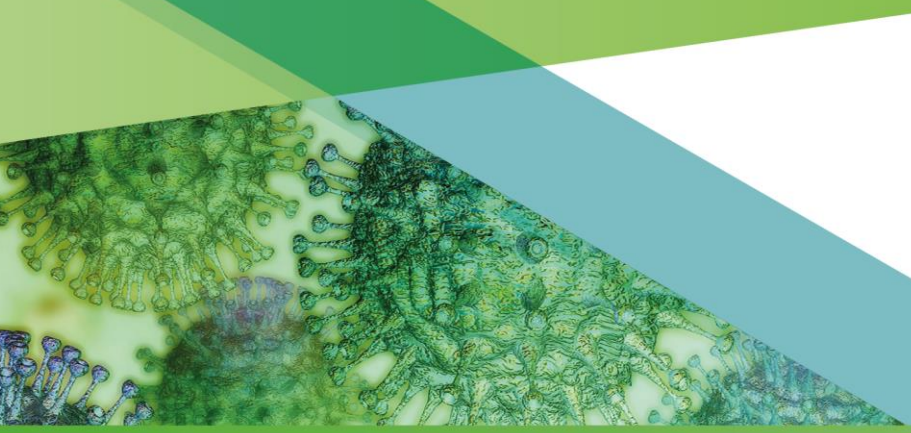

Guidelines for the implementation of non-pharmaceutical interventions against COVID-19

24 September 2020

Key messages

Non-pharmaceutical interventions (NPI) are public health measures that aim to prevent and/or control SARS-CoV-2 transmission in the community. As long as there is no effective and safe vaccine to protect those at risk of severe COVID-19, NPI are the most effective public health interventions against COVID-19.

These ECDC guidelines detail available options for NPI in various epidemiologic scenarios, assess the evidence for their effectiveness and address implementation issues, including potential barriers and facilitators.

General considerations on NPI to control COVID-19

- NPI have played a critical role in reducing transmission rates and the impact of COVID-19 in the European Union, European Economic Area (EU/EEA) and United Kingdom (UK). Until a safe and effective vaccine is available to all those at risk of severe COVID-19 disease, NPI will continue to be the main public health tool against SARS-CoV-2.
- Most NPI can have a negative impact on the general well-being of people, the functioning of society, and the economy. Therefore, their use should be guided by data on the local epidemiological situation, with the overall goal of protecting the most vulnerable individuals in the society.
- Specific recommendations to protect the most vulnerable include enhanced surveillance, comprehensive testing, and intensified infection prevention and control practices in settings that host high-risk individuals, such as long-term care facilities.
- In countries/regions/municipalities/communities where sustained control of SARS-CoV-2 has been achieved, as documented by comprehensive surveillance, NPI can be relaxed, allowing society to function almost normally. Under the current exceptional circumstances, imposing travel restrictions on those coming from countries or areas that have not yet achieved transmission control will probably make a meaningful difference to the SARS-CoV-2 epidemiology within the population.
- In countries/regions/municipalities/communities that experience community transmission, the authorities should ensure that personal NPI are understood and correctly applied by the population. This includes maintaining physical distance in all settings, hand hygiene and respiratory etiquette, and the wearing of face masks when physical distancing cannot be guaranteed. The use of face masks is recommended both indoors (e.g. supermarkets, shops and public transport) and in crowded outdoor settings. In addition, use of face masks should be strongly recommended for groups at risk of developing severe complications if infected (e.g. individuals in older age groups or with underlying conditions) and for those whose occupations bring them into extensive face-to-face contact with the public when there is ongoing transmission.

Decision-makers responsible for implementing population- and/or environmental-level NPI, either at local or national level, should consider the advice/evidence below when deciding on the combination of measures.

Considerations in the event of community transmission

During the SARS-CoV-2 community transmission phase, the following interventions may be considered, irrespective of incidence level.

- Promoting and facilitating physical distancing in all settings is an effective NPI to reduce the levels of SARS-CoV-2 transmission in the community.

Suggested citation: Guidelines for non-pharmaceutical interventions to reduce the impact of COVID-19 in the EU/EEA and the UK. 24 September 2020. ECDC: Stockholm; 2020.

- Advising the population to voluntarily self-isolate if experiencing COVID-19 compatible symptoms is an essential measure for reducing the number of secondary infections. This should be linked to easy access to testing and rapid contact tracing, testing of high-risk contacts irrespective of symptoms, and the quarantining of contacts.
- Advising the population to consistently meet with the same people in 'social bubbles', whether friends or co-workers, can allow for a greater degree of contact between people, while still minimising the risk of SARS-CoV-2 transmission and associated outbreaks.
- Limiting the size of indoor and outdoor gatherings decreases the likelihood of SARS-CoV-2 spreading to large numbers of people. Such a measure is more effective if implemented consistently, even for relatively small gatherings (e.g. >10 individuals). Additional organisational measures such as event cancellation, postponement or re-arrangement should be considered, depending on the underlying epidemiological situation.
- Promoting teleworking where possible can reduce the risk of outbreaks in the workplace.
- Closing selected businesses, such as places where people have limited possibility for physical distancing, could be more effective than closing all businesses, and therefore is a possible option for reducing transmission while avoiding large-scale economic and social impact.
- Proactive school closure is not recommended as an effective COVID-19 containment strategy at this stage as there is currently little (and conflicting) evidence on the effect it has on SARS-CoV-2 transmission in the community. Firstly, children (18 years and younger) mostly experience a benign clinical course of COVID-19 and do not seem to have been the main vector of SARS-CoV-2 in the community. Secondly, because the impact of school closure on children's education, families' economies, and on society as a whole is significant and well-documented.
- Environmental measures, such as regular cleaning of frequently-touched surfaces and appropriate ventilation of indoor spaces, can lower the risk of disease transmission in the community. Such measures are particularly relevant in healthcare settings to reduce nosocomial transmission and infection of healthcare workers.

Considerations in the event of widespread transmission

During widespread transmission of SARS-CoV-2, when hospitalisation rates, ICU admissions, and/or mortality is increasing, in addition to the NPI above, the following stricter measures can be considered.

- Stay-at-home measures are a last-resort option due to their significant impact on both society and individuals. Targeted implementation, both geographically and temporally, is preferred and can be considered to control outbreaks which are not responding to other measures. Available evidence does not prove that stay-at-home measures are more effective than other measures, such as the closing of (some) high-risk businesses.
- Population-wide testing strategies (testing all individuals, irrespective of symptoms) may be appropriate in local settings with high incidence. Such an approach would enable public health authorities to identify most of the infectious COVID-19 cases at a given point in time (e.g. including pre-symptomatic, pauci-symptomatic, and asymptomatic cases), allowing for their prompt isolation and the interruption of transmission chains. However, the effectiveness/cost-effectiveness of this approach remains unknown and should not compromise the accessibility or timeliness of testing for those who are symptomatic. Without timely analysis and notification to isolate cases, population-wide testing alone would not be effective in reducing transmission.
- Reactive closures of schools may be necessary as a consequence of widespread virus transmission in the community and educational settings. Reactive school and day-care closures will probably not reduce the impact of the epidemic, but may be necessary due to high absenteeism and operational issues, especially if the spread of SARS-CoV-2 coincides with the ongoing influenza season in an EU/EEA country.

Addressing NPI compliance

- Support for NPI has varied considerably across countries and in different population groups within the same country: what works to promote safe behaviour in one city, country, culture, or population may be ineffective or otherwise sub-optimal in another. Several EU/EEA countries have therefore been working to incorporate behavioural insights into their COVID-19 response work, using ongoing assessments of public attitudes, behaviour, and beliefs within their own populations. Innovative means have also been developed for collecting anonymised, aggregated data on people's movements, which can act as a proxy for compliance with measures (e.g. stay-at-home measures).
- While there is no 'one-size-fits-all' approach to promoting NPI compliance, there are nonetheless some key principles that can be applied in all settings, as defined in various theories of behaviour change. The COM-B model is one such theory, based on the common-sense idea that a given behaviour occurs when both the capability and opportunity are present, and when the individual concerned is more motivated to adopt that behaviour than any other. Systematically applying such models can optimise the effectiveness of strategies promoting NPI.

Scope of this document

The scope of this document is to outline the available options for non-pharmaceutical interventions in various epidemiological scenarios, assess the evidence for their effectiveness and address implementation issues, including potential barriers and facilitators.

This document does not state the measures in terms of level of importance. Instead, it discusses each one as a possible component in a suite of measures that should be included in a comprehensive and coordinated strategy.

Target audience

The target audience for this document is public health authorities in EU/EEA Member States and the UK.

Background

What are non-pharmaceutical interventions?

Non-pharmaceutical interventions (NPI) are public health measures that aim to prevent and/or control SARS-CoV-2 transmission in the community. In the absence of an effective and safe vaccine to protect individuals at risk of severe COVID-19, NPI are the most effective public health interventions against COVID-19. In most situations, a number of NPI should be implemented simultaneously to maximise effectiveness. NPI such as school and business closures and travel restrictions aim to reduce virus transmission and spread, but they have serious personal, social and economic consequences. Therefore such consequences need to be foreseen and, where possible, addressed before and during NPI implementation. Achieving sustained public compliance with any NPI is critical for its effectiveness. Therefore any NPI implementation plan should be accompanied by a robust communication strategy.

Since NPI are almost always applied in combinations and at varying levels of intensity, it is challenging to analyse the effectiveness of each measure individually. The assessment of the effectiveness of NPI is based on statistical methods and epidemiological modelling studies, as well as evidence from influenza and other respiratory viruses.

There are three main categories of NPI:

- individual, such as hand hygiene, respiratory hygiene and use of face masks,
- environmental, such as cleaning and ventilation of indoor spaces,
- population-related, such as promoting physical distancing and limiting and restricting movement and the gathering of people.

Widespread, timely testing and contact tracing are cornerstone measures of the response at all stages of the epidemic and underpin NPI measures to isolate cases and quarantine contacts. Testing and contact tracing strategies and operations are covered in detail elsewhere [1,2].

COVID-19 transmission

Evidence currently available indicates that COVID-19 may be transmitted from person to person by several different routes [3]. Infection is understood to be mainly transmitted via respiratory droplets containing the SARS-CoV-2 virus. Transmission through aerosols probably occurs in closed spaces (short-range aerosol), where many people linger for longer periods of time. It is also known to occur in healthcare settings during aerosol-generating procedures (e.g. intubation). Indirect transmission through fomites that have been contaminated by respiratory secretions is considered possible, although so far transmission through fomites has not been documented. Moreover, the role of other routes of transmission (e.g. faecal-oral or blood-borne) has not been documented.

Asymptomatic transmission (i.e. when the infectious person has no symptoms throughout the course of the disease) is difficult to quantify. Available data, mainly derived from observational studies, vary in quality and seem to be prone to publication bias [4,5]. Mathematical modelling studies (not peer-reviewed) have suggested that asymptomatic individuals might be major drivers behind the growth of the COVID-19 pandemic [6,7]. The infectious period begins at least two days before the onset of symptoms and symptoms can often be mild and non-specific. Since patients can transmit the disease without symptoms or before they realise they are ill, the isolation of sick people alone is insufficient for controlling the spread of COVID-19.

Table 1. Characteristics of SARS-CoV-2 transmission and relevance for NPI

	Value/description (+ ref)	Relevance for NPI
Main transmission routes	Respiratory droplets (large and aerosols), fomites [3]	Mask wearing, hand and respiratory hygiene, avoid indoor and crowded places
Incubation period	Range: 1-14 days [8-11] Median: 5-6 days	Duration of quarantine Follow-up of contacts
Infectious period	1-2 days before symptom onset 10 days after symptom onset in mild cases, 14-20 days in severe cases [12,13]	Duration of isolation, duration of quarantine
Basic reproduction number	2-4 [14,15]	All NPI
Infectiousness by age	Unclear	School measures
Proportion of asymptomatic cases	30-40% [16,17]	Mask wearing, hand hygiene, avoid indoor and crowded places, testing strategy, quarantine
Transmission by asymptomatic cases	Yes	Quarantine, testing strategy
Risk factors for transmission (personal)	Activities, number of contacts	Physical distancing, hand and respiratory hygiene, contact tracing
Risk factors for transmission (setting)	Close contact, indoor settings, crowding, travel	Physical distancing, mass gatherings, travel restrictions
Risk factors for severity (personal)	Old age, underlying diseases	Protection of vulnerable groups

Methodology

The following information sources were used to identify relevant evidence on the effectiveness and implementation of NPI to minimise the spread of SARS-CoV-2:

- Literature review: data from the scientific literature, identified through a structured literature search, was assessed. The search strategy is described in Annex 1.
- ECDC Response Measure Database: a brief descriptive analysis of the implementation of NPI in the EU/EEA and the UK was included. This analysis was taken from the ECDC Response Measures Database which collects information on NPI implemented in EU/EEA countries and the UK since January 2020. The information was extracted on 9 September 2020. Measures by specific countries can be found in the Weekly COVID-19 country overview [18].
- Compendium of relevant ECDC technical documents.

Considerations for implementation

Different compliance levels for various NPI

Substantial evidence has accrued indicating that the imposition of restrictive non-pharmaceutical interventions, such as stay-at-home measures, during the first phase of the COVID-19 pandemic in Europe was associated with increases in loneliness, stress levels and symptoms of depression [19]. Uncertainty about the likely duration of the measures, as well as actual or potential loss of income during this period have been identified as key determinants for these conditions [20,21]. There have also been reports that physical distancing within households where one family member is sick may be seen as socially unacceptable and not always feasible [22]. Further challenges have been encountered when promoting other measures that are perceived as onerous, such as avoiding face touching, disinfecting surfaces, and wearing masks or goggles [23]. All of these psychological and logistical issues may reduce compliance levels with the NPI in question as the pandemic continues to evolve through the northern hemisphere during the autumn and into the winter. By contrast, hand and respiratory hygiene are widely viewed as familiar, actionable, and socially responsible actions to take, and therefore compliance with directives to practice these measures is stronger [22].

Overall, it has become clear that compliance with different COVID-19 NPI varies, with the levels for a given NPI being determined both by people's outcome expectations (the belief that it is effective) and by their process expectations (the belief that it is not unduly inconvenient) [23].

Challenges to optimising NPI compliance levels

The relaxation of restrictions in most EU/EEA countries over the summer months has, in some people's minds, created an ambiguity or uncertainty about what actions to take in order to reduce the risk of COVID-19 infection. This uncertainty is in part due to a lack of clarity in some countries about when different NPI should be implemented and when they are not deemed necessary by the authorities [24]. This uncertainty may be complicated further as autumn begins in the northern hemisphere and people return to indoor environments that can facilitate the spread of the virus, and a re-imposition of some NPI should therefore be considered. In some countries, a growing and vocal opposition has emerged to any such re-imposition of restrictive measures, motivated by a range of issues including a desire for a return to 'normality', perceptions of a decreased threat from the virus, and broad political discontent from

extremist groups as well as from people protesting at the inequitable socio-economic impact of the pandemic and of the NPI themselves [25-27]. These issues, which have led to large protests in some countries [28], will need to be taken into consideration in any efforts to promote NPI during the autumn and winter months ahead.

An additional challenge to compliance concerns the confusion caused in some people's minds by the differing recommendations and approaches between and within countries. This makes them question why certain measures may be applied in one country but not in others. One example of this is the difference in approaches between countries regarding travel restrictions and entry requirements, such as screenings at points of entry and quarantine measures. As reported by media in relation to travel during the summer, the variety of measures has been a source of confusion [29]. This situation which, in addition to economic disruption, has also created additional uncertainty for citizens, prompted the EU to call for more clarity and predictability of any measures put in place that may restrict free movement [30].

One of the main challenges in achieving strong compliance with NPI – under any circumstances, let alone the given situation – is that there is no single approach that can be used in all settings and with all population groups [31]. Every government needs to take its own decisions on how to promote compliance with NPI, based on local conditions. Support for NPI has varied considerably across countries and different population groups within the same country. For example, data from a longitudinal multi-country study highlights the substantial variations in face mask usage. In late May-early June, this was lowest among the Scandinavian countries, with fewer than 12% of all respondents from Sweden, Finland, Norway and Denmark stating that they ever wore a face mask when they left the house, compared to 99% in Italy [32]. While face masks were not promoted in Scandinavia at this stage of the pandemic, the data indicate that, for a range of reasons – social, cultural and political factors; trust in the authorities; government strategy, national recommendations and the national and/or local epidemiological trajectory of COVID-19 [33,34] – what works to promote safe behaviour in one city, country, culture, or population may be ineffective or otherwise sub-optimal in another [31].

Principles for promoting compliance to NPI

While there is no 'one-size-fits-all' approach, there are some key principles that can be applied in all settings, as defined in various theories of behaviour change. The COM-B model [35] is one such theory, based on the common-sense idea that a given behaviour occurs when both the capability and opportunity are present and when the individual concerned is more motivated to enact that behaviour than any other [36]. This model has been suggested elsewhere as having relevance to the COVID-19 pandemic [37]. In the context of COVID-19 prevention, all three COM-B components (i.e. capability, opportunity, and motivation) have been shown to significantly predict good hygienic practices [38].

The COM-B model is applicable to all of the individual NPI measures discussed in this document. As such, it may be viewed as a useful heuristic technique for decision-makers when planning and assessing the potential efficacy of specific NPI.

Under the umbrella of the three COM-B principles, an array of sub-issues has been identified as being of potential importance for ensuring that NPI promotion strategies are locally relevant, acceptable, and feasible, and thereby of value when promoting compliance:

- **Capability**

One of the key factors in determining whether and the extent to which an individual has the capability to successfully enact an NPI is their understanding of the NPI in question. To this end, clear, unambiguous and specific guidance on the required behaviour is necessary from the government and other community leaders [23,39]. Some NPI, such as mask-wearing or the use of hand sanitiser, require some sort of material product if people are to be capable of implementing them.

- **Opportunity**

Authorities and service providers can maximise the opportunities that people have to enact an NPI by a number of means, such as the use of physical markers and channels which can work either at a conscious level or as a sub-conscious 'nudge' to encourage certain behaviour. Examples include establishing one-way flows for services and in shops and markets to reduce crowds and limit the number of contacts, or marking out > 1-metre intervals in shops, clinics and other places where it may be necessary to queue, or for desk spacing in schools [40]. Further to the point above on capability, the opportunity for people to comply with recommendations or orders to use products such as face masks or hand sanitiser will be optimised if they are affordable, acceptable, and people know how to use them correctly.

- **Motivation**

Under the current circumstances, when many people across the EU/EEA are increasingly reluctant to enact NPI as a means of reducing COVID-19 infections, it is particularly important to focus on the means to motivate the population to continue to comply with recommendations. Social norms are core determinants of human behaviour, therefore appealing to longstanding norms (e.g. community solidarity) as means of motivating people may be effective, as well as working to create new norms, such as not shaking hands and staying at home [39,41]. Emphasising the social norms of a specific target group (for example, healthcare workers, young people, the elderly, minority ethnic groups and religious communities) through role models and influencers who are respected by these groups can also increase their compliance to the NPI [41].

A general principle of risk communication is that the promotion of desired behaviour is more likely to lead to higher compliance levels than an emphasis on punishment for perceived breaches [39,41]. Indeed, there are suggestions that messages perceived as authoritarian or moralistic can be counter-productive, particularly where populations perceive unfairness in the management of breaches [39,42]. Enforcement strategies (e.g. mandatory versus recommended) can be important means of motivating people to comply with measures, but mandating NPI may be challenging for law enforcement agencies [43], and in some countries clear recommendations are seen as preferable to the imposition of mandatory measures [44,45].

Connecting behavioural insights with risk communication

Risk and crisis communication is essential for translating the insights gained from behavioural science into messages that are readily understood and accepted by target audiences. An important starting point is seeking to ensure that both behavioural sciences and emergency risk communication are afforded dedicated strategic roles within emergency response structures. Messaging should be consistent across multiple sources, tailored to specific cultural contexts [46], and should provide guidance on specific actions that can be undertaken. Ideally messages should be delivered using a range of media, social and traditional and, when developing messages, it is always best to consult the specific target audience in advance, if possible [46]. The provision of messages to certain communities (for example those who are medically and socially vulnerable) may be facilitated by partnerships with civil society, and may also require community engagement strategies [47,48].

The need for ongoing behavioural research

As indicated above, an overriding principle for promoting compliance with NPI is that what works well in one setting or population group may be ineffective in another. Local conditions and local culture must be taken into account if an NPI strategy is to be acceptable and feasible, and several EU/EEA countries have been working to incorporate behavioural insights into their COVID-19 response work, including through ongoing assessments of public attitudes, behaviour and beliefs [49-51]. World Health Organization's Regional Office for Europe has also developed a COVID-19 survey tool for use by Member States [52], and this has been in use in Germany since March [53]. Through this work, changes in social norms and expectations in different settings can be investigated, emerging issues (for example, stigma, misperceptions and conspiracy theories) can be identified, and direct feedback can be obtained from the population on current NPI strategies. This will enable a strong foundation to be built for planning and risk communication activities, to ensure that NPI are socially acceptable and feasible.

Cross-country datasets on COVID-19 knowledge, attitudes and behaviour have also been produced, providing useful comparisons of the acceptability and uptake of different NPI over time and in different countries [54]. In addition, innovative means have been developed for collecting anonymised, aggregated data on people's movement – which can act as a proxy for compliance with measures (e.g. stay-at-home measures) – one example being wearable activity tracking devices [55]. Analysis of Twitter has provided feedback on the public responses to COVID-19 NPI regimes [56], while Google's COVID-19 Community Mobility Reports give aggregated, anonymised details of daily mobility patterns in communities across the globe which can be used to analyse compliance with stay-at-home and other large-scale NPI [57].

In spite of these advances, there is currently a dearth of evidence on the evaluation of strategies to promote NPI compliance, and strong calls have been made to address this situation [36]. There is also very limited qualitative research in the literature on this subject, even though such an approach could throw important light on issues that may not be amenable to survey-type data, such as providing insights into potential barriers and facilitating factors for compliance with various NPI in different populations.

Non-pharmaceutical interventions

The non-pharmaceutical interventions (individual, environmental and population-level) are set out in three groups below.

Individual level

1. Physical distancing

Avoiding physical contact and keeping a physical distance of 1–2 m is considered to be a key preventive measure and physical distancing has been widely promoted in Europe and worldwide.

Evidence base for the measure

Currently there is scientific uncertainty regarding the distance that the SARS-CoV-2 can travel from an infectious individual when breathing, talking, coughing or sneezing. Therefore the correlation between proximity to an infectious person and the risk of virus transmission has not been completely defined. Furthermore, the risk of transmission is influenced by various factors that make each contact situation unique. Factors influencing the risk of transmission are the setting (indoors or outdoors), whether the infectious individual is coughing, sneezing or talking at the time of contact, the duration of exposure, and environmental conditions such as temperature, humidity and the type of air flow. Transmission risk is also related to other factors such as the concentration of viral particles in respiratory droplets and the amount of droplets produced. Although the evidence suggests that SARS-CoV-2 may travel more than two metres, the risk of transmission decreases with the distance from the infectious source [58]. In a recent systematic review and meta-analysis, physical distancing of one metre or more was linked to an approximately five-fold reduction of the transmission risk, with twice the increased protective effect for every extra metre of distance added [59]. In addition to ensuring appropriate distance, physical barriers, such as transparent screens, can be used to decrease exposure to infectious droplets, especially in settings where there are multiple interactions and physical distancing is not possible (e.g. cashiers).

Considerations for implementation

Posters can be used as a reminder to keep a physical distance, especially in places which tend to get crowded. Floor markings spaced at the recommended distance, seat markings and rearrangement of furniture can also facilitate the implementation of the measure in places where people gather, such as shops, public transportation and restaurants.

Keeping an appropriate physical distance may not be feasible in all settings, such as in households, on public transportation and for some occupations that involve close contact with other people.

2. Respiratory hygiene

Respiratory hygiene refers to covering the mouth and nose when coughing and sneezing (e.g. using a paper tissue or cloth handkerchief) with the aim of reducing person-to-person transmission through droplets which are a known mode of transmission for coronaviruses [60].

Cough etiquette is widely recommended in public health guidelines for all community settings (home, schools, workplaces, healthcare settings, etc.) at all times for all respiratory viruses and for COVID-19. Appropriate materials need to be supplied (e.g. tissues, no-touch waste bins, etc.). It is important that tissues are properly disposed of immediately after use and hands are then washed with soap and water [60].

Adherence to respiratory hygiene measures is strongly recommended throughout the course of the COVID-19 pandemic and as a good practice for the prevention of all diseases transmissible by direct contract as a result of respiratory secretions.

3. Hand hygiene

Hand hygiene refers to the frequent and appropriate washing of hands with soap and water or cleaning of hands with solutions, gels or tissues. Hands should be washed regularly using soap and water for 20–40 seconds; if hands are soiled, soap and water should precede the use of hand sanitisers [61]. The literature reports that alcohol-based hand sanitisers offer limited added benefit over soap and water in community settings and, if used, should contain 60–85% alcohol [59,60].

Recommending hand hygiene is considered a rational precaution, involving limited costs and no significant associated risks. Its effectiveness will probably increase in combination with other measures (e.g. use of face masks).

Evidence base for the measure

Hand hygiene is recommended as a key measure in multiple settings (healthcare and community settings) for the prevention of COVID-19, based on evidence from studies on influenza and other respiratory viral infections and on the capacity of SARS-CoV-2 to survive on environmental surfaces and objects [61-64]. Hand disinfection with alcohol-based solutions and hand washing inactivates influenza virus [65,66], and presumably also SARS-CoV-2, on hands. So far, there are only a limited number of studies on the effect of hand hygiene on the prevention of

COVID-19. A study from China reported that both sub-optimal hand hygiene before and after contact with patients was linked to an increased risk of infection [69].

An updated Cochrane systematic review on the effectiveness of hand hygiene, surface disinfection and other hygiene interventions in preventing the spread of respiratory viral illnesses identified 25 randomised trials comparing hand hygiene with a control group [70]. Hand hygiene interventions were associated with a 16% relative reduction of acute respiratory illness and a 36% reduction in absenteeism, although the effect on influenza-like illness and laboratory-confirmed influenza were not significant. The authors highlighted multiple limitations, such as the often small size of the trials, the high risk of bias and the heterogeneity of the interventions.

Considerations for implementation

Adherence to proper hand hygiene measures is strongly recommended throughout the course of the COVID-19 pandemic and as a good practice for the prevention of all diseases transmissible by direct contract through respiratory secretions or the faecal-oral route.

Hand hygiene is a complex behavioural issue and compliance has been erratic, even among trained healthcare workers [69]. Adherence has been sub-optimal even in interventional trials. Factors such as knowledge, perceptions, social acceptability and behavioural cues play key roles in adherence and need to be addressed by means of targeted information and educational campaigns. Widespread availability of hand-washing facilities, water, soap and hand hygiene solutions are crucial and need to be ensured. Skin irritation is the most commonly reported adverse effect linked to hand hygiene [68,70,71]. In addition, since the beginning of the pandemic there have been reports of serious adverse events, including deaths, after ingestion of alcohol-based hand rub solutions and abuse of disinfectants [72,73].

4. Face masks

A medical face mask (also known as surgical or procedure mask) is a medical device covering the mouth, nose and chin to provide a barrier that limits the transmission of an infective agent between hospital staff and patients. The masks are used by healthcare workers to prevent large respiratory droplets and splashes from reaching the mouth and the nose of the wearer and to help reduce and/or control the spread of large respiratory droplets at source. Medical masks comply with requirements defined in European Standard EN 14683:2014. Non-medical face masks (or 'community' masks) include various forms of self-made or commercial masks and face covers made of cloth, other textiles or other materials, such as paper. They are not standardised and are not intended for use in healthcare settings or by healthcare professionals. A respirator or filtering face piece (FFP), is designed to protect the wearer from exposure to airborne contaminants (e.g. infectious agents inhaled as large or small particle droplets) and is classified as personal protective equipment (PPE). Respirators are mainly used by healthcare workers to protect themselves, especially during aerosol-generating procedures. Respirators comply with requirements defined in European Standard EN 149:2001+A1:2009. Because the various respirators fit users differently, they need to be fitted individually in order to match each user.

Respirators are specifically designed to protect users from small airborne particles, including aerosols [74,75]. They are usually available in three sizes (small, medium or large) to allow for differences in face contours. European standard (EN 149:2001+A1:2009) defines classes of respirators depending on whether they are entirely or substantially constructed of filtering material [filtering face pieces (FFP) categories 1-3] [76].

Use of face masks in the community

Implementation of the use of face masks in the community when physical distancing cannot be guaranteed should be strongly considered, both indoors (e.g. supermarkets, shops and public transport) and in crowded outdoor settings in areas with community transmission of COVID-19. In addition, use of face masks should be strongly recommended for groups at risk of developing severe complications if infected (e.g. individuals in older age groups or having underlying conditions) and in people whose occupations involve extensive face-to-face contact with the public in areas where there is ongoing transmission.

Proper use and disposal of masks and proper hand hygiene need to be ensured by training users before distributing masks.

According to the ECDC Response Measures Database, 25 countries in the EU/EEA and the UK have implemented national recommendations for the use of face masks. In most countries, the use of masks was mandatory in closed public spaces or in public transport. Only three of the 25 countries had classified the recommendation to use masks as 'voluntary'. As of 9 September 2020, the mandatory mask use recommendations in EU/EEA and the UK had a median duration of 110 days (interquartile range (IQR) 49–126 days).

Evidence base for the measure

There is increasing evidence showing the effect of face masks in preventing SARS-CoV-2 transmission. In a recent systematic review, Chu et al. determined that on average there was more than a five-fold reduction of the transmission risk, from 17.4% with no face mask to 3.1% with a face mask (e.g. N95, surgical, or 12–16 layer cotton mask) [77]. In addition, several other studies on the use of either medical or non-medical face masks in the community have provided evidence on the efficacy of this measure at individual [78-80] and population level [81-83]. The evidence shows that face masks are not only effective in reducing the release of respiratory secretions (source control) [85], but also in protecting individuals that wear them correctly from infection (self-protection)

[86]. Furthermore, use of face masks is thought to be linked to milder disease among infected individuals by reducing the infectious inoculum [87].

Several recent studies show that non-medical face masks made of cotton and synthetic materials have favourable filtering properties comparable to medical face masks [87-93]. However, this depends on the material and the construction of the face mask, including layering (3–16 layers [95]) and combination of materials. So far, no studies have directly evaluated the effect of non-medical face masks on transmission. The European Committee for Standardisation (CEN) and other standardisation agencies have established standards for non-medical face masks [96,97].

Considerations for implementation

Proper use of face masks is the key to effectiveness and can be improved by clear guidance and appropriate communication and educational campaigns. ECDC has produced and published infographics [98] and videos [98-100] on how to properly put on and discard a face mask in the community. Concerns that mandatory face mask usage would generate a false sense of security that could decrease adherence to other types of protective behaviour, such as physical distancing, have been shown to be unfounded in several studies [102,103]. Use of face masks has been associated with decreased face-touching [104]. The decision to introduce mandatory use of face masks in community settings should take into account the local context, the availability of face masks for the public (which should not compromise the availability of face masks for health and social care workers) and the resources available to monitor implementation. The use of face masks in the community should be considered as a complementary measure and not as a replacement of the other preventive measures that are recommended to reduce community transmission [105].

Compliance with the use of face masks is affected by several factors such as availability, gender, age, and perceptions of vulnerability and severity of disease [106]. Women and the elderly are more willing to wear face masks than men and younger people. Social acceptance and perceived pressure from the family, mass media and the government are also associated with increased use of face masks. In contrast, limited knowledge of the disease is linked to lower compliance.

Policies on the use of face masks in the community for the prevention of COVID-19 transmission should take into account some potential barriers and side effects [107]. People wearing a face mask may perceive anxiety and difficulty in breathing [108]. This may be pronounced in individuals with underlying respiratory disease. However, there is no evidence that wearing a face mask exacerbates respiratory or other diseases. In addition, face masks may also impede communication, especially among people with hearing impairment [109] or during educational activities in schools.

Availability of medical face masks is expected to be limited during a pandemic and was indeed a large problem during the initial phase of the COVID-19 pandemic. This can be a serious barrier for the implementation of face mask policies in the community and needs to be addressed. Although the supply chain of medical masks has now recovered, the costs incurred by individuals in complying with this recommendation could be high. This may hamper the successful implementation of the NPI. Furthermore, individuals may choose to re-use face masks designed for single use, which could result in increased risk of self-contamination.

Use of non-medical ('community') face masks is an option that has been adopted widely and may successfully address the issue of availability and cost. Although there is no direct evidence that non-medical face masks are effective in protecting the user from COVID-19, data from experimental studies show that non-medical face masks have similar filtration characteristics to medical face masks. Furthermore, non-medical face masks can be produced easily in large quantities and are reusable [110].

Finally, the potential environmental implications of the widespread use of face masks should be considered when developing a face mask policy. The production and disposal of large amounts of face masks made of synthetic materials may have a harmful impact on the environment, if not appropriately managed [111].

The effect of using face masks depends on the prevalence of the disease in the community and would be more pronounced in settings with widespread community transmission. In places without significant community transmission, the potential harms and costs may outweigh the benefit [104,111].

5. Face shields and goggles

Face shields (visors) and goggles are used in healthcare in combination with face masks to prevent infectious droplets from reaching the eyes. A systematic review of evidence from SARS, MERS and COVID-19 in healthcare settings has shown that eye protection is effective in preventing infection [77]. However, thirteen out of 15 studies did not adjust for the possible confounding effect of the concomitant use of other PPE including face masks and therefore it is difficult to determine the independent effect of eye protection.

Face shields/visors have also been extensively used in the community as a substitute for face masks, based on the hypothesis that they represent a barrier to respiratory droplets in both directions. One experimental study using a coughing patient simulator and a breathing healthcare worker simulator showed that face shields can reduce the short-term exposure to large respiratory droplets by up to 96% but are less effective against smaller droplets that tend to be suspended in the air (68–80% reduction)[113]. Based on these results, face shields have been advocated for use in the community, given that they offer a number of advantages over face masks [114], such as ease of decontamination, the fact that they do not hinder communication, and that they are better tolerated.

However, due to lack of evidence for the effectiveness of face shields in the community and concerns about sub-optimal protection against aerosols, face shields/visors are only recommended in combination with face masks.

6. Gloves

The use of gloves for the prevention of SARS-CoV-2 transmission is considered ineffective. There is no documented transmission of SARS-CoV-2 by direct contact through the skin. To avoid bringing infectious material from objects and surfaces to the mouth, nose or eyes, the most effective strategy is to observe strict hand hygiene and respiratory etiquette [115].

Gloves are therefore not recommended as a personal protective measure against COVID-19 in the community. Gloves do not confer additional benefit and may lead to inadequate hand hygiene and increased contamination of surfaces [115].

Environmental level

7. Environmental cleaning

SARS-CoV-2 can survive in the environment [61] and has been detected on frequently-touched surfaces in healthcare facilities [63,115]. As with other respiratory viruses, touching contaminated surfaces and subsequently transferring the virus to the nose, mouth or eyes through the hands is believed to be a route of transmission. Therefore, environmental cleaning is recommended to decrease the spread of the virus through this route.

SARS-CoV-2 is an enveloped virus and therefore is sensitive to common detergents and disinfectants effective against viruses. In situations where there is widespread community transmission, regular cleaning and disinfection of surfaces in public spaces is recommended [117].

Standard detergents can be used to clean frequently-touched surfaces (e.g. door handles, banister rails, buttons, wash rooms, buses, etc.). In settings where there are patients with COVID-19 (healthcare or home care), decontamination of surfaces with diluted household bleach, or other disinfectants active against viruses, is recommended after regular cleaning [117].

Other methods for surface disinfection, such as spraying (also referred to as fumigation) disinfectants outdoors or in large indoor surface areas (rooms, classrooms or buildings), or using UV light radiation, are not recommended in the community due to the lack of effectiveness, possible damage to the environment and the potential exposure of humans to irritant chemicals [118].

8. Ventilation

Heating, ventilation and air-conditioning systems may play a complementary role in decreasing transmission in indoor spaces (including means of transportation) by increasing the rate of air exchange, decreasing recirculation of air and increasing the use of outdoor air. The minimum number of air exchanges per hour, in accordance with the applicable building regulations, should be ensured at all times. Increasing the number of air exchanges per hour will reduce the risk of transmission in closed spaces. This may be achieved by means of natural or mechanical ventilation, depending on the setting [118-120]. The use of air recirculation without filtration should be avoided as much as possible [120,122].

Evidence base for the measure

Poor ventilation in confined indoor spaces is associated with increased transmission of respiratory infections [122]. Several outbreak investigations have shown that COVID-19 transmission is particularly effective in crowded, confined indoor spaces such as workplaces (offices, factories) and other indoor settings - e.g. churches, restaurants, gatherings at ski resorts, parties, shopping centres, worker dormitories, dance classes, cruise ships and vehicles [118,123-130]. There are also indications that transmission can be linked to specific activities, such as singing in a choir [129] or during religious services that may be characterised by increased production of respiratory droplets and aerosols through loud speech and singing. There is no evidence on the effectiveness of methods for decontamination of air (e.g. UV light irradiation) for use in community settings.

Considerations for implementation

Ensuring the implementation of optimal ventilation adapted to each particular indoor setting could be critical in preventing outbreaks and transmission amplification events. Implementing proper ventilation systems requires specific engineering knowledge and factors such as feasibility and energy conservation also need to be considered. Increasing natural ventilation by opening the windows may be a valid approach in some settings with poor ventilation but not in buildings with adequate ventilation where this measure may increase the burden on the ventilation system and cause undesirable turbulent air flows [132].

Population level

9. Limiting close physical inter-personal interactions

9.1 Isolation of symptomatic cases not requiring hospitalisation

This measure refers to the isolation of confirmed or probable cases of COVID-19 managed in dedicated isolation facilities or at home (mild cases) for a defined period of time. Although all symptomatic persons should be tested for SARS-CoV-2 [2], in situations of widespread community transmission or when the laboratory capacity is not sufficient, a blanket recommendation may be given for individuals with COVID-19-compatible symptoms to stay home. The isolation of cases can be voluntary or mandatory depending on national regulations. ECDC has published guidance for discharge and ending isolation in the context of widespread community transmission of COVID-19 [133].

The objective of the measure is to reduce the chance that possibly infectious individuals will have contact with others. Early identification of cases to ensure rapid isolation and contact tracing is of paramount importance to prevent further spreading of the virus in the community [133]. Viral load generally persists for up to ten days after the onset of symptoms in mild-moderate cases and up to 20 days in severe cases [13].

Based on the SARS-CoV-2 clinical presentation, the most commonly observed symptoms are fever, cough, myalgia, fatigue and other non-specific respiratory symptoms, similar to those for other respiratory virus infections [134]. This makes clinical diagnosis particularly challenging when other respiratory viruses are co-circulating, for example during the influenza season [134]. Fever has been the most commonly-reported symptom for SARS-CoV-2 but this may not be present in some patients [134]. Other commonly-reported symptoms include loss of smell and taste, and gastrointestinal symptoms such as nausea, vomiting and diarrhoea [135]. Since asymptomatic cases are also well-documented [136-138], isolating individuals with COVID-19 compatible symptoms will be only partially effective.

Local areas of very intense SARS-CoV-2 transmission have been reported in Europe and elsewhere [139-141]. These areas often had high population density and the initial chains of transmission went undetected until widespread transmission was occurring. In such situations, population-wide testing strategies (testing all individuals, irrespective of symptoms) may be appropriate. Such an approach would enable public health authorities to identify most of the infectious COVID-19 cases at a given point in time (e.g. including pre-symptomatic, pauci-symptomatic, and asymptomatic cases), allowing for their prompt isolation and interruption of transmission chains. Depending on the size and population density of the affected area, and the capacity to reach, test and isolate, as well as to trace and quarantine contacts of cases, such an approach could be more cost effective than introducing and ensuring long-term compliance to more stringent public health measures. However, the effectiveness/cost-effectiveness of this approach remains unknown and the testing approach should not compromise the accessibility of testing for those who are symptomatic. Without timely analysis and notification to isolate cases, population-wide testing alone would not be effective in reducing transmission.

Evidence base for the measure

It is suggested that self-isolation of individuals with symptoms of a respiratory infection can reduce disease transmission and limit the spread of the virus in the community during an epidemic, as seen during influenza epidemics and pandemics [142]. During the COVID-19 pandemic so far, most interventions have been implemented in parallel or in rapid succession in the majority of the countries, and as such it is difficult to isolate and quantify the individual effect of each intervention.

Nevertheless, evidence from the COVID-19 pandemic suggests that isolation is an effective measure for reducing transmission [143]. A modelling study estimated that a high proportion of cases would need to self-isolate and a high proportion of their contacts would need to be successfully traced and quarantined, to keep the effective reproduction number below one in the absence of other measures [144]. Another study suggests that early detection, self-isolation, proper hand hygiene, and household quarantining will probably be more effective than travel restrictions in mitigating this pandemic [145].

On the other hand, although isolation, in combination with contact tracing, probably slowed early SARS-CoV-2 transmission, it was insufficient as a measure to contain the pandemic [146]. This was also concluded by a modelling study that assessed the effect of self-isolation as well as of other social distancing measures in 11 EU countries [15]. Simulation studies, assuming that self-isolation of symptomatic individuals would decrease their infectiousness by 35%, showed that self-isolation alone, or in combination with other measures (school closures, shielding of older people) would not be able to sufficiently decrease healthcare needs, or bring the reproduction number below one for a sustained period of time [146].

The effectiveness of voluntary isolation is reduced due to transmission via asymptomatic or pre-symptomatic cases. The presence of asymptomatic infections has been documented [136-138,147] and this means that isolation based on symptomatic case identification would be unlikely to fully prevent ongoing transmission. Furthermore, severe or immunocompromised cases could remain infectious for periods longer than that currently recommended for isolation, thus further reducing the effectiveness of such measure [13,148].

Considerations for implementation

There are complicated logistical issues associated with this measure (e.g. food provision, medical supplies, medical care) and training and supplies will therefore be essential to ensure support and infection control (e.g. PPE, proper waste disposal) for household members caring for a person who is ill.

Unless carefully managed, the isolated patient may not receive adequate care and support, especially if elderly or living alone. Caregivers would also have to stay at home to care for a patient. Those who are infected, and often their caregivers, will not be able to report to work or go to school, and therefore there may be financial and practical disincentives (e.g. lost income or job insecurity). Support for the financial, social, physical and other needs of patients and caregivers require careful planning.

In addition, healthy individuals in the same household with an isolated patient will have a high risk of infection. A combination of personal protective and environmental measures during isolation may reduce household transmission [142]. Educational activities and adequate supplies are essential to control infection among household members, especially those caring for people who are ill.

Acceptability will also determine the effectiveness of any measure. Although isolation could be well-accepted in certain settings, its acceptability may vary considerably. A systematic review of the public perception of non-pharmaceutical measures for reducing transmission of respiratory infections revealed concerns about isolation due to the perceived adverse impact and social stigma [22]. In five studies carried out during the 2009 influenza pandemic, between 50% and 96% of respondents stated that they would stay home from work if they experienced symptoms, whereas six other studies found that only <1% to 26% would do so [149].

9.2 Quarantining of contacts

Quarantining of contacts refers to isolation of healthy people who have had a high-risk exposure to a confirmed COVID19 case, as outlined in ECDC's guidance on contact tracing [1]. Some countries have also implemented quarantine for persons who have had exposure to a situation where transmission of SARS-CoV-2 may have occurred (e.g. travellers from areas with community transmission). Quarantine can be voluntary or mandatory and national strategies vary in EU/EEA and the UK.

The recommendation is usually to self-quarantine at home or in a dedicated facility and self-monitor for appearance of COVID-19-compatible symptoms. Public health authorities may call the contact person during the quarantine period to actively monitor symptoms. If symptoms are detected, testing should be carried out. The objective is the early detection of cases and separation from other healthy people to avoid transmission if disease develops, even during asymptomatic, pre-symptomatic or subclinical phases of the disease. ECDC also recommends that contact persons without symptoms are tested as soon as they are identified, which would allow further contact tracing to take place, given the risk that pre-symptomatic transmission may have occurred prior to the start of quarantine.

Inherent in the word quarantine is the idea of enforcement. Sometimes 'voluntary self-isolation', or even 'voluntary quarantine', or 'self-quarantine' are used to infer that people comply voluntarily with public health recommendations. 'Quarantine' differs from 'isolation' in that the latter refers to the separation of infected cases from other people to avoid the spread of the virus.

The duration of the quarantine depends on the estimated incubation period of the virus. The median incubation period for general transmission is considered to be five to six days for COVID-19, but may range from one to 14 days [8-11]. A systematic literature review and meta-analysis (preprint) estimated that only 20 of 10 000 contacts in active monitoring may develop symptoms between 14 and 21 days after exposure [8]. A duration of 14 days is therefore considered sufficient for monitoring people who have had contact with SARS-CoV-2 cases [8-10]. A test at day 10 after last exposure can be used to discontinue quarantine early if the test is negative [2]. Emerging evidence from modelling suggests that contacts could be tested and released even earlier from quarantine, given certain criteria on the timeliness of the contact tracing process are met, although ending quarantine early has a residual risk which may not be acceptable in certain circumstances, for example in the context of vulnerable populations [150].

The efficiency and resources needed to implement quarantine are dependent on the definition and, in particular, the scale of exposure in the target population. ECDC's guidance on contact tracing [1,151] should be used to assess the potential risk and plan the actions associated with contact tracing.

Evidence base for the measure

Recent evidence from the COVID-19 pandemic suggests that quarantine can be effective in reducing transmission and preventing new COVID-19 cases or deaths, if it is implemented early and in combination with other public health measures [151,152]. Evidence relating to influenza pandemics also indicates that quarantining exposed people may delay the peak of a local epidemic during the early stages, thus helping to reduce the burden of disease and delay further spread [142].

Furthermore, modelling studies consistently report a benefit from simulated quarantine measures. For example, quarantining of people exposed to confirmed or suspected cases averted 44–81% of incident cases and 31–63% of deaths compared to no measures, based on different scenarios [151]. A review of modelling studies suggested that when the models combined quarantine with other prevention and control measures, including school closures, travel restrictions and social distancing, they demonstrated a greater effect on the reduction of new cases, transmissions and deaths than individual measures alone [151]. Studies on SARS were also consistent with the findings from studies on COVID-19 [151]. Overall, quarantine may reduce the number of cases and delay the peak of transmission and the effectiveness of this measure is enhanced when it is implemented in combination with other measures.

Rapid identification of cases through contact tracing enhances the effectiveness of quarantine measures. It is crucial that symptomatic people are tested as soon as possible after symptom onset, test turnaround time is minimised and contacts are traced as rapidly as possible. Nevertheless, not all contacts may be quarantined early enough to prevent onward transmission. Modelling studies suggest that in addition to quarantine for high-risk contacts, the household members of such contacts could also be quarantined to minimise onward transmission [153,154].

Considerations for implementation

There are considerable logistical, social and communication challenges in implementing quarantine measures. Some people may be unable to quarantine at home - for example, if they have communal living arrangements. If resources allow, public health authorities could arrange to receive people at specially-arranged quarantine facilities (e.g. hotels). Quarantine may place a significant burden on the individual and Member States could consider supportive action, such as providing food and medicines. This would also reduce the risk of quarantined individuals having to go out and meet other people. There can also be substantial costs associated with quarantine, mainly due to a significant number of people being off work and the amount of testing needed for contact tracing purposes.

Compliance and acceptability may vary. Experience from previous pandemics and the SARS epidemic showed that compliance was sub-optimal in communities with cultural similarities to Europe [155,156]. When quarantine measures are implemented, national laws and regulations have to be taken into account. Engaging with quarantined contact persons through regular follow-up, encouragement and a discussion of the importance of quarantine could help compliance, but this is resource intensive.

9.3 Shielding medically- and sociably-vulnerable populations

These NPIs refer to interventions that specifically aim to protect medically- and socially-vulnerable individuals.

Medically-vulnerable people are those with an elevated risk of severe disease and death due to COVID-19. These include, but are not limited to, older people, those living in long-term care facilities, and people with underlying health conditions such as high blood pressure, obesity or diabetes [158].

Since early March 2020, and according to the ECDC Response Measures Database, 19 countries in the EU/EEA and the UK have implemented specific 'stay-at-home' recommendations for risk groups or vulnerable populations [159]. The median duration of these recommendations, as of 9 September, was 176 days (IQR 136-181).

Socially-vulnerable groups include individuals who are more liable to suffer from the consequences of the measures imposed (feelings of abandonment, loneliness), while being less able to comply with them due to their living conditions [160,161]. These include people with long-term physical, mental, intellectual or sensory impairments, the homeless, those living in abusive household settings, sex workers, and others [47,158]. These groups are also more likely to live in settings where the risk of SARS-CoV-2 outbreaks is higher.

9.4 Recommending 'social bubbles'

One approach to reducing the intensity of physical distancing involves 'social bubbles' [161,162]. Consistently meeting with the same people, whether friends or co-workers, can allow for a greater degree of contact, while still minimising the risk of SARS-CoV-2 transmission and associated outbreaks.

The concept has been used if several countries (e.g. New Zealand, Belgium and the United Kingdom) to mitigate the negative effect of social isolation by allowing increased social contacts, while limiting transmission risk [164]. According to the ECDC Response Measures Database, 15 countries in the EU/EEA and the UK have implemented different levels of stay-at-home recommendations for the general population, often with the recommendation to limit contacts to members of the household. As of 9 September 2020, the duration of stay-at-home-recommendations was a median of 49 days (IQR 16–62 days).

Evidence base for the measure

To our knowledge, no studies have evaluated the specific effect of social bubbles on real-life data. The effect of the measure has been shown on simulated data in modelling studies. For example, one study found that household bubbles of two households which were connected four days a week with a maximum age gap of three years would reduce hospital admissions by 50 to 75%, even though the authors recognise that the measure on its own would not be sufficient to prevent a resurgence of cases [165].

9.5 Long-term care facilities (LTCFs)

European countries have reported deaths attributed to COVID-19 among 5–6% of all current LTCF residents, and/or reported that up to 66% of all fatal cases have been among LTCF residents [165,166]. Therefore the LTCF setting demands specific attention.

The closed environment of LTCFs facilitates the spread of infectious diseases among residents. Furthermore, residents are typically medically- and/or socially-vulnerable, needing constant supervision and high-skilled nursing care [167,168].

The rapid spread of SARS-CoV-2 within and between LTCFs is fuelled by the transmission dynamics of COVID-19; the potential for asymptomatic transmission among and between staff and residents, the relatively low availability

of regular testing for staff and for residents, particularly upon (re-)admission, and the tendency for staff to work at more than one LTCF at a time [166,169].

Factors that have hampered the response to COVID-19 in LTCFs have included insufficient availability of PPE and human resources; insufficient training in infection prevention and control (IPC) including use of PPE and case management and the relatively low rate of hospital admissions from LTCFs [169-172]. Furthermore, there are substantial differences in the organisation of long-term care between and within European countries, affecting infectious disease preparedness and response in LTCFs. These were well documented by the European Social Policy Network (ESPN), in its 2018 report for the European Commission Directorate General for Employment, Social Affairs and Inclusion [174], and in the country-level reports summarised in that document [175]. The ESPN lists four main challenges which are common to all European countries: the 'adequacy of long-term care provision, the quality of formal home care as well as residential services, the employment of informal carers, and the financial sustainability of national long-term care systems' [174]. A WHO policy objective for mitigation of the impact of COVID-19 across long-term care recommends that countries 'initiate steps for transformation of health and long-term care systems to appropriately integrate and ensure continuous, effective governance of long-term care services' [176].

The ECDC guidance 'Infection prevention and control and preparedness for COVID-19 in healthcare settings' has specific recommendations for LTCFs, aligned with information on occupational health and safety from European Agency for Safety and Health at Work (EU-OSHA), in accordance with Occupational Safety and Health (OSH) regulations and codes of practice [177]. Crucially, the guidance also recommends that, in areas with community transmission, visitors and LTCF staff who provide care for residents or have contact with residents or communal areas of the LTCF should consider wearing medical masks at all times in addition to practising meticulous hand hygiene. Enhancing hand hygiene and physical distancing among residents, staff and visitors and even restricting non-essential visits and activities in areas with widespread community transmission are also recommended, although this should be balanced against the needs of the residents for care and social interaction. ECDC's 'Framework to monitor responses to the COVID-19 pandemic' specifically includes indicators to measure face mask policy, consumption and availability in LTCFs, in order to guide the public health response at sub-national, national and EU level response to COVID-19 in the EU/EEA and the UK [178].

ECDC's documents 'Surveillance of COVID-19 in long-term care facilities in the EU/EEA' [170] and 'COVID-19 testing strategies and objectives' [2] include a recommended testing strategy to quickly identify cases, including pre- and asymptomatic cases, to enable prompt case management, including isolation. An important benefit arising from the participation of LTCFs in regular COVID-19 surveillance is the establishment of communication lines between LTCFs and the health authorities prior to the start of an outbreak. In addition to providing situational awareness of the number and proportion of affected LTCFs and LTCF residents, ECDC's surveillance guidance and ECDC's monitoring framework both include indicators for medical mask use and availability [170].

There is also an increased risk of severe COVID-19 impact in other similar settings. These include hospital long-term care wards, hostels (without any type of nursing care), sheltered care homes, day centres, home-based centres and facilities for protected living. These settings may require specific interventions, however if special provisions are not available, countries could refer to available guidance for LTCFs and community care. ECDC's document 'Guidance on the provision of support for medically and socially vulnerable populations in EU/EEA countries and the United Kingdom during the COVID-19 pandemic' [47] contains considerations for institutions supporting the homeless and people with alcohol or drug dependence.

Considerations for implementation

Socially vulnerability in LTCF residents can be exacerbated by NPI for COVID-19 [159,178,179]. Relevant considerations for LTCFs, other than communicable disease prevention and control, are contained in WHO's policy brief 'Preventing and managing COVID-19 across long-term care services' [176] and technical working guidance 'Strengthening the health system response: Preventing and managing the COVID-19 pandemic across long-term care services in the WHO European Region' [181]. These include the psychological impacts resulting from measures that limit inter-personal interactions; the health impact of reduced access to appropriate external healthcare and from potentially reduced care due to staff shortages; the mental healthcare requirements for staff, residents and relatives and the requirement to secure access to dignified palliative care services during this pandemic.

The implementation of NPI measures in LTCFs, as with all NPI listed in this document, will vary among countries and cultures. As seen in European acute care hospitals, according to the Hofstede model definitions of cultural dimensions, uncertainty avoidance and power distance correlate with national rates of pre-surgical prophylaxis [182] and were estimated to explain between 25% and 50% of the variance in infection-related processes and outcomes [182]. Other than the Hofstede dimensions, in Europe several direct and proxy measures of national differences in social, economic, health system and policy practices also correlate with ambulatory antimicrobial consumption and antimicrobial resistance [184]. The experience in these settings reinforces the need for locally-adapted implementation of NPI in LTCFs.

9.6 Prisons

Prisons and general detention settings necessitate a strong, adapted surveillance and public health response to infectious diseases, including COVID-19, to limit spread and reduce the impact among prisoners and staff. While prisons are by definition closed environments, connections with the local community mean that progress in addressing infectious disease in the community will be hampered if the situation in prisons is not addressed. Responses should be carefully developed in light of the environmental factors that may increase the transmission risk of infectious diseases

such as COVID-19 (e.g. overcrowding and unsanitary facilities) and the demographic profile of the prison population with a high proportion of individuals at risk of severe COVID-19 [185].

There is currently limited published data on the number of cases of COVID-19 in prisons in EU/EEA countries and the UK, but there have been reports of outbreaks in prisons in several European countries [186,187]. The COVID-19 situation poses a major challenge for prison services, and has had a marked impact across the judicial sector, including court procedures, the probation service and prisons.

The recommended measures for containing COVID-19 transmission in prisons are outlined in ECDC's guidance [185]. These include the standard IPC measures in combination with specific physical distancing measures to reduce overcrowding, restrict visitors and 'cocoon' people at high-risk of severe disease. The guidance also includes recommendations for maintaining a COVID-19 free prison through rigorous implementation of IPC measures and a widespread testing strategy to identify cases early on and a system of cohorting to minimise the introduction of infection from new arrivals to the prison.

9.7 Migrants and refugees residing in reception and detention centres

Environmental factors such as overcrowding in reception and detention centres may increase exposure to SARS-CoV-2 among the migrants and refugees living there [188] . Outbreaks in reception and detention centres can spread quickly in the absence of adequate prevention measures.

All principles of physical distancing applied in the community should be applied in migrant reception and detention settings. Providing free and equitable prevention, testing, treatment and care to migrants and refugees in reception and detention centres is critical at all times, but particularly in the context of COVID-19.

There is no evidence that quarantining whole camps effectively limits transmission of SARS-CoV-2 in reception and detention settings, or that it provides any additional protection to the general population other than that which could be achieved using conventional containment and protection measures.

If physical distancing and risk-containment measures cannot be safely implemented, consideration should be given to reducing numbers or evacuating residents. In all situations where physical distancing cannot be maintained or properly implemented, the use of medical or non-medical face masks by migrants in reception and detention centres can be considered as a means of source control. In addition to physical distancing and use of face masks, hand and respiratory hygiene are the main non-pharmaceutical measures that should be considered and implemented in migrant reception and detention centres.

Communication on the risks and prevention of COVID-19 with migrant and refugees currently housed in reception and detention centres requires community engagement and health communication strategies that are adapted to meet the language, cultural and literacy needs of the different populations.

Migrant and refugee reception and detention centres should be given priority for testing, due to the risk of SARS-CoV-2 spreading rapidly in these settings. All individuals with COVID-19-compatible symptoms should be tested on arrival, and possible, probable or confirmed COVID-19 cases not requiring hospitalisation should be isolated or separated from others. Contact tracing should be undertaken for all cases identified as positive. New arrivals can also be considered for testing, irrespective of symptoms, to reduce the risk of cases being introduced into reception and detention centres. However, a negative test does not exclude the possibility of the person becoming infectious in the 14 days following the test.

9.8 Limiting size of gatherings

Limiting the size of indoor and outdoor gatherings is a measure to reduce the likelihood of SARS-Co-V-2 spreading to large numbers of people. It is recommended when there is community transmission, regardless of the incidence levels. Irrespective of the number of people permitted to gather, interpersonal distancing measures should always be in place, along with recommendations concerning personal measures, such as hand and respiratory hygiene, and the wearing of face masks. Additional organisational measures such as event cancellation, postponement or re-arrangement should be considered, depending on the underlying epidemiological situation.

Mass gatherings increase the number of close contacts between people for long periods, sometimes in contained spaces. Therefore, mass gatherings may lead to the introduction of the virus into the community hosting the event and/or facilitate virus transmission and spread. The potential role of mass gatherings in spreading SARS-CoV-2 has been documented during the course of the COVID-19 pandemic [189].

According to the ECDC Response Measures Database, 29 countries in the EU/EEA and the UK have implemented limitations on mass gatherings, with events limited to various sizes, and other limitations/recommendations being applied simultaneously. The median duration of overall mass gathering limitations, as of 9 September 2020, was 123 days (IQR 92 to 179 days). The median duration of stricter limitations on smaller gatherings with less than 50 participants was 95 days (IQR 76 to 129 days).

A recent analysis of eight non-pharmaceutical interventions implemented in 41 countries found the highest reduction of the effective reproduction number *R* when gatherings were limited to 10 people or less (36%; 16–53%), as opposed to 100 people or less (21%; 1–39%) and to 1 000 people or less (2%; -20–22%) [190]. Data originating from seasonal and pandemic influenza models indicate that during the mitigation phase, cancellations of mass gatherings before the peak of epidemics or pandemics may reduce the height of the epidemic.

The extent of transmission during mass gatherings may justify the application of other measures (e.g. web-casting, education campaigns on good hygiene, enhanced environmental measures) and a risk assessment, depending on the type of event. Individuals in high-risk groups should refrain from attending mass gatherings when there is SARS-CoV2 community transmission.

9.9 Measures at the workplace, including teleworking

According to the ECDC Response Measures Database, 25 countries in the EU/EEA and the UK had either implemented teleworking recommendations or, in some instances, closed workplaces. The median duration of these recommendations, as of 9 September 2020, was 136 days (IQR from 76 to 180 days).

SARS-CoV-2 can transmit from person-to-person at workplaces and in other public settings where people gather in contained spaces for long periods, as shown by several outbreaks in occupational settings [191]. Viral transmission may therefore be reduced by decreasing the frequency and length of social interactions and the physical contacts between individuals. Studies on seasonal and pandemic influenza have also shown that measures at workplaces can be modestly effective in mitigating an epidemic and these could therefore be considered during the mitigation phase.

Workplace measures refer to a variety of actions to reduce the risk of transmission in the workplace and the community. These measures include flexible working schedules/shifts for employees; the opportunity for distance working/teleworking; encouraging physical distancing measures within the workspace; increased use of email and teleconferences to reduce close contacts; reduced contact between employees and customers; reduced contact between employees; adoption of flexible leave policies and advocating the use of other personal protective countermeasures [192]. In the event of acute respiratory illness, self-isolation is advisable.

The selection of measures will depend on the company and the type of work. Personal protective and environmental measures should be applied in combination at workplaces.

Workplace closures may be justified in exceptional circumstances, depending on the type of workplace and local epidemiological situation (e.g. when stricter measures are necessary to reduce transmission). Employees should be encouraged to self-isolate at home if experiencing respiratory symptoms.

9.10 Closure of non-essential businesses

According to ECDC Response Measures Database, 25 countries in the EU/EEA and the UK have implemented different types of closures for non-essential businesses or public places, most commonly closing or limiting the opening hours of entertainment venues and cafés, bars and restaurants. The closure of non-essential businesses (not including grocery stores and pharmacies), along with gyms and sports centres, was almost as common. The median duration of the closures was 53 days (IQR 46 to 63 days), with considerable variation in the duration and completeness of the closure of different public spaces.

Evidence base for the measure

A recent analysis of the effect of eight non-pharmaceutical interventions in 41 countries between January and May 2020 found that closing (some) high-risk businesses reduced the SARS-CoV-2 effective reproduction number by 31% (13–46%), which was only slightly lower than the effect of closing most non-essential businesses; 40% (22–55%) [190]. Examples of businesses included in the `high-risk' category were restaurants, bars, nightclubs, cinemas and gyms. Another study identified dining at a restaurant as a risk factor for COVID-19 but not visiting a gym or a bar/coffee shop [192].

Considerations for implementation

Closure of some businesses that are linked to the gathering of people in indoor spaces is an option for reducing transmission, while avoiding large-scale economic and social impact.

9.11 School closures

To date, school-aged children and children attending day-care facilities have been considered to be among the main drivers of infectious agent outbreaks, such as influenza or hand-foot-and-mouth disease, and school closures have been recommended as a measure to interrupt the transmission of influenza. However, evidence for the effectiveness of school closures is unclear for infections caused by coronaviruses, such as COVID-19, where the transmission dynamics are different [193]. So far, it is unclear whether school closures during certain phases of the COVID-19 pandemic and in certain socio-economic contexts are an effective way of reducing community transmission. It is also unknown whether school closures can reduce the burden on the healthcare system. Proactive school closures refer to the early and planned closure of schools and day-care facilities to limit local virus transmission and spread at schools and into the community. School closures can be associated with significant costs to society and the economy.

Evidence base for the measure

Only a small proportion (<5%) of overall COVID-19 cases reported in the EU/EEA and the UK have been among children (those aged 18 years and under). When diagnosed with COVID-19, children are much less likely to be hospitalised or have fatal outcomes than adults. Children are more likely to have a mild or asymptomatic infection, meaning that the infection may go undetected or undiagnosed. When symptomatic, children shed virus in similar quantities to adults and can infect others just as adults do [194,195]. However, it is unknown how infectious asymptomatic children are.

While very few significant outbreaks of COVID-19 in schools have been documented, they do occur, although they may be difficult to detect due to the relative lack of symptoms in children. There is conflicting published evidence on the impact of school closure/re-opening on community transmission levels, although the evidence from contact tracing in schools, and observational data from a number of EU countries suggest that re-opening schools has not been associated with significant increases in community transmission.

Evidence originating from seasonal and pandemic influenza modelling studies has shown that proactive school closures before the peak of influenza virus activity have had a moderate positive impact in reducing community transmission [197]. There will be a need to minimise contacts between children and the general population outside of schools to reduce opportunities for transmission. In the event of proactive school closures, plans for inter-sectorial collaboration and for society in general should be considered to mitigate the significant secondary effects. Plans to help mitigate transmission within schools while children continue to attend may include smaller school groups, physical distancing of children in the class, promotion of other non-pharmaceutical countermeasures and outdoor classes. In the event of illness, voluntary isolation at home is advisable.

Reactive closures of schools may be necessary as a consequence of widespread virus transmission in the community and educational settings. Reactive school and day-care closures will probably not reduce the impact of the epidemic, but may be necessary due to high absenteeism and operational issues, especially if the spread of SARS-CoV-2 coincides with the ongoing influenza season in an EU/EEA country. Therefore, communities need to prepare for this eventuality and consider plans for inter-sectorial collaboration and for society in general in order to mitigate secondary effects. As with proactive school closures, the timing and duration of the closures will need to be carefully considered on a case-by-case basis.

Considerations for implementation

School closures due to COVID-19 may involve a very high educational cost for the students and a high economic cost for the adults. A 2010 economic modelling analysis of school closures during influenza outbreaks in the UK, France, Belgium, and the Netherlands suggested that a four-week and 13-week school closure minimally reduced the clinical attack rate, but greatly increased the economic damage to the nation, due to the forced absenteeism of working parents [197].

According to the ECDC Response Measures Database, 30 countries in the EU/EEA and the UK closed their secondary schools; 28 closed higher education and/or primary schools and 26 countries closed preschools/day-care centres. The extent of the closures varied among countries, ranging from the implementation of full distance-learning to partial closures. The median duration of school closures as of 9 September 2020 varied from 68 days (IQR from 55 to 81 days) for preschools/day-care to 87 days (IQR from 67 to 137 days) for higher education.

Given that the influenza virus is circulating in the community during the ongoing influenza season across the EU/EEA, in order to reduce the burden on healthcare systems, proactive school closures may be considered if there is also ongoing transmission of SARS-CoV-2 in an area. The decision concerning school closures and their optimal timing and duration would need to be carefully considered on a case-by-case basis. Bearing in mind the impact of school closure, the decision should weigh the expected impact of the epidemic against the adverse effects of such closures on the community.

Impact of school closures

Long-term school closures undoubtedly have negative educational, social, and health ramifications for children who live under vulnerable circumstances, in marginal communities, or in abusive households. Schools and local public health authorities must consider the sociological and mental ramifications of school closures if the goal is to protect vulnerable populations from the negative effects of COVID-19 infection [198]. School closures may result in some children being unsupervised at home, curtailing the child's learning capacity if expected to learn remotely. Children facing social hardships are known to suffer greater societal dissociation, be prone to passive sedentary behaviour and have poorer health outcomes in general [198].

Based on the current data indicating that children are less likely to be the main vectors of SARS-CoV-2, the collective detrimental effect of school closures on children and society outweighs the benefits.

9.12 Stay-at-home measures

Several countries in the EU introduced stay-at-home measures, either as recommendations or as orders during the period of widespread community transmission. Such measures have been applied either locally/regionally or even nationally. In some cases stay-at-home orders have been introduced for only part of the day (curfew). According to the ECDC Response Measures Database, 15 countries in the EU/EEA and the UK have implemented mandatory stay-at-home orders, with a median duration of 46 days (IQR 41 to 52 days).

Evidence base for the measure

Since this has often been the last measure added to a bundle of others, it is difficult to address the added value. A recent analysis of the effect of eight non-pharmaceutical interventions in 41 countries between January and May 2020 found that stay-at-home orders reduced the reproduction number by 18% (4–31%), compared to a 31% reduction when closing (some) high-risk businesses and a 40% (22–55%) reduction when closing most non-essential businesses [190]. Another study also concluded that there was limited added value to introducing stay-at-home orders as an addition to other physical distancing measures [200].

Considerations for implementation

Stay-at-home measures can dramatically reduce close physical interactions but are a last-resort option due to their significant impact on both society and individuals. Targeted implementation, both geographically and temporally, is preferred and can be considered to control outbreaks that are not responding to bundles of other measures. Implementation of stay-at-home measures early on during the first phase of the outbreak can probably help to rapidly reduce virus transmission. However, the adjustment phase needs to be gradual in order to prevent sudden acute increases.

10. Travel-related measures

Travel-related measures, including domestic and international travel advice, border closures, travel-related restrictions, and quarantine or combinations of testing and quarantine aim to prevent or limit the geographical spread of virus transmission within a country or across borders by reducing long-distance transmission and importation. Other travel-related measures can include entry screening at national borders, airports, or other places where travellers from affected areas may enter (points of entry (PoE)). Travel advice (or travel recommendations) refers to official government advice, which has legal and economic implications, that travellers should consider in order to minimise their risk of infection. Travel and trade restrictions are regulated under the International Health Regulations (IHR) part III [60] and within EU Member States under article 29 of Directive 2004/38/EC [201]. In addition, public health authorities also issue advice to travellers in the form of health promotion activities (recommending certain types of behaviour, hand washing, etc.).Travelling from areas with SARS-CoV-2 community transmission to areas with no transmission increases the risk of virus re-introduction. However, the movement of people between areas where community transmission is already ongoing has a limited impact on COVID-19 trends. In such situations, the risk of transmission would depend on the NPI in place and the compliance of the population [158].

10.1 International travel restrictions and border closures

International travel restrictions aim to reduce the risk of virus importation from countries with high transmission by implementing travel restrictions to or from an affected area. Such restrictions can include the closure of international borders, entry bans for travellers from specific countries or regions, and measures to reduce passenger volumes (e.g. flight cancellations and airport closure). Border closures due to public health risks are regulated internationally under the IHR. Within the EU, freedom of movement may be limited for public health reasons within the limits of the EU Treaties and in accordance with Directive 2004/38/EC (art. 29)[60].

According to the ECDC Response Measures Database, among the 31 countries of the EU/EEA and the UK, 29 have, at some point, implemented some type of travel ban on travelling to, or from, selected areas. The first ban of this type was introduced on the 9 February 2020, while the most recent was introduced on 12 August 2020.

Seventeen countries have completely closed their borders, not allowing any kind of travel unless for specified reasons (in most cases only for nationals/permanent residents). The first measure of this kind was introduced on 10 January 2020, while the most recent was implemented on 1 September 2020, according to the ECDC Response Measures Database.

Evidence base for the measure

The evidence available on the impact of international travel restrictions and border closures is inconclusive. Border closures will only delay the introduction of the virus into a country if they are almost complete and when they are rapidly implemented during the early phases prior to the detection of the first autochthonous case, which is feasible only in specific, isolated settings (e.g. for island nations) [142,202]. Mathematical modelling and genomic epidemiology suggest that the early implementation of travel restrictions from Wuhan, China was effective in delaying the occurrence of local SARS-CoV-2 transmission within certain countries [145,202,203]. However, there is limited evidence available on the effect beyond the early phases of the epidemic.

Mathematical modelling (not peer-reviewed) has shown that international travel restrictions may have a limited impact on the internal spread of SARS-CoV-2 [199,204], with a possible exception when low-incidence settings experience a large number of arrivals from higher-incidence settings [205]. The impact of measures to reduce the risk of importation by decreasing air traffic passenger volumes remains unclear on the basis of the available literature. The selection of airports where measures are to be implemented requires careful consideration and more evidence is needed for other modes of transport (water and land transport) [205,206].

The epidemiological situation that unfolded in Europe during spring 2020 indicates that the international travel restrictions imposed in many EU countries at an early stage had at most a limited, delaying effect. It is highly unlikely that SARS-CoV-2, which is currently distributed across the globe, can be controlled by means of border closures [158].

Considerations for implementation

Given the wide range of travel-related restrictions implemented by EU/EEA countries and the UK, coordination, rapid information exchange between countries, and clear communication with the public are crucial. A lack of up-to-date, official government information and changing travel recommendations and restrictions can cause uncertainty and confusion among travellers, and among staff responsible for the implementation on-site. This can result in logistical challenges and reduce compliance with the measures.

International travel restrictions cannot be sustained over a long period of time and are unlikely to result in behavioural change, while causing significant societal effects, social and economic disruption. Border closures have been implemented extensively in response to the COVID-19 pandemic in the EU/EEA and the UK, as well as worldwide, with the aim of reducing long-distance transmission and importation. Border closures result in substantial challenges for logistics, trade and the movement of people, particularly during a crisis period.

Special consideration should be given to the challenges of implementing and adhering to border closures and the subsequent mobility restrictions in settings with ongoing humanitarian crises, which present additional challenges for already vulnerable and marginalised populations [208].

10.2 Measures on conveyances and travel hubs

These measures refer to actions taken on conveyances and travel hubs (planes, ships, trains, local transport, airports, ports, train stations, bus stations and metro stations) to limit transmission of SARS-CoV-2 [209]. This can include avoidance of crowding on platforms and when embarking/disembarking; engineering controls such as ventilation; use of masks; increasing interpersonal distance while travelling and surface disinfection.

Evidence base for the measure

Individual cases or small clusters of infections on board aircrafts have been documented in literature on COVID-19 [209-217]. However, several studies also document the fact that there was no infection on board an aircraft after a flight was taken by symptomatic or asymptomatic infectious case. Therefore, although transmission on board aircraft appears to be possible, there is a lack of evidence for large transmission events, suggesting that it is not common. Many of the reports were published during a period when there was widespread awareness of COVID-19 transmission and travellers were using masks. Some of the studies describe repatriation flights under strict conditions to control transmission.

Transmission on trains: a study from China estimated the risk for train passengers analysing data from 2 334 index cases and 72 093 contacts [219]. The average attack rate was 0.3%, ranging from 0 to 10.3%, and increasing with closer proximity to the index case and longer periods of travel.

10.3 Travel advice

Travel advice (or travel recommendations) refers to official government advice, which has legal and economic implications, that travellers should consider in order to minimise their risk of infection during domestic and international travel. Travel and trade restrictions are regulated under the International Health Regulations (IHR) part III and within EU Member States under article 29 of Directive 2004/38/EC [201]. ECDC has published a template leaflet for travel advice relating to SARS-CoV-2. According to the ECDC Response Measures Database, 15 countries in the EU/EEA and the UK have issued internal travel advice, the first being issued on 17 January 2020. Twenty-seven countries have also issued international travel advice, the first of which was issued on 6 January 2020.

Evidence base for the measure

Although there is a lack of evidence on the effectiveness of travel advice, it is known that close contact between people during a journey also increases the risk of disease transmission and spread [142,219,220]. Voluntary physical distancing plays an important role in controlling the outbreak [221-223] and evidence from mathematical modelling suggests that changes in mobility patterns, as a result of individual travel decisions, may be sufficient to contain an epidemic [225]. However, in certain contexts, government action may be needed in addition to voluntary behaviour change to promote adherence to travel advice [225,226]. Advising against travel during an epidemic aims to reduce the number of people who are infected during trips to areas or countries where community transmission is ongoing and to reduce the risk of importation from affected countries. Preventing the travel of symptomatic individuals is the most efficient way to reduce transmission between passengers during travel.

Considerations for implementation

In the context of travel recommendations, travellers should have access to timely information on all travel-related measures at the place of origin, during transportation and at the destination. In addition, travellers should receive updates on the local situation and have access to medical advice and assistance at the destination. Travellers should be reminded to follow the appropriate preventive measures described in this document, while symptomatic travellers should be discouraged from travelling.

Attitudes and risk perceptions among travellers can be monitored to provide targeted travel advice, in particular for risk groups, as travel patterns and the willingness to travel continue to change during the COVID-19 pandemic [227-230].

10.4 Screening at points of entry at national borders

This measure refers to entry screening at national borders, airports, or other places where travellers from affected areas may enter a country. Screening can refer to screening by health questionnaires, temperature scanners or laboratory tests. Passengers' temperatures can be screened using devices such as non-contact infrared thermometers to assess whether individuals have symptoms of infection (i.e. body temperature >38°C). In addition, a health declaration form or health screening questionnaire can be used to detect cases in incoming passengers. Health declaration forms generally focus on possible exposure (either through travel or contact with a known case) and experience of symptoms such as fever, cough or other respiratory symptoms and these forms have to be assessed by

health professionals. Additional measures may include proactive sharing of information on the infection, advice on how to seek medical assistance should symptoms develop and on how to reduce the risk of infecting others. Finally, in some areas passengers are currently being tested, before or after travel, in an attempt to exclude or discourage people with active infections from travelling. Overall, these measures aim to reduce the number of infectious people entering a country, focusing on those coming from countries that are experiencing an epidemic [232].

According to the ECDC Response Measures Database, 23 countries in the EU/EEA and the UK implemented some type of border screenings for international travellers, with the first screening starting on 21 January 2020. Since 14 March 2020, 13 countries have also introduced PCR testing for travellers returning from abroad. The latest reported border screening measures were introduced on 1 September 2020.

Evidence base for the measure

Entry screening of passengers with temperature scanners is not effective in delaying or mitigating local transmission. This is mainly due the inability to detect cases during the incubation period, prior to onset of virus shedding and the high proportion of cases who do not develop fever or any symptoms [142,232]. Internal modelling work at ECDC supports these findings. Studies at points of entry have shown that mass screening programmes using non-contact devices (such as infrared thermal scanners) have not been effective in identifying infectious persons and limiting spread of disease, as detection rates have been consistently low. A recent modelling study in pre-print for the UK estimates that temperature screening alone is only 0.78% effective in detecting cases (CI: 0.19–1.64) [234]. Furthermore, thermal screening is costly and resource intensive [234-236]. Wastewater-based surveillance of airplanes and cruise ships could potentially be considered as a complementary data source on SARS-CoV-2 infection among travellers, although this has several limitations [238]. Emphasis should therefore be placed on discouraging symptomatic individuals from travelling and providing information and easy access to diagnosis and care when travellers develop symptoms.

Targeted screening of travellers from areas of high community transmission at points of entry, with laboratory tests for active infection (PCR or antigen detection) at destination airports, appears to yield notable numbers of cases. A modelling study indicated that screening involving laboratory tests combined with quarantine may play a role in decreasing the number of cases entering a country [239], while another modelling study estimated that PCR testing of incoming passengers on arrival alone is 39.6% (CI: 35.2–43.7) effective in detecting COVID-19 cases [234]. Furthermore, it is important to point out that a large proportion of passengers testing positive with PCR will have already passed the infectious period.

In exceptional situations, for example in the case of small island nations with no autochthonous transmission, screening of passengers from high transmission areas might help to limit/delay the number of virus introductions. Countries such has New Zealand, Iceland and Malta have achieved some success with these measures.

Considerations for implementation

Entry screening measures are subject to several limitations and are not an efficient use of human and other health resources given their lack of effectiveness in delaying or mitigating local transmission. Implementation requires appropriate infrastructure and facilities, screening equipment, protocols, PPE and availability of trained staff at points of entry. Additional strategies and resources will be required, if applicable, for the follow-up and communication with travellers, referral to healthcare services and quarantine arrangements. Implementing entry screening where the infrastructure is not available (e.g. shipping ports or ground crossings) may lead to additional challenges, including safety concerns, delays in implementation and reduced compliance with the measures. During secondary screening measures, which rely on the provision of accurate health or travel information, travellers could withhold relevant information for fear of stigmatisation or negative consequences (e.g. being placed in quarantine) [240]. Additional efforts may be required to develop suitable communication strategies and social support mechanisms to encourage accurate reporting. Emphasis should be placed on providing access to timely information concerning all travel-related measures and general health information and situational updates at points of entry.

10.5 Quarantine of passengers

In the EU/EEA and the UK, 28 countries have introduced mandatory quarantine for international travellers, with the first quarantine implemented on 1 January 2020, and the most recent new measure reported on 1 September 2020 according to the ECDC database.

Evidence base for the measure

A recent review of the effectiveness of traveller quarantine to reduce transmission (in relation to SARS) only identified 'very low-certainty evidence' that quarantining travellers from a country with a declared outbreak would reduce incidence and deaths [151].

If not properly implemented, the quarantining of travellers may create additional sources for contamination and dissemination of the disease. If Member States choose to implement quarantine measures for travellers on arrival at their destination, they should do so based on a risk assessment and consideration of local circumstances [241].

10.6 Domestic travel restrictions

This measure refers to travel restrictions (e.g. airport and train station closures, internal movement restrictions between cities/regions) implemented within a country or region to prevent or limit the geographical extent of virus transmission. According to the ECDC Response Measures Database, 10 countries in the EU/EEA and the UK issued mandatory restrictions on domestic travel, the first being introduced on 1 March 2020.

Evidence base for the measure

There is evidence that close contact of people increases transmission and spread of SARS-CoV-2 during travel [242]. Passenger volumes in national traffic and well-connected locations could play an important role in the establishment of local disease transmission [242,243]. Evidence suggests that the broad domestic travel restrictions implemented during the early stages of the COVID-19 pandemic reduced population mobility [222,226,230] and contributed to the short-term control of the pandemic, with varying degrees of effectiveness being reported [201,244-246].

As the epidemiological situation can vary within a country, domestic travel restrictions could potentially delay the spread of the virus to parts of the country with limited or no community transmission, if implemented during the early stages of an epidemic. However, undetected local transmission may be ongoing prior to the implementation of domestic travel restrictions or lockdowns for defined geographical areas. Evidence from mathematical modelling (not peer reviewed) based on data from 130 countries and territories suggests that internal movement restrictions, which interrupt trips of all lengths, are strongly associated with reduction of the time-varying reproduction number (Rt) [200]. However, other studies have found that domestic travel restrictions, such as a cordon sanitaire or the closure of public transportation systems, are unlikely to be effective unless accompanied by other NPI, such as physical distancing, and behavioural changes [145,243,247]. Since movement restrictions and physical distancing measures were implemented almost simultaneously, it is difficult to relate observed changes in transmission dynamics to a single measure.

Relevant ECDC guidance documents

Individual level

Respiratory hygiene, hand hygiene, and PPE

Technical report: Guidelines for the use of non-pharmaceutical measures to delay and mitigate the impact of 2019-nCoV. 10 February 2020.

Technical report: Infection prevention and control and preparedness for COVID-19 in healthcare settings - fourth update. 3 July 2020.

Technical report: Use of gloves in healthcare and non-healthcare settings in the context of the COVID 19 pandemic. 2 July 2020.

Video on COVID-19: Do you know how to wear a face mask properly? (long version) 28 August 2020.

Video on COVID-19: How to wear your single-use face mask? (short version) 28 August 2020.

Video on COVID-19: How to wear your re-usable/textile face mask? (short version) 25 August 2020.

Infographic: Using face masks in the community. 14 April 2020.

Poster: Effective hand-washing. 12 March 2020.

Environmental level

Environmental cleaning

Technical report: Disinfection of environments in healthcare and non-healthcare settings potentially contaminated with SARS-CoV-2. 26 March 2020.

Ventilation

Technical report: Heating, ventilation and air-conditioning systems in the context of COVID-19. 22 June 2020.

Population level

Limiting physical inter-personal interactions

Technical report: Guidelines for the use of non-pharmaceutical measures to delay and mitigate the impact of 2019-nCoV. 10 February 2020.

Technical report: COVID-19 in children and the role of school settings in COVID-19 transmission. 6 August 2020.

Technical report: Guidance for discharge and ending isolation in the context of widespread community transmission of COVID-19 – first update. 8 April 2020.

Technical report: Guidance on the provision of support for medically- and socially-vulnerable populations in EU/EEA countries and the United Kingdom during the COVID-19 pandemic. 3 July 2020

Technical report: Infection prevention and control and preparedness for COVID-19 in healthcare settings - fourth update. 3 July 2020.

Technical report: Surveillance of COVID-19 at long-term care facilities in the EU/EEA. 19 May 2020.

Technical report: Infection prevention and control and surveillance for coronavirus disease (COVID-19) in prisons in EU/EEA countries and the UK. 3 July 2020.

Technical report: Guidance on infection prevention and control of COVID-19 in migrant and refugee reception and detention centres in the EU/EEA and the UK. 15 July 2020.

Shielding of medically- and sociably-vulnerable populations

Technical report: Guidance on the provision of support for medically- and socially-vulnerable populations in EU/EEA countries and the United Kingdom during the COVID-19 pandemic. 3 July 2020.

Technical report: Surveillance of COVID-19 at long-term care facilities in the EU/EEA. 19 May 2020.

Technical report: Infection prevention and control and surveillance for coronavirus disease (COVID-19) in prisons in EU/EEA countries and the UK. 3 July 2020.

Technical report: Guidance on infection prevention and control of coronavirus disease (COVID-19) in migrant and refugee reception and detention centres in the EU/EEA and the UK. 15 June 2020.

Travel-related restrictions

Technical report: Considerations for travel-related measures to reduce spread of COVID-19 in the EU/EEA. 26 May 2020.

Technical report: Considerations relating to passenger locator data, entry and exit screening and health declarations in the context of COVID-19 in the EU/EEA and the UK. **12 June 2020**

Strategies for implementation of NPI

No single control measure is sufficient to mitigate or control COVID-19. Countries in Europe and elsewhere have been applying multiple NPI with a view to controlling the spread of COVID-19. Any decision on the optimal strategy for implementation of NPI needs to take into account the epidemiological situation as well as the characteristics of the population being targeted. The goal is to implement NPI in the most effective and targeted manner possible, minimising their personal, social and economic impact.

Several measures should be in place, irrespective of the epidemiological situation. Such measures include the isolation of cases and quarantining of close contacts, recommendations for meticulous hand and respiratory hygiene and recommendations for teleworking.

In countries/regions with very low prevalence, the key to limiting the spread of the virus is to identify cases, carry out contact tracing, quarantine and isolate. Measures such as the restriction of non-essential travel from countries/regions with high prevalence have also been widely applied. Restrictions on the size of gatherings can be adapted on the basis of local risk assessments.

In places with wider community transmission, it is more important to ensure physical distancing, adapting the available options on the basis of disease prevalence and trajectory, as well as the geographic extent of the outbreak. To this end, restricting the size of gatherings, recommending social bubbles, protecting vulnerable populations and implementing face mask policies are all appropriate. It is unclear how effective it is to close schools and this also has a significant impact on society. Closing non-essential high-risk businesses and establishing restrictions on movement are last-resort measures that appear to have been effective in countries with high prevalence. However, the considerable impact of such measures on society needs to be balanced against their effectiveness.

Countries should be prepared to adapt their strategies rapidly in response to indications of increased transmission. Introduction of further interventions could be considered at local or regional level, or for specific population groups, according to epidemiological data [158].

Table 2 presents an overview of control measures and indications for implementation based on the epidemiological situation.

Policymakers should keep in mind that there may be a delay of up to 40 days between the introduction of NPI and an observed effect on the trajectory of the epidemic, which is longer than the incubation period of the infection [249]. This may be related to the time it takes for people to change their behaviour and for the change in behaviour to have an effect.

Table 2. Non-pharmaceutical interventions and indications for implementation during the COVID-19 pandemic based on the national/regional epidemiological situation

Non-pharmaceutical intervention	Low prevalence	High prevalence	Geo-level	Disease impact	Negative societal impact	Comment
Hygiene measures						
Meticulous hand and respiratory hygiene	+	+	National	High	Low	
Face masks						
Recommendation to use face mask in public spaces	+/-	+	National	High	Low	
Isolation and quarantine						
Recommended isolation of confirmed, probable and possible COVID-19 cases	+	+	National	High	Low	
Quarantine for contacts of cases	+	+	National	High	Low	
Quarantine of specific groups (e.g. travellers from a region or a country with high incidence of COVID-19).	+/-	+/-	National	Low	Low	Can be implemented, but: - Challenging to harmonise classification across countries and regions; - Administrative borders may not match epidemiologically relevant areas; -Questionable effectiveness when community transmission is ongoing across EU/EEA and the UK.
Physical distancing						
Recommended >1-2 metres physical distance between individuals in public places	+	+	National	High	Low	
Closing of public spaces (e.g. non-essential shops, restaurants, entertainment venues)	-	+/-	Sub-national (preferably)	High	Medium	To consider at local/regional level first to minimise socio-economic disruption and political acceptability. To consider closing largest and most crowded spaces first.
Closing of public transport	-	+/-	Sub-national (preferably)	High	High	To consider at local/regional level first. To consider reducing capacity first.
Closing workplaces	-	+	Sub-national (preferably)	High	Medium	To consider at local/regional level first.
Recommending teleworking	+	+	National	High	Low	
Closing of schools (preschool, primary, secondary and tertiary)	-	+/-	Sub-national (preferably)	High	High	To consider, depending on pupils' age. Questionable effectiveness, especially in younger age-groups. To consider negative externalities.
Protecting high-risk groups and vulnerable populations	+/-	+	National	High	Medium	To also consider for hard-to-reach populations (e.g. testing in ethnic minorities or deprived populations).
Stay-at-home orders and recommendations	-	+/-	Sub-national (preferably)	High	High	To consider at local/regional level first to minimise socio-economic disruption and political acceptability.
Mass gatherings						
Interventions in place for public gatherings (small, medium and mass gatherings)	+/-	+	National	High	Medium	
Movement restrictions						
International travel restrictions	+/-	-	National	Low	High	May be considered in places with very low prevalence to limit introductions
National movement restrictions or recommendations	-	+	Sub-national	Medium	Medium	Prefer recommendation over restriction. To consider at local/regional level first, avoiding border closures.

+: recommended, +/- can be considered, -: not recommended
Supporting evidence for each measure provided in the main text of the document.

Contributing ECDC experts (in alphabetical order)

Internal experts: Agoritsa Baka, Orlando Cenciarelli, Bruno Ciancio, Irina Jovel Quiñonez Dalmau, Erika Duffell, Lisa Ferland, Helen Johnson, Tommi Karki, Pete Kinross, John Kinsman, Senia Rosales Klintz, Lorenzo Lionello, Angeliki Melidou, Lina Nerlander, Teymur Noori, Pasi Penttinen, Anastasia Pharris, Diamantis Plachouras, Andreea Salajan, Ettore Severi, Carl Suetens, Jonathan Suk, Klaus Weist, Andrea Würz.

Acknowledgments - Contributors to the ECDC Response Measures Database: Ariana Wijermans, Aurea Oradini Alacreu, Barbara Albiger, Barbora Kinross, Bertrand Sudre, Brigitta Wohlgemuth-Zembski, Catarina Vitor, Csaba Kodmon, Dragoslav Domanovic, Emilie Finch, Emma Wiltshire, Emmanuel Robesyn, Ettore Severi, Favelle Lamb, Felix Lotsch, Grazina Mirinaviciute, Helena Simanova, Irina Ljungqvist, Jevgenijs Golovcuks, Joana Haussig, John Kinsman, Leonidas Alexakis, Lisa Ferland, Lorenzo Lionello, Luciana Muresan, Maria Tseroni, Natalia Alberska, Otilia Mardh, Rodrigo Filipe, Saara Kotila, Sabrina Nothdurfter, Scott Chiossi, Sebastian Deka, Silvia Funke, Svetla Tsolova, Tarik Derrough, Tjede Funk, Tommi Karki.

Disclaimer

References

1. European Centre for Disease Prevention and Control (ECDC). Contact tracing: Public health management of persons, including healthcare workers, having had contact with COVID-19 cases in the European Union [Internet]. Stockholm: ECDC; 2020 [cited 7 September 2020]. Available from: https://www.ecdc.europa.eu/en/covid-19-contact-tracing-public-health-management
2. European Centre for Disease Prevention and Control (ECDC). COVID-19 testing strategies and objectives. 15 September 2020. [Internet]. Stockholm: ECDC; 2020. Available from: https://www.ecdc.europa.eu/en/publications-data/covid-19-testing-strategies-and-objectives#no-link
3. La Rosa G, Bonadonna L, Lucentini L, Kenmoe S, Suffredini E. Coronavirus in water environments: Occurrence, persistence and concentration methods - A scoping review. Water Res. 2020;179:115899-.
4. Health Information and Quality Authority (HIQA). Evidence summary for asymptomatic transmission of COVID-19. 21 April 2020. [Internet]. Dublin: HIQA; 2020. Available from: https://www.hiqa.ie/sites/default/files/2020-04/Evidence-summary-for-asymptomatic-transmission-of-COVID-19.pdf
5. Koh WC, Naing L, Rosledzana MA, Alikhan MF, Chaw L, Griffith M, et al. What do we know about SARS-CoV-2 transmission? A systematic review and meta-analysis of the secondary attack rate, serial interval, and asymptomatic infection. medRxiv. 2020.05.21.20108746.
6. Aguilar JB, Faust JS, Westafer LM, Gutierrez JB. A Model Describing COVID-19 Community Transmission Taking into Account Asymptomatic Carriers and Risk Mitigation. medRxiv. 2020.03.18.20037994.
7. Huang L-S, Li L, Dunn L, He M. Taking Account of Asymptomatic Infections in Modeling the Transmission Potential of the COVID-19 Outbreak on the Diamond Princess Cruise Ship. medRxiv. 2020.04.22.20074286.
8. Wei Y, Wei L, Liu Y, Huang L, Shen S, Zhang R, et al. A systematic review and meta-analysis reveals long and dispersive incubation period of COVID-19. medRxiv. 2020.06.20.20134387.
9. Wenxiao T, Houlin T, Fangfang C, Yinong W, Tingling X, Kaiju L, et al. Epidemic Update and Risk Assessment of 2019 Novel Coronavirus — China, January 28, 2020. China CDC Weekly. 2020;2(6):83-6.
10. Backer JA, Klinkenberg D, Wallinga J. Incubation period of 2019 novel coronavirus (2019-nCoV) infections among travellers from Wuhan, China, 20–28 January 2020. Euro surveillance: bulletin Europeen sur les maladies transmissibles = European communicable disease bulletin. 2020;25(5):2000062.
11. Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y, et al. Early Transmission Dynamics in Wuhan, China, of Novel Coronavirus–Infected Pneumonia. New England Journal of Medicine. 2020;382(13):1199-207.
12. Singanayagam A, Patel M, Charlett A, Lopez Bernal J, Saliba V, Ellis J, et al. Duration of infectiousness and correlation with RT-PCR cycle threshold values in cases of COVID-19, England, January to May 2020. Euro surveillance: bulletin Europeen sur les maladies transmissibles = European communicable disease bulletin. 2020;25(32):2001483.
13. van Kampen JJA, van de Vijver DAMC, Fraaij PLA, Haagmans BL, Lamers MM, Okba N, et al. Shedding of infectious virus in hospitalized patients with coronavirus disease-2019 (COVID-19): duration and key determinants. medRxiv. 2020.06.08.20125310.
14. Riccardo F, Ajelli M, Andrianou X, Bella A, Del Manso M, Fabiani M, et al. Epidemiological characteristics of COVID-19 cases in Italy and estimates of the reproductive numbers one month into the epidemic. medRxiv. 2020:2020.04.08.20056861.
15. Flaxman S, Mishra S, Gandy A, Unwin HJT, Mellan TA, Coupland H, et al. Estimating the effects of non-pharmaceutical interventions on COVID-19 in Europe. Nature. 2020;584(7820):257-61.
16. Oran DP, Topol EJ. Prevalence of Asymptomatic SARS-CoV-2 Infection: A Narrative Review. Ann Intern Med. 2020;173(5):362-7.
17. Lavezzo E, Franchin E, Ciavarella C, Cuomo-Dannenburg G, Barzon L, Del Vecchio C, et al. Suppression of a SARS-CoV-2 outbreak in the Italian municipality of Vo'. Nature. 2020;584(7821):425-9.
18. European Centre for Disease Prevention and Control (ECDC). Weekly COVID-19 country overview [Internet]. Stockholm: ECDC; 2020 [cited 9 September 2020]. Available from: https://www.ecdc.europa.eu/en/covid-19/country-overviews
19. Novotny JS, Gonzalez Rivas JP, Kunzova S, Skladana M, Pospisilova A, Polcrova A, et al. Association between stress and depressive symptoms and the Covid-19 pandemic. medRxiv. 2020.07.28.20163113.
20. Evidence Aid. Quarantine measures had negative mental health impacts during SARS and MERS [Internet]. Southmoor: Evidence Aidd; 2020 [updated 25 June 2020; cited 18 August 2020]. Available from: https://evidenceaid.org/resource/quarantine-measures-had-negative-mental-health-impacts-during-sars-and-mers/
21. Charoensukmongkol P, Phungsoonthorn T. The effectiveness of supervisor support in lessening perceived uncertainties and emotional exhaustion of university employees during the COVID-19 crisis: the constraining role of organizational intransigence. J Gen Psychol. 2020:1-20.
22. Teasdale E, Santer M, Geraghty AW, Little P, Yardley L. Public perceptions of non-pharmaceutical interventions for reducing transmission of respiratory infection: systematic review and synthesis of qualitative studies. BMC Public Health. 2014;14:589.
23. Kantor BN, Kantor J. Non-pharmaceutical Interventions for Pandemic COVID-19: A Cross-Sectional Investigation of US General Public Beliefs, Attitudes, and Actions. Frontiers in Medicine. 2020;7(384).
24. Prosser AMB, Judge M, Bolderdijk JW, Blackwood L, Kurz T. 'Distancers' and 'non-distancers'? The potential social psychological impact of moralizing COVID-19 mitigating practices on sustained behaviour change. British Journal of Social Psychology. 2020;59(3):653-62.

25. Gascón M. "Mengele también era médico": así acabó este país peor que España con el rebrote del covid [Internet]. Madrid: El Confidencial; 2020 [updated 05 August 2020; cited 7 September 2020]. Available from: https://www.elconfidencial.com/mundo/europa/2020-08-05/rumania-coronavirus-europa-protestas_2703528/
26. BBC News. Germany coronavirus: Anger after attempt to storm parliament [Internet]. London: BBC News; 2020 [updated 30 August 2020; cited 7 September 2020]. Available from: https://www.bbc.com/news/world-europe-53964147
27. The Guardian. Covid-19: why do pandemics trigger civil unrest? Podcast. London: The Guardian; 2020.
28. Sauerbrey A. Meet Germany's Bizarre Anti-Lockdown Protesters [Internet]. New York: The New York Times; 2020 [updated 31 August 2020; cited 10 September 2020]. Available from: https://www.nytimes.com/2020/08/31/opinion/germany-covid-lockdown-protests.html?searchResultPosition=3
29. Riegert B. Coronavirus travel rules: With EU open for travelers, who can go where? [Internet]. Berlin: Deutsche Welle (DW); 2020 [updated 3 August 2020; cited 10 September 2020]. Available from: https://www.dw.com/en/what-are-the-eu-coronavirus-travel-restrictions/a-54397078?maca=en-rss-en-all-1573-rdf
30. European Comission. Coronavirus: Commission proposes more clarity and predictability of any measures restricting free movement in the European Union [Internet]. Brussels: European Comission; 2020 [updated 4 September 2020; cited 10 September 2020]. Available from: https://ec.europa.eu/commission/presscorner/detail/en/IP_20_1555
31. Becher M, Stegmueller D, Brouard S, Kerrouche E. Comparative experimental evidence on compliance with social distancing during the COVID-19 pandemic. medRxiv. 2020.07.29.20164806.
32. Big Data Analytical Unit, Institute of Global Health Innovation,. Covid-19: Insights on face mask use. Global review [Internet]. London: Imperial College London; 2020 [cited 07 September 2020]. Available from: https://www.imperial.ac.uk/media/imperial-college/institute-of-global-health-innovation/ICL-YouGov-Covid-19-Behavour-Tracker_Global_FaceMask_20200609_VF.pdf.
33. Herren MC, K. Brownwright T, Y. Liu E, El Amiri N, Majumder MS. Democracy and Mobility: A Preliminary Analysis of Global Adherence to Non-Pharmaceutical Interventions for COVID-19. SSRN [pre-print] [Internet]. 2020 Apr 7 PMC7366805]:[3570206 p.].
34. Matthews Pillemer F, Blendon RJ, Zaslavsky AM, Lee BY. Predicting support for non-pharmaceutical interventions during infectious outbreaks: a four region analysis. Disasters. 2015;39(1):125-45.
35. Michie S, van Stralen MM, West R. The behaviour change wheel: A new method for characterising and designing behaviour change interventions. Implementation Science. 2011;6(1):42.
36. West R, Michie S, Rubin GJ, Amlôt R. Applying principles of behaviour change to reduce SARS-CoV-2 transmission. Nature Human Behaviour. 2020;4(5):451-9.
37. Michie S. Behavioural science must be at the heart of the public health response to covid-19 [Internet]. London: The BMJ; 2020 [updated 28 February 2020; cited 9 September 2020]. Available from: https://blogs.bmj.com/bmj/2020/02/28/behavioural-science-must-be-at-the-heart-of-the-public-health-response-to-covid-19/
38. Gibson Miller J, Hartman TK, Levita L, Martinez AP, Mason L, McBride O, et al. Capability, opportunity, and motivation to enact hygienic practices in the early stages of the COVID-19 outbreak in the United Kingdom. Br J Health Psychol. 2020.
39. Bonell C, Michie S, Reicher S, West R, Bear L, Yardley L, et al. Harnessing behavioural science in public health campaigns to maintain 'social distancing' in response to the COVID-19 pandemic: key principles. Journal of epidemiology and community health. 2020;74(8):617-9.
40. World Health Organization (WHO). Overview of Public Health and Social Measures in the context of COVID-19 [Internet]. Geneva: WHO; 2020 [updated 18 May 2020; cited 7 Septeber 2020]. Available from: https://www.who.int/publications/i/item/overview-of-public-health-and-social-measures-in-the-context-of-covid-19
41. Habersaat KB, Betsch C, Danchin M, Sunstein CR, Böhm R, Falk A, et al. Ten considerations for effectively managing the COVID-19 transition. Nature Human Behaviour. 2020;4(7):677-87.
42. Lockwood S. Coronavirus: Italy becoming impatient with lockdown - and social unrest is brewing [Internet]. London: Sky news; 2020 [updated 29 March 2020; cited 7 September 2020]. Available from: https://news.sky.com/story/coronavirus-italy-becoming-impatient-with-lockdown-and-social-unrest-is-brewing-11965122
43. Raidió Teilifís Éireann (RTE). Mandatory quarantine not possible to enforce - Ryan [Internet]. Dublin: RTE; 2020 [updated 07 July 2020; cited 7 September 2020]. Available from: https://www.rte.ie/news/coronavirus/2020/0707/1151833-coronavirus-travel/
44. Jonung L , Nergelius J. Grundlagen sätter ramarna för Sveriges coronastrategi [Internet]. Stockholm: Dagens Nyheter; 2020 [updated 2 August 2020; cited 7 September 2020]. Available from: https://www.dn.se/debatt/grundlagen-satter-ramarna-for-sveriges-coronastrategi/
45. Kamerlin SCL, Kasson PM. Managing Coronavirus Disease 2019 Spread With Voluntary Public Health Measures: Sweden as a Case Study for Pandemic Control. Clinical Infectious Diseases: an official publication of the Infectious Diseases Society of America. 2020.
46. World Health Organization (WHO). Risk communications [Internet]. Geneva: WHO; 2020 [cited 9 September 2020]. Available from: https://www.who.int/emergencies/risk-communications
47. European Centre for Disease Prevention and Control (ECDC). Guidance on the provision of support for medically and socially vulnerable populations in EU/EEA countries and the UK during the COVID-19 pandemic, 3 July 2020 [Internet]. Stockholm: ECDC; 2020. Available from: https://www.ecdc.europa.eu/sites/default/files/documents/Medically-and-socially-vulnerable-populations-COVID-19.pdf

48. European Centre for Disease Prevention and Control (ECDC). Guidance on community engagement for public health events caused by communicable disease threats in the EU/EEA [Internet]. Stockholm: ECDC; 2020. Available from: https://www.ecdc.europa.eu/en/publications-data/guidance-community-engagement-public-health-events-caused-communicable-disease
49. National Institute for Public Health and the Environment (RIVM). Applying behavioural science to COVID-19 [Internet]. Bilthoven: RIVM; 2020 [cited 8 September 2020]. Available from: https://www.rivm.nl/en/novel-coronavirus-covid-19/research/behaviour
50. Sante Publique France. Covid-19: une enquête pour suivre l'évolution des comportements et de la santé mentale pendant l'épidémie Paris: Sante Publique France; 2020 [cited 8 September 2020]. Available from: https://www.santepubliquefrance.fr/etudes-et-enquetes/covid-19-une-enquete-pour-suivre-l-evolution-des-comportements-et-de-la-sante-mentale-pendant-l-epidemie
51. The Behavioural Insights Team. COVID-19 - a behavioural perspective [Internet]. London: The Behavioural Insights Team; 2020 [cited 7 September 2020]. Available from: https://www.bi.team/
52. World Health Organization (WHO) Regional Office for Europe. WHO tool for behavioural insights on COVID-19 [Internet]. Copenhagen: WHO Regional Office for Europe; 2020 [cited 7 September 2020]. Available from: https://www.euro.who.int/en/health-topics/health-emergencies/coronavirus-covid-19/technical-guidance/who-tool-for-behavioural-insights-on-covid-19
53. Betsch C, Wieler LH, Habersaat K. Monitoring behavioural insights related to COVID-19. The Lancet. 2020;395(10232):1255-6.
54. Imperial College London. COVID-19 Behaviour Tracker [Internet]. London: Imperial College London; 2020 [cited 7 September 2020]. Available from: http://www.coviddatahub.com/
55. Pépin JL, Bruno RM, Yang R-Y, Vercamer V, Jouhaud P, Escourrou P, et al. Wearable Activity Trackers for Monitoring Adherence to Home Confinement During the COVID-19 Pandemic Worldwide: Data Aggregation and Analysis. J Med Internet Res. 2020;22(6):e19787.
56. Doogan C, Buntine W, Linger H, Brunt S. Public Perceptions and Attitudes Toward COVID-19 Nonpharmaceutical Interventions Across Six Countries: A Topic Modeling Analysis of Twitter Data. J Med Internet Res. 2020;22(9):e21419.
57. Google. COVID-19 Community Mobility Reports [Internet]. Mountain View, California: Google; 2020 [cited 09 September 2020]. Available from: https://www.google.com/covid19/mobility/
58. Jones NR, Qureshi ZU, Temple RJ, Larwood JPJ, Greenhalgh T, Bourouiba L. Two metres or one: what is the evidence for physical distancing in covid-19? BMJ. 2020;370:m3223.
59. Chu DK, Akl EA, Duda S, Solo K, Yaacoub S, Schünemann HJ, et al. Physical distancing, face masks, and eye protection to prevent person-to-person transmission of SARS-CoV-2 and COVID-19: a systematic review and meta-analysis. The Lancet. 2020;395(10242):1973-87.
60. European Centre for Disease Prevention and Control (ECDC). Guidelines for the use of non-pharmaceutical measures to delay and mitigate the impact of 2019-nCoV [Internet]. Stockholm: ECDC; 2020 [cited 25 August 2020]. Available from: https://www.ecdc.europa.eu/sites/default/files/documents/novel-coronavirus-guidelines-non-pharmaceutical-measures_0.pdf
61. World Health Organization (WHO). WHO Guidelines on Hand Hygiene in Health Care: a Summary [Internet]. Geneva: WHO; 2009 [cited 07 September 2020]. Available from: https://www.who.int/gpsc/5may/tools/who_guidelines-handhygiene_summary.pdf
62. Qualls N, Levitt A, Kanade N, Wright-Jegede N, Dopson S, Biggerstaff M, et al. Community Mitigation Guidelines to Prevent Pandemic Influenza - United States, 2017. MMWR Recommendations and reports : Morbidity and Mortality Weekly Report. Recommendations and reports. 2017;66(1):1-34.
63. van Doremalen N, Bushmaker T, Morris DH, Holbrook MG, Gamble A, Williamson BN, et al. Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1. The New England Journal of Medicine. 2020;382(16):1564-7.
64. Ong SWX, Tan YK, Chia PY, Lee TH, Ng OT, Wong MSY, et al. Air, Surface Environmental, and Personal Protective Equipment Contamination by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) From a Symptomatic Patient. JAMA. 2020;323(16):1610-2.
65. Zhou J, Otter JA, Price JR, Cimpeanu C, Garcia DM, Kinross J, et al. Investigating SARS-CoV-2 surface and air contamination in an acute healthcare setting during the peak of the COVID-19 pandemic in London. Clinical Infectious Diseases: an official publication of the Infectious Diseases Society of America. 2020.
66. Chia PY, Coleman KK, Tan YK, Ong SWX, Gum M, Lau SK, et al. Detection of air and surface contamination by SARS-CoV-2 in hospital rooms of infected patients. Nature Communications. 2020;11(1):2800.
67. Grayson ML, Melvani S, Druce J, Barr IG, Ballard SA, Johnson PD, et al. Efficacy of soap and water and alcohol-based hand-rub preparations against live H1N1 influenza virus on the hands of human volunteers. Clinical Infectious Diseases: an official publication of the Infectious Diseases Society of America. 2009;48(3):285-91.
68. Tuladhar E, Hazeleger WC, Koopmans M, Zwietering MH, Duizer E, Beumer RR. Reducing viral contamination from finger pads: handwashing is more effective than alcohol-based hand disinfectants. The Journal of Hospital Infection. 2015;90(3):226-34.
69. Ran L, Chen X, Wang Y, Wu W, Zhang L, Tan X. Risk Factors of Healthcare Workers With Coronavirus Disease 2019: A Retrospective Cohort Study in a Designated Hospital of Wuhan in China. Clinical Infectious Diseases: an official publication of the Infectious Diseases Society of America. 2020.

70. Jefferson T, Jones M, Al Ansari LA, Bawazeer G, Beller E, Clark J et al. Physical interventions to interrupt or reduce the spread of respiratory viruses. Part 1 - Face masks, eye protection and person distancing: systematic review and meta-analysis. medRxiv. 2020.03.30.20047217.
71. Whitby M, Pessoa-Silva CL, McLaws ML, Allegranzi B, Sax H, Larson E, et al. Behavioural considerations for hand hygiene practices: the basic building blocks. The Journal of Hospital Infection. 2007;65(1):1-8.
72. Ferguson FJ, Street G, Cunningham L, White IR, McFadden JP, Williams J. Occupational Dermatology in the time of the Covid-19 pandemic: A report of experience from London and Manchester, United Kingdom. Br J Dermatol. 2020.
73. Simonsen AB, Ruge IF, Quaade AS, Johansen JD, Thyssen JP, Zachariae C. High incidence of hand eczema in Danish schoolchildren following intensive hand hygiene during the COVID-19 pandemic: a nationwide questionnaire study. Br J Dermatol. 2020.
74. Yip L, Bixler D, Brooks DE, Clarke KR, Datta SD, Dudley S, et al. Serious Adverse Health Events, Including Death, Associated with Ingesting Alcohol-Based Hand Sanitizers Containing Methanol - Arizona and New Mexico, May-June 2020. MMWR Morbidity and Mortality Weekly Report. 2020;69(32):1070-3.
75. Gormley NJ, Bronstein AC, Rasimas JJ, Pao M, Wratney AT, Sun J, et al. The rising incidence of intentional ingestion of ethanol-containing hand sanitizers. Crit Care Med. 2012;40(1):290-4.
76. Smith JD, MacDougall CC, Johnstone J, Copes RA, Schwartz B, Garber GE. Effectiveness of N95 respirators versus surgical masks in protecting healthcare workers from acute respiratory infection: a systematic review and meta-analysis. CMAJ: Canadian Medical Association journal = journal de l'Association medicale canadienne. 2016;188(8):567-74.
77. Coia JE, Ritchie L, Adisesh A, Makison Booth C, Bradley C, Bunyan D, et al. Guidance on the use of respiratory and facial protection equipment. The Journal of Hospital Infection. 2013;85(3):170-82.
78. MacIntyre CR, Chughtai AA. Facemasks for the prevention of infection in healthcare and community settings. BMJ. 2015;350:h694.
79. Doung-ngern P, Suphanchaimat R, Panjagampatthana A, Janekrongtham C, Ruampoom D, Daochaeng N, et al. Associations between mask-wearing, handwashing, and social distancing practices and risk of COVID-19 infection in public: a case-control study in Thailand. medRxiv. 2020.06.11.20128900.
80. Payne DC, Smith-Jeffcoat SE, Nowak G, Chukwuma U, Geibe JR, Hawkins RJ, et al. SARS-CoV-2 Infections and Serologic Responses from a Sample of U.S. Navy Service Members - USS Theodore Roosevelt, April 2020. MMWR Morbidity and Mortality Weekly Report. 2020;69(23):714-21.
81. Hendrix MJ, Walde C, Findley K, Trotman R. Absence of Apparent Transmission of SARS-CoV-2 from Two Stylists After Exposure at a Hair Salon with a Universal Face Covering Policy - Springfield, Missouri, May 2020. MMWR Morbidity and Mortality Weekly Report. 2020;69(28):930-2.
82. Mitze T, Kosfeld R, Rode J, K W. Face Masks Considerably Reduce COVID-19 Cases in Germany: A Synthetic Control Method Approach [Internet]. Bonn, Germany: IZA Institute of Labor Economics; 2020 [cited 25 August 2020]. Available from: https://www.iza.org/publications/dp/13319/face-masks-considerably-reduce-covid-19-cases-in-germany-a-synthetic-control-method-approach
83. Cheng VC-C, Wong S-C, Chuang VW-M, So SY-C, Chen JH-K, Sridhar S, et al. The role of community-wide wearing of face mask for control of coronavirus disease 2019 (COVID-19) epidemic due to SARS-CoV-2. J Infect. 2020;81(1):107-14.
84. Community Use Of Face Masks And COVID-19: Evidence From A Natural Experiment Of State Mandates In The US. Health Affairs. 2020;39(8):1419-25.
85. Bandiera L, Pavar G, Pisetta G, Otomo S, Mangano E, Seckl JR, et al. Face Coverings and Respiratory Tract Droplet Dispersion. medRxiv. 2020.08.11.20145086.
86. MacIntyre CR, Chughtai AA. A rapid systematic review of the efficacy of face masks and respirators against coronaviruses and other respiratory transmissible viruses for the community, healthcare workers and sick patients. International Journal of Nursing Studies. 2020;108:103629.
87. Gandhi M, Beyrer C, Goosby E. Masks Do More Than Protect Others During COVID-19: Reducing the Inoculum of SARS-CoV-2 to Protect the Wearer. Journal of General Internal Medicine. 2020.
88. Royal Society, British Academy. Face masks and coverings for the general public: Behavioural knowledge, effectiveness of cloth coverings and public messaging. [Internet]. London: The Royal Society; 2020 [cited 25 August 2020]. Available from: https://royalsociety.org/-/media/policy/projects/set-c/set-c-facemasks.pdf?la=en-GB&hash=A22A87CB28F7D6AD9BD93BBCBFC2BB24
89. Fischer EP, Fischer MC, Grass D, Henrion I, Warren WS, Westman E. Low-cost measurement of facemask efficacy for filtering expelled droplets during speech. Science Advances. 2020:eabd3083.
90. Zangmeister CD, Radney JG, Vicenzi EP, Weaver JL. Filtration Efficiencies of Nanoscale Aerosol by Cloth Mask Materials Used to Slow the Spread of SARS-CoV-2. ACS Nano. 2020;14(7):9188-200.
91. Konda A, Prakash A, Moss GA, Schmoldt M, Grant GD, Guha S. Aerosol Filtration Efficiency of Common Fabrics Used in Respiratory Cloth Masks. ACS Nano. 2020;14(5):6339-47.
92. Lustig SR, Biswakarma JJH, Rana D, Tilford SH, Hu W, Su M, et al. Effectiveness of Common Fabrics to Block Aqueous Aerosols of Virus-like Nanoparticles. ACS Nano. 2020;14(6):7651-8.
93. Varallyay C, Li N, Case B, Wolf B. Material Suitability Testing for Nonmedical Grade Community Face Masks to Decrease Viral Transmission During a Pandemic. Disaster Medicine and Public Health Preparedness. 2020:1-7.
94. Teesing GR, van Straten B, de Man P, Horeman-Franse T. Is there an adequate alternative to commercially manufactured face masks? A comparison of various materials and forms. The Journal of Hospital Infection. 2020;106(2):246-53.

95. Aydin O, Emon B, Cheng S, Hong L, Chamorro LP, Saif MTA. Performance of fabrics for home-made masks against the spread of COVID-19 through droplets: A quantitative mechanistic study. Extreme Mechanics Letters. 2020;40:100924.
96. European Committee for Standardization (CEN). New EU CEN guidelines for Community masks | Quality & Compliance [Internet]. Eurofins; 2020 [cited 25 August 2020]. Available from: https://www.eurofins.com/consumer-product-testing/covid-19-product-testing/cwa-cen-mask-testing/
97. AFNOR. Download AFNOR Spec - Barrier masks V1.0 [Internet]. AFNOr; 2020 [cited 25 August 202]. Available from: https://masques-barrieres.afnor.org/home/telechargement?culture=en-GB
98. European Centre for Disease Prevention and Control (ECDC). Infographic: Using face masks in the community [Internet]. Stockholm: ECDC; 2020 [updated 14 April 2020; cited 7 September 2020]. Available from: https://www.ecdc.europa.eu/en/publications-data/infographic-using-face-masks-community
99. European Centre for Disease Prevention and Control (ECDC). Video on COVID-19: Do you know how to wear a face mask properly? (long version) [Internet]. Stockholm: ECDC; 2020 [updated 24 August 2020; cited 7 September 2020]. Available from: https://www.ecdc.europa.eu/en/publications-data/video-covid-19-do-you-know-how-wear-face-mask-properly-long-version
100. European Centre for Disease Prevention and Control (ECDC). Video on COVID-19: How to wear your single use face mask? (short version) [Internet]. Stockholm: ECDC; 2020 [updated 28 August 2020; cited 7 September 2020]. Available from: https://www.ecdc.europa.eu/en/publications-data/video-covid-19-how-wear-your-single-use-face-mask-short-version
101. European Centre for Disease Prevention and Control (ECDC). Video on COVID-19: How to wear your re-usable/textile face mask? (short version) [Internet]. Stockholm: ECDC; 2020 [updated 25 August 2020; cited 7 September 2020]. Available from: https://www.ecdc.europa.eu/en/publications-data/video-covid-19-how-wear-your-re-usabletextile-face-mask-short-version
102. Mantzari E, Rubin GJ, Marteau TM. Is risk compensation threatening public health in the covid-19 pandemic? BMJ. 2020;370:m2913.
103. Seres G, Balleyer A, Cerutti N, Friedrichsen J, S. M. Face Mask Use and Physical Distancing before and after Mandatory Masking: Evidence from Public Waiting Lines. SSRN [pre-print]. 2020.
104. Chen Y-J, Qin G, Chen J, Xu J-L, Feng D-Y, Wu X-Y, et al. Comparison of Face-Touching Behaviors Before and During the Coronavirus Disease 2019 Pandemic. JAMA Network Open. 2020;3(7):e2016924-e.
105. Schünemann HJ, Akl EA, Chou R, Chu DK, Loeb M, Lotfi T, et al. Use of facemasks during the COVID-19 pandemic. The Lancet Respiratory Medicine. 2020.
106. Seale H, Dyer CEF, Abdi I, Rahman KM, Sun Y, Qureshi MO, et al. Improving the impact of non-pharmaceutical interventions during COVID-19: examining the factors that influence engagement and the impact on individuals. BMC Infectious Diseases. 2020;20(1):607.
107. Bakhit M, Krzyzaniak N, Scott AM, Clark J, Glasziou P, Del Mar C. Downsides of face masks and possible mitigation strategies: a systematic review and meta-analysis. medRxiv. 2020.06.16.20133207.
108. Bhutani M, Hernandez P, Yang C, Bourbeau J, Licskai C, Dechman G, et al. Canadian Thoracic Society recommendations regarding the use of face masks by the public during the SARS-CoV-2 (COVID-19) pandemic. Canadian Journal of Respiratory, Critical Care, and Sleep Medicine. 2020:1-2.
109. Chodosh J, Weinstein BE, Blustein J. Face masks can be devastating for people with hearing loss. BMJ. 2020;370:m2683.
110. Chughtai AA, Seale H, Macintyre CR. Effectiveness of Cloth Masks for Protection Against Severe Acute Respiratory Syndrome Coronavirus 2. Emerging Infectious Diseases. 2020;26(10).
111. Aragaw TA. Surgical face masks as a potential source for microplastic pollution in the COVID-19 scenario. Marine Pollution Bulletin. 2020;159:111517.
112. Iversen BG, Vestrheim DF, Flottorp S, Denison E, Oxman AD. Should individuals in the community without respiratory symptoms wear facemasks to reduce the spread of COVID-19? [Internet]. Oslo: Norwegian Institute of Public Health; 2020 [cited 18 August 2020]. Available from: https://www.fhi.no/globalassets/dokumenterfiler/rapporter/2020/should-individuals-in-the-community-without-respiratory-symptoms-wear-facemasks-to-reduce-the-spread-of-covid-19-report-2020.pdf
113. Lindsley WG, Noti JD, Blachere FM, Szalajda JV, Beezhold DH. Efficacy of Face Shields Against Cough Aerosol Droplets from a Cough Simulator. Journal of Occupational and Environmental Hygiene. 2014;11(8):509-18.
114. Perencevich EN, Diekema DJ, Edmond MB. Moving Personal Protective Equipment Into the Community: Face Shields and Containment of COVID-19. JAMA. 2020;323(22):2252-3.
115. European Centre for Disease Prevention and Control (ECDC). Use of gloves in healthcare and non-healthcare settings in the context of the COVID 19 pandemic [Internet]. Stockholm: ECDC; 2020. Available from: https://www.ecdc.europa.eu/en/publications-data/gloves-healthcare-and-non-healthcare-settings-covid-19
116. Ong SWX, Tan YK, Sutjipto S, Chia PY, Young BE, Gum M, et al. Absence of contamination of personal protective equipment (PPE) by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Infection Control & Hospital Epidemiology. 2020;41(5):614-6.
117. European Centre for Disease Prevention and Control (ECDC). Disinfection of environments in healthcare and non-healthcare settings potentially contaminated with SARS-CoV-2 [Internet]. Stockholm: ECDC; 2020. Available from: https://www.ecdc.europa.eu/sites/default/files/documents/Environmental-persistence-of-SARS_CoV_2-virus-Options-for-cleaning2020-03-26_0.pdf
118. World Health Organization (WHO). Coronavirus disease (COVID-19). Situation Report- 115 [Internet]. Geneva: WHO; 2020 [cited 14 September 2020]. Available from: https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200514-covid-19-sitrep-115.pdf?sfvrsn=3fce8d3c_6

119. World Health Organization (WHO). Natural ventilation for infection control in health-care settings [Internet]. Geneva: WHO; 2009 [cited 14 September 2020]. Available from: https://apps.who.int/iris/bitstream/handle/10665/44167/9789241547857_eng.pdf?sequence=1
120. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE). ASHRAE Position Document on Infectious Aerosols [Internet]. Atlanta: ASHRAE; 2020 [cited 14 September 2020]. Available from: https://www.ashrae.org/file%20library/about/position%20documents/pd_infectiousaerosols_2020.pdf
121. European Agency for Safey and Health at Work (EU-OSHA). OSH WIKI. COVID-19: guidance for the workplace [Internet]. Santiago de Compostela: EU-OSHA; 2020. Available from: https://oshwiki.eu/wiki/COVID-19:_guidance_for_the_workplace#See
122. Federation of European Heating, Ventilation and Air Conditioning Associations (REHVA). REHVA COVID-19 guidance document, 3 April 2020 [Internet]. Brussels: REHVA; 2020. Available from: https://www.rehva.eu/fileadmin/user_upload/REHVA_COVID-19_guidance_document_ver2_20200403_1.pdf
123. Knibbs LD, Morawska L, Bell SC, Grzybowski P. Room ventilation and the risk of airborne infection transmission in 3 health care settings within a large teaching hospital. American Journal of Infection Control. 2011;39(10):866-72.
124. Lu J, Gu J, Li K, Xu C, Su W, Lai Z, et al. COVID-19 Outbreak Associated with Air Conditioning in Restaurant, Guangzhou, China, 2020. Emerging Infectious Diseases. 2020;26(7):1628-31.
125. Rothe C, Schunk M, Sothmann P, Bretzel G, Froeschl G, Wallrauch C, et al. Transmission of 2019-nCoV Infection from an Asymptomatic Contact in Germany. The New England Journal of Medicine. 2020;382(10):970-1.
126. Qian H, Miao T, Liu L, Zheng X, Luo D, Li Y. Indoor transmission of SARS-CoV-2. medRxiv. 2020.04.04.20053058.
127. Park SY, Kim YM, Yi S, Lee S, Na BJ, Kim CB, et al. Coronavirus Disease Outbreak in Call Center, South Korea. Emerging Infectious Diseases. 2020;26(8):1666-70.
128. Li Y, Qian H, Hang J, Chen X, Hong L, Liang P, et al. Evidence for probable aerosol transmission of SARS-CoV-2 in a poorly ventilated restaurant. medRxiv. 2020.04.16.20067728.
129. Shen Y, Li C, Dong H, Wang Z, Martinez L, Sun Z, et al. Community Outbreak Investigation of SARS-CoV-2 Transmission Among Bus Riders in Eastern China. JAMA Internal Medicine. 2020.
130. Hamner L, Dubbel P, Capron I, Ross A, Jordan A, Lee J, et al. High SARS-CoV-2 Attack Rate Following Exposure at a Choir Practice - Skagit County, Washington, March 2020. MMWR Morbidity and Mortality Weekly Report. 2020;69(19):606-10.
131. Leclerc Q, Fuller N, Knight L, Funk S, Knight G. What settings have been linked to SARS-CoV-2 transmission clusters? [version 2; peer review: 2 approved]. Wellcome Open Research. 2020;5(83).
132. McKinsey & Company. Can HVAC systems help prevent transmission of COVID-19? [Internet]. McKinsey & Company; 2020 [updated 9 July 2020; cited 25 August 2020]. Available from: https://www.mckinsey.com/industries/advanced-electronics/our-insights/can-hvac-systems-help-prevent-transmission-of-covid-19
133. European Centre for Disease Prevention and Control (ECDC). Guidance for discharge and ending isolation in the context of widespread community transmission of COVID-19, 8 April 2020 [Internet]. Stokcholm: ECDC; 2020. Available from: https://www.ecdc.europa.eu/en/publications-data/covid-19-guidance-discharge-and-ending-isolation
134. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. The Lancet. 2020;395(10223):497-506.
135. Docherty AB, Harrison EM, Green CA, Hardwick HE, Pius R, Norman L, et al. Features of 20 133 UK patients in hospital with covid-19 using the ISARIC WHO Clinical Characterisation Protocol: prospective observational cohort study. BMJ. 2020;369:m1985.
136. To KK-W, Tsang OT-Y, Leung W-S, Tam AR, Wu T-C, Lung DC, et al. Temporal profiles of viral load in posterior oropharyngeal saliva samples and serum antibody responses during infection by SARS-CoV-2: an observational cohort study. The Lancet Infectious Diseases. 2020;20(5):565-74.
137. Zou L, Ruan F, Huang M, Liang L, Huang H, Hong Z, et al. SARS-CoV-2 Viral Load in Upper Respiratory Specimens of Infected Patients. New England Journal of Medicine. 2020;382(12):1177-9.
138. Hoehl S, Rabenau H, Berger A, Kortenbusch M, Cinatl J, Bojkova D, et al. Evidence of SARS-CoV-2 Infection in Returning Travelers from Wuhan, China. New England Journal of Medicine. 2020;382(13):1278-80.
139. European Centre for Disease Prevention and Control (ECDC). COVID-19 Surveillance report [Internet]. Stockholm: ECDC; 2020. Available from: https://covid19-surveillance-report.ecdc.europa.eu/
140. Vestergaard LS, Nielsen J, Richter L, Schmid D, Bustos N, Braeye T, et al. Excess all-cause mortality during the COVID-19 pandemic in Europe – preliminary pooled estimates from the EuroMOMO network, March to April 2020. Euro surveillance: bulletin Europeen sur les maladies transmissibles = European communicable disease bulletin. 2020;25(26):2001214.
141. Martellucci CA, Sah R, Rabaan AA, Dhama K, Casalone C, Arteaga-Livias K, et al. Changes in the spatial distribution of COVID-19 incidence in Italy using GIS-based maps. Ann Clin Microbiol Antimicrob. 2020;19(1):30-.
142. World Health Organization (WHO). Non-pharmaceutical public health measures for mitigating the risk and impact of epidemic and pandemic influenza [Internet]. Geneva: WHO; 2019 [cited 7 September 2020]. Available from: https://apps.who.int/iris/bitstream/handle/10665/329438/9789241516839-eng.pdf?ua=1

143. Cowling BJ, Ali ST, Ng TWY, Tsang TK, Li JCM, Fong MW, et al. Impact assessment of non-pharmaceutical interventions against coronavirus disease 2019 and influenza in Hong Kong: an observational study. The Lancet Public Health. 2020;5(5):e279-e88.
144. Kucharski AJ, Klepac P, Conlan AJK, Kissler SM, Tang ML, Fry H, et al. Effectiveness of isolation, testing, contact tracing, and physical distancing on reducing transmission of SARS-CoV-2 in different settings: a mathematical modelling study. The Lancet Infectious Diseases. 2020.
145. Chinazzi M, Davis JT, Ajelli M, Gioannini C, Litvinova M, Merler S, et al. The effect of travel restrictions on the spread of the 2019 novel coronavirus (COVID-19) outbreak. Science. 2020;368(6489):395-400.
146. Davies NG, Kucharski AJ, Eggo RM, Gimma A, Edmunds WJ, Jombart T, et al. Effects of non-pharmaceutical interventions on COVID-19 cases, deaths, and demand for hospital services in the UK: a modelling study. The Lancet Public Health. 2020;5(7):e375-e85.
147. Wei WE, Li Z, Chiew CJ, Yong SE, Toh MP, Lee VJ. Presymptomatic Transmission of SARS-CoV-2 - Singapore, January 23-March 16, 2020. MMWR Morbidity and Mortality Weekly Report. 2020;69(14):411-5.
148. Zhu L, Gong N, Liu B, Lu X, Chen D, Chen S, et al. Coronavirus Disease 2019 Pneumonia in Immunosuppressed Renal Transplant Recipients: A Summary of 10 Confirmed Cases in Wuhan, China. Eur Urol. 2020;77(6):748-54.
149. Tooher R, Collins JE, Street JM, Braunack-Mayer A, Marshall H. Community knowledge, behaviours and attitudes about the 2009 H1N1 Influenza pandemic: a systematic review. Influenza and Other Respiratory Viruses. 2013;7(6):1316-27.
150. Quilty BJ, Clifford S, Flasche S, Kucharski AJ, Edmunds WJ. Quarantine and testing strategies in contact tracing for SARS-CoV-2. medRxiv. 2020.08.21.20177808.
151. European Centre for Disease Prevention and Control (ECDC). Contact tracing for COVID-19: current evidence, options for scale-up and an assessment of resources needed [Internet]. Stocholm: ECDC; 2020. Available from: https://www.ecdc.europa.eu/en/publications-data/contact-tracing-covid-19-evidence-scale-up-assessment-resources
152. Nussbaumer-Streit B, Mayr V, Dobrescu AI, Chapman A, Persad E, Klerings I, et al. Quarantine alone or in combination with other public health measures to control COVID-19: a rapid review. The Cochrane database of systematic reviews. 2020;4(4):Cd013574.
153. Salje H, Tran Kiem C, Lefrancq N, Courtejoie N, Bosetti P, Paireau J, et al. Estimating the burden of SARS-CoV-2 in France. Science. 2020;369(6500):208-11.
154. Hinch R, Probert W, Nurtay A, Kendall M, Wymant C, Hall M, et al. Effective Configurations of a Digital Contact Tracing App: A report to NHSX [Internet]. 2020 [updated 16 April 2020; cited 7 September 2020]. Available from: https://cdn.theconversation.com/static_files/files/1009/Report_-_Effective_App_Configurations.pdf?1587531217
155. Aleta A, Martín-Corral D, Pastore y Piontti A, Ajelli M, Litvinova M, Chinazzi M, et al. Modelling the impact of testing, contact tracing and household quarantine on second waves of COVID-19. Nature Human Behaviour. 2020.
156. Bell D, Nicoll A, Fukuda K, Horby P, Monto A, Hayden F, et al. Non-pharmaceutical interventions for pandemic influenza, national and community measures. Emerging Infectious Diseases. 2006;12(1):88-94.
157. DiGiovanni C, Conley J, Chiu D, Zaborski J. Factors influencing compliance with quarantine in Toronto during the 2003 SARS outbreak. Biosecurity and Bioterrorism: biodefense strategy, practice, and science. 2004;2(4):265-72.
158. European Centre for Disease Prevention and Control (ECDC). Coronavirus disease 2019 (COVID-19) in the EU/EEA and the UK – eleventh update, 10 August 2020. [Internet]. Stockholm: ECDC; 2020. Available from: https://www.ecdc.europa.eu/sites/default/files/documents/covid-19-rapid-risk-assessment-20200810.pdf.
159. European Centre for Disease Prevention and Control (ECDC). Download data on country response measures to COVID-19 [Internet]. Stockholm: ECDC; 2020. Available from: https://www.ecdc.europa.eu/en/publications-data/download-data-response-measures-covid-19
160. Suarez-Gonzalez A. Detrimental effects of confinement and isolation in the cognitive and psychological health of people living with dementia during COVID-19: emerging evidence [Internet]. London: International Long-Term Care Policy Network; 2020 [cited 8 September 2020]. Available from: https://ltccovid.org/2020/07/01/detrimental-effects-of-confinement-and-isolation-on-the-cognitive-and-psychological-health-of-people-living-with-dementia-during-covid-19-emerging-evidence/
161. Evandrou M, Falkingham J, Qin M, Vlachantoni A. Older and 'staying at home' during lockdown: analysis of informal care receipt during the COVID-19 pandemic amongst people aged 70 and over in the UK. SocArXiv. 2020.
162. Block P, Hoffman M, Raabe IJ, Dowd JB, Rahal C, Kashyap R, et al. Social network-based distancing strategies to flatten the COVID-19 curve in a post-lockdown world. Nature Human Behaviour. 2020;4(6):588-96.
163. Leng T, White C, Hilton J, Kucharski AJ, Pellis L, Stage H, et al. The effectiveness of social bubbles as part of a Covid-19 lockdown exit strategy, a modelling study. medRxiv. 2020.06.05.20123448.
164. United Kingdom, Department of Health and Social Care,. Guidance. Meeting people from outside your household. [Internet]. London: Department of Health and Social Care; 2020 [updated 2 September 2020; cited 07 September 2020]. Available from: https://www.gov.uk/guidance/meeting-people-from-outside-your-household-from-4-july
165. Willem L, Abrams S, Petrof O, Coletti P, Kuylen E, Libin P, et al. The impact of contact tracing and household bubbles on deconfinement strategies for COVID-19: an individual-based modelling study. medRxiv. 2020.07.01.20144444.
166. Comas-Herrera A, Zalakaín J, Litwin C, Hsu AT, Lemmon E, Henderson D, et al. Mortality associated with COVID-19 outbreaks in care homes: early international evidence [Internet]. London: International Long-term

Care Policy Network (ILPN) and Care Policy and Evaluation Centre (CPEC) at the London School of Economics and Political Science (LSE); 2020 [updated 26 June 2020; cited 7 September 2020]. Available from: https://ltccovid.org/2020/04/12/mortality-associated-with-covid-19-outbreaks-in-care-homes-early-international-evidence/
167. Team EPHE, Danis K, Fonteneau L, Georges S, Daniau C, Bernard-Stoecklin S, et al. High impact of COVID-19 in long-term care facilities, suggestion for monitoring in the EU/EEA, May 2020. Euro surveillance: bulletin Europeen sur les maladies transmissibles = European communicable disease bulletin. 2020;25(22).
168. European Centre for Disease Prevention and Control (ECDC). Healthcare-associated infections in long-term care facilities [Internet]. Stockholm: ECDC; 2020 [cited 8 September 2020]. Available from: https://www.ecdc.europa.eu/en/healthcare-associated-infections-long-term-care-facilities
169. Suetens C, Latour K, Kärki T, Ricchizzi E, Kinross P, Moro ML, et al. Prevalence of healthcare-associated infections, estimated incidence and composite antimicrobial resistance index in acute care hospitals and long-term care facilities: results from two European point prevalence surveys, 2016 to 2017. Euro surveillance: bulletin Europeen sur les maladies transmissibles = European communicable disease bulletin. 2018;23(46):1800516.
170. European Centre for Disease Prevention and Control (ECDC). Surveillance of COVID-19 at long-term care facilities in the EU/EEA [Internet]. Stockholm: ECDC; 2020. Available from: https://www.ecdc.europa.eu/en/publications-data/surveillance-COVID-19-long-term-care-facilities-EU-EEA
171. Medecins Sans Frontieres (MSF). Why protecting and supporting staff in care homes during COVID-19 is so vital [Internet]. Geneva: MSF; 2020 [updated 24 April 2020; cited 8 September 2020]. Available from: https://www.msf.org/why-protecting-staff-care-homes-during-covid-19-so-vital
172. Medecins Sans Frontieres (MSF). Left behind in the times of COVID-19 [Internet]. Brussels: MSF; 2020 [cited 8 September 2020]. Available from: https://www.msf.org/sites/msf.org/files/2020-07/Left%20behind%20-%20MSF%20care%20homes%20in%20Belgium%20report.pdf
173. Lorenz-Dant K. International examples of measures to support unpaid carers during the COVID-19 pandemic [Internet]. London: International Long-Term Care Policy Network; 2020 [cited 8 September 2020]. Available from: https://ltccovid.org/wp-content/uploads/2020/05/International-measures-to-support-unpaid-carers-in-manage-the-COVID19-situation-20.05.20-complete-3.pdf
174. Spasova S, Baeten R, Coster S, Ghailani D, Peña-Casas R, Vanhercke B. Challenges in long-term care in Europe - A study of national policies 2018 [Internet]. Brussels: European Comission; 2020 [cited 8 September 2020]. Available from: https://ec.europa.eu/social/main.jsp?catId=738&langId=en&pubId=8128&furtherPubs=yes
175. European Comission Directorate General for Employment, Social Affairs and Inclusion. Publications catalogue & documents database. ESPN Thematic repot on challenges in long term care (country reports) [Internet]. Brussels: European Comission; 2020 [cited 9 September 2020]. Available from: https://ec.europa.eu/social/main.jsp?pager.offset=0&advSearchKey=espnltc_2018&mode=advancedSubmit&catId=22&policyArea=0&policyAreaSub=0&country=0&year=0
176. World Health Organization (WHO). Preventing and managing COVID-19 across long-term care services: Policy brief, 24 July 2020 [Internet]. Geneva: WHO; 2020 [cited 8 September 2020]. Available from: https://www.who.int/publications/i/item/WHO-2019-nCoV-Policy_Brief-Long-term_Care-2020.1
177. European Centre for Disease Prevention and Control (ECDC). Infection prevention and control and preparedness for COVID-19 in healthcare settings - fourth update [Internet]. Stockholm: ECDC; 2020. Available from: https://www.ecdc.europa.eu/en/publications-data/infection-prevention-and-control-and-preparedness-covid-19-healthcare-settings
178. European Centre for Disease Prevention and Control (ECDC). Pillar 6: Infection prevention and control [Internet]. Stockholm: ECDC; 2020 [cited 8 September 2020]. Available from: https://www.ecdc.europa.eu/en/all-topics-z/coronavirus/threats-and-outbreaks/covid-19/prevention-and-control/monitoring-4
179. Wu B. Social isolation and loneliness among older adults in the context of COVID-19: a global challenge. Global Health Research and Policy. 2020;5:27.
180. Campbell AD. Practical Implications of Physical Distancing, Social Isolation, and Reduced Physicality for Older Adults in Response to COVID-19. Journal of Gerontological Social Work. 2020:1-3.
181. World Health Organization (WHO) REgional Office for Europe. Strengthening the Health Systems Response to COVID-19 - Technical guidance #6, 21 May 2020 (produced by the WHO European Region) [Internet]. Copenhagen: WHO Regional Office for Europe; 2020 [cited 8 September 2020]. Available from: https://www.euro.who.int/en/health-topics/Health-systems/pages/strengthening-the-health-system-response-to-covid-19/technical-guidance-and-check-lists/strengthening-the-health-systems-response-to-covid-19-technical-guidance-6,-21-may-2020-produced-by-the-who-european-region
182. Cheng AC, Worth LJ. Cultural dimensions relevant to antimicrobial stewardship: the contribution of individualism and power distance to perioperative prescribing practices in European hospitals. Healthcare Infection. 2015;20(4):124-7.
183. Borg MA. Lowbury Lecture 2013. Cultural determinants of infection control behaviour: understanding drivers and implementing effective change. The Journal of Hospital Infection. 2014;86(3):161-8.
184. Blommaert A, Marais C, Hens N, Coenen S, Muller A, Goossens H, et al. Determinants of between-country differences in ambulatory antibiotic use and antibiotic resistance in Europe: a longitudinal observational study. Journal of Antimicrobial Chemotherapy. 2013;69(2):535-47.
185. European Centre for Disease Prevention and Control (ECDC). Infection prevention and control and surveillance for coronavirus disease (COVID-19) in prisons in EU/EEA countries and the UK – July 2020

[Internet]. Stockholm: ECDC; 2020. Available from: https://www.ecdc.europa.eu/sites/default/files/documents/IPC-and-surveillance-for-coronavirus-disease-in-prisons.pdf
186. Centre for Crime and Justice Studies. Covid-19 in prisons: Focus on England and Wales [Internet]. London: Centre for Crime and Justice Studies; 2020 [updated 5 June 2020; cited 7 September 2020]. Available from: https://www.crimeandjustice.org.uk/news/2020-06-05/covid-19-prisons-focus-england-and-wales
187. European Public Service Union (EPSU). Fighting covid19 in prisons and detention centres in Europe: Protected prison workers – protected inmates [Internet]. Brussels: EPSU; 2020 [updated 15 April 2020; cited 7 September 2020]. Available from: https://www.epsu.org/article/fighting-covid19-prisons-and-detention-centres-europe-protected-prison-workers-protected
188. European Centre for Disease Prevention and Control (ECDC). Guidance on infection prevention and control of COVID-19 in migrant and refugee reception and detention centres in the EU/EEA and the UK [Internet]. Stockholm: ECDC; 2020. Available from: https://www.ecdc.europa.eu/en/publications-data/covid-19-guidance-prevention-control-migrant-refugee-centres
189. Ebrahim SH, Memish ZA. COVID-19 – the role of mass gatherings. Travel Medicine and Infectious Disease. 2020;34:101617.
190. Brauner JM, Mindermann S, Sharma M, Stephenson AB, Gavenčiak T, Johnston D, et al. The effectiveness of eight nonpharmaceutical interventions against COVID-19 in 41 countries. medRxiv. 2020.05.28.20116129.
191. European Centre for Disease Prevention and Control (ECDC). COVID-19 clusters and outbreaks in occupational settings in the EU/EEA and the UK [Internet]. Stockholm: ECDC; 2020. Available from: https://www.ecdc.europa.eu/en/publications-data/covid-19-clusters-and-outbreaks-occupational-settings-eueea-and-uk
192. Lee VJ, Lye DC, Wilder-Smith A. Combination strategies for pandemic influenza response - a systematic review of mathematical modeling studies. BMC Med. 2009;7:76.
193. Fisher KA, Tenforde MW, Feldstein LR, Lindsell CJ, Shapiro NI, Files DC, et al. Community and Close Contact Exposures Associated with COVID-19 Among Symptomatic Adults ≥18 Years in 11 Outpatient Health Care Facilities - United States, July 2020. MMWR Morbidity and Mortality Weekly Report. 2020;69(36):1258-64.
194. Viner RM, Russell SJ, Croker H, Packer J, Ward J, Stansfield C, et al. School closure and management practices during coronavirus outbreaks including COVID-19: a rapid systematic review. Lancet Child Adolesc Health. 2020;4(5):397-404.
195. Parri N, Lenge M, Buonsenso D. Children with Covid-19 in Pediatric Emergency Departments in Italy. New England Journal of Medicine. 2020;383(2):187-90.
196. Garazzino S, Montagnani C, Donà D, Meini A, Felici E, Vergine G, et al. Multicentre Italian study of SARS-CoV-2 infection in children and adolescents, preliminary data as at 10 April 2020. Euro surveillance: bulletin Europeen sur les maladies transmissibles = European communicable disease bulletin. 2020;25(18):2000600.
197. Rashid H, Ridda I, King C, Begun M, Tekin H, Wood JG, et al. Evidence compendium and advice on social distancing and other related measures for response to an influenza pandemic. Paediatric Respiratory Reviews. 2015;16(2):119-26.
198. Keogh-Brown MR, Smith RD, Edmunds JW, Beutels P. The macroeconomic impact of pandemic influenza: estimates from models of the United Kingdom, France, Belgium and The Netherlands. The European Journal of Health Economics: HEPAC: health economics in prevention and care. 2010;11(6):543-54.
199. Mayurasakorn K, Pinsawas B, Mongkolsucharitkul P, Sranacharoenpong K, Damapong S-N. School closure, COVID-19 and lunch programme: Unprecedented undernutrition crisis in low-middle income countries. J Paediatr Child Health. 2020;56(7):1013-7.
200. Liu Y, Morgenstern C, Kelly J, Lowe R, Jit M. The impact of non-pharmaceutical interventions on SARS-CoV-2 transmission across 130 countries and territories. medRxiv. 2020.08.11.20172643.
201. European Parliament. Directive 2004/38/EC of the European Parliament and of the Council of 29 April 2004 on the right of citizens of the Union and their family members to move and reside freely within the territory of the Member States amending Regulation (EEC) No 1612/68 and repealing Directives 64/221/EEC, 68/360/EEC, 72/194/EEC, 73/148/EEC, 75/34/EEC, 75/35/EEC, 90/364/EEC, 90/365/EEC and 93/96/EEC [Internet]. Official Journal L58, 30/04/2004 P772004. Available from: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02004L0038-20110616
202. Koh WC, Naing L, Wong J. Estimating the impact of physical distancing measures in containing COVID-19: an empirical analysis. medRxiv. 2020.06.11.20128074.
203. Komissarov AB, Safina KR, Garushyants SK, Fadeev AV, Sergeeva MV, Ivanova AA, et al. Genomic epidemiology of the early stages of SARS-CoV-2 outbreak in Russia. medRxiv. 2020.07.14.20150979.
204. Adekunle A, Meehan M, Rojas-Alvarez D, Trauer J, McBryde E. Delaying the COVID-19 epidemic in Australia: evaluating the effectiveness of international travel bans. Australian and New Zealand Journal of Public Health. 2020;44(4):257-9.
205. Russell TW, Wu J, Clifford S, Edmunds J, Kucharski AJ, Jit M. The effect of international travel restrictions on internal spread of COVID-19. medRxiv. 2020.07.12.20152298.
206. Nakamura H, Managi S. Airport risk of importation and exportation of the COVID-19 pandemic. Transport Policy. 2020;96:40-7.
207. Shi S, Tanaka S, Ueno R, Gilmour S, Tanoue Y, Kawashima T, et al. Travel restrictions and SARS-CoV-2 transmission: an effective distance approach to estimate impact. Bull World Health Organ. 2020;98(8):518-29.

208. Paniz-Mondolfi A, Munoz M, Florez C, Gomez S, Rico A, Pardo L, et al. SARS-CoV-2 spread across the Colombian-Venezuelan border. medRxiv. 2020.07.09.20149856.
209. International Air Transport Association (IATA). Restarting aviation following COVID-19. Medical evidence for various strategies being discussed as at 8 May 2020 IATA Medical Advisory Group [Internet]. Geneva: IATA; 2020 [cited 7 September 2020]. Available from: https://www.iata.org/contentassets/f1163430bba94512a583eb6d6b24aa56/covid-medical-evidence-for-strategies-200508.pdf
210. Bae SH, Shin H, Koo HY, Lee SW, Yang JM, Yon DK. Asymptomatic Transmission of SARS-CoV-2 on Evacuation Flight. Emerging Infectious Diseases. 2020;26(11).
211. Hoehl S, Karaca O, Kohmer N, Westhaus S, Graf J, Goetsch U, et al. Assessment of SARS-CoV-2 Transmission on an International Flight and Among a Tourist Group. JAMA Network Open. 2020;3(8):e2018044-e.
212. Schwartz KL, Murti M, Finkelstein M, Leis JA, Fitzgerald-Husek A, Bourns L, et al. Lack of COVID-19 transmission on an international flight. Canadian Medical Association Journal. 2020;192(15):E410-E.
213. Chen J, He H, Cheng W, Liu Y, Sun Z, Chai C, et al. Potential transmission of SARS-CoV-2 on a flight from Singapore to Hangzhou, China: An epidemiological investigation. Travel Medicine and Infectious Disease. 2020;36:101816.
214. Okada P, Buathong R, Phuygun S, Thanadachakul T, Parnmen S, Wongboot W, et al. Early transmission patterns of coronavirus disease 2019 (COVID-19) in travellers from Wuhan to Thailand, January 2020. Euro surveillance: bulletin Europeen sur les maladies transmissibles = European communicable disease bulletin. 2020;25(8):2000097.
215. Nir-Paz R, Grotto I, Strolov I, Salmon A, Mandelboim M, Mendelson E, et al. Absence of in-flight transmission of SARS-CoV-2 likely due to use of face masks on board. Journal of Travel Medicine. 2020.
216. Draper AD, Dempsey KE, Boyd RH, Childs EM, Black HM, Francis LA, et al. The first 2 months of COVID-19 contact tracing in the Northern Territory of Australia, March-April 2020. Communicable Diseases Intelligence (2018). 2020;44.
217. Eldin C, Lagier J-C, Mailhe M, Gautret P. Probable aircraft transmission of Covid-19 in-flight from the Central African Republic to France. Travel Medicine and Infectious Disease. 2020;35:101643-.
218. Zhang J, li J, Wang T, Tian S, Lou J, Kang X, et al. Transmission of SARS-CoV-2 on Aircraft. SSRN [pre-print] [Internet]. 2020. Available from: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3586695
219. Hu M, Lin H, Wang J, Xu C, Tatem AJ, Meng B, et al. The risk of COVID-19 transmission in train passengers: an epidemiological and modelling study. Clinical Infectious Diseases: an official publication of the Infectious Diseases Society of America. 2020.
220. Yang N, Shen Y, Shi C, Ma AHY, Zhang X, Jian X, et al. In-flight transmission cluster of COVID-19: a retrospective case series. Infectious Diseases (London, England). 2020:1-11.
221. Kong D, Wang Y, Lu L, Wu H, Ye C, Wagner AL, et al. Clusters of 2019 coronavirus disease (COVID-19) cases in Chinese tour groups. Transbound Emerg Dis. 2020.
222. Maloney WAT, Temel. Determinants of Social Distancing and Economic Activity during COVID-19: A Global View. Maloney,William F.; Taskin,Temel.2020. Policy Research working paper no. WPS 9242;COVID-19 Washington, D.C.: World Bank Group. Available from: http://documents.worldbank.org/curated/en/325021589288466494/Determinants-of Social-Distancing-and-Economic-Activity-during-COVID-19-A-Global-View
223. Badr HS, Du H, Marshall M, Dong E, Squire MM, Gardner LM. Association between mobility patterns and COVID-19 transmission in the USA: a mathematical modelling study. The Lancet Infectious Diseases. 2020.
224. Ng T-CV, Cheng H-Y, Chang H-H, Liu C-C, Yang C-C, Jian S-W, et al. Effects of case- and population-based COVID-19 interventions in Taiwan. medRxiv. 2020.08.17.20176255.
225. Espinoza BC-C, Carlos;Perrings, Charles. Mobility restrictions for the control of epidemics: When do they work? PLOS ONE. 2020;15(7):e0235731.
226. Oum THW, K. Socially optimal lockdown and travel restrictions for fighting communicable virus including COVID-19. Transp Policy (Oxf). 2020;96:94-100.
227. Jacobsen GDJ, K. H. Statewide COVID-19 Stay-at-Home Orders and Population Mobility in the United States. World Med Health Policy. 2020.
228. Graham AK, F.;Kruse, W. Attitudes of ageing passengers to air travel since the coronavirus pandemic. J Air Transp Manag. 2020;87:101865.
229. Shamsrizi P, Jochum J, Kreuels B, Ramharter M. Traveling into the Abyss: Risk Perception of German Travelers at the Onset of the COVID-19 Pandemic. The American Journal of Tropical Medicine and Hygiene. 2020.
230. Lamb TL, Winter SR, Rice S, Ruskin KJ, Vaughn A. Factors that predict passengers willingness to fly during and after the COVID-19 pandemic. Journal of Air Transport Management. 2020;89:101897.
231. Beck MJ, Hensher DA. Insights into the impact of COVID-19 on household travel and activities in Australia – The early days under restrictions. Transport Policy. 2020;96:76-93.
232. European Centre for Disease Prevention and Control (ECDC). Considerations relating to passenger locator data, entry and exit screening and health declarations in the context of COVID-19 in the EU/EEA and the UK [Internet]. Stockholm: ECDC; 2020. Available from: https://www.ecdc.europa.eu/en/publications-data/passenger-locator-data-entry-exit-screening-health-declaration
233. Quilty BJ, Clifford S, group2 Cnw, Flasche S, Eggo RM. Effectiveness of airport screening at detecting travellers infected with novel coronavirus (2019-nCoV). Euro surveillance: bulletin Europeen sur les maladies transmissibles = European communicable disease bulletin. 2020;25(5):2000080.

234. Taylor R, McCarthy CA, Patel V, Moir R, Kelly L, Snary E. The risk of introducing SARS-CoV-2 to the UK via international travel in August 2020. medRxiv. 2020.09.09.20190454.
235. Health Information and Quality Authority (HIQA). Evidence summary for non-contact thermal screening as an effective means of identifying cases of COVID-19 [Internet]. Dublin: HIQA; 2020 [cited 18 August 2020]. Available from: https://www.hiqa.ie/sites/default/files/2020-08/Evidence-summary-of-non-contact-thermal-screening.pdf
236. Bielecki M, Crameri GAG, Schlagenhauf P, Buehrer TW, Deuel JW. Body temperature screening to identify SARS-CoV-2 infected young adult travellers is ineffective. Travel Medicine and Infectious Disease. 2020;37:101832.
237. Bays D, Bennett E, Finnie T. Using simulation to assess the potential effectiveness of implementing screening at national borders during international outbreaks of influenza, SARS, Ebola virus disease and COVID-19. medRxiv. 2020.07.10.20150664.
238. Ahmed W, Bertsch PM, Angel N, Bibby K, Bivins A, Dierens L, et al. Detection of SARS-CoV-2 RNA in commercial passenger aircraft and cruise ship wastewater: a surveillance tool for assessing the presence of COVID-19 infected travellers. Journal of Travel Medicine. 2020;27(5).
239. Clifford S, Quilty BJ, Russell TW, Liu Y, Chan Y-WD, Pearson CAB, et al. Strategies to reduce the risk of SARS-CoV-2 re-introduction from international travellers. medRxiv. 2020.07.24.20161281.
240. Wei L, Sha Z, Wang Y, Zhang G, Jia H, Zhou S, et al. Willingness and beliefs associated with reporting travel history to high-risk coronavirus disease 2019 epidemic regions among the Chinese public: a cross-sectional study. BMC Public Health. 2020;20(1):1164.
241. World Health Organization (WHO). Public health considerations while resuming international travel [Internet]. Geneva: WHO; 2020 [updated 30 July 2020; cited 7 September 2020]. Available from: https://www.who.int/news-room/articles-detail/public-health-considerations-while-resuming-international-travel
242. European Centre for Disease Prevention and Control (ECDC). Outbreak of acute respiratory syndrome associated with a novel coronavirus, China: first local transmission in the EU/EEA – third update. 31 January 2020 [Internet]. Stockholm: ECDC; 2020. Available from: https://www.ecdc.europa.eu/en/publications-data/risk-assessment-outbreak-acute-respiratory-syndrome-associated-novel-1
243. Davis JT, Chinazzi M, Perra N, Mu K, Pastore y Piontti A, Ajelli M, et al. Estimating the establishment of local transmission and the cryptic phase of the COVID-19 pandemic in the USA. medRxiv. 2020.07.06.20140285.
244. Chang M-C, Kahn R, Li Y-A, Lee C-S, Buckee CO, Chang H-H. Variation in human mobility and its impact on the risk of future COVID-19 outbreaks in Taiwan. medRxiv. 2020.04.07.20053439.
245. Hu C-S. Analysis of COVID-19 Cases and Public Measures in China. SN Comprehensive Clinical Medicine. 2020.
246. Jiang X, Chang L, Shi Y. A retrospective analysis of the dynamic transmission routes of the COVID-19 in mainland China. Scientific Reports. 2020;10(1):14015.
247. Lin Y, Peng F. Control Strategies against COVID-19 in China: Significance of Effective Testing in the Long Run. medRxiv. 2020.08.22.20179697.
248. Quilty BJ, Diamond C, Liu Y, Gibbs H, Russell TW, Jarvis CI, et al. The effect of travel restrictions on the geographical spread of COVID-19 between large cities in China: a modelling study. BMC Medicine. 2020;18(1):259.
249. Stockdale JE, Doig R, Min J, Mulberry N, Wang L, Elliott LT, et al. Long time frames to detect the impact of changing COVID-19 control measures. medRxiv. 2020.06.14.20131177.

Annex 1. Literature search methodology and results

Search strategy for literature on non-pharmaceutical measures

Relevant publications were identified by searching:

- targeted websites of national health authorities and universities;
- generic web search engines (e.g. Google) through customised searches;
- PubMed;
- pre-print servers for non-peer-reviewed scientific manuscripts; and
- the media.

Searches were complemented by hand searches and retrieval of any additional sources that met the eligibility criteria that could be found in the lists of references.

Search string used in PubMed

("COVID-19"[Supplementary Concept] OR "severe acute respiratory syndrome coronavirus 2"[Supplementary Concept] OR "COVID-19 vaccine"[Supplementary Concept] OR "COVID-19 serotherapy"[Supplementary Concept] OR "COVID-19 diagnostic testing"[Supplementary Concept] OR "COVID-19 drug treatment"[Supplementary Concept] OR "LAMP assay"[Supplementary Concept]* OR "Coronavirus Infections"[Mesh:noexp] OR "Wuhan coronavirus"[TW] OR "Wuhan seafood market pneumonia virus"[TW] OR COVID19[TW] OR "COVID-19"[TW] OR "COVID-2019"[TW] OR "coronavirus disease 2019"[TW] OR "SARS-CoV-2"[TW] OR SARS2[TW] OR "2019-nCoV"[TW] OR "2019 novel coronavirus"[TW] OR "severe acute respiratory syndrome coronavirus 2"[TW] OR "2019 novel coronavirus infection"[TW] OR "coronavirus disease 2019"[TW] OR "coronavirus disease-19"[TW] OR "novel coronavirus"[TW] OR coronavirus[TW] OR "SARS-CoV-19"[TW] OR "SARS-CoV-2019"[TW])

The publications retrieved have been collated in an Endnote library which is maintained by the ECDC Library. The EndNote library database is designed to retrieve all new publications related to COVID-19 in PubMed and pre-print services since the start of the epidemic and is updated daily.

For this document, publications retrieved between 1 July and 31 August 2020 (21 344 publications) were screened as an update to current ECDC guidance documents (as of 30 June 2020). The search strategy for non-pharmaceutical measures contained the search terms set out in the table below (applied to the ECDC Endnote library).

	Key concept	Search terms [Boolean operator]	EndNote field
1	Non-pharmaceutical measures	non AND pharmaceutical AND intervention	Any field
	Public health measures	non AND pharmaceutical AND measures	Any field
	Non-pharmaceutical interventions	non AND pharmaceutical AND measures AND effectiveness	Any field
		non AND pharmaceutical AND intervention AND effectiveness	Any field
2	Hand hygiene	hand hygiene OR hand AND hygiene	Any field
		hand washing OR hand AND washing	Any field
		hand disinfection OR hand AND disinfection	Any field
		hand disinfection OR hand washing AND effectiveness	Any field
		hand disinfection OR hand washing OR hand hygiene AND hand sanitizers	Any field
		hand hygiene AND effectiveness	Any field
		hand hygiene AND non-alcohol-based hand rub	Any field
		hand hygiene AND alcohol-based hand rub	Any field
		hand hygiene AND soap AND water	Any field
3	Respiratory etiquette	respiratory AND etiquette	Any field
		cough AND etiquette	Any field
4	Face masks	face AND coverings	Any field
		face AND masks	Any field
		community AND masks OR surgical masks	Any field
5	Personal protective equipment'	personal protective measures OR personal AND protective AND measures	Any field

	Key concept	Search terms [Boolean operator]	EndNote field
	Personal protective measures'	personal protective equipment OR personal AND protective AND equipment	Any field
		Gloves OR visors OR eye protective devices OR eye protection	Any field
6	Environmental measures	environment OR environmental AND measures	Any field
		surface OR stainless steel OR copper AND cleaning OR disinfectant	Any field
		disinfection OR virus AND inactivation AND effectiveness	Any field
7	Social distancing measures	social OR physical AND distancing	Any field
	Physical distancing measures	quarantine OR isolation	Any field
		workplace OR teleworking OR Absenteeism	Any field
8	Travel advice	travel AND advice	Any field
	Entry and exit screening	travel OR travellers AND airport OR aircraft	Any field
		travel AND restriction	Any field
9	Travel restrictions	travel AND restriction AND effectiveness	Any field
		border AND closure	Any field
		border AND closure AND effectiveness	Any field
10	Vulnerable populations	vulnerable AND medically	Any field
		vulnerable AND socially	Any field
		long-term care OR skilled nursing homes OR nursing homes	Any field
		prison OR prisoner OR migrant OR refugee	Any field
11	Implementation of behavioural interventions	implementation AND behavioural AND intervention	Any field
12	Compliance/adherence	compliance OR adherence	Any field
13	Resistance/acceptance	resistance OR acceptance	Any field
14	Sustainability	sustainability	Any field
15	Peer-pressure/peer-support	peer AND pressure	Any field
		peer AND support	Any field
16	Social norms	social AND norms OR social norms	Any field