of the biggest challenges caused by the spread of COVID-19 is health care system overloading, in particular, the insufficient number of ventilators and beds in intensive care units.

Although containment and mitigation strategies have different objectives, they both work to alleviate the burden on health care systems by 'buying time' for patients occupying hospital beds to recover, and by keeping the number of new patients to a manageable level, given the limited capacity of health care systems. Figure 4 show the number of infected persons over time in two alternative scenarios with or without the implementation of effective measures to contain and mitigate the pandemic. Without the implementation of the policies, the virus is expected to quickly spread through a population causing a peak of infections. For example, in the case of COVID-19 the peak of infection is expected to happen in about 2.5-3.5 months, since the beginning of the outbreak in the United Kingdom and the United States

(Ferguson et al., 2020[16]). With the implementation of policies to contain and mitigate the spread, the epidemic is expected to last longer but the peak of the infection is 'flatter' avoiding that the health care system is overloaded by a too high number of patients, compared to its capacity.

Figure 4. Containment and mitigation measures help reduce the infection rate curve to levels manageable by countries given their health system capacity



At the same time, containment and mitigation measures have economic and social impacts. Our review identified a number of issues, depending on the type of policy implemented and the level of enforcement. Mental health problems, both caused by the anxiety generated by the COVID-19 disease and by the policies implemented to contain it, are considered among the key emerging costs caused by this situation (see Box 3).

Box 3. COVID-19 and policies to contain it will have a significant impact on the mental health of the population, but policy actions can be implemented to lessen this burden

The COVID-19 outbreak is expected to have a significant and potentially lasting impact on the mental health of all OECD populations for several reasons. Firstly, this novel outbreak is an understandable source of anxiety, with a highly concerning and rapidly changing situation. Secondly, people are asked to significantly change their habits in a way that that may negatively impact their mental health (Brooks et al., 2020[27]; World Health Organization, 2020[28]). For example, many people are being asked to self-isolate, thereby changing their usual routine which can promote positive mental health such as participation in the workplace, social connection and physical exercise, while other persons, for instance, health workers and carers, face significant pressure and potential disease risk exposure. Thirdly, some people may be facing increased employment or housing insecurity, which increases the risk of mental ill-health. Finally, increased pressure on health systems may make it more difficult for people living with mental ill-health to access support (at present, around 15% of the OECD population experience a mild or moderate mental illness, and around 5% a severe mental illness at any time).

Steps can be taken to support good mental health during and after the COVID-19 outbreak (World Health Organization, 2020[28]; IASC, 2020[29]). For people experiencing heightened anxiety, or feelings of depression and loneliness, many resources have been made available online (NAMI, 2020[30]; CDC, 2020[31]; World Health Organization, 2020[32]). These resources give advice on steps that can be taken to promote mental wellbeing in this difficult period, including: trying to limit news and information consumption; maintaining forms of social contact for instance by phone or internet; undertaking physical activity at home; getting enough rest, eating healthfully, and avoiding tobacco, alcohol or other drugs. Advice for those caring for children has also been made widely available (World Health Organization, 2020[33]).

At the community-level, some OECD populations have found ways to support persons exposed to particular stress and risk related to the COVID-19 outbreak, for example: applauding health and front line workers at a fixed time each night; written messages of solidarity shared from windows or on social media; as well as efforts by communities to reach out to elderly or vulnerable persons to assist with day-to-day living, such as purchasing food and medicines. These forms of support can boost the morale and wellbeing of persons offering assistance as well as those receiving it. At the employer level, example initiatives to boost employee morale include access to online or app-based mindfulness and meditation programmes.

Efforts are needed to ensure those with existing mental health issues continue to access care and support while health systems are stretched. In many countries, general practitioners (GPs) are the primary care providers for people with mental illness as well as being at the 'front line' of responding to COVID-19. Example initiatives to help GPs respond to patients with mental health issues include provision of basic guidance on how they should speak to patients, for example, easy-to-understand information which they can send or refer patients to (NHS, 2020[34]; World Health Organization, 2020[32]).

Steps taken to allow pharmacists to renew repeat prescriptions as well as making telemedicine consultations more easily available will also enhance access to care for patients with mental health issues. Countries should also look to maintain services for persons with acute mental health needs to the greatest extent possible.

In the period after the most acute COVID-19 outbreak, mental health services would benefit from additional resources. This represents a challenge for many OECD countries whose mental health services for mild-to-moderate disorders were already stretched prior to the outbreak. At a time where health care resources are under extreme pressure, psychological support for health care and front line workers, as well as support for communities where the toll of COVID-19 has been most acute and bereaved families, should be prioritised.

What are the policy options?

A number of policy options are currently under discussion or have been implemented to contain and mitigate the COVID-19 pandemic (Table 1). The WHO global influenza preparedness plan lists a number of policy categories and policy options that countries could implement at various stages of an epidemic outbreak (World Health Organization, 2005[35]). The list of categories include the following six areas:

1. Information and communication
2. Reduction of the risk of transmission
3. Increase in social distance
4. Decrease interval between symptom onset and isolation
5. Disinfection measures
6. Travel restrictions.

Within each category of policies, potential policy actions are divided into one of the following three groups: 1) to be implemented; 2) to be considered; and 3) not to be implemented given the current evidence.

Table 1. Examples of non-medical policy options to contain and mitigate a pandemic, commonly used for COVID-19

	Information and communication	Reduction of the risk of transmission	Increase in social distance	Decrease interval between symptom onset and isolation	Disinfection measures	Travel restrictions
To be implemented	• Information to public and medical personnel as well as travellers advice on hygiene	• Confinement • Face mask for symptomatic persons	• Voluntary home confinement of symptomatic persons	• Public campaign to encourage self-diagnosis	• Hand-washing • Household disinfection of potentially contaminated surfaces	• Recommended deferral of non-essential travel • Self-reporting if symptoms appear in travellers from affected areas • Thermal screening for exit travellers
To be considered			• Closure of schools • Population-wide measures to reduce mixing of adults			
Not to be implemented, given the current level of evidence		• Identification and contact tracing	• Masks in public places	• Thermal scanning in public places	• Widespread environmental disinfection • Air disinfection	• Cordon sanitaire • Screening for symptoms • Thermal screening for entry travellers

Note: This table is not comprehensive, rather it includes selected examples, based on current discussion on potential policy actions to contain and mitigate the COVID-19 outbreak. Some policies and policy categories have been adapted from the original. Thermal screening for exit travellers (as opposed to entry travellers) is preferred in order to avoid contagion of other travellers.
Source: OECD analyses on World Health Organization (2005[35]), "WHO global influenza preparedness plan : the role of WHO and recommendations for national measures before and during pandemics", https://apps.who.int/iris/handle/10665/68998.

OECD countries have implemented many of the policies contained in Table 1, but at different levels of strength. To date, the response to the COVID-19 pandemic has been fairly similar across countries in terms of the type of policies implemented, essentially including all the main 'to do' policy actions listed in the table. Countries, however, differ on two main dimensions:

- **The timing of the implementation of the policy**. Countries have implemented policies at different times, depending on the evolution of the outbreak in the local setting, with stronger policies and more comprehensive packages implemented as the number of infected people and the mortality caused by COVID-19 started increasing exponentially;
- **The strength of implementation.** Within the same type of policies, countries decided to implement actions at different levels of strength depending on their own specific circumstances such as the severity of the outbreak and the feasibility of a policy in the local context. As the epidemic spread, countries tended to implement more homogeneous and stronger policies.

The remainder of this section describes a range commonly employed policy measures to contain disease outbreaks. For each policy measure an assessment of the measure's effectiveness is undertaken, which is based on available studies from previous epidemic outbreaks, modelling studies and selected case studies.

Social distancing

Social distancing refers to policies that deliberately increase physical space between people (John Hopkins Medicine, 2020[36]). Such policies come in many forms including banning large gatherings; encouraging people to work from home; and closing non-essential stores such as restaurants and cafes. These policies may be implemented across a community or target specific at-risk groups such as the elderly and those with pre-existing health conditions (Anderson et al., 2020[13]). The primary objective of social distancing is to prevent transmission thereby flattening the peak of the disease (Anderson et al., 2020[13]). In the short-term this will ease pressure on the health care system, while in the long-term it provides time for new treatment and vaccines to be developed (Anderson et al., 2020[13]).

Several studies analysing the impact of social distancing on disease outbreaks exist (Chen et al., 2020[37]). For example, a systematic review of workplace social distancing found the policy reduces the influenza attack rate (i.e. the proportion of individuals in a population who contract the disease) by 23% in the general population (Ahmed, Zviedrite and Uzicanin, 2018[38]). This is supported by an earlier study which found working-from-home was 'moderately effective' in reducing influenza transmission by 20-30% (Rashid et al., 2015[39]). Further, social distancing in Sydney, Australia, during the 1918-19 influenza pandemic is estimated to have reduced the attack rate by nearly 40% (i.e. from 60% to 37%) indicating 22% of the population were spared infection (Caley, Philp and McCracken, 2008[40]).

One approach to social distancing is the banning of mass events (e.g. music festivals or large spectator sporting events). While often seen as a logical element of containment strategies, the evidence suggest that this intervention is most effective when implemented together with other social distancing measures (Ishola and Phin, 2011[41]; Markel et al., 2007[42]). This is because contact-time at such events is relatively small compared to the time spent in schools, workplaces, or other community locations such restaurants (Ferguson et al., 2020[16]). As with other containment strategies, the earlier bans on mass gatherings are enforced, the greater their impact (Hatchett, Mecher and Lipsitch, 2007[43]).

Several challenges are associated with social distancing. Salient examples include reduced economic activity caused by closures and reduced social interaction (Rashid et al., 2015[39]; OECD, 2020[44]); neglect of vulnerable populations, such as the elderly (Boddy, Young and O'Leary, 2020[45]); as well as psychological damage such as acute distress disorder, anxiety and insomnia (Brooks et al., 2020[27]).

Social distancing has been employed by various countries in the latest COVID-19 outbreak. Examples include closures of schools, mass gatherings, restaurants, pubs and bars in the United Kingdom (UK

Government, 2020[46]), and all non-essential stores in certain Australian states and territories (Premier of Victoria, 2020[47]). More restrictive policies have been implemented in China, Italy, France and Spain where citizens are legally required to stay-at-home except for when accessing essential services (e.g. pharmacies and supermarkets).

Table 2 provides a list of certain policies implemented by OECD countries to enhance social distancing in response to the COVID-19 pandemic. Examples range in their intensity and thus their impact on day-to-day life for affected populations.

Table 2. Examples of policies implemented by OECD countries to promote social distancing

Policy action	Description	Examples
Closure of non-essential services	All services not maintaining primary functions in the community (e.g. food retailers and pharmacies) are closed	Many European countries such as Italy, France and Spain have temporarily closed restaurants and bars, as well as shops and recreational facilities, amongst others
Smart-working and tele-working	Workers do not need to travel to the place of work but use new technologies to work from home	A number of European countries such as the United Kingdom have encouraged teleworking in cases where it is an option. Countries enforcing lock-down have also encouraged teleworking
Banning large gatherings	Gatherings of a large number of people (e.g. for sport events or concerts) are cancelled	The maximum number of people that can gathers varies across countries, with Austria and Germany banning gatherings of as little as five and two persons, respectively
Self-quarantine	People's movements are restricted by encouraging them to stay at home	Self-quarantine is implemented by many countries and for different groups such as suspect cases (Singapore), people at risk of becoming a case including travellers (Australia) or vulnerable groups including the elderly population (the Netherlands)
Lock-down	People's movements are severely restricted with the exception of essential travel (e.g. to buy food)	The Czech Republic, Italy, France, Spain and Bavaria (Germany) have all implemented lock-down policies

School closures

School closures aim to decrease the number of contacts by school children, and thus reduce transmission of the disease throughout the community. Two types of school closures are distinguished: proactive school closures before that any infection is associated with schools, and reactive school closures as a response when a student, a parent, or a staff member is sick. School closures, either proactive or reactive, reduce influenza transmission but with a wide range of effectiveness varying between pandemics, between cultures or setting (e.g. rural or urban), and depending on the level of transmission in schools and on the timing of the decision. School closures can, likely at best, reduce the peak attack rate by about 40% (Ferguson et al., 2006[48]; Cauchemez et al., 2009[49]) and delay the peak of the epidemic by a week or two (Rashid et al., 2015[39]; Bin Nafisah et al., 2018[50]). Reactive school closures may reduce influenza transmission by 7-15%, rarely up to 90-100% when transmission between children is assumed to be very influential (Rashid et al., 2015[39]). A study of novel H1N1 in New York found that reactive school closure reduce school-based transmission of influenza-like illness at school by 7% (Egger et al., 2012[51]). A modelling study estimated that school closures during an epidemic with a reproduction number of 2.5 would reduce the final attack rate from 65% to 60% (Milne et al., 2008[52]).

A number of factors modify the effectiveness of school closures. School closures are most effective for infections with limited rate of spread, when they are implemented in the early phases of an outbreak and when attack rates are higher in children than in adults (Jackson et al., 2014[53]). In addition, several studies suggest that measures to reduce out-of-school contacts should be implemented alongside school closures. Finally, school closures may need to be maintained throughout of the epidemic (Rashid et al., 2015[39]).

School closures have significant economic and social effects. Evidence shows that 16-45% of parents would need to take leave to supervise children at home; 16-18% of parents would lose income, and about 20% of households would have difficulty arranging childcare (Rashid et al., 2015[39]). School closures have high economic cost due to the loss of productivity of parents' absenteeism from work. Based on data from the United Kingdom, economic modelling shows that 0.2-1% of GDP loss occurs due to school closure lasting the duration of a pandemic wave (Rashid et al., 2015[39]).

At the time of preparation of this report, 113 countries have announced or implemented school closures in the view of slowing the spread of COVID-19: 102 countries have closed schools nationwide, impacting more than 840 million children and youth, while 11 others have implemented localised school closures (UNESCO, 2020[54]). In the OECD area, nationwide school closures is effective in 29 countries, while Canada and the United States have applied localised school closures. At the same time, to assist parents to cope with school closures, a number of countries have introduced labour market and social policy responses (OECD, 2020[55]).

Travel restrictions

To prevent or delay the entry of a disease into a country, it is common for policy-makers to implement several travel restrictions. Screening, for example, is common in airports during a disease outbreak, and may include thermal scans to identify passengers with a high external body temperature as well as health questionnaires to detect symptoms and possible exposure (by providing information on travel history) (Selvey, Antão and Hall, 2015[56]). Other restrictions include bans on (or advice to restrict) non-essential travel, voluntary or legally mandated isolation upon arrival into a new country as well as border closures (Mateus et al., 2014[57]; Australian Government, 2020[58]; Foreign & Commonwealth Office, 2020[59])

Evidence to assess the effectiveness of travel restrictions are limited given they are frequently implemented alongside other countermeasures thereby making it difficult to ascertain causal effects (Mateus et al., 2014[57]). Consequently, the impact of national and international travel restrictions are typically measured using mathematical models. A systematic review by Mateus et al. (2014[57]) generalised findings from the literature related to influenza and concluded travel restrictions delay but do not prevent pandemics (e.g. by 3-4 weeks when 90% of air travel is restricted in affected countries, or by two months if more restrictive measures are introduced). Similar findings are also confirmed for other epidemic diseases. For example, a 60% reduction in airline passenger traffic from the Ebola affected region of West Africa was estimated to have delayed the spread of the disease to other continents by between 2-30 days (Poletto et al., 2014[60]). Regarding internal travel, a 2006 study found travel restrictions between cities in the United States during the 2001-02 influenza season delayed peak mortality by 16 days (Brownstein, Wolfe and Mandl, 2006[61]). The impact of internal travel restrictions have also been estimated for the COVID-19 outbreak, for example, Kucharski et al. (2020[62]) estimated that the introduction of travel control measures in Wuhan, China, reduced the median daily reproduction number from 2.35 to 1.05.

A major impact of travel restrictions is the flow-on effect this has on trade and business. As a result, travel restrictions dampen economic activity, for example, by reducing demand in tourism-dependent industries such as hotels, restaurants and aviation (Rashid et al., 2015[39]). In addition, screening may further stretch limited resources by isolating or quarantining travellers with symptoms unrelated to the disease of interest (Priest et al., 2015[63]).

In response to the COVID-19 outbreak, countries across the world have implemented measures to restrict international travel. In Australia, as of 20th March 2020, the Government closed its borders to non-residents and non-citizens (Prime Minister of Australia, 2020[64]). Further, temporary internal borders have been erected by South Australia, Western Australia, Northern Territory and Tasmania. The United States on March 11th restricted travel for foreign nationals arriving from Europe, which on March 14th was extended to the United Kingdom and Ireland (U.S. Department of State, 2020[65]). As of the 17th of March, European countries have closed external borders (European Commission, 2020[66]), further, many EU countries have closed borders to other member states (e.g. Germany temporarily closed its borders to neighbouring countries Austria, Switzerland, France, Luxembourg and Denmark) (Federal Foreign Office, 2020[67]). Similarly, the United States and Canada have temporarily closed their border for non-essential, non-urgent travel.

Contact tracing and quarantine

Contact tracing aims to identify, list and closely watch people who have been in contact with an infected person, even if they do not display symptoms. This helps the traced persons to get care and treatment early, and prevents further transmission of the virus (World Health Organization, 2017[68]). Quarantine (i.e. isolation) can be spent either at home or in hospital or specifically equipped structures.

There is limited data on the effectiveness of contact tracing and quarantine. Evidence that is available is largely based on modelling studies, which suggest quarantine decreases the peak case load, the attack rate and would also delay the peak. Household quarantine is potentially the most effective measure to reduce attack rates in the community, but only if compliance is high (Rashid et al., 2015[39]). Voluntary or self-isolation of infected people is moderately effective. For instance, voluntary quarantine of households with an infected individual may delay the peak of influenza by two to 26 days, and reduce the peak daily attack rate from 1.9% to 1.5%, or even up to 0.1%, depending on the associated interventions (e.g. such as treating infected people and applying prophylaxis to their households the day after the symptoms start, school closure) (Ferguson et al., 2006[48]). Modelling work simulating the isolation of cases and contacts in the case of the COVID-19 pandemic concluded that about 70% of cases had to be traced to successfully contain the outbreak, assuming a reproductive number of 2.5 (Hellewell et al., 2020[69]).

The effectiveness depends on numerous factors. First, it depends on whether infected people and their family members actually reduce their contact while they are ill. Another important factor is the time at which an infected individual becomes infectious. Isolation and quarantine is most effective in controlling the disease if the virus shedding starts after the onset of the clinical symptoms. For example, this was the case for SARS (the Severe Acute Respiratory Syndrome), a disease caused by another coronavirus as COVID-19, while, in the case of influenza, sick people are infectious during the incubation period (Fraser et al., 2004[70]).

Implementation of contact tracing and quarantine measures bears economic costs, and is associated with psychological, legal, and ethical issues. First, contact tracing requires substantial resources to sustain after the early phase of the epidemic since the number of infected people and contacts grow exponentially. While there is no obvious rationale for a routine use of contact tracing in the general population, it may be adapted in some circumstances (e.g. if there was an infected person on an aircraft) (Fong et al., 2020[71]). In addition, isolation is likely to cause distress and mental health problems (see Box 3), requiring additional services such as creating support lines and advice, helping people create plans, encouraging messages and calls and maintaining some routine (Lunn et al., 2020[72]).

A number of countries worldwide have used contact tracing and quarantine to control and contain the spread of COVID-19, such as China, South Korea, and Italy. Singapore, where the surveillance capacity for COVID-19 is high, is a good example of tracing contacts of infected people (Ng et al., 2020[73]). In particular, in Singapore, contact tracing was initiated for all the confirmed and suspected cases since the early days of the COVID-19 outbreak. Patients and suspected patients were traced for 14 days prior of their infection. All the identified contacts presenting symptoms were referred to hospitals for isolation and testing and then placed under 14 days quarantine from the last date of exposure (Lee, Chiew and Khong, 2020[74]).

Korea made use of modern technologies, such as cell phones, closed-circuit television (CCTV) and bank transactions, to collect data on the movements of COVID 19 infected people. This information was then shared via text message with people living nearby. Korea's extensive tracing, testing and isolation measures appear to have been effective in reducing the virus' spread. The case of Korea is also interesting because the country managed to use big data and new technologies to lower the cost of contact tracing making it an efficient solution also in the case of an epidemic affecting a large number of people. However, some ethical questions have been also raised. The detailed information could be used to identify individual cases and publicly expose their status. There also are privacy concerns about exposing peoples' activities and movements. Moreover, the resulting social stigma and privacy issues may prevent potentially infected people from coming forward and getting tested (Zastrow, 2020[75]).

Public information campaigns

During an epidemic, policymakers can use campaigns to communicate with the public. These campaigns need to inform the public about the development of the epidemic and the risk it poses, with the aim of encouraging them to take the appropriate protective measures, such as hand washing or social distancing. In addition to saving lives, clear and timely information can also help preserve a country's social, economic and political stability in the face of emergencies (World Health Organization, 2018[76]).

Especially in the case of COVID-19, which is a rapidly evolving situation with little knowledge about the disease, effective communication is crucial. Without it, the many unknowns can give space for rumours to develop and panic to set in (World Health Organization, 2018[76]). On the other hand, it is important to strike a balance between preventing panic and encouraging action. A study of the public perception of the influenza A/H1N1 (swine flu) outbreak in the United Kingdom found that few people changed their behaviour, and linked this to a believe that the outbreak had been exaggerated (Rubin et al., 2009[77]). The authors suggest that convincing the public that the threat is real may be a more pressing task for public health agencies than providing reassurance.

Evidence on the effectiveness of public information campaigns is limited. As mentioned above, the perceived risk can affect whether people change their hygiene behaviour, which means that the effectiveness of campaigns differs from one disease or epidemic to the next. Other studies have shown that the impact of campaigns can be increased by using trusted spokespeople like public health officials and through a role model effect from officials (Quinn et al., 2013[78]). The 2003 SARS outbreak hit Singapore in late February, prompting the government into action. An important element of Singapore's containment strategy – in addition to the closure of schools and case isolation – was an integrated mass media campaign. This campaign included advertisements in the four languages (English, Chinese, Malay and Tamil) in newspapers and on television, a dedicated website, a toll-free hotline, booklets, posters and stickers. At the local level, town councils and other organizations organised discussion sessions and demonstrations for residents. A survey looking at whether the public followed the recommended behaviour found that adherence to the compulsory temperature checks was high: 85% of the respondents said that they monitored their temperature daily (Karan et al., 2007[79]).

Environmental and personal hygiene

The evidence to date suggests COVID-19 is primarily spread from person-to-person via small respiratory droplets (GAVI Alliance, 2020[80]). The disease may also be transmitted through fomites, that is, objects that can carry infections (e.g. furniture) (Center for Disease Control and Prevention, 2020[81]).

In order to reduce the risk of transmission through fomites, policy-makers may require public and private spaces where infected individuals are likely, or known, to have frequented be cleaned and/or disinfected (e.g. schools, offices, day care centres) (Otter and Galletly, 2018[82]). This process is referred to as environmental decontamination (ED) and results in contamination levels that do not harm the health of individuals (Otter and Galletly, 2018[82]).

Given that the virus causing COVID-19 can remain on surfaces for an extended period of time, and that cleaning, as well as disinfectant, can reduce contamination levels, theoretically, ED can reduce transmission rates. Using these assumptions, a modelling study to estimate the impact of regular cleaning of high-touch surfaces in an office found the measure reduces the infection risk of influenza by 2.14% (Zhang and Li, 2018[83]).

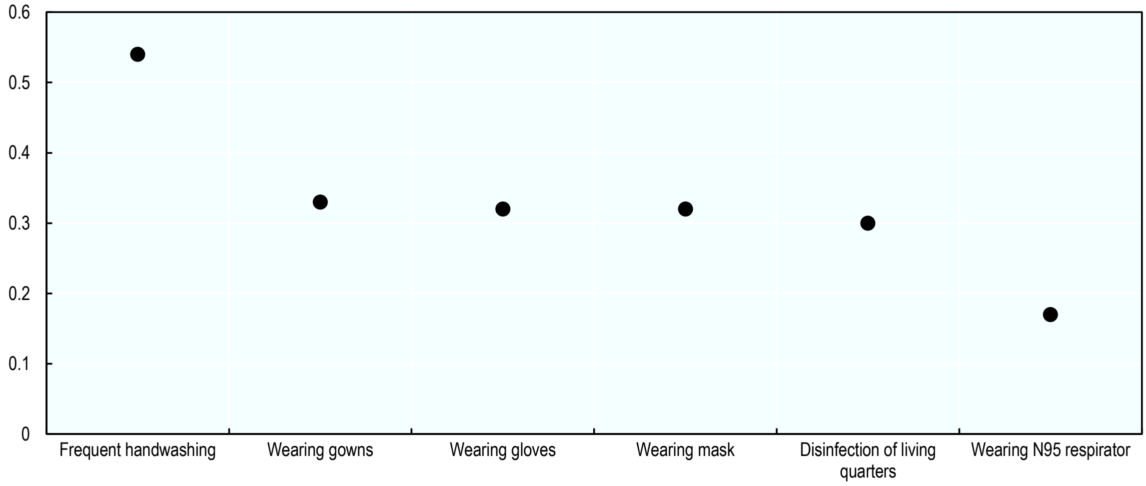
The academic literature on environmental hygiene is limited with a recent systematic review identifying three studies (Xiao et al., 2020[84]). These studies all focus on younger children (i.e. those of school age) and do not accurately reflect ED efforts implemented during a pandemic. For example, one study measured the impact of disinfecting toys every two weeks (Ibfelt et al., 2015[85]), while another estimated the impact of bleach use in the home on respiratory illness (Casas et al., 2015[86]). For this reason, these studies should not necessarily be taken as evidence on the impact ED has on coronaviruses given SARS-CoV-2 can stay on a surface for up to three days.

The spread of COVID-19 has led countries to implement various ED policies. This is evidenced by the number of governments with online resources dedicated to best practice environmental and disinfection practices (e.g. (Australian Government Department of Health, 2020[87]; Center for Disease Control and Prevention, 2020[81])).

Personal hygiene measures include frequent hand washing, sneezing or couching practices, and the use of protective facemasks. Various studies have shown that these interventions can protect individuals by reducing their risk of getting infected (Figure 5) (Jefferson et al., 2011[88]). A study of the SARS outbreak in Hong Kong, China found that people who got infected were less likely to frequently have worn a face mask in public (odds ratio 0.36) or to have washed their hands 11 or more times per day (Lau et al., 2004[89]). A randomised trial during the influenza A(H1N1) pandemic showed a 35% to 51% reduction in the incidence of influenza-like illness when using both masks and proper hand hygiene practices and cough etiquette (Aiello et al., 2010[90]). Similarly, a meta-analysis found that combining masks and hand hygiene reduced the risk of influenza infection by 27% (Wong, Cowling and Aiello, 2020[91]).

Figure 5. Impact of personal hygiene measures on respiratory viruses

Odds ratios



Note: Results are reported as odds ratios (OR). An OR less (more) than one indicators a lower (higher) probability of contracting the virus. The lower the OR, the more effective the policy measure.
Source: Jefferson et al. (2011[88]), "Physical interventions to interrupt or reduce the spread of respiratory viruses", http://dx.doi.org/0.1002/14651858.CD006207.pub4.

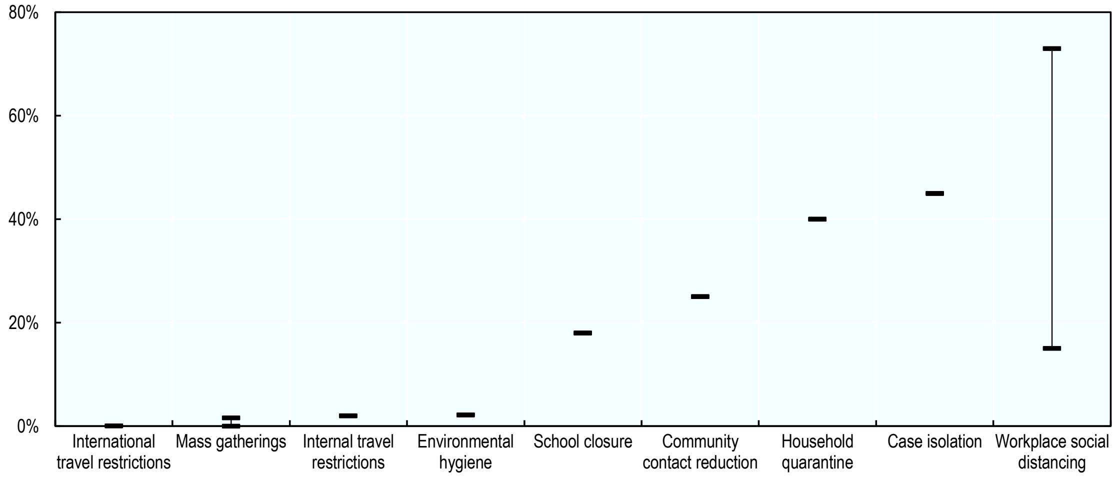
Summary of policy measures on key outcome measures

The impact of pandemic policy measures on outcome variables of interest are summarised in the figures below. Specifically, the impact on: 1) the attack rate, which represents the proportion of the population who are infected; and 2) the number of days the policy measure delays the peak of a disease.

Results from the analysis indicate that social distancing is the most effective measure for both reducing the attack rate as well as delaying the disease peak. For example, work place social distancing measures (such as working from home and workplace closures) can reduce the disease attack rate by between 23-73% (Ahmed, Zviedrite and Uzicanin, 2018[38]; Rashid et al., 2015[39]). Less effective measures include travel restrictions, in particular international restrictions, which is estimated to reduce the attack rate by just 0.02% (Mateus et al., 2014[57]).

Figure 6. Impact of policy measures on influenza attack rates

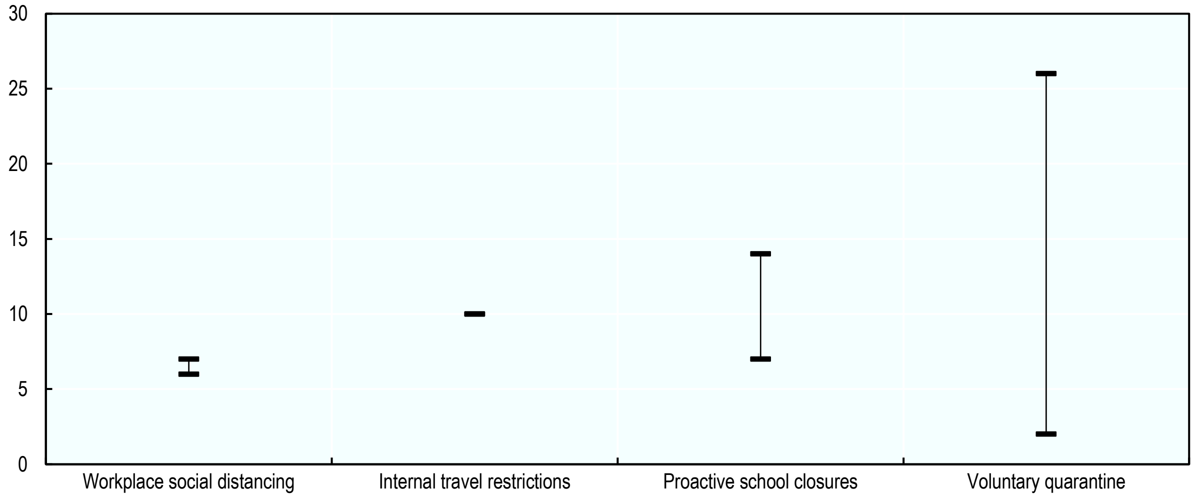
Reduction in disease attack rates (%)



Note: Not all policy measures are listed due to data availability.
Source: OECD analyses on (Rashid et al., 2015[39]; Ahmed, Zviedrite and Uzicanin, 2018[38]; Mateus et al., 2014[57]; Milne et al., 2008[52]; Ferguson et al., 2006[48]).

Figure 7. Impact of policy measures on the timing of influenza peak

Delay in the peak of the disease (in days)



Note: Not all policy measures are listed due to data availability.
Source: OECD analyses on (Rashid et al., 2015[39]; Ahmed, Zviedrite and Uzicanin, 2018[38]; Mateus et al., 2014[57]; Ferguson et al., 2006[48]).

Modelling studies consistently conclude that policy packages, as opposed to individual policies, are the most effective approach to reduce the impact of an epidemic (Lee, Lye and Wilder-Smith, 2009[92]). For example, Ferguson et al. (2006[48]) estimated that home quarantine reduces the overall attack rate by approximately 10% (i.e. from 27% to 24%), with this figure increasing to approximately 70% when adding school and workplace closures, effective border controls, and antiviral treatment and prophylaxis. A study from the United States found the reduction in the overall attack rate was 30 percentage points higher for a policy package including antiviral treatment and prophylaxis, quarantine, isolation and school closures (90% reduction in the attack rate) when compared to community and workplace social distancing only (60% reduction in the attack rate) (Halloran et al., 2008[93]). Finally, a modelling study from Milne et al. (2008[52]) estimated that a combination of school closures, case isolation, workplace non-attendance and limited community contact can reduce the final attack rate by 96% (i.e. from 55% to 2%) compared to between 12-45% (i.e. from 55% to 30-48%) when policies are implemented independently.

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