



Improving pandemic preparedness and management

*Group of Chief Scientific Advisors to the European Commission
European Group on Ethics in Science and New Technologies (EGE)*

*Special advisor to President Ursula von der Leyen
on the response to the coronavirus and COVID-19*

Joint Opinion, November 2020

Independent
Expert
Report



Research and
Innovation

Improving pandemic preparedness and management

Group of Chief Scientific Advisors to the European Commission

European Group on Ethics in Science and New Technologies

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EUROPEAN COMMISSION

INDEPENDENT EXPERT REPORT

Improving **pandemic preparedness and management**

Lessons learned and ways forward

*Group of Chief Scientific Advisors
European Group on Ethics in Science and New Technologies
Special advisor to President Ursula von der Leyen on the response
to the coronavirus and COVID-19
Joint Opinion*

Brussels, 11 November 2020

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The development of this Opinion was led by a steering group on behalf of all joint advisors. The steering group consisted of Pearl Dykstra, Éva Kondorosi, Paul Nurse and Rolf-Dieter Heuer (GCSA); Christiane Woopen and Siobhán O'Sullivan (EGE); Peter Piot (Special Advisor to the European Commission President); and Janusz Bujnicki (former member of the Group of Chief Scientific Advisors). The work of the steering group was led by Pearl Dykstra and Christiane Woopen. All joint advisors have endorsed this Opinion.

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¹ SAPEA brings together knowledge and expertise from over 100 academies and learned societies in over 40 countries across Europe. Funded through the EU’s Horizon 2020 programme, the SAPEA consortium comprises Academia Europaea (AE), All European Academies (ALLEA), the European Academies Science Advisory Council (EASAC), the European Council of Academies of Applied Sciences, Technologies and Engineering (Euro-CASE) and the Federation of European Academies of Medicine (FEAM).

EXECUTIVE SUMMARY

The COVID-19 pandemic has painfully confirmed what experts have warned against since the 2009 H1N1 and 2014-2016 Ebola pandemics: the world has been gravely under-prepared for large outbreaks of emerging infectious diseases.

The EU is drawing lessons from the COVID-19 crisis, with new policy initiatives brought forward by the European Commission on better preparedness for future health threats. To support and inform that process, we as science and ethics advisors have examined evidence on the responses to the COVID-19 and, in part, to previous pandemics – which has revealed important lessons learned and to be learned. On that basis, we have formulated a range of recommendations, which are summarised below.

Prevent and pre-empt

- Support multifaceted efforts to investigate, map and reduce the risk of emerging infectious diseases globally, including the surveillance of pathogen reservoirs, mitigation, forecasting and early detection of potential outbreaks.
- Support a combination of complementary approaches for accelerating the research on and development of responses to pathogens with epidemic and pandemic potential.
- Strengthen multi- and cross-disciplinary research on pandemic prevention, preparedness, responses and impacts, analysing the multi-faceted societal aspects and consequences of health crises.

Enhance coordination across Member States and at international level

- Establish a standing EU advisory body for health threats and crises, including epidemics and pandemics. This body should liaise with advisory bodies in the Member States as well as at EU and global level. It should have a multidisciplinary and inclusive membership so it can advise on biomedical, behavioural, social, economic, cultural, ethical, legal, technological and international aspects.
- Ensure that monitoring efforts are comprehensive, evidence-based, rapidly shared and well-coordinated across the EU, enabling strategic decisions in response to the situation at hand, insights through real-time comparisons, as well as collective action where appropriate.
- Establish a joint early-response mechanism to contain epidemics and pandemics, including a toolbox of strategies, such as testing, tracing, and isolating as well as containment measures. Any strategy needs to be based on scientific evidence, guided by the fundamental rights framework

and applied in a situation-dependent manner. Herd immunity is a concept best applied in the context of vaccine-acquired immunity. Achieving herd immunity through natural infection by a previously unknown pathogen involving risks to life and health conflicts with the WHO's ethical framework and its multi-principled approach, requiring that utility and equity considerations are balanced.

- Coordinate research and the development and implementation of medical countermeasures during a pandemic or other health threat. Crucial scientific questions should be clarified as quickly as possible after the onset of a health threat such as a pandemic to rapidly inform effective and safe public health measures.
- Coordinate research and the development and evaluation of social measures to mitigate harm and to increase resilience in case of pandemics or other public health crises. Social, economic, ethical, psychosocial and cultural challenges raised by a pandemic should be addressed as quickly as possible after its onset to inform a range of nuanced and locally appropriate measures.

Strengthen systems for preparedness and management

- Encourage Member States to provide healthcare for all, respecting the principles of justice and solidarity and adhering to the commitments established in the context of European fundamental rights instruments, such as the European Pillar of Social Rights, and the Sustainable Development Goals.
- Ensure robust and equitable access to critical products and services for all EU citizens and demonstrate global solidarity. This involves pre-emptively providing criteria for the allocation, among and within Member States, of limited resources essential to manage a pandemic and mitigate harm, with due regard to the moral equality of all persons.
- Encourage Member States to strengthen public health infrastructure as an essential part of efficient and equitable health services, including interoperable and interconnected health information systems; develop rapid and reliable testing and tracing systems supported by laboratory networks and monitoring capabilities; build public health workforce capacity and strengthen community infrastructures of social care.
- Establish systems for effective risk communication and tackling disinformation and misinformation during crises and strengthen the ECDC's role also in this regard. Develop communication strategies for advice and policy that are evidence-based, fit for purpose, flexible and nuanced and that counter stigmatising and homogenising discourses that serve to exclude and marginalise.
- Together with EU Member States, develop strategies to sustain education in all sectors and in accordance with the Digital Education Plan 2021-2027. The closure of educational institutions touches on several key areas

of society and has long-lasting social, economic, medical and psychosocial consequences. It should be carried out with utmost restraint.

- Encourage Member States to strengthen efforts in community involvement and organisation and support civil-society organisations.
- Foster appropriate engineering and other controls in public buildings to limit infection risk indoors for airborne diseases, such as sufficient and effective ventilation, possibly enhanced by particle filtration and air disinfection, avoiding air recirculation and overcrowding. Such measures can help to avoid the need for applying more invasive and restrictive measures such as the closure of educational institutions and work places.

Uphold fundamental rights and strengthen social justice

- Uphold highest standards in the protection of fundamental rights and civil liberties during pandemics. In the rare case of encroachments on rights and liberties to limit harm and risks during pandemics they should be considered only with utmost care, be explicitly limited in time, continuously reviewed and justified with respect to their necessity and proportionality and lifted as soon as possible.
- Implement the European Pillar of Social Rights, for example by extending social security benefits to workers in non-standard and precarious employment and updating policies towards an appropriate acknowledgement of the value of care work.

Find solidarity-based and sustainable ways of living

- Take action in a cross-cutting manner based on the increasing body of knowledge about unsustainable ways of living, which also contribute to the emergence of epidemics and pandemics. This includes addressing the links between health crises and environmental degradation from a 'planetary health' perspective, and related fields, such as environmental protection, food, transport and urban planning. It also includes addressing the links between health crises, poverty and structural inequalities.

1. INTRODUCTION

This year, the coronavirus disease (COVID-19) pandemic, caused by the SARS-CoV-2 virus, has painfully confirmed what many reports and papers had already expressed since the 2009 H1N1 and 2014-2016 Ebola pandemics: the world is gravely under-prepared for large outbreaks of emerging infectious diseases (GPMB, 2019; Moon et al., 2017; Nuzzo et al., 2019).

Although sometimes referred to as very rare and unexpected 'black swan' events, scientists, healthcare practitioners and others had warned policy makers of the high likelihood of pandemics. Epidemics and pandemics have occurred throughout human history and are the predictable result of an increasingly growing, urbanised and mobile human world population that is expanding into and exploiting the natural world (UNEP & ILRI, 2020; IPBES, 2020). Indeed, COVID-19 is the latest in a series of recent epidemics and pandemics, and will not be the last one. In fact, the rate of emerging infectious disease outbreaks seems to be increasing significantly over time (GPMB, 2019; Jones et al., 2008; Moon et al., 2017; Smith et al., 2014). In addition, the socioeconomic costs of these outbreaks are also reported to be increasing (Dobson et al., 2020).

Besides the costs of lives and health, epidemics and pandemics have devastating effects on societal and individual wellbeing more largely. They strongly impact economies, livelihoods and psychosocial wellbeing across entire communities. Measures taken to mitigate them can come with threats to civil liberties and fundamental rights.

Even though insights in the exact impacts of the COVID-19 pandemic are tentative and evolving, it has already become clear that both the disease and some emergency countermeasures have had substantial socio-economic costs, often hitting the marginalised and most vulnerable in society the hardest (e.g. Bambra et al., 2020; ECDC, 2020b; UN, 2020). We have also been witnessing how real-time global communication via social networks facilitates the spreading of denialism and misinformation and has resulted in both damaging under- and over-reactions (Frutos et al., 2020).

The COVID-19 pandemic and the responses to it have moreover caused other medical conditions to go untreated as regular healthcare was interrupted; school closures have exacerbated inequalities in access to education; domestic violence has increased; and mental health and personal well-being of entire populations have been negatively affected (de Pedraza et al., 2020; Feral-Pierssens et al., 2020; Nicola et al., 2020; Sharp et al., 2020).

This highlights the centrality of values, such as solidarity, equity and social justice, to societal resilience, as well as the importance of response strategies taking the diversity of risks brought about by pandemics into account and building on respective long-term considerations. The current experience shows that good pandemic management is nuanced and is rooted in the scientific understanding of

both the disease and its effects, coupled with critical societal and ethical considerations. It also confirms that preparedness consists in building resilient institutions based on sustainability and social justice.

This joint Opinion addresses how Europe can ensure better management of, and preparedness for, epidemics and pandemics. It builds on lessons learned from the current crisis and other epidemics and pandemics and provides recommendations for improvement. It is intended to inform responses and policies in the context of pandemics at European level, among them the European Commission's legislative proposals for a strengthened Health Union.

This joint Opinion is a continuation of the cooperation between the Group of Chief Scientific Advisors to the European Commission, the European Group on Ethics in Science and New Technologies (EGE), and the special advisor to European Commission President Ursula von der Leyen on the response to the coronavirus and COVID-19. The advice draws upon their collective expertise and analysis of the current crisis, based on evidence, knowledge and insights gathered from expert elicitation and rapid evidence reviews.² The strength of this Opinion lies in its interdisciplinary approach, examining the complexity of pandemics in their manifold aspects and combining insights from research with analyses of the ways in which European values and fundamental rights can come under pressure in an emergency context of this kind, but can also serve as critical orientation during crises.

In June, we published a joint statement giving guidance to politicians and policy makers, their advisors and the scientific community on how policy advice may best be given and used in times of complexity and uncertainty, such as during the ongoing COVID-19 crisis.³ In 2021, we intend to deliver a joint Opinion on strengthened European resilience to crises in general.

² For more information on the methodologies and the sources of information and evidence used to develop this Opinion, see Annex 1.

³ Statement on scientific advice to European policy makers during the COVID-19 pandemic, 24 June 2020, <https://doi.org/10.2777/854269>

2. CONDITIONS THAT GIVE RISE TO INCREASING RISKS FOR PANDEMICS

Epidemics and pandemics arise from a wide range of origins, pathogens and drivers, making their prevention and preparedness complex (IPBES, 2020). The source of a disease is obviously of biological nature, human behaviour and socio-economic and ecological factors are also key drivers of their emergence and spreading.

Pathogens may be newly emerging, i.e. not previously recognised in humans, or re-emerging or resurging, for example due to acquired resistance to treatment (e.g. malaria, tuberculosis) or inadequate vaccination of the population (e.g. measles, diphtheria). Indeed, the increase of vaccine hesitancy and dropping vaccination coverage are worrying developments, which have already resulted in unprecedented outbreaks of vaccine-preventable diseases in the EU (Bechini et al., 2019). Besides naturally emerging, pathogens might also be released accidentally (e.g. from research labs) or deliberately (in case of biological weapons and bioterrorism agents such as anthrax), which require considerations of biosafety and biosecurity (GPMB, 2019; Nuzzo et al., 2019).

Most concerning and high-impact outbreaks have been caused by viruses (including COVID-19, HIV/AIDS, Ebola, Zika and pandemic influenza) (Adalja et al., 2018; Morse et al., 2012; Simpson et al., 2020), but the majority of emerging infectious disease outbreaks are caused by bacteria (e.g. plague, anthrax, cholera, Q fever, typhus, rickettsial diseases) (Jones et al., 2008; Smith et al., 2014). Besides viruses (25-40%) (Simpson et al., 2020) and bacteria (48-54%), outbreaks also emerge from prions (e.g. Creutzfeldt–Jakob disease and its BSE-associated variant vCJD), protozoa (5-11%; e.g. malaria, toxoplasmosis), fungi (2-6%; e.g. *Candida* infections, valley fever) and helminths (3-4%; e.g. schistosomiasis, soil-transmitted helminthiasis) (Jones et al., 2008; Simpson et al., 2020; Smith et al., 2014; Weber et al., 2019). However, the probability that these latter organisms cause a pandemic is more limited (Adalja et al., 2018).

Pathogens with pandemic potential – microorganisms that constitute a ‘global catastrophic biological risk’ (GCBR) – typically have common attributes, including efficient respiratory transmission between humans; lack of pre-existing immunity in humans; lack of medical countermeasures (i.e. treatments, vaccines); capability of spreading during incubation period prior to onset of strong symptoms; and intrinsic microbial characteristics (i.e. virulence) (Adalja et al., 2018) (see also Figure 1). Many pathogens mutate at a high rate, which allows them to adapt to fluctuating environments, including the host’s immune response. In particular RNA viruses have very high mutation rates – up to a million times higher than their hosts (Duffy, 2018). Hyper-mutable bacteria have also been isolated from human patients (Hall & Henderson-Begg, 2006). Viruses and bacteria also have the ability to transfer genes ‘horizontally’ (i.e. between genomes of different strains or species). Bacteria can exchange their genetic

material using mobile genetic elements or via bacteriophages (bacterial viruses), including antimicrobial resistance genes (Botelho & Schulenburg, 2020; Partridge et al., 2018). Viruses – in particular RNA viruses, due to their increased ability to mutate – are the most likely class of pathogens to cause a pandemic, although in the right context, any microbial organism could evolve or be engineered to become a global catastrophic biological risk (GCBR) (Adalja et al., 2018; Botelho & Schulenburg, 2020; Partridge et al., 2018; Simpson et al., 2020).

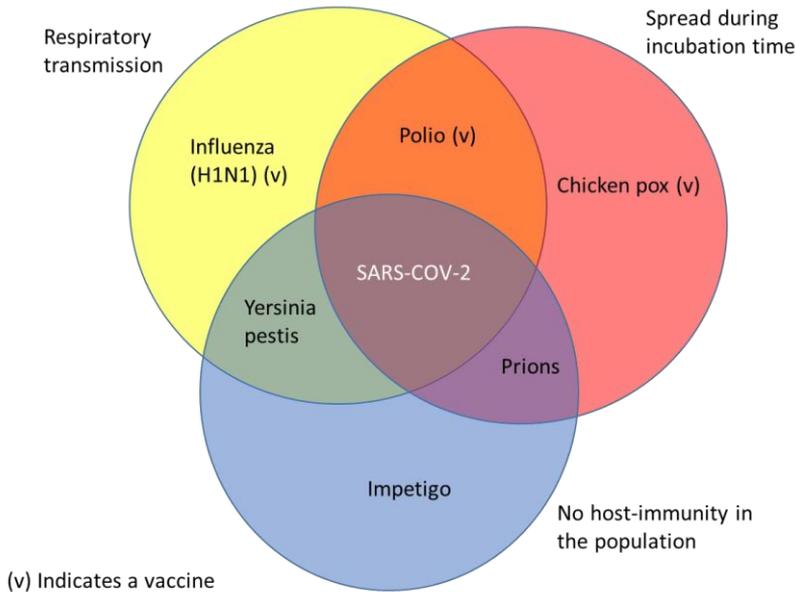


Figure 1: Venn diagram grouping selected pathogens according to three major risk factors for pandemics

Major risk factors are respiratory transmission, spread during the incubation time, and absence of host-immunity (Adalja et al. 2018). For COVID-19 all three risk factors apply. For influenza, chicken pox and polio host immunity in the population is ensured by vaccination. (Figure developed by the authors)

Due to the discovery and development of antimicrobials (e.g. penicillin, ampicillin), the pandemic risk of bacteria has been radically reduced (Adalja et al., 2018). However, due to misuse of antibiotics there is an increasing emergence of antimicrobial-resistant (AMR) bacterial strains (e.g. MRSA, drug-resistant tuberculosis), constituting a global public health threat (E. Y. Klein et al., 2018; O’ Neil, 2014). An increasing number of at least 700 000 people die each year due to drug-resistant diseases globally (low estimate for 2014; O’ Neil, 2014), with 33 110 in Europe (estimate for 2015; Cassini et al., 2019), making the effort to combat antimicrobial-resistance an international priority for global health security.

The majority of human infectious diseases (58-65%), including COVID-19, is zoonotic (K. E. Jones et al., 2008; Smith et al., 2014; Taylor et al., 2001; Woolhouse & Gowtage-Sequeria, 2005), meaning that the responsible pathogens

are derived from animals and transmitted to humans. Nearly all these zoonotic pathogens arise from warm-blooded animals, predominantly mammals and in some cases birds (Morse et al., 2012; Wolfe et al., 2007). Animals can act as 'reservoirs' of human pathogens, which can result in periodical local re-emergence of a disease, but also in spreading of the disease to otherwise unconnected human populations by migratory animals, for example.

Most animal-to-human transmissions occur where contact between humans and animals is close and/or frequent, thus with livestock, domesticated wildlife and pets, but also with 'peri-domestic wildlife' (e.g. rats and other pests) (UNEP, 2020). The majority of zoonotic diseases have their origin in wildlife (Jones et al., 2008), from which they have been transmitted to humans either directly, for example due to wildlife and bush-meat trade, or indirectly via (peri-)domestic animals as intermediate hosts (Dobson et al., 2020; UNEP, 2020). It is well-established that the emergence of such transmissions is typically driven by human activities, including deforestation and other changes to land use (e.g. for construction or intensive crop and livestock farming), wildlife exploitation, as well as increased meat consumption, urbanisation and mobility with globalised trade, travel and migration (Gibb et al., 2020; Gottdenker et al., 2014; McCloskey et al., 2014; Nava et al., 2017; Petersen et al., 2018; Simpson et al., 2020; Stephen, 2020; UNEP, 2020).

Many infectious diseases are vector-borne (23-25%; e.g. malaria, dengue, Zika, leishmaniosis, Lyme disease) (Jones et al., 2008; Smith et al., 2014). With vector-borne diseases, the viruses, bacteria or parasites are transmitted – between humans or from animals to humans – by other living organisms, often bloodsucking insects such as mosquitoes.

Outbreaks of infectious diseases, in particular zoonoses and vector-borne diseases, have risen over time and are expected to increasingly emerge as climate change worsens (Jones et al., 2008; Smith et al., 2014; Stephen, 2020). Indeed, outbreaks have been linked with extreme weather or climate events, e.g. with unusual rainfall and rising temperatures, including the resulting thawing of permafrost, as well as with climate change-associated effects on habitats and geographic range of vectors and disease reservoirs (Anwar et al., 2019; Caminade et al., 2019; Fouque & Reeder, 2019; Nava et al., 2017; UNEP, 2020; Waits et al., 2018).

3. INEQUALITIES, DISCRIMINATION AND ECONOMIC HARDSHIP

COVID-19 and previous pandemics have shown that the outbreak of a highly infectious disease causes a broader societal crisis and highlights pre-existing social ills. This requires responses to be of a holistic nature, addressing all aspects and causes of the crisis, and to aim for sustainable recovery and veritable resilience. Comparing the various strategies rolled out by governments over the last months across the globe, one lesson learned, as this chapter will show, is the need to consider the myriad consequences of a pandemic and their interplay when devising crisis preparedness and management plans.

While limiting the spread of the disease, lockdowns and similar containment measures have had severe consequences on individuals and groups. As was already shown in the context of former pandemics and epidemics, new empirical studies point to the interrelatedness of structural inequalities and the severity of the impact of a health crisis, with disadvantaged populations often hit the hardest (Bambra et al., 2020). Witnessing the global and cross-societal spread of SARS-CoV-2, it has been posited – often in an effort to support an atmosphere of unity and solidarity – that ‘the virus does not discriminate.’ This has been criticised on the basis that it disregards the increased vulnerability to the various effects of the pandemic of the most socially and economically deprived (EGE, 2020). The following sections summarise past and ongoing research and thinking about the links between societal inequities and pandemics.

Health inequalities

Complementing the history of research showing clear links between poverty and increased infection risks, a recent study comparing COVID-19 related death rates in municipalities of France concluded that mortality is twice as large in the poorest municipalities compared to others, with housing conditions and occupational exposure likely being strong factors (Brandily et al., 2020). Economic pressure or precarious employment might lead to reluctance or inability to take sick leave, consult physicians, arrange teleworking or rely upon employer-provided health insurance (Lynch, 2020)⁴. Statistics from Spain and the USA, as well as a rich body of research conducted in the context of the Spanish influenza pandemic of 1918 and the H1N1 outbreak of 2009 similarly indicate that socio-economically disadvantaged groups are disproportionately affected by infectious diseases (Bambra et al., 2020). To describe the links between health inequalities and socio-economic status, Bambra et al. (2020) have revived the analytical concept of the “syndemic pandemic”, first developed by Merrill Singer in the 1990s to help

⁴ Miller C., Kliff S., Sanger-Katz M. (March 2020) Avoiding Coronavirus May Be a Luxury Some Workers Can’t Afford, The New York Times, <https://www.nytimes.com/2020/03/01/upshot/coronavirus-sick-days-service-workers.html>

understand the relationships between HIV/AIDS, substance use and violence in the USA at the time (Figure 2).

"A syndemic exists when risk factors or comorbidities are intertwined, interactive and cumulative — adversely exacerbating the disease burden and additively increasing its negative effects (...). We argue that for the most disadvantaged communities, COVID-19 is experienced as a syndemic — a co-occurring, synergistic pandemic that interacts with and exacerbates their existing NCDs [non-communicable diseases] and social conditions." (Bambra et al., 2020)

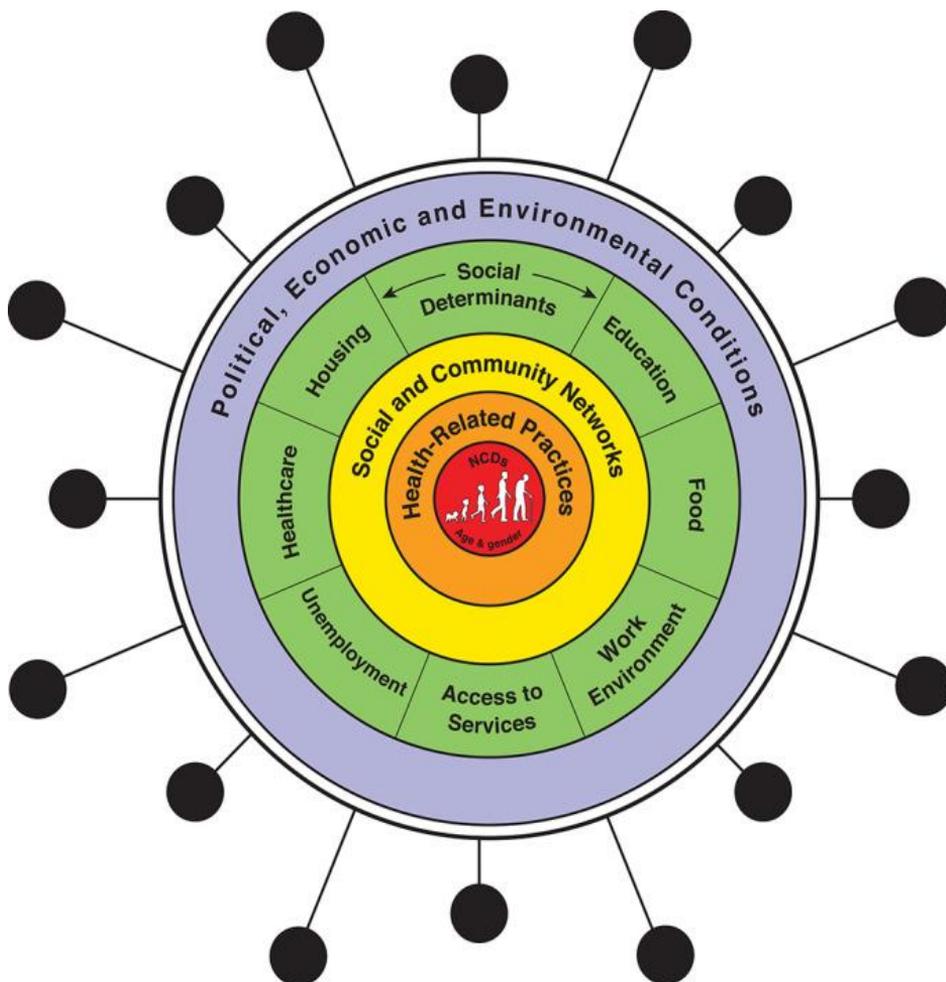


Figure 2: The syndemic of COVID-19, non-communicable diseases (NCDs) and the social determinants of health

(Bambra et al., 2020, with permission from Dahlgren & Whitehead, 2007)

Besides poverty, discrimination on the basis of ethnicity is known to be a key social determinant of health inequalities. Data from England and Wales show that

black, Asian and minority ethnic community populations represented 34.5% of the critically ill COVID-19 patients in the period until 16 April 2020 (ICNARC, 2020). This seems not to have changed within the second wave of infections. For example, as up to August and in September the non-white proportion of non-white patients admitted to intensive care units in England, Wales and Northern Ireland amounted to 34% and 38% respectively (ICNARC, 2020). In Romania, Bulgaria and other Eastern European Countries, some Roma communities faced particularly high infection rates, leading to additional stigmatisation and incidents of police violence against them (e.g. Matache & Bhabha, 2020). Most available data on the impact of ethnicity on clinical outcomes in COVID-19 is drawn from the UK; many other countries are not disaggregating data by ethnicity. It has been suggested that more research on this is necessary as links appear to be strong (Pan et al., 2020; El-Khatib et al., 2020). The situation is complicated by the fact that ethnic discrimination often corresponds with, and exacerbates, socio-economic disadvantage.

Reports also point to disadvantages for migrating people or displaced populations, whose living conditions, whether in camps or on the move, often make adherence to public health measures difficult and impede to access information or to seek medical or psycho-social help (e.g. Bukuluki et al., 2020). Reluctance to implement containment measures in asylum seekers' camps, for instance, sparked forms of protest as dangerous as the Moria blaze of early September 2020,⁵ pointing to the critical role of values and fundamental rights in crisis management and beyond.⁶

Efforts to establish which groups might require particular protection from SARS-CoV-2 have focused on an analysis of age groups, with older persons being at increased risk of severe disease and death following a COVID-19 infection.⁷ Strict measures implemented to isolate older adults both from each other and from younger population groups, such as with heavily restricted visiting and confinement rules in care homes, have caused important debates about

⁵ After the first infection cases in Moria, the government ordered a general quarantine in the overpopulated camp and did not isolate the infected and their close contacts. Médecins Sans Frontières was forced to close its temporary isolation facility and a clinic built with donations from the Dutch government was never opened. Stevis-Gridneff M. (September 2020) After fire razes squalid Greek camp, homeless migrants fear what's next, The New York Times, <https://www.nytimes.com/2020/09/13/world/europe/camp-fire-greece-migrants.html>

⁶ Stevis-Gridneff M. (July 2020) E.U. Adopts Groundbreaking Stimulus to Fight Coronavirus Recession, The New York Times, <https://www.nytimes.com/2020/07/20/world/europe/eu-stimulus-coronavirus.html>

⁷ "We know that over 95% of these deaths occurred in those older than 60 years. More than 50% of all deaths were people aged 80 years or older. We also know from reports that 8 out of 10 deaths are occurring in individuals with at least one underlying co-morbidity, in particular those with cardiovascular diseases/hypertension and diabetes, but also with a range of other chronic underlying conditions." WHO Europe Statement, Kluge H., WHO Regional Director (April 2020) Older people are at highest risk from COVID-19, but all must act to prevent community spread.

intergenerational solidarity and equity (e.g. Fletcher, 2020). In May 2020, the World Health Organization's (WHO) regional office reported that nearly every second COVID-19 death in Europe has occurred in long-term-care institutions.⁸ Utilitarian suggestions to distribute scarce medical resources in favour of younger COVID-19 patients were surprisingly strong. Ethicists have cautioned against weighing the value of life of different population groups according to a resource optimisation calculus, and have warned against minimising older persons' worth for society, their right to high-quality healthcare and their dignity (Carrieri et al., 2020). A qualitative and intersectional lens has been advised to prevent ageism in a pandemic, by showing that older populations are heterogeneous and pointing to problematic structural disparities in later life (SAPEA, 2019; Swinford et al., 2020). It has been criticised that extreme isolation and other measures with strong psycho-social effects, including mental health risks, have been imposed on older adults without their consultation and respect for their right to self-determination, as well as without accounting for their limited access to psycho-social services (Azcona et al., 2020). Calls for pandemic management strategies based on a more nuanced understanding of vulnerability and a recognition of the multiple ways in which older persons enrich society have been made (AGE Platform Europe, 2020).

The severity of COVID-19 (measured by hospitalisation, admission to intensive care units, and rates of fatality) has been shown to be two-fold greater for men than women (Klein et al., 2020). However, a high infection risk is assumed for women, not due to factors determined by sex, but by gender, as they constitute the majority of care givers in both the informal sector (e.g. in families and informal employment for eldercare) and the formal sector (e.g. as nurses, teachers, community workers) (Gausman & Langer, 2020).

In this context, it was suggested that further consideration should also be given to the role of children (see also section *Educational inequality*) in transmitting SARS-CoV-2, as newer evidence is inconsistent with first studies regarding their contribution to the spread of the disease (e.g. Heald-Sargent et al., 2020; T. C. Jones et al., 2020; Juanjuan Zhang et al., 2020). In addition, recent research highlights that many infected children may be asymptomatic or pre-symptomatic, and that both asymptomatic and symptomatic persons infected with SARS-CoV-2 may shed virus for up to three weeks (DeBiasi & Delaney, 2020).

This section sheds light on inequities in health and in the provision of health care and supports further examination of how universal accessibility of quality services for all can be strengthened. It has been suggested that privatisation,

⁸ WHO (May 2020) New WHO/Europe guidance shows more can be done to protect people in need of long-term care during the COVID-19 pandemic, <https://www.euro.who.int/en/health-topics/health-emergencies/coronavirus-covid-19/news/news/2020/5/new-who-europe-guidance-shows-more-can-be-done-to-protect-people-in-need-of-long-term-care-during-the-covid-19-pandemic>

decentralisation, short-term planning and substantial budget cuts have undermined health care systems and equality in their access (e.g. Armocida et al., 2020; Bambra, 2013). Health inequality also persists between countries, with the more vulnerable populations of the globe facing greater morbidity from preventable and treatable causes (WHO, 2017). The current pandemic has given rise to several calls for international cooperation towards universal health coverage, highlighting the importance of solidarity in the distribution of treatments and vaccines against COVID-19 (e.g. EGE, 2020).

Disregard for other medical needs

Hospitals and medical practices have also been reporting a strong decline in visits and interventions for medical conditions other than COVID-19, both due to cancellations on their own part and tendencies to defer consultations on the part of patients. Factual cancellation policies (e.g. Søreide et al., 2020) together with interpretation of and communication about hospitals as a place of danger have led to emergency room visits falling drastically in the early months of 2020: a worldwide study by the European Society of Cardiology, published in May 2020, found that the number of heart attack patients seeking help in emergency rooms has decreased by more than 50% (Pessoa-Amorim et al., 2020).

Closure of medical offices also led to delays in preventive routine screenings and interruption of long-term treatment plans, including of chemotherapy for cancer patients (Cancer Action Network, 2020; Maringe et al., 2020; Sharpless, 2020). Like other specialists, urologists have also highlighted that the strong reduction in elective surgeries might imply long-term consequences for patients (Morlacco et al., 2020).

Psycho-social consequences

The presence and imminent dangers of a highly infectious disease, potentially leading to death, has psychological effects across entire societies. So does, very likely, also imposed home-confinement (Pfefferbaum & North, 2020). Previous pandemics have shown that psychological reactions can range from irritability, fear of contracting family members, anger, confusion, frustration, loneliness and denial, through to anxiety, depression, insomnia, despair and suicide (Brooks et al., 2020). Particularly prone to these effects of a pandemic are persons with pre-existing mental disorders, who often show stronger symptoms during and in the aftermath of a pandemic due to higher susceptibility to stress compared to the general population (e.g. Chevance et al., 2020; Yao et al., 2020). Patients in long-term care facilities, among them old persons, persons with disabilities and persons with mental disorders, experience particularly stressful periods due to the strict isolation measures implemented in most caring facilities for prolonged periods (e.g. Boucaud-Maitre et al., 2020; Dubey et al., 2020). It has also been noted that persons who contract the disease and those at heightened risk for it are at increased risk for adverse psycho-social outcomes (Pfefferbaum & North, 2020).

While digital information and communication technologies have facilitated the immediate sharing of important pandemic-related information, they have also enabled what has been termed 'an infodemic', contributing to 'cyberchondria' and overloads of unfiltered information, often misinformation, resulting in increased anxiety (Laato et al., 2020, see also section *The public response: trust, communication, mis- and dis-information*).

Coupled with other pandemic-related causes for stress, such as job losses and economic burden, inequalities again co-determine levels and forms of psycho-social resilience among social groups. It has been indicated that marginalised groups can be particularly susceptible to mental distress caused by a pandemic (Dubey et al., 2020), such as homeless people who might be unable to quarantine and access basic sanitation facilities and often have chronic mental and physical conditions (Tsai & Wilson, 2020), migrants who might be unable to access health care, appropriate housing environments or information in their languages (OHCHR, IOM, UNHCR, & WHO, 2020), or prisoners who might live amassed in little space with potentially limited access to information, care, open spaces and sanitation (Kinner et al., 2020).

Frontline health care workers faced with overwork, inadequate protection from contamination, frustration from failure to give optimal patient-care and isolation have a high risk of developing unfavourable mental health outcomes and may therefore need special attention as regards psychological support or interventions (Lai et al., 2020).

Younger age-groups of children and adolescents have been described as scarcely affected by the COVID-19 crisis, while age-specific psycho-social consequences both of the dangers of an infection and of their changing life conditions during home confinement have received little attention (e.g. Wang et al., 2020). UNICEF has reported about the need to nuance pandemics policies affecting children and warned against family priorities potentially shifting away from childcare in times of crisis and hardship, with education and health care for children being at particular risk in disadvantaged contexts and regions (Richardson et al., 2020). It has been highlighted that children with developmental disabilities, already a particularly vulnerable group, are at increased risk during pandemics as they often have more significant healthcare, mental and educational needs and depend on community-based services, which are potentially more difficult to provide during pandemics (Aishworiya & Kang, 2020).

Insufficient importance has been attributed to mental health in disadvantaged groups during the current pandemic, pointing to the need "to understand how changes in social and welfare policies, reinforced community initiatives (e.g. mutual aid groups), and improved family supports and social networks, can transform the experience of the most vulnerable, and modify the effects of this pandemic, and anything similar in future, on mental health" (Morgan & Rose, 2020; see also Holmes et al., 2020).

Racism linked to an imagined origin of the disease

Beyond well-studied links between ethnicity and increased risk exposure in pandemics, the association of the SARS-CoV-2 virus and COVID-19 disease with China, where it first led to an epidemic, has spurred increased racism against people of Asian descent and appearance across the globe. Similar scapegoating occurred in the context of other pandemics and epidemics, with people linking the disease to an imagined origin.

When the bubonic plague spread in San Francisco in 1900, for instance, Chinese residents were quarantined in Chinatown, while white merchants could leave the area (Barde, 2004 in Gover et al., 2020). In the context of the SARS epidemic in 2007, a surge of risk and blame discourses in New York City's Chinatown was registered, despite an absence of infections in the area (Eichelberger, 2007). As Wuhan experienced an intense spread of SARS-CoV-2 in early 2020, officials and journalists quickly named it "the Chinese virus" (e.g. Viala-Gaufrey & Lindaman, April 2020)⁹; prejudiced comments about Chinese socio-cultural habits went viral on social media (Chung & Li, 2020; Shimizu, 2020)¹⁰; and entire lists of hate crimes motivated by COVID-19-related Sinophobia have been published¹¹.

It has also been argued that such stigmatisation and shame potentially cause PTSD, anxiety or depression (Gover et al., 2020) and prevent carriers of the virus from reporting their condition and receiving timely health-care attention (Chung & Li, 2020). Racist sentiments and 'politics of fear' may moreover hinder international cooperation in governance, trade and finance, and impede coordination and solidarity, critical in the management of pandemic crises (Dubey et al., 2020).

At the same time, the pandemic has been reported to catalyse anti-racist movements, for example among Chinese immigrants and their descendants in

⁹ Viala-Gaufrey J., Lindaman D. (April 2020) Donald Trump's 'Chinese virus': the politics of naming, *The Conversation*, <https://theconversation.com/donald-trumps-chinese-virus-the-politics-of-naming-136796>

¹⁰ "On Jan 24, 2020, misinformation that "Chinese passengers from Wuhan with fever slipped through the quarantine at Kansai International Airport" was disseminated through multiple social media channels. Although Kansai International Airport promptly denied the fact, discrimination against Chinese people has become widespread in Japan. #ChineseDon'tComeToJapan is trending on Twitter, and Chinese visitors have been tagged as dirty, insensitive, and even bioterrorists." Shimizu K. (March 2020) 2019-nCoV, fake news, and racism, [https://doi.org/10.1016/S0140-6736\(20\)30357-3](https://doi.org/10.1016/S0140-6736(20)30357-3). "One example is Kwong Wing Catering, a pro-movement restaurant chain, which in a Facebook announcement on Jan 28, 2020, said it would only serve English or Cantonese-speaking but not Mandarin-speaking customers as a public health measure. The Facebook post garnered the third most supportive reactions and interactions since the Facebook page's inception in September, 2019." Yat-Nork Chung, R., Ming L., M. (March 2020) Anti-Chinese sentiment during the 2019-nCoV outbreak, *The Lancet*, [https://doi.org/10.1016/S0140-6736\(20\)30358-5](https://doi.org/10.1016/S0140-6736(20)30358-5)

¹¹ https://en.wikipedia.org/wiki/List_of_incidents_of_xenophobia_and_racism_related_to_the_COVID-19_pandemic

France, “who have broken their silence, united” against discrimination and denialism of anti-Asian racism in France (Wang et al., 2020).

Economic hardship

Physical distancing measures involved partial to complete lockdowns of economies. This resulted in loss of income and serious economic hardship for many and has led, and is expected to further lead, to a dramatic rise in unemployment and poverty rates.

In April 2020, the European Trade Union Confederation reported that the unemployment rate increased by at least 4 million, while 7 million contract employees were forced into so-called short-time work schemes as a result of the COVID-19.¹² While office workers could more easily transition to flexible working arrangements, industrial, tourism, retail and transport workers faced job loss or reduction in working hours due to decreased demand (Pak et al., 2020). Several reports estimate that the most disadvantaged sections of the working population, such as gig workers, migrant workers, women, old workers, sick workers, young professionals, artists, culture professionals and under-protected self-employed will be impacted the most (Fana et al., 2020; ILO, 2020a), especially in countries with weak social protection systems. To bring one example, in Austria in March 2020 one in seven persons with lower education levels (less than nine years of schooling) have lost their employment (Kittel et al., 2020; Pichler et al., 2020¹³).

Globally, 49 million individuals might fall into extreme poverty in 2020, as has been concluded in the context of a study about the effects of the current crisis on poor communities across four continents (Buheji et al., 2020) (see also Figure 3). The World Bank expects 11 million people to be driven into poverty across East Asia and the Pacific (World Bank, 2020). The ILO estimates that almost 1.6 billion informal economy workers, out of a total global workforce of 3.3 billion, “have suffered massive damage to their capacity to earn a living” (ILO, 2020b).

¹² European Trade Union Confederation (April 2020) ETUC calls on Eurogroup to help over 10 million workers hit by crisis, <https://www.etuc.org/en/pressrelease/etuc-calls-eurogroup-help-over-10-million-workers-hit-crisis>

¹³ Pichler P., Schmidt-Dengler P. & Zulehner C. (April 2020) Von Kurzarbeit und Kündigungen sind sozial schwächere Personen am meisten betroffen: Die Arbeitssituation der Österreicher*innen seit der Corona-Krise, University of Vienna – Corona Blog, <https://viecer.univie.ac.at/corona-blog/corona-blog-beitraege/blog09/> (for EN see also: <https://medium.com/@bprainsack/covid-19-affects-us-all-unequally-lessons-from-austria-faf8398fddc1> by Prainsack B. et al., Austrian Corona Panel Project, or Kittel B. et al., 2020)

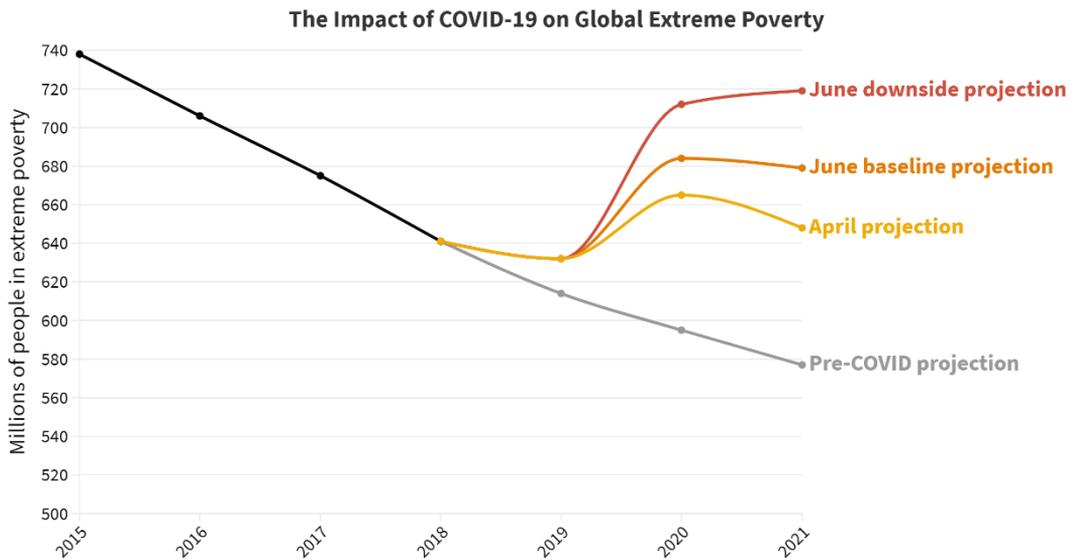


Figure 3: The impact of COVID-19 on global extreme poverty

Extreme poverty is measured as the number of people living on less than \$1.90 per day (used with permission from Lakner et al., 2020, modified from Mahler et al., 2020).¹⁴

The pandemic-induced economic crisis is expected to deepen the uneven development at multiple geographical scales. While the Global North/Global South divide is likely to increase, Europe is predicted to also see a worsening of its protracted north/south and its east/west disparities (Sokol & Pataccini, 2020). The OECD forecasts a wave of bankruptcies and job losses to severely aggravate the pre-existing structural weaknesses of South-East European economies and particularly warns from the pandemic's effects on what already are worrisome rates of youth unemployment in the region (OECD, 2020a). With the interruption of international travels Eastern European seasonal workers initially stayed in their home countries or returned to them, for many meaning a loss of their main income source – until several countries relying on this work force, mostly in the agriculture, health care and eldercare sectors, negotiated travel exemptions for migrant workers. Romanian researchers reported that “several thousand Romanians who were ‘needed’ abroad – many from the poorer regions that were already hardest hit by COVID-19 – crammed onto buses and planes (with little social distancing) to board flights to Germany. (...) [I]n total 188 specially chartered flights left Romania for western European countries at a time when scheduled flights were suspended,” (Crețan & Light, 2020), when citizens of destination countries were under protection regimes of a higher level, and when

¹⁴ Mahler et al. (June 2020) Updated estimates of the impact of COVID-19 on global poverty, <https://blogs.worldbank.org/opendata/updated-estimates-impact-covid-19-global-poverty>

having weak health protection as migrant workers in host countries put both them and others in contact with them at greater risk (e.g. Liem et al., 2020).

Economists calculated that in June Greece faced an unemployment rate 12% higher than it would have been without the health crisis, likely to be explained by a slowdown of seasonal hiring in tourism in Mediterranean countries (Betcherman et al., 2020). The tourism crisis together with Southern Europe's strong dependency on small businesses, struggling more than large ones during the lockdown, have led the IMF to forecast that unemployment rates are expected to peak in 2020 at over 20% in Spain and Greece, 14% in Portugal, and 13% in Italy, compared to, for example, 4% in Germany (IMF, April 2020)¹⁵.

Despite efforts of many governments and international organisations to provide emergency social security measures, such as unemployment compensation for those affected by job loss,¹⁶ a critique of such policies is that they have often disregarded necessary structural considerations about pre-existing social inequalities (e.g. Kelman, 2020; Patel et al., 2020). This should also include considerations about the often underestimated number of informal workers in Europe, who do not have access to special financial support measures provided by governments to businesses and employees (Williams & Kayaoglu, 2020), as well as homeless people, unregistered people and others who are unable or unqualified to apply for state support. In response to their precarious situation, social movements, such as activism for housing security, have increased during the pandemic, as is for example reported from Lisbon, by "capitalising on the visibility for the right to housing, as a basic human right and an unconditional public health imperative" (Mendes, 2020). It may be that people in difficult circumstances disregard what may seem as more uncertain risks related to the pandemic in relation to what may seem as more real risks related to their livelihoods (e.g. Bamba et al., 2020), with various implications as regards nuanced planning and communication about special measures and compliance with them during pandemics.

Economic and labour disparities in the experience of a pandemic interact with other factors shaping inequalities. Figures show that in the USA citizens of Asian and South-American background experienced almost twice the overall increase in unemployment; jobless rates of workers with lower levels of education (without a high school diploma) grew to 6.8%, the highest percentage in three years; and the rate for women is 0.2 percentage point higher than the one for men (Burns,

¹⁵ IMF (April 2020) World Economic Outlook: The Great Lockdown (Chapter 1), <https://www.imf.org/en/Publications/WEO/Issues/2020/04/14/weo-april-2020>

¹⁶ E.g. for overviews of European national measures see <https://www.etuc.org/en/publication/covid-19-watch-etuc-briefing-notes>; supported by the European instrument for temporary Support to mitigate Unemployment Risks in an Emergency (SURE), https://ec.europa.eu/info/sites/info/files/economy-finance/sure_factsheet.pdf

April 2020).¹⁷ Another study found that already in the first month of the pandemic over 57% of women making less than \$30,000 have lost income; and that 42% of non-white workers reported losing income, compared to just 26% of white workers in the same income bracket (Bertrand et al, April 2020).¹⁸ A UK survey showed that “women were 96% more likely than men to have been made redundant because of the COVID-19 pandemic, with 8.6% of women reporting job loss during lockdown compared to 4.4% of men” (Oreffice & Quintana-Domeque, 2020). The gender gap in job losses has been explained by women’s larger representation in the hardest-hit sectors, such as hospitality, retail, health care, schools and the arts (e.g. ILO, 2020a; Kochhar & Barroso, 2020¹⁹).

Gender inequality

Beyond findings about the effects of structural health inequality for women in pandemics (as described in the section *Health inequalities*), it has become clear that broader considerations about how gender roles determine the experience of societal changes during a health crisis are important cornerstones of any well-developed response strategy (Azcona et al., 2020). Nevertheless, as has already been found in analyses of the Ebola and Zika crises, gender experts tend to be excluded from public health interventions and gender components remain ignored (Davies & Bennett, 2016). A recent UN Women report warns about the COVID-19 crisis exacerbating gender inequality and derailing the hard-won progress on equality (Azcona et al., 2020).

Research has shown that the burdens carried by women cumulate and potentially escalate during an emergency situation, as they take up care-taking, community and home schooling responsibilities, often without the alleviation of their professional activities (McLaren et al., 2020), or while losing their jobs. According to a study involving a sample representative of the UK population as regards age, sex and ethnicity, between February and June 2020 British women have experienced a reduction of their work hours 50% more than men, while they have increased their hours spent with unpaid housework and childcare (195% more childcare and home schooling hours than men, and 48% hours more in housework) (Oreffice & Quintana-Domeque, 2020). Responding to an Austrian survey in May 2020, almost half of all mothers, but less than a third of all fathers

¹⁷ Burns D. (April 2020) How the coronavirus job cuts played out by sector and demographics, Reuters, <https://www.reuters.com/article/us-health-coronavirus-usa-jobs/how-the-coronavirus-job-cuts-played-out-by-sector-and-demographics-idUSKBN21M0EL>

¹⁸ Bertrand M., Dialynas C., Briscese G., Grignani M., Nassar S. (April 2020) How are Americans coping with the COVID-19 crisis? 7 key findings from household survey, Poverty Lab & Rustandy Center for Social Sector Innovation, University of Chicago, <https://www.chicagobooth.edu/research/rustandy/blog/2020/how-are-americans-coping-with-the-COVID19-crisis-7-key-findings>

¹⁹ Kochhar R., Barroso A. (March 2020) Young workers likely to be hard hit as COVID-19 strikes a blow to restaurants and other service sector jobs, Pew Research Center, <https://www.pewresearch.org/fact-tank/2020/03/27/young-workers-likely-to-be-hard-hit-as-covid-19-strikes-a-blow-to-restaurants-and-other-service-sector-jobs/>

indicated that they spend considerably more time with child care (Kittel et al., 2020; Berghammer, May 2020²⁰). German researchers also reported that women often seem to carry most of the cognitive burden of childcare during the current pandemic, while men mostly mentioned concerns over paid work (Czymara et al., 2020). A representative Dutch survey, however, showed that 22% of fathers engage in more care tasks than before, and 17% in more household work, potentially suggesting the crisis as a moment that could also facilitate a more egalitarian division of care taking and household work in the future (Yerkes et al., 2020).

Pandemics also highlight that a great percentage of essential work is provided by women, most centrally in child care, eldercare and health care. While this exposes them to increased risk during a health crisis (see section *Health inequalities*), it is not appropriately or not at all remunerated (Craig, April 2020²¹; EGE, 2018). As has been described (see section *Economic hardship*), women are moreover at higher risk of income loss than men during lockdowns, leading to a downstream effect of increased dependence (Ryan & El Ayadi, 2020). Reports have also indicated that psychological and relational effects of home confinement and physical isolation can result in an increase of domestic sexual and gender-based violence (ibid.). UN Women reported that in France calls to domestic violence helplines rose 32% (Azcona et al., 2020). A large German study found that 3% of women experienced physical violence during confinement, with even higher percentages in families that faced financial hardship (Steinert & Ebert, June 2020).²² Risk factors associated with domestic violence are exacerbated by the current policies of home confinement and social isolation, while access to help services is compromised during a pandemic (Moreira & Pinto da Costa, 2020).

Educational inequality

The closure of schools was also acknowledged as a worrisome interruption of structured learning and development for children. Lockdowns have urged schools to organise online teaching where possible, often despite a lack of necessary skills and infrastructure. In a recent OECD survey, only two out of three teachers said that they could support student learning through the use of digital technology, one in four school principals reported a shortage or inadequacy of digital

²⁰ Berghammer C. (May 2020) Alles traditioneller? Arbeitsteilung zwischen Männern und Frauen in der Corona-Krise, <https://viecer.univie.ac.at/corona-blog/corona-blog-beitraege/blog33/> (for EN see also: <https://medium.com/@bprainsack/the-coronation-of-austria-part-3-30eb2ca2f03d> by Prainsack B. et al, Austrian Corona Panel Project, or Kittel B. et al., 2020)

²¹ Craig L. (April 2020) COVID-19 has laid bare how much we value women's work, and how little we pay for it, <https://theconversation.com/covid-19-has-laid-bare-how-much-we-value-womens-work-and-how-little-we-pay-for-it-136042>

²² Steinert J. & Ebert C. (June 2020) Häusliche Gewalt während der Corona-Pandemie, preliminary results: <https://www.tum.de/nc/die-tum/aktuelles/pressemitteilungen/details/36053>, <https://www.hfp.tum.de/globalhealth/forschung/covid-19-and-domestic-violence/>

technology, and one in five schools reported insufficient Internet access (OECD, 2020b). A large body of research has moreover established that the relational aspects of education, including both direct pupil-to-teacher contact and direct contact among pupils, play a key role in personal and cognitive development, especially in younger children (e.g. Hawkins et al., 2012; Silverman et al., 2020; Stodel, Thompson, & MacDonald, 2006).

A sudden shift to home-schooling also created new burdens for parents, becoming a key resource for the provision of education and their children's home environments a key factor co-determining their learning experience. In this context, research about the effects of school closures due to natural disasters, war or strikes made clear previously that learning loss in periods of unexpected school closures is high (e.g. Belot & Webbink, 2010). Several recent surveys seem to confirm this, indicating that all pupils are behind with respect to their 2019/2020 school curriculum, with children from disadvantaged households struggling the most with distance learning (e.g. Graham & Sahlberg, March 2020²³; Sharp et al., 2020). A UK study concluded that children in richer families are spending more time with educational activities than those from the poorer families consulted, with the overall difference exceeding one hour per day (Andrew et al., 2020). In poorer families the availability of digital infrastructure and devices might be limited and parents might face increased economic hardship and psycho-social stress hindering them to support the home-schooling of their children (Graham & Sahlberg, March 2020²⁴), whereas better-off parents might be able to afford private tuition and receive stronger support from more resourceful schools (Andrew et al., 2020). A Dutch survey found that higher educated parents perceive themselves as more capable to home school their children than do parents with lower education degrees (Bol, 2020). Danish researchers studied library take-outs and similarly concluded that better educated, richer and non-immigrant parents were more successful in using libraries to support their home schooling (Jæger & Blaabæk, 2020). School closures are hence likely to further deepen socio-educational divides (Blundell et al., 2020).

It is clear that educational quality and conditions for home schooling also differ among poorer and wealthier countries and regions, and it has also been assumed that families in Eastern and Southern Europe, where more patriarchal gender norms prevail, might be less likely to adapt labour division equitably, with women suffering more from the cumulating workload (Blaskó et al., 2020).

It has therefore been suggested that mandatory school closure policies to limit the spread of SARS-CoV-2 be carefully considered in light of both the available

²³ E.g. Graham, A. & Sahlberg P. (March 2020) Schools are moving online, but not all children start out digitally equal, *The Conversation*, <https://theconversation.com/schools-are-moving-online-but-not-all-children-start-out-digitally-equal-134650>

²⁴ E.g. Graham A. & Sahlberg P. (March 2020) Schools are moving online, but not all children start out digitally equal, *The Conversation*, <https://theconversation.com/schools-are-moving-online-but-not-all-children-start-out-digitally-equal-134650>

evidence about their public health benefit and the established evidence about their long-term implications for child development (Silverman et al., 2020).

Countering inequalities as part of preparedness and response strategies: conclusions

This chapter shows how pandemics and other health crises affect population groups in different ways. First studies on this in the context of COVID-19 and research about previous epidemics and pandemics indicate that health crises and measures taken to mitigate harm and risks often hit disadvantaged members of society the hardest.

This is supported by knowledge from disasters research more broadly. As with all disasters and crises in which a hazard, in this case a virus, becomes associated with major societal disruption, the concept of vulnerability applies not just to direct contact with the hazard itself but to the indirect societal consequences of the damage and disruption brought by the hazard (Few et al., 2020). Disasters research shows that these are multiple, interacting, dynamic and often long-duration, with long-term implications especially for the most vulnerable social groups. In some cases, this heightened vulnerability may not become manifest immediately but emerges through time (e.g. Hicks & Few, 2015).

Policies and practices of pandemic management – if viewed through a lens of equitability – would therefore be focussed on understanding, anticipating, monitoring and minimising the impact of the crisis especially on those highly vulnerable groups (Few et al., 2020). Among the social determinants of vulnerabilities are age, gender, ethnicity and employment and socio-economic status, as this chapter shows. They often interact, which calls for intersectional perspectives on cumulative disadvantage.

Pandemic preparedness and management plans would therefore need to address the multi-faceted nature and myriad consequences of pandemics and build on respective long-term considerations. As this chapter indicates, addressing inequality in institutional and legal structures would be critical. Crisis resilience and preparedness root in societal institutions of solidarity and sustainable long-term planning towards stronger equity.

4. CAPACITY AND ORGANISATION OF PUBLIC HEALTH SYSTEMS

European countries hold primary responsibility for organising and delivering health services and medical care. Therefore, the European countries and their national (public) health systems play a major role in the management of epidemics. EU policy serves to complement national policies.

National health systems are varied and reflect different societal and political choices. Nevertheless, the Council of the European Union named universality, access to good quality care, equity, and solidarity as common values.²⁵ Still, the analysis of differences between the health systems of different European countries is complex.²⁶

Public health spending amounts to about 15% of total government expenditure in the EU, but it varies from about 7% to over 20% between EU member countries.²⁷ Health care systems have to face increased expenditure due to the aging of the population, the increase of diet and lifestyle related conditions, and technological advances. At the same time, countries have tried to reduce health care expenditure, in particular after the 2008/09 financial crisis. This has left the health sector in many countries to operate at close to 100%, leaving little room for crisis response (Legido-Quigley et al., 2020; Devi, 2020).

The communication of the European Commission on effective, accessible and resilient health systems (COM/2014/0215) calls for stable funding mechanisms, sound risk adjustment methods, good governance, strengthening of information flows, adequate costing and a health work force of adequate capacity in order to improve the resilience of health systems. The scientific opinion "Adaptation to health effects of climate change in Europe"²⁸ called on the EU to increase its support for the health sector to make it more resilient.

²⁵ Council Conclusions on Common values and principles in European Union Health Systems (2006/C 146/01), <https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2006:146:0001:0003:EN:PDF>

²⁶ Organization and financing of public health services in Europe, https://www.euro.who.int/_data/assets/pdf_file/0009/383544/hp-series-50-eng.pdf

²⁷ European Semester Thematic factsheet – Health Systems (2017), https://ec.europa.eu/info/sites/info/files/file_import/european-semester-thematic-factsheet-health-systems_en_0.pdf

²⁸ https://ec.europa.eu/info/publications/adaptation-health-effects-climate-change-europe_en

Pandemic preparedness plans

In Europe, adequate preparedness for pandemics is a national obligation under the International Health Regulations (2005) and the EU Decision on serious cross-border threats to health (1082/2013/EU). National preparedness for pandemics relies to a considerable extent on national pandemics plans. The WHO provides guidance on the development of such plans. The guidance states that at the country level “pandemic preparedness should be seen as an integral part of preparedness to threats to human health caused by any emergency, e.g. outbreaks of any disease or the occurrence of natural disasters or chemical incidents”.²⁹ Still, most guidance focuses on influenza pandemics, and uses the terms “pandemics” and “influenza pandemics” interchangeably.³⁰ In consequence, national pandemic preparedness plans (often called Pandemic Influenza Plans) also focus on influenza pandemics. In spring 2020 these plans needed to be adapted to the characteristics of the COVID-19 pandemic. One example of such a need for adaptation was that, as guidance advised against confinement measures, no communication was foreseen to reduce panic buying in anticipation of confinement measures (Ghanchi, 2020). All European countries have developed such plans, but only 13 countries have revised the plans following the 2009 H1N1 influenza epidemic.

Capacity of health systems to respond to pandemics

The resilience of health systems was defined by the European Observatory on Health Systems and Policies as “...the ability to prepare for, manage (absorb, adapt and transform) and learn from shocks such as pandemics”.³¹ In a related policy brief, preparedness is discussed in function of four key health system functions: governance, financing, resources and service delivery.

There are different ways to assess the performance and preparedness of national health systems. All countries have committed to Universal Health Coverage (UHC) by 2030, as part of the UN 2030 Agenda for Sustainable Development.³² This includes financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all. The UHC service index (Figure 4) is one of the indicators for the sustainable development goals (Lozano et al., 2020). In Europe the United

²⁹ <https://www.euro.who.int/en/health-topics/communicable-diseases/influenza/pandemic-influenza/pandemic-preparedness>

³⁰ Ibid.

³¹ The European Observatory on Health Systems and Policies published a policy brief “Strengthening health systems resilience – Key concepts and strategies”, <https://apps.who.int/iris/bitstream/handle/10665/332441/Policy-brief%2036-1997-8073-eng.pdf>

³² UNGA Resolution 74/2: Political declaration of the high-level meeting on universal health coverage, <https://undocs.org/en/A/RES/74/2> (18 October 2019)

Kingdom, France, Sweden, Norway and the Netherlands have the highest scores for this index.³³

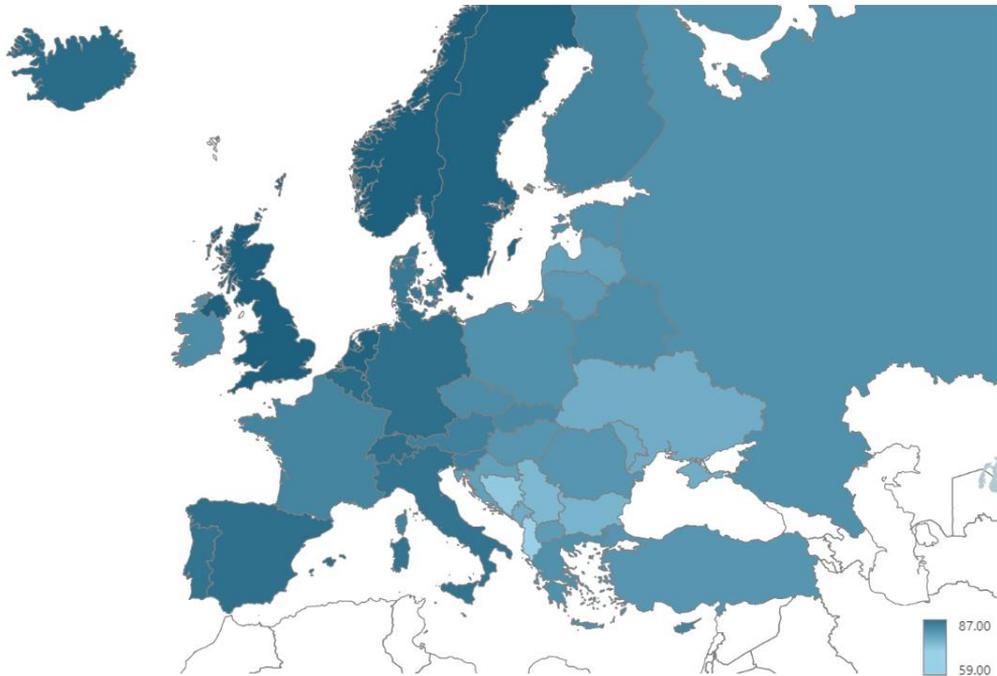


Figure 4: Universal Health Coverage service index for essential health services

The index is based on tracer interventions that include reproductive, maternal, new-born and child health, infectious diseases, non-communicable diseases and service capacity and access. It is presented on a scale of 0 to 100 (published online, used with permission from WHO).

The Global Health Security (GHS) Index, first published in 2019, is more specific for capabilities related to pandemics. It intends to benchmark health security and related capabilities of countries that make up the States Parties to the International Health Regulations (IHR, 2005).³⁴ The countries in the category "most prepared" were, in overall score order, the United States, the United Kingdom, the Netherlands, Australia, Canada, Thailand, and Sweden (Figure 5).

³³ <https://www.ghsindex.org/wp-content/uploads/2020/04/2019-Global-Health-Security-Index.pdf>

³⁴ <https://www.ghsindex.org/about/>

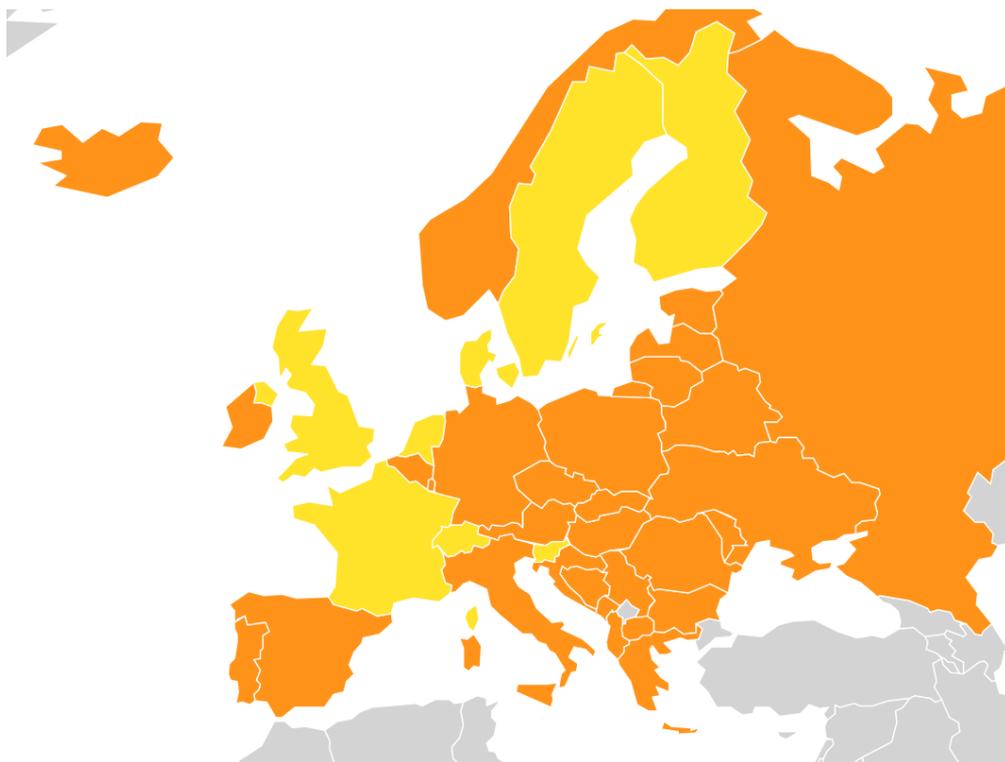


Figure 5: The Global Health Security (GHS) Index map - prepared for epidemics or pandemics

While no country is fully prepared for pandemics or epidemics, those depicted in yellow are better prepared than those depicted in orange, according to the global health security index (used with permission from Cameron, Nuzzo, & Bell, 2019).

In contrast, among 21 countries analysed, England, Wales and Spain experienced the highest death toll during the first COVID-19 wave in terms of excess deaths relative to the population (Kontis et al., 2020). It appears that high scores for preparedness indices have not necessarily protected countries from developing severe epidemics; some of the best-prepared countries have among the higher numbers of infections and deaths relative to the size of the population. Abbey et al. (2020) compared the GHS index to the performance of countries with respect to the COVID-19 pandemic, and found an overestimation of the preparedness of some countries scoring highly on the GHS index and underestimation of the preparedness of other countries with relatively lower scores on the GHS index (Abbey et al., 2020). Discrepancies can be caused by some deficits in the weighting of categories and the sources of data utilised by the expert panel,

putting too little emphasis on testing and adaptability of health systems.³⁵ For example, the United States scored well in the 2019 category “Testing and reporting”, but took much longer than South Korea and Germany to start testing the population. The fact that the GHS panel evaluated information provided by each country, instead of engaging directly with the responsible authorities, has the potential to obscure crucial weaknesses in a country's capacity to confront outbreaks (Abbey et al. 2020). Some Asian countries performed better than expected because their experience with SARS taught them to react swiftly and effectively. For other countries performing well the authors cite extensive testing, rapid monitoring and effectively enforced quarantine and isolation mechanisms as contributing to an effective response. Beyond health care system preparedness, political decisions play a central role in shaping the response to epidemic outbreaks.

The Global Preparedness Monitoring Board (GPMB) aims to assess the world's ability to protect itself from health emergencies and identify critical gaps to preparedness across multiple perspectives. In 2018, only one third of countries had the capacities required under the IHG (GPMB, 2019).

The institute for Public Policy Research, a UK think tank, published an analysis³⁶ of why the United Kingdom's health and care system struggled to cope with the pandemic and suggested what can be improved. It reported that the pandemic did not only cause many casualties directly, but also imperilled regular health care like 'non-urgent' operations and cancer treatments. This resulted in high numbers of excess deaths of causes other than COVID-19. The authors trace the difficulties back to decisions taken in response to the 2008/09 financial crash, aimed at providing the same with less resources. This caused a lack of capacity (e.g. hospital bed numbers), staffing, and equipment such as scanners, digital modernisation and sustainable funding. The authors present proposals to strengthen capacity, as well as to improve population health and reduce health inequalities. Their suggestions include increased staffing, increased resources for digital modernisation and sustainable funding of health and social care. Improving the general health of the population (e.g. by combating obesity, alcohol use and smoking, meeting vaccine coverage, better diagnosis and treatment of cancer) and reducing health inequalities are expected to make the population more resilient to disease outbreaks.

Organisation of public health systems

With the outbreak of a pandemic health systems need to transform rapidly, shifting to emergency response, while maintaining quality health care provision in

³⁵ <https://www.unsdsn.org/how-much-do-we-know-about-countries-preparedness-to-respond-to-pandemics-insights-from-two-country-level-indices>

³⁶ <https://www.ippr.org/files/2020-07/resilient-health-and-care-july20.pdf>

all fields. When the number of infections grows exponentially each day of delay in the response may have tragic consequences. Having the ability to respond is not the same thing as actually doing so; the political and policy context are crucial.

Financial management of the response to pandemics requires, next to adequately funded health systems, flexibility and the possibility to re-programme existing expenditures toward the health care response. Being able to do so depends on systems that define rules and regulations for budget allocation and spending—the public financial management system. In France and the Netherlands, for example, such rules are adaptable and funds can be re-programmed rapidly.³⁷

Laboratory capabilities are crucial for managing a pandemic. The European Centre for Disease Prevention and Control (ECDC) published a comparison of values for a composite index of national public health laboratory capacities as of 2016. France, the United Kingdom, Sweden and Belgium were among the countries with the highest scores, scoring significantly higher than Germany, for example, which ranked only 18th amongst European countries (ECDC, 2018a). However, Germany reacted rapidly in the early stages of the COVID-19 pandemic. It was one of the first countries to develop a diagnostic test developed at Berlin’s Charité hospital, and the government mobilised both public and private laboratories to rapidly scale up testing capacity. In February, the German government mandated that all insurance companies pay for COVID-19 tests, thereby motivating private laboratories to scale up quickly (Wieler et al., 2020). Being able to test on a large scale also made it possible to test asymptomatic people and gain a better understanding and control of the epidemic. Germany decided to do the latter already in May 2020, well before the WHO revised its guidance to include the information that people without symptoms can also infect others.³⁸ Germany’s successful testing schemes were thus enabled not only by intrinsic capacities of the public health system but also by strategic decisions taken at an early stage.

³⁷ <https://www.cgdev.org/blog/covid-19-crisis-and-budgetary-space-health-developing-countries>

³⁸ <https://www.who.int/news-room/commentaries/detail/transmission-of-sars-cov-2-implications-for-infection-prevention-precautions>

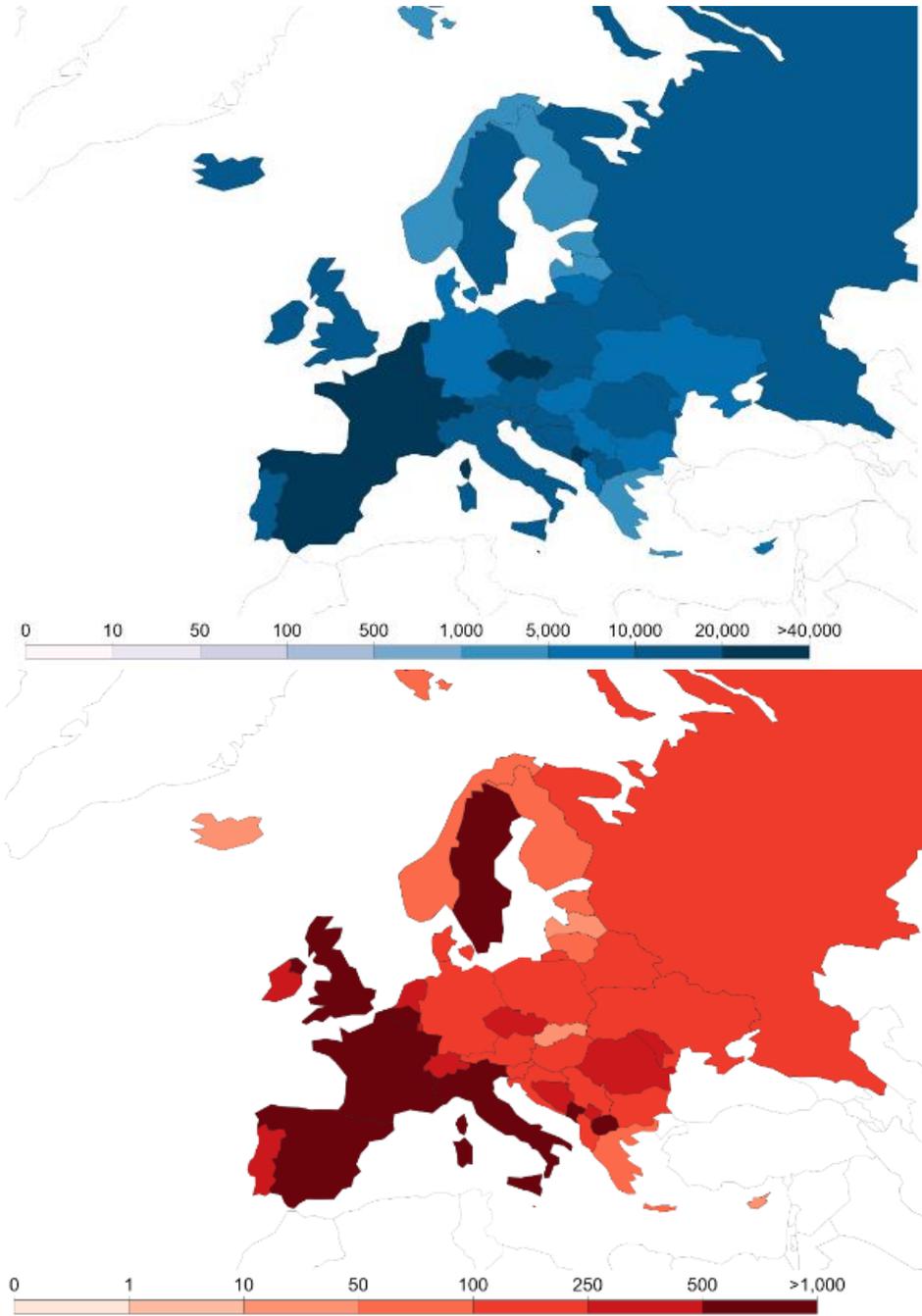


Figure 6: Cumulative confirmed COVID-19 cases (top) and deaths (bottom) per million people

Situation on 5 November 2020 (used under CC BY 4.0 license from Ritchie et al., 2020, <https://ourworldindata.org/covid-cases>, with data from European Centre for Disease Prevention and Control).

5. PUBLIC HEALTH AND RESPONSE MANAGEMENT

Prevention and early detection

Net benefits of stopping pandemics before they start are likely to be enormous (Dobson et al., 2020). The emergence of a new infectious disease itself cannot be predicted or controlled – for example, it is impossible to avoid the circulation of coronaviruses in the wild, in the sylvatic cycle (Frutos et al., 2020). However, an alignment of drivers which together risk leading to an epidemic, and which are largely social and ecological, is largely known. This offers possibilities of improved early detection and prevention (ibid.).

Available evidence suggests the need to broaden the focus beyond known pandemic threats (such as influenza) and to place much more emphasis on anticipating and preparing to stop the next emerging pandemics at their origin (Frutos et al., 2020; McCloskey et al., 2014; UNEP, 2020). Past failures to anticipate epidemics despite prior investments in research, surveillance and pathogen discovery (as was the case for the Zika virus; Stephen, 2020) also suggests the need to extend the surveillance and anticipation of much broader social and ecological risk factors (ibid.), which are non-linear and involve complex systemic relationships (UNEP, 2020). A core implication of that finding is the need for global collaboration for sharing and making sense of such complex interdisciplinary intelligence and translating it into early warnings (Stephen, 2020).

The alignment of high-risk factors often occurs in low-income countries, which typically lack the necessary resources, e.g. for local surveillance and laboratory diagnostics (see Lee et al., 2020), but also for identifying socio-ecological changes in community vulnerability (Stephen, 2020). Hence the implication for international policy (including e.g. EU development and aid policies) is to support those countries in implementing the first layer of local preventive measures (Pak et al., 2020).

Insights from COVID-19 on biomedical countermeasures

Accelerating the biomedical response to pandemics (diagnostics, vaccines and treatments) is of crucial importance – and a lesson from the Ebola epidemic (Simpson et al., 2020). Rapid biomedical response requires overcoming numerous crucial barriers in research, clinical trials, and manufacturing (Simpson et al., 2020; Wolf et al., 2020). Positive steps in that direction are already being taken. They include the WHO's Research and Development Blueprint to decrease the time for development, assessment, and authorisation of medical countermeasures for the world's most dangerous pathogens. In the USA the Biomedical Advanced Research and Development Authority (BARDA) supports the transition of medical countermeasures from research to FDA approval and use. BARDA's activities include funding, technical support and services ranging from a clinical support

network to a fill-finish manufacturing network. As applied specifically to COVID-19, the recent EU-supported Access to COVID-19 Tools (ACT) Accelerator,³⁹ is also a positive example.

There are many elements of accelerating medical preparedness for future pandemic threats which do not vary depending on specific epidemiology and pathophysiology and therefore can be developed across pathogens (Simpson et al., 2020). However, there is a high likelihood that future pandemics ('Disease X') will be caused by the 'Pathogen X' archetype of a highly virulent RNA virus (ibid.) as is SARS-CoV-2.

Transmission of the disease and consequences for protective measures

At the onset of the pandemic, very little was known about the way the new pathogen, SARS-CoV-2, is transmitted. In this situation it was difficult for scientists to confidently make strong public health recommendations.

Known health risk mitigation measures applied by governments in pandemics thus far include lockdowns, quarantines, mobility and travel restrictions, restrictions on social and economic activities (such as retail, schools), physical distancing measures, hygienic measures including mask wearing, diagnostic testing, temperature screening, contact tracing, as well as communication and community engagement measures (Bruinen de Bruin et al., 2020; Lee et al., 2020; Webster, 2020). Yet, in order to define and implement effective non-medical public health risk mitigation measures it is essential to first clarify possible modes of infection.

Pathways of transmission

Infectious agents can be transmitted in a number of ways, such as by sexual intercourse (e.g. HIV and many others), blood (e.g. hepatitis B), insects (e.g. dengue, Zika, malaria), faecal contamination, food or close contact (e.g. Ebola). Respiratory, or airborne, transmission is an important and efficient way for spreading bacterial and viral infections like tuberculosis, measles, and chicken pox.

Infections with airborne transmission spread by exposure to pathogen-transporting droplets and aerosols emitted by infected persons. The majority of aerosols are 1–10 µm in diameter and can linger in the air for a long time. These viruses transported with the aerosols may be able to infect people who are further away from the infected person or after that person has left the space (Peebles, 2020). There is increasing evidence that SARS-CoV-2 can be transmitted through aerosols (Setti et al., 2020). SARS-CoV-2 was also shown to remain viable and infectious in aerosols for hours (van Doremalen et al., 2020). As a consequence

³⁹ <https://www.who.int/initiatives/act-accelerator>

SARS-CoV-2 may spread over larger distances (up to 10 m) and can linger for longer times, for hours instead of minutes (Setti et al., 2020).

The insights from the COVID-19 pandemic regarding its transmission and the prevention thereof, summarised below, hold for future infectious diseases which, similarly to SARS-CoV-2, can be transmitted through aerosols.

Physical distancing and avoidance of crowds will reduce airborne transmission. While for COVID-19 the recommendations for social distancing range from 1 m to 2 m in different countries, there are scientific reports about people with COVID-19 who infected others who were more than 1,8 m away or entered the space shortly after the infected person had left. These transmissions occurred within enclosed spaces that had inadequate ventilation, sometimes linked with heavy breathing. Under such circumstances, the amount of infectious aerosols can become concentrated enough to spread the virus to other people (CDC website: How COVID-19 spreads⁴⁰). The finding that the virus can be spread through airborne transmission, which increases the risk of infection in closed spaces, raises particular concerns for the colder season.

In the early phase of the COVID-19 outbreak there was limited data on the effectiveness of facemasks for reducing the transmission of SARS-CoV-2. It was suggested that people should be encouraged to wear face masks in application of the precautionary principle. Even a small reduction in the number of new infections could make a major difference to the burden on the health systems (e.g. for the availability of hospital bed space, in particular in intensive care units and regarding ventilators).

More rigorous analyses added direct evidence regarding the effectiveness of face masks, including from animal studies, which can better exclude confounding variables. This available science supports using masks. Recent studies show that they do not only diminish the chances of both transmitting and contracting the coronavirus, but may also reduce the severity of infection, if people do contract the disease, by reducing the virus dose a person might receive (Peeples, 2020). Generally, wearing masks and physical distancing have proven to be effective counter measures (Loewenthal et al., 2020; Chu et al., 2020).

A variety of masks are used by the public, and the data on effectiveness of the different types of masks are often statistically underpowered and contradictory, which leads to confusion in policy-makers and citizens who are interpreting and understanding the evidence differently (Peeples, 2020). This may also undermine the willingness of the public to wear masks. Optimal materials, thickness (including number of layers) and fit of masks, as well as durability and washing requirements need to be determined and solutions should be found for problems such as poor filtration and moisture retention (Greenhalgh et al., 2020). Also the

⁴⁰ <https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/how-covid-spreads.html>

effects of mask wearing on human behaviour needs to be better understood: some evidence suggests that wearing a face mask might drive the wearer and surrounding people to also adhere more strictly to other measures, such as social distancing (Marchiori, 2020), while there are other studies indicating that people wearing masks may feel 'too' safe and increase other risk-associated behaviour (Luckman et al., 2020). Face masks are worn frequently in several East Asian countries to prevent spread of respiratory diseases, starting with the Spanish flu a century ago. Research on social and psychological aspects of mask wearing would also be useful for controlling other diseases, which are spread by airborne transmission, such as influenza. In addition, further education of the public is needed to explain how to wear and handle masks (Peeples, 2020).

As it cannot be known which pathogen will cause the next pandemic, and how it will be transmitted, it is advisable to ensure that a sufficient quantity of masks is always available or can be produced on short notice, for instance by repurposing manufacturing capacity. Wearing masks is a simple, cheap, and effective measure during pandemics with airborne transmission with a comparably small impact on social and economic life.

In addition to wearing masks and distancing measures, ventilation makes a difference. Evidence warrants engineering controls targeting airborne transmission as part of an overall strategy to limit infection risk indoors. Appropriate building engineering controls, which can often be easily implemented and without much cost, include sufficient and effective ventilation, possibly enhanced by particle filtration and air disinfection, avoiding air recirculation and avoiding overcrowding (Morawska et al., 2020). It has been argued that the use of such engineering controls in public buildings, including hospitals, shops, offices, schools, kindergartens, libraries, restaurants, cruise ships, elevators, conference rooms or public transport, in parallel with effective application of other controls would be an additional important measure to reduce the likelihood of transmission (ibid.).

Transmission by asymptomatic people

The period during which infected people are contagious varies between different diseases. This parameter has a major impact on the epidemiological presentation of a disease, and on the type of measures that are effective. It is, however, not known in the beginning of an epidemic caused by a new pathogen. In the case of COVID-19, it was initially assumed by many that pre- and a-symptomatic people would not transmit the disease, or would do so very rarely. As a consequence, in most European countries mitigation measures have focused on patients with symptoms. Contacts of patients were asked to isolate if and when they had symptoms, and contact tracing was not immediately initiated during the first wave of COVID-19. It is now known that SARS-COV-2 can be transmitted by asymptomatic infected people, which supports the case for wide testing and for the general public to wear face masks (Gandhi et al., 2020).

The issue of asymptomatic transmission illustrates the difficulties associated with lack of knowledge about the characteristics of new pathogens. The absence of evidence on asymptomatic transmission did not mean evidence of absence, and strategies for management of the epidemic should not have dismissed the possibility of asymptomatic transmission. A similar reasoning holds for the wearing of masks; absence of robust evidence of efficacy does not mean evidence of absence of efficacy. Thus, careful decision-making in conditions of uncertainty is a crucial part of the management of epidemics.

Hygiene measures

Frequent hand hygiene is one of the most important measures for combating the spread of SARS-CoV-2. This also means that the availability of sufficient amounts of water, soap and disinfectant solutions is required.⁴¹ Safe drinking water is crucial for avoiding the spread of many infectious diseases in general. Ensuring the availability of sanitation facilities for all is important. This has been of particular concern as regards schools and workplaces, and has raised challenges particularly in low and middle income countries (Mushi & Shao, 2020).

The possibility of transmission by fomites, i.e. objects or materials which are likely to carry infection, such as clothes, utensils, and furniture, warrants specific hygiene measures, such as regular cleaning and disinfecting of surfaces. Viable SARS-CoV-2 virus and/or RNA detected by RT-PCR can be found on surfaces for periods ranging from hours to days, depending on the ambient environment (including temperature and humidity) and the type of surface.⁴² However, despite strong evidence of virus survival on surfaces, there is little or no evidence on contamination via surfaces (Mondelli et al., 2020).

Testing, tracing and isolating strategies

Results from modelling studies show that Test-Trace-and-Isolate (TTI) strategies are a useful tool to limit the spread of SARS-CoV-2, in particular when the number of new infections is low (Contreras et al., 2020). According to these studies, TTI measures can reduce the effective reproduction number R (which signifies the average number of people that one infected person will pass the virus to) by half. However, to bring R down to 1 in order to stop exponential growth of the number of infections, additional measures, such as social distancing, increased hygiene and wearing masks, are necessary (ibid.). This is because the implementation of TTI-strategies is impaired by imperfect quarantining behaviour, undiscovered contacts and unnoticed asymptomatic cases. It is estimated that 40–75% of infections may be mild or asymptomatic (Jeyanathan et al., 2020).

⁴¹ <https://www.who.int/publications/i/item/water-sanitation-hygiene-and-waste-management-for-the-covid-19-virus-interim-guidance>

⁴² <https://www.who.int/news-room/commentaries/detail/transmission-of-sars-cov-2-implications-for-infection-prevention-precautions>

Testing capacities are still limited and vary strongly between Member States (ECDC, 2020c) (see Figure 7). The following factors need to be considered prior to implementation of any population-wide testing strategy: the epidemiological situation, costs, logistics, technical feasibility, resource availability, contact tracing capabilities, other barriers to testing, potential false positivity and timely notification of test results (ibid.).

In view of testing capacities being limited, it has been suggested to use tests in a targeted and strategic manner.⁴³ In addition to the limited laboratory capacity for testing, insufficiencies in the logistical work flow have been posing challenges, such as the management and communication of test results, as shown by recent incidents, e.g. in the United Kingdom and Bavaria, where people tested positive were missed by contact tracers and not requested to self-isolate due to the use of inadequate IT tools or manual handling of data.

For TTI to work it is paramount that persons who were tested positive or who were in contact with confirmed COVID-19 cases are isolated as quickly as possible (ECDC, 2020c). This is emphasised by the fact that the pre-symptomatic period, during which the infected persons show no signs of the disease yet, but can infect other people, lasts 2 to 12 days (compared to the incubation period for influenza of 1 to 4 days). Asymptomatic individuals may even show a significantly longer duration of viral shedding, i.e. a longer time during which they transmit the virus than their symptomatic counterparts (Jeyanathan et al., 2020). Individuals have been shown to be infectious up to 2.5 days before symptom onset and as many as 50% of infections seem to occur through pre-symptomatic people (Ganyani et al., 2020; Spellberg et al., 2020).

Therefore, after the identification of the contact cluster of an infected person, the contacts should be isolated as a preventive measure without waiting for the test results, to avoid risking further infections. Privacy-friendly and secure contact tracing and warning apps should be developed in a way that they are effective.⁴⁴ They should be interoperable so that they can be used across borders.

⁴³ Kleiner M. et al. (September 2020) Gemeinsam können wir es schaffen: Jeder einzelne Beitrag schützt Gesundheit, Gesellschaft und Wirtschaft, <https://www.itwm.fraunhofer.de/content/dam/itwm/de/documents/PressemitteilungenPDF/2020/stellungnahme-forschungsorganisationen-covid-24-09-2020.pdf>

⁴⁴ <https://www.privacyinternational.org/long-read/3792/covid-contact-tracing-apps-are-complicated-mess-what-you-need-know>

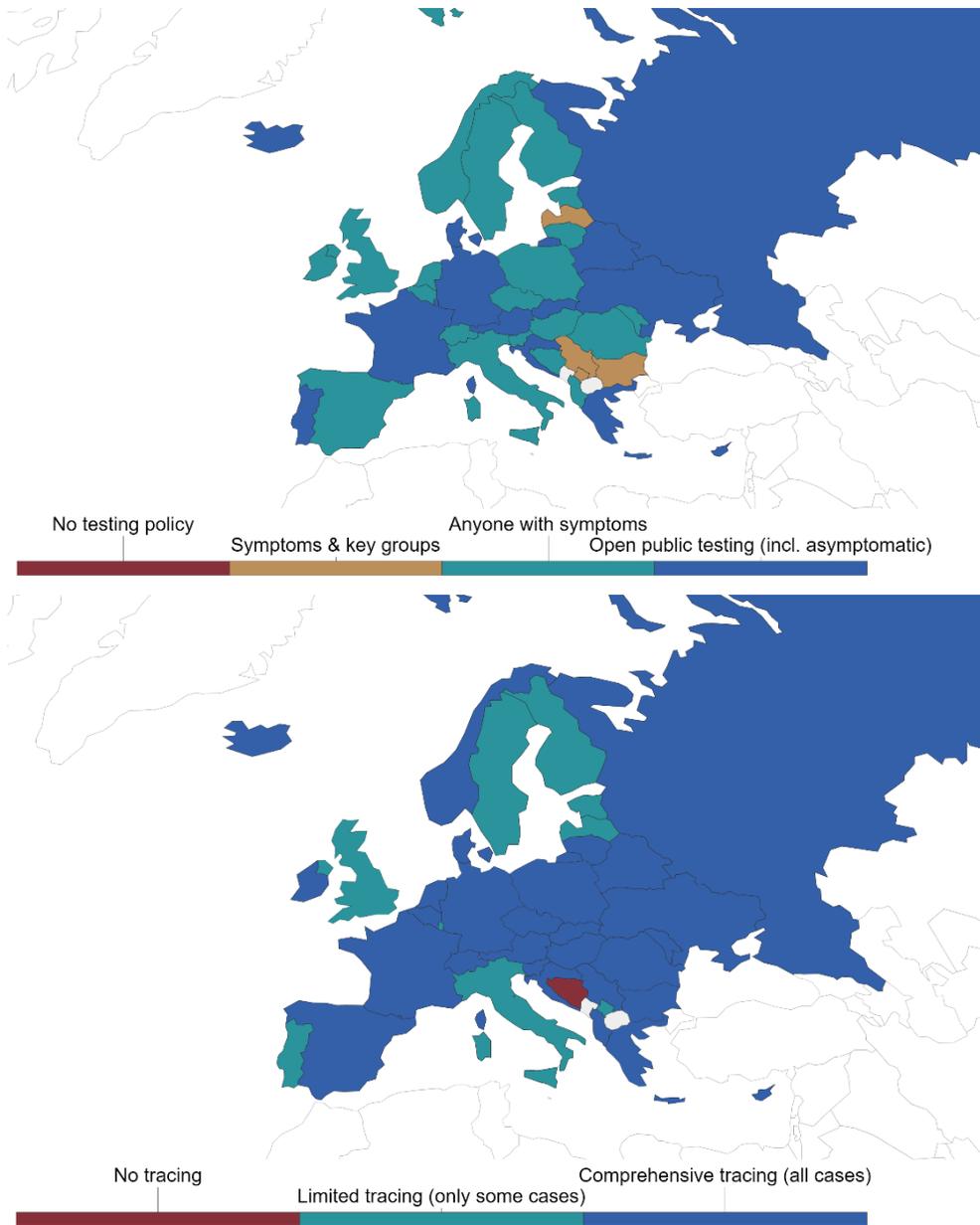


Figure 7: COVID-19 Testing Policies (top) and COVID-19 contact tracing policies (bottom)

Situation on 6 November 2020 (used under CC BY 4.0 license from Ritchie et al., 2020, "Coronavirus (COVID-19) Testing", published online at <https://ourworldindata.org/coronavirus-testing>, with data from Hale et al., 2020, "Oxford COVID-19 Government Response Tracker").

It has moreover been suggested that receiving a negative test result after 5 to 7 days of quarantining should safely allow for ending one's quarantine.⁴⁵ In order to step up testing capacities, suitable additional university and commercial laboratories could be identified and repurposed to complement the work of existing testing laboratories.

The ECDC provided recommendations for scaling up contact tracing by adapting traditional approaches to available local resources and by using a number of resource-saving measures including the use of well-trained non-public-health staff and volunteers, repurposing existing resources such as call centres, reducing the intensity of contact follow-up, and using new technologies such as contact management software and mobile apps (ECDC, 2020a). This is particularly important in view of the approaching Northern Hemisphere winter with a possible epidemic of influenza virus, which causes similar symptoms as SARS-CoV-2, to differentiate between the two pathogens (Stowe et al., 2020; Jianguo Zhang et al., 2020).

In summary, a combination of measures designed to reduce the time during which those infected interact with others – i.e. intensive large-scale and easily accessible diagnostic testing which provides rapid results, and intensive contact tracing – has been shown to be particularly effective (Kontis et al., 2020).

The rapidity of the response, i.e. the early onset of mitigation measures, is crucial for its effectiveness (Amer et al., 2020; Loewenthal et al., 2020) (see also Figure 8). Advanced modelling tools have strong potential to help in time-critical decisions on mitigation measures (Amer et al., 2020; Dehning et al., 2020; Loewenthal et al., 2020).

Strict lockdowns have been necessary as an 'emergency brake' across the world to reduce infection rates in the first phases of the epidemic. The timely onset of lockdowns has been shown to be an important factor for containment (Amer et al., 2020; Dehning et al., 2020; Loewenthal et al., 2020). However, the strictness and duration of lockdowns, which also have adverse social and economic effects, have been found to be less relevant for effectiveness (Loewenthal et al., 2020).

Next page:

Figure 8: Time line of events and application of COVID-19 risk mitigation measures

(Used under CC BY 4.0 from Bruinen de Bruin et al., 2020)

⁴⁵ <https://www.itwm.fraunhofer.de/content/dam/itwm/de/documents/PressemitteilungenPDF/2020/stellungnahme-forschungsorganisationen-covid-24-09-2020.pdf>

Immune response

Infection with SARS-CoV-2 induces protective immunity through antibody and cellular responses. There is also some evidence for cross-immunity induced by other coronaviruses. Understanding adaptive immunity to SARS-CoV-2 is important for vaccine development, interpreting the COVID-19 pathogenesis and its spread, evaluating the possibility of reaching herd immunity and the decision on effective pandemic control measures. This includes the need for measuring the longevity of antibodies SARS-CoV-2 to get insights into the possible duration of the naturally acquired or vaccine-induced protective immunity. Previous longitudinal studies of patients with SARS-CoV infections reported substantial waning of neutralising antibody titres between 1 year and 2 years after infection (Cao et al., 2007). Other studies found significant levels of neutralising antibodies in recovered SARS patients even 9 to 17 years after initial infection (Anderson et al., 2020). Concerning SARS-CoV-2, available studies show that the concentration of virus specific antibodies declines rapidly after recovery from COVID-19 which may limit the time period during which the serum from previously infected people can be applied for the treatment of patients and the utility of 'immunity passports'. It may also have implications for the development of an efficacious vaccine and cautions against the concept of herd immunity (Patel et al., 2020). On the other hand, memory B cells and T cells may be maintained, even if SARS-CoV-2 specific antibodies cannot be detected anymore in the serum and may help to provide a long lasting protection against the disease (Cox & Brokstad, 2020). Clinical recurrences of COVID-19 symptoms have been reported, and may be due to reinfections, a viral relapse or an inflammatory rebound (Gousseff et al., 2020). The immune response to a vaccine may be different from the response to the natural virus and it is not yet known if multiple or multi-annual vaccinations will be needed.

Cross immunity

Cross-protective immunity is referring to the protection against one pathogen due to the pre-existing adaptive immunity developed from the past exposure to another pathogen. A key question is also whether humans have pre-existing 'immune memory' from infections with related viruses that provides some protection against SARS-CoV-2. Among the several coronaviruses causing disease in humans, most are associated with mild symptoms, including the 'common cold'. Severe acute respiratory syndrome coronavirus (SARS-CoV), Middle East respiratory syndrome coronavirus (MERS-CoV) and SARS-CoV-2 cause severe respiratory syndromes. The coronaviruses share significant similarity at genetic and morphological level (Lu et al., 2020) and prior exposure to one virus could confer partial immunity to another. In fact, available data suggests a considerable amount of cross-reactivity and recognition by the hosts' immune response between different coronavirus infections (Grifoni et al., 2020; Nguyen-Contant et al., 2020).

Studies are ongoing⁴⁶ to investigate whether antibodies, which children develop against the 'common cold' coronavirus as part of their immune response, protect against a severe form of COVID-19, or on the contrary, whether some antibodies in children and adults worsen the disease symptoms through dangerous inflammatory reactions – a phenomenon called antibody dependent enhancement of disease. The latter could hamper the development of a safe vaccine against COVID-19 as was the case for dengue fever (Jeyanathan et al., 2020).

Herd immunity

In their response to SARS-CoV-2, some countries referred to the so-called herd immunity approach. The idea behind this approach is that the disease would stop spreading when a sufficient share of the population had become immune as a result of infection.⁴⁷ Until there is an effective COVID-19 vaccine, the only way to achieve this would be to allow the virus to infect a large part of the population while protecting the most vulnerable until an infection-acquired immunity is reached in the low-risk population. Against this, concerns have been raised that herd immunity may only be achieved at an unacceptable cost of lives and by overburdening health systems.⁴⁸

Empirical evidence from many countries shows that it is not feasible to 'shield' vulnerable populations, while allowing a virus to circulate freely amongst the rest of society.⁴⁹ The proportion of vulnerable people may constitute as much as one third of some populations (including the elderly, people with disabilities or underlying conditions, as well as marginalised groups and those in other congregated settings) (ibid.). Many of the aforementioned groups depend upon younger, healthy carers, which makes a physical separation between these population groups practically impossible.

It is also important to bear in mind that once the number of new infections is so high that health offices cannot efficiently trace the infection chains anymore, i.e. when entering the exponential growth phase of the pandemic, it is much more difficult to control the spread of the virus.⁵⁰

The fact that a significant percentage of people do not show any or only limited disease symptoms (Jeyanathan et al., 2020) may accelerate the development of

⁴⁶ Study carried out by a team led by Professor George Kassiotis at London's Francis Crick Institute, and by scientists led by Dan Davis at the University College London, <https://www.itwm.fraunhofer.de/content/dam/itwm/de/documents/PressemitteilungenPDF/2020/stellungnahme-forschungsorganisationen-covid-24-09-2020.pdf>

⁴⁷ <https://gbdeclaration.org/> <https://gbdeclaration.org/>

⁴⁸ E.g. Alwan et al. (October 2020) Scientific consensus on the COVID-19 pandemic: we need to act now, *The Lancet*, [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(20\)32153-X/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)32153-X/fulltext)

⁴⁹ Ibid.

⁵⁰ Kleiner et al. (September 2020) Gemeinsam können wir es schaffen: Jeder einzelne Beitrag schützt Gesundheit, Gesellschaft und Wirtschaft

herd immunity. However, according to current estimates it is still not possible to achieve in the medium term a state where a sufficient percentage of the population is protected against SARS-CoV-2 due to naturally acquired immunity. According to the head of emergencies at the WHO “best estimates” indicate that until today roughly 10% of people worldwide may have been infected by the coronavirus, which would amount to 20 times the number of confirmed cases. Thus, the natural development of herd immunity, if possible at all, may take a long time and vaccination will probably be needed to speed up the process of achieving herd immunity. Although estimates vary largely depending on the factors, which are considered in the calculations relating to the heterogeneity of the population and behavioural differences⁵¹ it is currently believed that herd immunity to SARS-CoV-2 would require that 60-70% of the population would have to be infected with SARS-CoV-2.

As mentioned above, the durability of the immune protection against SARS-CoV-2 after recovery from COVID-19 is not yet understood. Furthermore, asymptomatic and mildly ill individuals seem to develop only low levels of antibody-mediated immunity, which further questions the plausibility of the herd immunity concept in the case of SARS-CoV-2 (Jeyanathan et al., 2020).

Some infectious diseases are not completely cleared and cause long-term health issues. Examples are varicella zoster (causing shingles at a later stage), HIV, hepatitis B virus (causing cirrhosis and liver cancer), Lyme disease, herpes simplex virus (causing cold sores), human papilloma virus (causing cervical cancer). There are indications that SARS-CoV-2 can cause long-term health problems, including in young, previously healthy people,⁵² and the extent of possible consequences is not fully understood yet.⁵³

In addition to the aforementioned practical considerations and scientific uncertainties, the herd immunity approach raises ethical concerns: It is a strictly utilitarian calculus (greatest good for the greatest number of people). This is out of step with the WHO Ethical Framework which adopts a multi-principled approach balancing utility and equity considerations. Recognising the moral equality of all persons, does not allow for some people to be ‘sacrificed’ for the interests of others. The lives of vulnerable members of the community must be considered to have an equal value to those at lower risk. Moreover, the prolonged isolation of large parts of the population is highly unethical as it may further exacerbate

⁵¹ Hartnett (June 2020) The Tricky Math of Herd Immunity for COVID-19, Quantamagazine, <https://www.quantamagazine.org/the-tricky-math-of-covid-19-herd-immunity-20200630/>

⁵² Nature Editorial, Let patients help define long-lasting COVID symptoms, October 2020, <https://media.nature.com/original/magazine-assets/d41586-020-02797-1/d41586-020-02797-1.pdf>

⁵³ Wark (July 2020) Here’s what we know so far about the long-term symptoms of COVID-19, <https://theconversation.com/heres-what-we-know-so-far-about-the-long-term-symptoms-of-covid-19-142722>

socio-economic inequities and structural discriminations⁵⁴ and may well be worse for vulnerable groups as they may have fewer social networks, and the burden of long periods of isolation for older/sick persons may represent a relatively greater loss to them than to younger people. Such an approach also risks stigmatising or othering these groups. It could negatively impact on solidarity, which can be understood as mutual support among the whole population and a willingness to share the benefits and burdens, with special consideration of the most vulnerable (e.g. Prainsack, 2020). Finally, from a human rights perspective, a herd immunity approach would likely be in breach of Article 2 of the European Convention on Human Rights (the right to life) and potentially Article 14 which protects from discrimination. Human rights are inherent to all human beings, regardless of race, sex, nationality, ethnicity, language, religion, or any other status.

Development of treatments and vaccines

In view of the devastating effects of the COVID-19 pandemic on individuals and societies worldwide, treatments and vaccines have to be developed at unprecedented speed while the existing knowledge of the characteristics of the virus and the diseases it causes are still limited and evolving every day. Though the aim is to compress the time for the development, manufacturing and distribution of treatment and vaccines as much as possible to provide a relief to the present crisis, it is imperative not to compromise on the safety and efficacy of any authorised medicinal product or procedure.

Clinical trials for treatments

The current literature on the treatment of COVID-19 is full of 'anecdotal reports' of therapeutic successes in clinical trials with a small number of patients and observational cohort studies claiming efficacy with little regard to the effect of unrecognized confounders. A huge number of such statistically underpowered trials were launched simultaneously, and a recent paper reported that only 30 out of 1,840 registered trials have actually been reported as peer-reviewed or preprint publications. In these uncoordinated efforts, very few trials addressed early interventions aiming at preventing hospitalisation, but rather focussed on the advanced disease states when patients are already hospitalised (Park et al., 2020).

The most meaningful and pertinent trials for COVID-19 treatments were the so-called adaptive trials which combine the scientific rigor brought by randomisation and the ethical duty to provide patients with a potentially beneficial therapy. Using a master protocol, they allow to change therapeutic options in the course of a study according to interim results, so that inefficient or unsafe treatments can

⁵⁴ Alwan et al. (October 2020) Scientific consensus on the COVID-19 pandemic: we need to act now, *The Lancet*, [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(20\)32153-X/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)32153-X/fulltext)

be removed from the studies whereas newly emerging candidate treatments can be included (Goldman & Silva, 2020).

Thus, the RECOVERY trial provided essential information for the management of the most severe COVID-19 cases by demonstrating the beneficial action of dexamethasone in reducing mortality among those who were receiving respiratory support (either invasive mechanical ventilation by 12.3 age-adjusted percentage points or oxygen alone by 4.1 age-adjusted percentage points) (The RECOVERY Collaborative Group, 2020). In addition, the RECOVERY trial showed a lack of efficacy for hydroxychloroquine and for lopinavir–ritonavir. It will continue to evaluate the role of dexamethasone in children, as well as the roles of azithromycin, tocilizumab, and convalescent plasma. Remdesivir is another treatment that has been tested in a large, adaptive, randomised, double-blind, placebo-controlled trial. It was demonstrated to shorten the time to recovery by about 5 days in adults hospitalised with COVID-19 and evidence of lower respiratory tract infection (Beigel et al., 2020). Mortality remained high, however, despite the use of Remdesivir, which indicates that treatment with an antiviral drug alone is likely not sufficient for all patients (Beigel et al., 2020). Remdesivir was approved by the US Food and Drug Administration on 23 October 2020 and received a conditional marketing authorisation in the EU for the treatment of COVID-19 in adults and adolescents from 12 years of age with pneumonia who require supplemental oxygen. Contrasting to the findings of Beigel et al., most recent interim results from the Solidarity Therapeutics Trial, a study with more than 30 participating countries coordinated by the World Health Organization, indicate that like hydroxychloroquine, lopinavir/ritonavir and interferon regimens, Remdesivir appears to have little or no effect on the duration of the hospital stay or the 28-day mortality among hospitalised patients. The European Medicines Agency (EMA) announced to review the WHO data once available.

A thorough review of the situation during the 2014-16 Ebola outbreak in West Africa, when many small studies were launched with few providing conclusive results, concluded that “randomized, controlled trials are the most reliable way to identify the relative benefits and risks of investigational products, and every effort should be made to implement them during epidemics” (NASEM, 2017).

In view of the present and past experiences with pandemics it is essential to prevent detrimental competition between trials that are underpowered. This is a scientific necessity and an “ethical duty toward patients which agree to be exposed to potential risks with the understanding that by doing so they contribute to create firm evidence regarding efficacy and safety of the new medicines they receive” (Goldman & Silva, 2020). To ensure the inclusion of sufficient numbers of patients and to generate complementary results addressing distinct clinical and public health questions rather than competing results for the same, it is important to coordinate clinical studies across borders and to avoid fragmentation.

Vaccine development

Vaccine development is a lengthy, expensive process, which usually takes 10 to 15 years. In view of the urgent need for a vaccine against SARS-CoV-2, the attempt is now to compress the development timeline to 1 to 2 years. Because of the major risks related to the high failure rates of potential vaccine candidates and the associated costs, developers typically follow a linear sequence of steps, with multiple pauses for data analysis or manufacturing process checks (Lurie et al., 2020). To reduce the time from research and development to the deployment to the necessary extent, an integrated approach is needed to address the whole value chain and to parallelise many steps without waiting for the successful outcome of the preceding steps. Recognising that this approach comes with increased financial risks for the developers, the European Commission adopted a vaccine strategy in June 2020, which aims at accelerating the development of COVID-19 vaccines while ensuring their quality, safety and efficacy and securing timely access for Member States and worldwide⁵⁵.

Once vaccines are proven to be safe and efficacious, billions of doses will have to be produced, filled and distributed globally. This requires enormous manufacturing capacities, which are not available yet. Building manufacturing capacity can cost hundreds of millions of euros. Furthermore, for novel platform technologies, most of which have not been used for vaccine development so far, such as the mRNA technology, large-scale manufacturing has never been done. Thus, facilities capable of producing large quantities must be identified, technologies transferred, and manufacturing processes adapted, all without knowing which vaccine candidate will be viable (Lurie et al., 2020). To ensure end-to-end development and large-scale manufacturing and deployment, as well as fair allocation, and to protect private-sector partners from significant financial losses, it has been proposed to establish a global financing system for future pandemic preparedness (ibid).

Beyond the assessment of vaccine efficacy and safety in clinical trial phase III for authorisation, complementary questions have to be addressed to inform public health policies regarding safe and effective vaccination strategies and complementary measures. For instance, the efficacy and safety in different population groups such as children and pregnant women has to be investigated, including also high risk groups such as old persons (> 70 years) and people with pre-conditions. Particular attention will have to be paid to the possible occurrence of antibody dependent enhancement of disease. In this regard, the significant presence of cross-reactive immunity in some individuals calls for the possible stratification of clinical trial participants according to their status of pre-existing coronavirus immunity (Jeyanathan et al., 2020). As with naturally acquired

⁵⁵ COM(2020)245, 17 June 2020: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0245&from=EN>

infection, the potential duration and degree of vaccine-induced immunity is unknown; similarly, it is uncertain whether single-dose vaccines will confer immunity (Jeyanathan et al., 2020). The answer to these questions will help to decide, which vaccine is most suitable for which target group, how to prioritise the population groups for vaccination and whether a combination of two different vaccines is more effective than one. Industry is unlikely to address all these questions and to include all the respective target groups in the clinical trials.

Phase IV studies are conducted after market authorisation, when the vaccine is widely administered in the population, to ensure longer term monitoring of vaccine effectiveness and safety. Considering the number of COVID-19 vaccine candidates advancing in development, it is likely that several vaccines will be put on the market in a relatively short time span. The post-marketing monitoring will require significant sample sizes (in the 100.000s) as well as different complementary study designs. Importantly, the first wave of candidate vaccines that are available may not necessarily be the most efficacious ones, and comparative trials will be needed. Close EU-wide coordination between public health and regulatory authorities, as well as with industry is essential. Experience, e.g. from the occurrence of narcolepsy following influenza vaccination in the 2009 pandemic, has illustrated the importance of solid phase IV studies to identify rare and unexpected adverse events occurring sometimes years after the vaccine authorisation (Johansen et al., 2016). In the context of accelerated vaccine development, particular caution is required, and monitoring should be carried out for a sufficiently long time. Schemes for compensation as a result of vaccine damages can support take-up of vaccines, and are fair both in terms of justice and reciprocity. In times of vaccine hesitancy, it will be crucial to reach a broad consensus on the monitoring results and the ensuing guidance, based on robust evidence and communicated in a transparent way, in order to increase public trust and confidence.

For COVID-19 and beyond, a network of vaccine trials at European level may help to ensure the generation of robust data to inform public health policy, the inclusion of a sufficiently high number of volunteers from different population groups, the readiness of trial sites and may contribute to avoiding fragmentation. Such a coordinated approach would also improve the coherence and comparability of the collected data.

In preparation of any mass vaccination campaign it is of crucial importance to start communication strategies already during the development and production of vaccines to increase the likelihood of their acceptance by the public (see chapter *The public response: trust, communication, mis- and dis-information*). In this, the vaccine supply system, specificities of national immunisation programmes, networks of primary health providers, and other issues concerning the implementation of a vaccination campaign need to be considered for each country and guidance at EU level is important. In general, the effectiveness of mitigation measures is crucially influenced by the public response, including trust in and compliance with the measures.

The public response: trust, communication, mis- and dis-information

Evidence (Bavel et al., 2020; Biddlestone et al., 2020; Bruinen de Bruin et al., 2020; Kuiper et al., 2020; L. J. Wolf et al., 2020) suggests that public response to onerous risk mitigation measures (such as physical distancing, mask wearing and lockdowns) is influenced by a number of cultural factors – such as the prevalence of values privileging individual freedom or those privileging moral responsibility for community welfare and self-discipline and the degree of social stigma associated with non-compliance or compliance (Tomczyk et al., 2020). Moreover, there are early findings suggesting that the public response also has sociodemographic correlates (across cultures), such as age and gender (Brouard et al., 2020; Tomczyk et al., 2020), and psychological ones such as personality types (Brouard et al., 2020), personal belief systems, personal ideologies, and affinity with opinion-based groups (Brouard et al., 2020; Maher et al., 2020; Plohl & Musil, 2020). Science advice on risk mitigation measures may vary across countries, as seen for the COVID-19 pandemic. It may be tailored to specific circumstances such as local cultural factors, which may also influence different public responses (Bavel et al., 2020; Biddlestone et al., 2020; Bruinen de Bruin et al., 2020; Kuiper et al., 2020; L. J. Wolf et al., 2020).

Nevertheless, the degree of public compliance looks to be affected across the board by trust (in public authorities, in the message and in the messengers) as an overarching factor (Bavel et al., 2020; Devine et al., 2020; Plohl & Musil, 2020). The idea that greater trust in government leads to more compliance with health measures is consistent with the experience and study of past pandemics such as the Ebola outbreak, SARS, avian influenza and H1N1 (reviewed in Devine et al., 2020), and studies specific to COVID-19 further suggest that institutional trust is also associated with lower mortality levels (ibid.). Therefore, “understanding the dynamics of trust, how it facilitates and hinders policy responses” is fundamental to effective policy response to future health crises (ibid.).⁵⁶ The experience and study of the COVID-19 pandemic has offered a number of relevant lessons for the future.

The pandemic has given rise to an infodemic, defined as “an excessive amount of information about a problem, which makes it difficult to identify a solution, [and

⁵⁶ The literature review on public trust and the response to pandemics (Devine et al. 2020) highlights the complexity of the trust dynamics: trust is generally seen as a ‘good thing’; however, excessive trust by the government in the citizens’ sense of responsibility may hinder effective response, e.g. by slowing down the introduction of restrictive containment measures, whereas excessive trust by the governed may lead them to believe that the public authorities are handling the pandemic competently (and hence, e.g. be slower to take personal precautions beyond what is required by law) while they may not be. Conversely, a certain amount of scepticism on the part of the governed is a part of democratic accountancy and improves governance, whereas excessive distrust opens the governed to the influence of conspiracy beliefs.

which] can spread misinformation, disinformation and rumours during a health emergency, (...) hamper an effective public health response, and create confusion and distrust" (WHO 2020). Infodemics thrive particularly through social media, due to the fact that they have largely removed the traditional roles of information gatekeepers (e.g. media editors who could potentially act as fact-checkers; (Lewandowsky & Cook, 2020). Disinformation⁵⁷ is a particularly egregious phenomenon as its aims include not only to influence public opinion, but more broadly to "polarise views by infiltrating online communities and amplifying divisive narratives" as well as "to sow confusion and erode the value placed on facts" (Mair et al., 2019).

Action is already being taken by international organisations, notably the WHO⁵⁸ and the EU, to tackle misinformation and disinformation. The WHO is developing a Network for Information in Epidemics (EPI-WIN) based on the concept of 'trust chains',⁵⁹ and has set up a 'myth-busting' site (see Figure 9).⁶⁰ The EU, notably through the Joint Communication from June 2020,⁶¹ has outlined a range of countermeasures, which include promoting authoritative content and fact-checking activities, e.g. through cooperation with social media platforms around a voluntary code of practice, while also aiming to safeguard the freedom and expression and pluralistic democratic debate.

⁵⁷ Following the EU 2020 Joint Statement (see below), 'disinformation' is defined as spreading false information 'with an intention to deceive or cause public harm' (e.g. by a hostile foreign power, or for internal political gain), while 'misinformation' refers to such actions when they may have been done in good faith.

⁵⁸ See also the joint statement by WHO, UN, UNICEF, UNESCO et al., 'Managing the COVID-19 infodemic: Promoting healthy behaviours and mitigating the harm from misinformation and disinformation', <https://www.who.int/news/item/23-09-2020-managing-the-covid-19-infodemic-promoting-healthy-behaviours-and-mitigating-the-harm-from-misinformation-and-disinformation>

⁵⁹ The WHO concept of 'trust chains' is based on partnering with organisations which are trusted by different audiences to amplify evidence-based information tailored to these audiences (WHO 2020).

⁶⁰ <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public/myth-busters>

⁶¹ Joint Communication to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions "Tackling COVID-19 disinformation – Getting the facts right", <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020JC0008>

Methanol, ethanol, and bleach are poisons. Drinking them can lead to disability and death. Methanol, ethanol and bleach are sometimes used in cleaning products to kill the virus on surfaces – however you should never drink them. They will not kill the virus in your body and they will harm your internal organs.

To protect yourself against COVID-19, disinfect objects and surfaces, especially the ones you touch regularly. You can use diluted bleach or alcohol for that. Make sure you clean your hands frequently and thoroughly and avoid touching your eyes, mouth and nose.

FACT: Drinking methanol, ethanol or bleach DOES NOT prevent or cure COVID-19 and can be extremely dangerous

World Health Organization #COVID19 #coronavirus

5 April 2020

The graphic features a blue background with white and yellow text. On the right, there is an illustration of a person's head and shoulders with a large red 'X' over it, and a bottle of liquid and a hand sanitizer bottle, also with a red 'X' over them, symbolizing that drinking these substances is dangerous and does not cure the virus.

Figure 9: Example of WHO myth buster

"FACT: Drinking methanol, ethanol or bleach DOES NOT prevent or cure COVID-19 and can be extremely dangerous" (<https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public/myth-busters#methanol>, used with permission from WHO).

The EU Joint Communication states that 'misinformation can be addressed through well-targeted rebuttals and myth busting and media literacy initiatives'. While the ready availability of clear and authoritative core information, is an essential prerequisite, it is not sufficient: contrary to what the title of the Communication seems to suggest, 'getting the facts right' is not enough to change minds. Refuting misinformation ('debunking') involves dealing with complex cognitive processes (Cook & Lewandowsky, 2011; Lewandowsky & Cook, 2020) and emotional responses to information (Mair et al., 2019). Human reasoning universally uses strategies such as confirmation bias and motivated reasoning (whereby people selectively look for information confirming their pre-established views) as well as disconfirmation bias (whereby, conversely, they tend to dismiss information that contradicts their prior beliefs). An epidemic outbreak is clearly an emotionally charged event (see Oikkonen, 2017).

Emotional response to information is influenced by political group identities and deeply ingrained worldviews, particularly for polarising subjects (Maher et al., 2020; Oikkonen, 2017), which also indirectly affect the general degree of trust in science and experts (Plohl & Musil, 2020). An extreme case is that of conspiracy beliefs, whose adherents combine particular cognitive perseverance in upholding beliefs in the absence of evidence with very severe distrust of official information and traditional messengers (Freeman et al., 2020; Lewandowsky & Cook, 2020). Conspiracy beliefs are thus not linked only to cognitive traits. They may be an extreme manifestation of a sense of 'not being heard', shared by larger sections of the population. Such beliefs are found to be linked with a sense of powerlessness, anger, perceived vulnerability (ibid.) and individualism (Biddlestone et al., 2020;

Bristielle, 2020). Despite their small numbers, conspiracy theorists are found to have a disproportionate influence due to their typical high levels of activism; their ideas influence a “substantial minority of the population” (ibid.).

Early scientific evidence shows that holding conspiracy beliefs about the COVID-19⁶² pandemic (e.g. Bristielle, 2020; Freeman et al., 2020) is associated with endorsement of other conspiracy theories, notably those on climate-change and vaccine conspiracy beliefs. COVID-19 conspiracy theories have typically provided the rationale for anti-mask movements and similar acts of civil disobedience (ibid.).

Evidence offers a number of elementary principles to help tackle the issue of dis- and misinformation, including conspiracy beliefs. These include: (a) starting and ending the core facts to be communicated (rather than the myth to be debunked) and ensuring their clarity, pithiness, concreteness, and plausibility within the narrative (b) ensuring explicit warnings – before mentioning the myth – that the upcoming information is false, (c) explaining the fallacy and (d) providing an entire coherent narrative based on the core facts, which is to fill the cognitive gap left by the misinformation that is being refuted (Cook & Lewandowsky, 2011). Earlier research (in 2010s) has raised concerns that refuting misinformation may inadvertently reinforce it, and that frequent refutation may also increase familiarity with (and thus belief in) the myth to be debunked, (the ‘backfire effect’). However, recent evidence shows that the backfire effect is actually rarer and poses fewer risks than once thought (Lewandowsky and Cook 2020b; Mair et al., 2019). Consequently, repeating misinformation while refuting it has been found to be largely safe (as long as the above message design principles are respected), and can even increase the saliency and effectiveness of the refutation (Lewandowsky and Cook 2020b).

There is substantial evidence (Lewandowsky & Cook, 2020; Mair et al., 2019) supporting the effectiveness of prebunking (or inoculation) – whereby publics are pre-emptively made aware that they may be misled in future, or are exposed to hypothetical, weak false claims which are debunked (ibid.): for example, prebunking has been shown to be more effective than classic debunking in refuting anti-vaccination conspiracy theories (Jolley & Douglas, 2017; Lewandowsky & Cook, 2020). (Lewandowsky & Cook, 2020; Mair et al., 2019)⁶³ supporting the effectiveness of prebunking (or inoculation) – whereby the public are pre-emptively made aware that they may be misled in future, or are exposed to hypothetical, weak false claims which are debunked (ibid.), for example, prebunking has been shown to be more effective than classic debunking in refuting anti-vaccination conspiracy theories.

⁶² E.g. conspiracy beliefs regarding the impact of 5G technology on COVID-19 (see e.g. Bruns, Harrington, & Hurcombe, 2020)

⁶³ Mair et al. (2019) conclude that the effectiveness of inoculation shows clear promise while further replication studies are needed.

The above findings are of direct relevance for pandemic preparedness and response, whereby vaccine acceptance and take-up are already predicted to pose a challenge even before vaccines are developed, due to a proliferation of anti-vaccination conspiracy beliefs which have led to a rise in general vaccine hesitancy in European populations (French et al., 2020). Next to active resistance from the anti-vaccination movement, vaccination campaigns for COVID-19 and future pandemics are expected to run against 'passive competition' from inaccurate media coverage, negative social norms (e.g. distrust in experts; a sense of 'not being heard') as well as economic and structural factors such as cost and access (French et al., 2020).

WHO already advocates a pre-emptive pro-vaccination strategy for epidemics (WHO, 2014). There are existing detailed guidelines for implementing such strategies, drawing mainly on insights from behavioural sciences and social marketing,⁶⁴ e.g. generic ones put forward by ECDC (2014) and those developed specifically for the anticipated COVID-19 vaccination campaign (French et al. 2020). The latter combines the following core components: (1) mobilising a 'pro-vaccination' coalition of the public, private and NGO sectors; (2) evidence-based social marketing campaigns to promote vaccine demand; (3) community engagement and trust building programmes; (4) a vaccine accessibility strategy; (5) a co-ordinated communication strategy offering a compelling narrative which avoids potential backfire effects (ibid.).

The above approach is designed for large sections of the public, including notably 'the vaccine hesitant'. Evidence suggests that engaging with conspiracy theorists and active resisters further requires reliance on trusted messengers (ideally the 'exiters', i.e. former conspiracy theorists), appeal to critical thinking, empathy and avoiding ridicule (Lewandowsky & Cook, 2020). Available evidence underscores the key importance of community engagement, which includes mechanisms for listening to public concerns and understanding their values (ECDC & ASEF, 2016; Nuzzo et al., 2019).

Another core factor affecting the public response to health risk mitigation measures – which the joint advisors have already addressed in some detail earlier⁶⁵ – is trust in the science underlying these measures, and the

⁶⁴ Social marketing is a discipline which uses the principles and tools of marketing in order to direct the public towards socially desirable goals.

⁶⁵ Joint statement on scientific advice to European policy makers during the COVID-19 pandemic by the European Commission's Group of Chief Scientific Advisors, the European Group on Ethics in Science and New Technologies, and Peter Piot, special advisor to the President of the European Commission: https://ec.europa.eu/info/news/joint-statement-scientific-advice-european-policy-makers-fight-against-covid-19-pandemic-2020-jun-24_en. An earlier opinion by GCSA on sustainable food systems also addressed relevant issues of trust in another context: e.g. the essential role of public trust (e.g. in certification schemes) in a situation of information asymmetry (in that case, between producers and consumers): <https://ec.europa.eu/info/research-and-innovation/strategy/support-policy->

transparency of the public authorities about how, and to what extent, they have 'followed the science' (see also Newton, 2020). As science advice may vary across countries, accounting for that divergence in a clear, transparent manner, is also a part of sustaining trust in the science.

Finally, available evidence – particularly for the COVID-19 pandemic – offers insights on the core factors which influence public trust in the government, and thus the degree of public compliance with onerous mitigation measures. More individualist cultures could benefit from public appeals to adopt more collectivist attitudes at times of health emergencies, including future crises (Biddlestone et al., 2020) – however, the influence of that cultural tendency must not be oversimplified as more factors are at play. A narrative built around the message of 'we are all in this together' has the potential to be a fruitful endeavour (ibid.). However, next to transparency and clarity, a critical requirement is for public officials to set an example and lead by example. Failure to do so has been demonstrated to have devastating effects on the level of public trust and hence public compliance (see Fancourt et al., 2020; Newton, 2020, for a UK example).

[making/scientific-support-eu-policies/group-chief-scientific-advisors/towards-sustainable-food-system_en](#)

EXAMPLES OF GOOD PRACTICE IN RESPONSE MANAGEMENT

Prevention and early warning

- The Coalition for Epidemic Preparedness Innovations (CEPI), has tracked global efforts in COVID-19 vaccine development activity and is advocating strong international cooperation to ensure that vaccines, when developed, will be manufactured in sufficient quantities and that equitable access will be provided to all nations regardless of ability to pay (Pak et al., 2020).

Biomedical countermeasures: vaccines, diagnostics and therapeutics

- WHO's Research and Development Blueprint, adopted in 2016 to decrease the time for development, assessment and authorisation of medical countermeasures for the world's most dangerous pathogens
- ACT-Accelerator – COVID-19 Global Response (COVAX)

Public health risk mitigation measures

- Massive decentralised testing and tracing programmes for COVID-19: South Korea, Germany, Italy, Taiwan, Japan, Singapore
- South Korea's lessons learnt from MERS and applied to COVID-19
- Rapid and timely response to the Hong Kong 2003 SARS outbreaks
- EIT Crisis Response Initiative

Social security risk mitigation measures

- National emergency financial aid schemes, e.g. temporary unemployment support
- Civil society organisation of mutual help, e.g. Doctors Without Borders' provision of essential healthcare and sanitation facilities for those in need
- Exploitation of digital means to continue education

Communication, tackling mis- and disinformation, sustaining public trust

- WHO's pre-emptive pro-vaccination strategy for epidemics (WHO 2014)
- WHO's Network for Information in Epidemics (EPI-WIN)

6. KNOWLEDGE GAPS AND RESEARCH PERSPECTIVES

Decision-making during a health crisis is best informed by having a strong evidence-base (ECDC, 2018b). At the same time, anticipation of the types of decisions needed and what new information is most important for developing policy can help prioritise research.

Research and innovation play an important role during, after, and in anticipation of public health emergencies (WHO, 2016) and are essential for preparedness. The knowledge that is generated through research in anticipation of, in the midst of, and after a health emergency is critical to build future capacity to better achieve the goals of preparedness and response: preventing injury, illness, disability, and death and supporting recovery (Lurie et al., 2013).

Progress was observed in the past research related to virology, epidemiology, and infectious diseases among others. However, in research linked to public health, its governance, technology, and risk communication there seem to be gap areas (Zhang & Shaw, 2020). Identifying trends and gaps in the initial response of the research community to the COVID-19 pandemic may provide a valuable guidance in the prioritisation of actions to researchers, clinicians, and policymakers in the preparedness and response to future large-scale public health crises (Budd et al., 2020).

The rapidly evolving nature of the COVID-19 pandemic and the unknowns coming with a new virus underlined the need for research and innovation to close knowledge gaps and to provide sustainable solutions. At the same time, for every insight into COVID-19, more questions emerge and others linger (Callaway et al., 2020).

Since the West Africa Ebola outbreak in 2014-2016, the WHO has established the R&D Blueprint strategy. The WHO R&D Blueprint⁶⁶ is a global strategy and preparedness plan that aims at the rapid activation of research and development activities during epidemics. Its goal is to fast-track the availability of effective tests, vaccines and medicines that can be used to save lives. In this most recent outbreak this has allowed the WHO to work closely with global experts, governments and partners to rapidly expand scientific knowledge on the virus. Experts recognised that an important amount of information is available but there are still concerns about knowledge gaps and lack of clear evidence to support some interventions. For example, what is the quality of life among survivors after severe disease, what are effective public health measures at the national and international levels that can retard the transmission while minimising the impact on global citizens and the global economy?

⁶⁶ https://www.who.int/research-observatory/analyses/rd_blueprint/en/

The WHO global research roadmap (WHO, 2020) has identified social science-related research as a priority area, more focus will be needed in multi-, cross- and trans-disciplinary research related to public health and disaster risk reduction. Studies on societal dimensions may cover social, cultural and economic habits increasing the risk of outbreaks, socio-economic and psychosocial consequences of pandemics and of mitigation measures, and broader questions of epidemic-resilient societal structures. This will involve fields of study as manifold as health inequality, poverty, employment, gender, ageing, housing, urbanism and rurality, mobility, environmental sustainability and law and governance.

In 2016, the EU Scientific Panel for Health (Sipido et al., 2016) called for research policies to facilitate high-quality, cross-border collaboration within Europe and beyond; ensure a harmonised, simplified, and transparent regulatory framework that supports innovation; multidisciplinary research across the innovation cycle, and to create an European Council for Health to support biomedical and clinical research in Europe.

Coordination of efforts is needed and should be expanded at European level. Ad-hoc measures and plans are important, but these will not prepare Europe for future public health crises. An agency for biomedical research and development would support the EU's capacity and readiness to respond to cross-border threats and emergencies, and address supply chain dependencies, notably for pharmaceutical products. This Agency may address fragmentation and may help in underpinning coordination and synergy, between Member States' activities, as well as act as a single point of entry for all health research.

Furthermore, to be better prepared for future pandemics, including 'Disease X' — a newly emerging epidemic disease, and following the experience with influenza vaccines, it has been recommended (Nuzzo et al., 2019) that novel development and manufacturing platforms be established that can be readily adapted to the respective pathogens. These should ideally make use of diverse technologies to increase the likelihood of obtaining one successful and suitable vaccine candidate. For instance, the US National Institute of Allergy and Infectious Diseases has led an initiative to support early development of platforms and test them against 'prototype pathogens' from various viral families (Lurie et al., 2020).

Marston, Paules & Fauci (2017) describe three research approaches, in particular, that can be used to improve vaccine development for emerging infectious diseases. The first of these approaches prepares vaccine candidates for specific pathogens that have been prioritised by the WHO on the basis of their "lethality and severity of disease, transmissibility, animal hosts and vectors, and dearth of existing countermeasures." Although the aforementioned criteria allow to prepare vaccines for the most critical emerging infectious diseases, it is impossible to exactly predict every pathogen that will develop into a pandemic in the future (as was the case for HIV, SARS and Zika; see Marston, Paules, & Fauci, 2017).

For this reason, the second research approach rests on expanding vaccine platforms independently of specific pathogens. These platforms use different strategies and technologies to build vaccine candidates that can be applied and adapted to various pathogens. Currently novel platforms are being developed, such as viral vectors and nucleic acids, which might significantly decrease the time needed to create new vaccines. Lurie et al. (2020) suggest that these novel vaccine platforms could take the steps from viral sequencing to clinical trials in only 16 weeks. The Coalition for Epidemic Preparedness Innovation develops reserves of investigational vaccines for each pathogen after completing phase 2a trials, so that they are ready to enter into clinical trials at the onset of future outbreaks (Lurie et al., 2020).

During health emergencies, manufacturing capacities could be developed in parallel to the creation of vaccine candidates. However, this would imply that large investments need to be made before sufficient data on the safety and efficacy of the vaccine candidate are available, therefore posing a significant financial risk (ibid.).

The third research approach is not concerned with the development of vaccine platforms, but with the application of these platforms to prepare vaccine candidates for 'prototype pathogens' (Marston et al., 2017). As viruses are categorised into families based on their functional and structural properties, vaccine candidates for one pathogen may also work for similar microorganisms of the same family.

It should be noted that none of these research approaches by themselves are considered to be sufficient for preparedness in vaccine development. Instead, they should be seen as complementary, implying that all three approaches should be pursued (Marston et al., 2017; Lurie et al. 2020).

In order to inform the public health response to a pandemic and to provide for appropriate scientific evaluation of any new intervention or medicine, research will be required. Data from such research plays a crucial role in mitigating mortality and morbidity during a pandemic. It must be acknowledged however, that significant pressures can be brought to bear in terms of planning, executing and reporting research during a public health emergency, which raises issues of research quality and integrity. London et al. (2020) warn against 'pandemic research exceptionalism' in which methodological standards of high-quality research are lowered, as this may heighten structural and individual biases in scientific research that can endanger the safety and well-being of patients.

A particular feature of the current pandemic has been the significant number of publications on COVID-19 being released on pre-print servers. While pre-prints offer the benefit of rapid access to new scientific data, this comes at the expense of a thorough peer-review of the research (Bramstedt, 2020; Dinis-Oliveira, 2020), as was illustrated by clinical data published regarding the effectiveness of hydroxychloroquine in COVID-19 patients. Both, rigorous research criteria and the

peer-review process, are essential components for the quality of scientific research, ensuring that false leads can be avoided and resources will be allocated to the most promising interventions.

Several studies suggest that research quality could be better protected by making sure that data and methods are shared appropriately (Boetto et al., 2020; Davis et al., 2020; London & Kimmelman, 2020). This has been one of the key weaknesses in the research response to the current pandemic. To provide an example, of the 31 large clinical trials on COVID-19 interventions surveyed by Davis et al. (2020), only three made their protocols publicly available. While this makes peer-review more difficult, it also entails the risks of creating competition between trials and duplicating research efforts. Coordination of clinical trials is necessary to ensure that scarce resources do not go to waste. Moreover, journals may improve research transparency by requiring researchers to publish their original data while asking them to pre-specify research protocols.

7. POLICY/INSTITUTIONAL CONTEXT AND BACKGROUND

The EU responses to the COVID-19 crisis and policy initiatives on better preparedness for health crises

It is recognised that, in response to the acute crisis caused by the COVID-19 pandemic, the EU and its Member States have introduced measures to mitigate impact on health as well as social and economic impacts, such as protecting employment and supporting medical care services for vulnerable groups, maintaining the functioning of the European single market, and supporting the transport and tourism sector. Public health measures were taken to stabilise the situation and bring the number of new infections to a level better manageable by health systems. To place this joint advice in the context of the policy initiatives taken in the EU, we summarise below the main elements of the EU response without claiming completeness.

In January the *Early Warning and Response System* (EWRS) of the EU was triggered, and monitoring of COVID-19 cases in Europe began. The *EU Health Security Committee* (HSC) had held dedicated meetings on COVID-19 since January 2020. This Committee is chaired by the European Commission and comprises representatives of national ministries for health. After the H1N1 influenza outbreak, the Commission gave it the responsibility of coordinating responses to cross-border threats to health in Europe. However, as the mandate of the HSC is mainly limited to information exchange and coordination, it does not have the power to enforce common measures and recommendations for the response to the COVID-19 outbreak.⁶⁷

The European Commission's *Advisory Panel on COVID-19*⁶⁸ was established on 16 March to advise the Commission on the formulation of response measures in line with the different stages of the COVID-19 pandemic. It is tasked with the identification and mitigation of significant gaps, inconsistencies or inadequacies in measures taken to contain and manage the spread of COVID-19 including in clinical management and treatment as well as with the prioritisation of health care, civil protection and other resources as well as support measures to be organised or coordinated at EU level. Subsequently, it comprises the recommendation of policy measures for addressing and mitigating medium and long-term consequences of COVID-19.

⁶⁷ https://ec.europa.eu/health/hsc_covid19_en

⁶⁸ Commission Decision setting up the Commission's advisory panel on COVID-19:

C(2020)1799, 16 March 2020,

<https://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupDetail&groupID=3719>

Based on existing legislation and structures, such as the *Cross Border Healthcare Directive*,⁶⁹ early measures taken by the European Commission were aimed at overcoming the challenges in the availability and sharing of and the access to personal protective equipment, medicines and medical devices. This included the use of joint procurement procedures and common strategic stockpiles of medical equipment, including intensive medical care equipment, personal protective equipment, vaccines and therapeutics, and laboratory supplies under the EU Civil Protection Mechanism. It also involved increased controls of market surveillance and safety authorities to ensure that only safe protective equipment is offered on the EU single market.

In April 2020 the *EU ERAvsCorona action plan*⁷⁰ laid out the ten first priority short-term coordinated actions in research and innovation. It aims at coordination, cooperation, data sharing and joint funding between the Commission and the Member States, like the support of large EU wide clinical trials, establishment of a one-stop shop for Coronavirus Research and Innovation funding, creation of a research data sharing platform and support to a pan-EU Hackathon to mobilise European innovators and civil society.

For supporting research and innovation against COVID-19 the European Commission also used pre-established tools and structures, as well as existing networks and partnerships, based on the experience of previous pandemics, like the 2014–2016 Western African Ebola outbreak. Altogether the European Commission mobilised EUR 1 billion under Horizon 2020 for funding COVID-19 related research and innovation. The forthcoming Horizon Europe programme is expected to continue funding research and innovation to address COVID-19 and epidemics and pandemics more generally.

As part of the 27 May Communication '*Europe's moment: Repair and Prepare for the Next Generation*',⁷¹ the European Commission created a new standalone *EU4Health programme*, for supporting prevention, crisis preparedness, the procurement of vital medicines and equipment, as well as improving long-term health outcomes. It is intended to "deliver a long-term vision for well-performing and more resilient public health systems, notably by investing in disease prevention and surveillance, and improving access to healthcare, diagnosis and treatment."

The same Communication proposes putting in place a stronger crisis preparedness and management for future scenarios, e.g. by strengthening *rescEU*, an element of the *EU Civil Protection Mechanism* to protect citizens from disasters and to

⁶⁹ <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32011L0024&from=EN>

⁷⁰ https://ec.europa.eu/info/sites/info/files/research_and_innovation/research_by_area/documents/ec_rtd_era-vs-corona_0.pdf

⁷¹ COM(2020)456, 27 May 2020: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0456&from=EN>

manage all types of emerging risks. The intention is to ‘strengthen the rescEU’s capacity to invest in emergency response infrastructure, transport capacity and emergency support teams’ and ‘create an EU-level reserve of essential supplies and equipment to be mobilised in response to major emergencies.’

The European Commission also put in place the *Clearing House for medical equipment used for COVID-19*⁷² (CCH) as a platform for the assessment of and exchange with Member States on demand and supply of key COVID-19 medical countermeasures, as well as monitoring and helping to improve EU industry capacity in this field.

The *EU Strategy for COVID-19 vaccines*,⁷³ adopted on 17 June, aims at ‘ensuring the quality, safety and efficacy of COVID-19 vaccines; securing timely access to vaccines for Member States and their population while leading the global solidarity effort; and at ensuring equitable and affordable access for all in the EU as early as possible.’ It builds on two pillars by securing the production of a sufficient quantity of vaccines in the EU through Advance Purchase Agreements with vaccine producers via the Emergency Support Instrument and by adapting EU rules in order to accelerate the development, authorisation and availability of vaccines while maintaining the standards for vaccine quality, safety and efficacy.

The 15 July *Communication on short-term EU health preparedness for COVID-19 outbreaks*⁷⁴ outlines key measures to be taken in the short-term in preparation for further COVID-19 outbreaks in Europe. Particular attention is paid to reducing the burden of the 2020/2021 seasonal flu.

The Communication underlines the importance of rapid scalability of testing, contact tracing and public health surveillance to control the possible progression of the pandemic and to avoid having to reinstate strict confinement measures. It also states that the systematic identification of vulnerable locations and populations in all Member States is key to tailoring activities specifically to vulnerable groups and to high density settings with limited ability for people to physically distance.

The Communication invites Member States to urgently establish a clear overview on their needs for medical supplies, their national production capacities and stockpiles of essential equipment. It also emphasises the importance of ensuring that adequate personal protective equipment reaches the critical social support care sector providing services for, for example, older and disabled persons. Regarding health care surge capacities, the Communication states that national

⁷² https://ec.europa.eu/info/live-work-travel-eu/health/coronavirus-response/emergency-support-instrument/covid-19-clearing-house-medical-equipment_en

⁷³ COM(2020)245, 17 June 2020: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0245&from=EN>

⁷⁴ COM(2020)318, 15 July 2020: https://eur-lex.europa.eu/resource.html?uri=cellar:f6fbab84-c749-11ea-adf7-01aa75ed71a1.0002.02/DOC_1&format=PDF

strategies should be in place to maximise the ability of health systems to cope with increased demand during pandemics and epidemics, highlighting that in such instances support from neighbouring countries and EU Member States might be essential. Furthermore, the Communication underlines that other areas of healthcare must not be neglected and that the prioritisation of healthcare provision must be done according to guidance strictly based on medical criteria.

On 13 October, the Council adopted a *Recommendation on a coordinated approach to the restriction of free movement in response to the COVID-19 pandemic*.⁷⁵ It aims at coordinating measures on travel restrictions between Member States, making them more evidence-based and using a standardised colour code for the risk regions published by ECDC. It also encourages Member States to use common criteria when considering restricting free movement, using measures more consistently and communicating them timelier.

In her first *State of the Union Address*,⁷⁶ European Commission President Ursula von der Leyen said on 16 September that the EU must “strengthen our crisis preparedness and management of cross-border health threats”, mentioning also that the Commission will propose to “reinforce and empower the European Medicines Agency and the European Centre for Disease Prevention and Control”. For this purpose, the European Commission is planning to propose a legal package in November 2020 to strengthen the health security framework for a better EU coordination of preparedness and response to serious cross-border health threats, based on the lessons learned from the current crisis.

President Ursula von der Leyen also announced to “build a *European BARDA* – an agency for biomedical advanced research and development.” This new agency would support the EU’s capacity and readiness to respond to cross-border threats and emergencies, and address supply chain dependencies, notably for pharmaceutical products.

With the *Communication on the preparedness for COVID-19 vaccination strategies and vaccine deployment*⁷⁷ of 15 October the European Commission described key elements to be taken into consideration by Member States for their COVID-19 vaccination strategies in order to prepare the EU and its citizens for the time when one or more safe and effective vaccine(s) is/are available, as well as priority groups to consider for vaccination.

⁷⁵ <https://data.consilium.europa.eu/doc/document/ST-11689-2020-REV-1/en/pdf>

⁷⁶ https://ec.europa.eu/commission/presscorner/detail/en/SPEECH_20_1655

⁷⁷ https://ec.europa.eu/health/sites/health/files/vaccination/docs/2020_strategies_deployment_en.pdf

International background

Pandemics are by definition international – preparing for them and responding to them require cooperation across countries and continents, irrespective of geopolitical alliances and in line with the United Nation’s foundational principles of global solidarity and justice.

The main framework for such international coordination is the World Health Organization (WHO), the UN agency specialised in health. The WHO is empowered by the International Health Regulations (IHR) to act as the main global health surveillance system. The IHR⁷⁸ have as stated purpose “to prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted to public health risks, and which avoid unnecessary interference with international traffic and trade.” The IHR were adopted by the World Health Assembly in 2005 and became a binding instrument of international law as they entered into force in 2007.

The pandemic preparedness of the WHO has focussed on influenza for more than 70 years, with the Global Influenza Surveillance and Response System created in 1952 and the Global Influenza Programme in 1947. These programmes enable the collection, correlation and distribution of information regarding influenza epidemics. Key documents on pandemic preparedness developed in this context include the 2005 “WHO global influenza preparedness plan”⁷⁹ and the “checklist for pandemic preparedness planning”.⁸⁰ The Pandemic Influenza Preparedness (PIP) framework was developed in response to concerns emerging after the 2006 H5N1 epidemic.⁸¹ It enables the sharing of samples in the case of an influenza pandemic.

In response to failures in the preparation for and management of disease outbreaks and other health emergencies, the WHO and World Bank Group convened the Global Preparedness Monitoring Board (GPMB). The GPMB is an independent monitoring and accountability body to ensure preparedness for global health crises. Expert panels convened by the GPMB have made specific recommendations for reforms, summarised in the GPMB Annual Report 2019: “A world at risk”.⁸² In September 2020, the GPMB published a second report, “A

⁷⁸ International Health Regulations 2005, https://apps.who.int/iris/bitstream/handle/10665/43883/9789241580410_eng.pdf;jsessionid=84602D39DE32CD2C84A0FC41A2AED066?sequence=1

⁷⁹ https://www.who.int/csr/resources/publications/influenza/WHO_CDS_CSR_GIP_2005_5.pdf

⁸⁰ https://www.who.int/csr/resources/publications/influenza/WHO_CDS_CSR_GIP_2005_4/en

⁸¹ WHA Report A69/21 Implementation of the International Health Regulations (2005); Report of the Review Committee on the Role of the International Health Regulations (2005) in the Ebola Outbreak and Response; Report by the Director-General, 2016:

http://apps.who.int/gb/ebwha/pdf_files/WHA69/A69_21-en.pdf, accessed 20 August 2019

⁸² https://apps.who.int/gpmb/assets/annual_report/GPMB_Annual_Report_English.pdf

world in disorder”,⁸³ in which “the GPMB provides a harsh assessment of the global COVID-19 response, warning that the world cannot afford to be unprepared again when the next pandemic hits.”

The main lessons learnt described in the 2020 report of the GPMB are:

- Political leadership makes the difference to protect both health and the economy;
- Preparedness is also about what people do to protect each other and act in the best interest of all;
- The impact of pandemics goes far beyond their immediate health effects, and education, social and economic sectors need to be made “pandemic proof”;
- Current measures of preparedness are not predictive: ‘National measures of preparedness have not predicted the effectiveness of countries’ response in stopping viral spread and saving lives, and the critical importance of social protection has been neglected. The ultimate test of preparedness is response’;
- Expenditure for prevention and preparedness give a very high return on investment.

In general, up to date intelligence on potential infectious diseases threats worldwide is essential to ensure early and effective European preparedness and response. This will require strengthening bilateral and multilateral international collaboration the EU and third countries, including through existing and additional programmes in research, information sharing, and strengthening of public health institutions in vulnerable low income countries.

Relation between the WHO and the EU

The European Commission has long-standing bilateral relations with the WHO. The current relations are based on an exchange of letters in 2001, aiming to consolidate the cooperation between the two organisations. The WHO office in Brussels facilitates relations between the WHO and the EU, whereas the WHO regional office for Europe in Copenhagen serves the WHO European Region, which comprises 53 countries. Their staff are public health, scientific and technical experts, based in the main office in Copenhagen, Denmark, in five technical centres and in country offices in 30 Member States. One of the areas of cooperation between the EU and WHO is on antimicrobial resistance (AMR), with amongst others the one-health action plan of the EU contributing to the global agenda.

⁸³ https://apps.who.int/gpmb/assets/annual_report/GPMB_AR_2020_EN.pdf

EU structures for pandemic preparedness

The 1998 *Decision setting up a network for the epidemiological surveillance and control of communicable diseases in the Community*,⁸⁴ led to the creation of the Early Warning and Response System. In 2004, the EU Health Security Committee was given the responsibility for pandemic preparedness.

The main EU structure dealing with pandemic preparedness is the EU agency European Centre for Disease Control (ECDC). It was established in 2005 with pandemic preparedness as its priority. Its mission includes the collection, evaluation and dissemination of scientific data; the provision of scientific opinions and training; the coordination of the European network of relevant bodies and operating surveillance networks; and the exchange of information. The ECDC supports, together with the WHO, the development of national “Pandemic Preparedness Plans” by providing guidance. It does not have laboratory facilities itself.

During the 2009 Influenza A (H1N1) outbreak, the ECDC and the WHO (Europe regional office) both operated next to each other. The review by the WHO of the IHR and the handling on the H1N1 pandemic led to the publication in 2010 of the “Recommendations for good practice in pandemic preparedness: identified through evaluation of the response to pandemic (H1N1) 2009”⁸⁵ The authors expressed concerns about “under-planning”, and the need for the WHO to coordinate better with the ECDC.

⁸⁴ 2119/98/EC, 24 September 1998: <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:31998D2119>

⁸⁵ https://www.euro.who.int/_data/assets/pdf_file/0017/128060/e94534.pdf

8. RECOMMENDATIONS

As science and ethics policy advisors we have examined the responses to the COVID-19 and, in part, previous pandemics, identified important lessons learned and to be learned and formulated the following recommendations to support the European Commission's efforts in strengthening Europe's preparedness for, and management of, future pandemics and epidemics.

This is a collaboration between the European Commission's Group of Chief Scientific Advisors, the European Group on Ethics in Science and New Technologies and the Special Advisor to the President of the European Commission on the response to COVID-19 and brings together different disciplines and perspectives. It analyses the complexity of pandemics drawing on insights from research and scholarship and taking European values and respect for fundamental rights as critical orientation.

Scientific advice in an ongoing crisis, as indicated in our first joint statement ([*Statement on scientific advice to European policy makers during the COVID-19 pandemic*](#), June 2020), needs to be transparent, based on high quality evidence, adaptive and open to scientific scrutiny. Science and scientific advice do not emerge from value-free spaces and can be interpreted, weighed and applied in different ways. This is where values, ethics and fundamental rights matter as they inform interpretations and decisions in the course of science and actions taken on the basis of science.

The outbreak of infectious disease causes a broader societal crisis and highlights pre-existing social ills. This requires responses to be of a holistic nature, addressing all aspects and causes of the crisis and their complex interplay in an interdisciplinary framework, which aims at sustainable recovery and resilience by building strong and solidarity-based institutions.

The lessons learned have identified the limitations of an ad-hoc approach to health crises: pre-established networks, systems and infrastructure would have enabled a more rapid and coordinated response – crucial in the early phase of an outbreak. Many of our following recommendations require EU-level collaboration with coordinated management, which could be performed by agencies such as the proposed Biomedical Advanced Research and Development Authority (BARDA)-like structure, building on properly resourced existing elements, such as the European Centre for Disease Prevention and Control (ECDC) and the European Medicines Agency (EMA). We therefore endorse the European Commission's proposals concerning the respective creation and strengthening of these agencies.

Successful pandemic management and preparedness need to be based on European and international collaboration, driven by the long-standing European values of openness, cooperation and solidarity – understood as practices and institutions of mutual support among all people and all Member States in Europe, with particular attention to the needs of the vulnerable. The COVID-19 pandemic

has highlighted the inter-dependency of people and other species, mutual vulnerabilities and the need for shared responsibilities within and between the Member States of the European Union, as well as internationally. Cross-border health threats such as pandemics do not stop at the EU borders. The COVID-19 pandemic is not going to be over anywhere, until it is over everywhere, worldwide. The inter-dependency extends to humans, animals and the environment, and it encompasses health, economic, social and cultural sectors. Pandemics preparedness and management is a collective capability of the whole EU as part of the international community, based on building resilience.

Each epidemic or pandemic affects societies and different parts and members of a society in different ways. Each outbreak has its own specific characteristics. There cannot be a single preparedness and management strategy. What is needed is a toolbox of flexible strategies that can be adjusted and further developed in a particular epidemiological, economic, social and cultural context.

On this basis, we recommend the European Commission to:

1. PREVENT AND PRE-EMPT

- **Support multifaceted efforts to investigate, map and reduce the risk of emerging infectious diseases globally**, including the surveillance of pathogen reservoirs, mitigation, forecasting and early detection of potential outbreaks. This entails proactive pathogen discovery in wildlife and livestock populations and understanding the mechanisms and risks of cross-species host-switching, coupled with prevention efforts against spillover of pathogens to humans and the monitoring of spillover events when they do occur, as well as modelling of the potential spread of emerging pathogens. This will involve a strong global collaboration built on a combination of research, awareness raising, biosecurity and biosafety improvements and capacity building.
- **Support a combination of complementary approaches for accelerating the research on and development of responses to pathogens with epidemic and pandemic potential**, including (1) pathogen-specific work; (2) pathogen-independent platform-based technology; and (3) prototype-pathogen efforts at European and international level in collaboration with governments, non-government organisations and private companies.
- **Strengthen multi- and cross-disciplinary research on pandemic prevention, preparedness, responses and impacts**. This should include biomedical studies as well as studies on societal dimensions, such as social, cultural and economic habits increasing the risk of outbreaks, socio-economic and psychosocial consequences of pandemics and of mitigation measures and broader questions of epidemic-resilient societal structures, for example with regard to health inequalities, poverty, employment, gender, ageing, housing, urbanism and rurality, mobility,

environmental sustainability and legal and governance frameworks. These efforts should also cover analyses of public and policy discourses related to pandemic responses that have the potential to homogenise, stigmatise and problematize different population groups. Specific investigations into effective testing, tracing and isolating strategies (TTI) and other monitoring and containment strategies, such as sector-specific approaches, to avoid closures of public institutions and borders as well as impairment of public life, are also important. Studies into the development, effectiveness, necessity and proportionality of pan-European, interoperable technologies in the management of epidemics and pandemics are also recommended, acknowledging the social and ethical dimensions of their development and implementation, and addressing potentials and risks to dignity and fundamental rights and freedoms.

2. ENHANCE COORDINATION ACROSS MEMBER STATES AND AT INTERNATIONAL LEVEL

- **Establish a standing EU advisory body for health threats and crises**, including epidemics and pandemics. This body should have a multidisciplinary and inclusive membership so it can advise on biomedical, behavioural, social, economic, cultural, ethical, legal, technological and international aspects. Its composition and functioning should also respond to the challenges and requirements involved by its role in advising on new and surprising questions and complex and changing situations, as it will need to be expert, farsighted, rapid, flexible and creative, while often facing the unknown, uncertainties and chaos. It should have liaisons to representatives from relevant advisory bodies in the Member States, at EU-level, including the ECDC, and internationally to ensure EU-wide and global sharing and exchange of information. The result should be a shared evidence-base about effective and socially and economically sustainable mitigation and management strategies for health threats and crises, including epidemics and pandemics. The envisaged EU advisory body would also ensure that the advice provided to Member State governments and the European Commission is consistent, with differences in advice to different Member States clarified and clearly communicated. It would also ensure that key criteria guide EU coordination regarding international concerns such as travel, ensuring coherence and non-discrimination among Member States.
- **Ensure that monitoring efforts are comprehensive, evidence-based, rapidly shared and well-coordinated across the EU**, enabling strategic decisions in response to the situation at hand, insights through real-time comparisons, as well as collective action where appropriate. The COVID-19 pandemic highlighted that even key indicators, such as the number of deaths, were measured and assessed differently among Member States, hindering effective collaboration, insights and

comparisons. For instance, the exclusion of deaths in nursing homes from official numbers in some Member States established practical barriers with respect to identifying clustering patterns and targeting and designing responses, and symbolic challenges with respect to communicating and pursuing inclusive mitigating strategies. Moreover, indicators were often limited to biomedical aspects, preventing a more complete assessment of the crisis and the effects of implemented measures. A *European Dashboard* with information from all Member States about the medical, economic and social impacts would be helpful, also for transparency and communication to the public. The Dashboard should also include indicators on unemployment and poverty, social isolation and social exclusion, school attendance, limitations of civil liberties and fundamental rights, as well as containment measures. Therefore, a European data platform, strategy and infrastructure for preparedness and management of health crises is recommended.

- **Establish a joint early-response mechanism to contain epidemics and pandemics, including a toolbox of strategies**, such as testing, tracing, isolating as well as local/regional/national containment measures. Any strategy needs to be based on scientific evidence, guided by the fundamental rights framework and applied in a situation-dependent manner. Herd immunity is a concept best applied in the context of vaccine-acquired immunity. Achieving herd immunity through natural infection by a previously unknown pathogen involving risks to life and health conflicts with the WHO's ethical framework and its multi-principled approach, requiring that utility and equity considerations are balanced. The moral equality of all persons means that the lives of vulnerable members of society must be considered to have equal value to the lives of those at less risk. Achieving a state where a sufficient share of the population has become immune as a result of natural infection can also create practical challenges regarding the protection of vulnerable populations, overburden health care systems and result in a high number of deaths and long-term morbidity.
- **Coordinate research and the development and implementation of medical countermeasures during a pandemic or other health threat.** Crucial scientific questions should be clarified as quickly as possible after the onset of a health threat such as a pandemic to rapidly inform effective and safe public health measures. These questions relate to, for example, distinctive molecular characteristics, means of transmission, the type and duration of the natural immune response to the pathogen, the clinical picture and the course of the disease in different populations. Research efforts should be coordinated and findings and insights shared at European and international levels to make best use of limited resources to accelerate the acquisition of scientific understanding. Initiatives similar to the [ERAvsCorona Action Plan](#) can facilitate such coordination at a European level. Similarly, EU coordination of the development and implementation of diagnostic tests and clinical trials for

the development of treatments and vaccines can avoid fragmentation of studies, duplication, or competition for trial participants and help to secure the generation of robust evidence. We recommend the establishment of an EU-wide network of large-scale, multi-centric clinical trials for both therapeutics and vaccines, to ensure that regulatory requirements are met and to inform public health policies. For treatments, we recommend supporting adaptive trials using a pre-developed and ethically approved master protocol, and allowing therapeutic options to change according to interim results and newly emerging candidate treatments. To safeguard the efficacy and safety of newly developed vaccines and treatments when using accelerated procedures, it is necessary to coordinate trials in all phases, including a sufficiently high number of volunteers from different population groups and risk groups. The obtained results are essential to inform public health choices including the development of optimal vaccination strategies.

- **Coordinate research and the development and evaluation of social measures to mitigate harm and to increase resilience in case of pandemics or other public health crises.** Social, economic, ethical, psychosocial and cultural challenges raised by a pandemic should be addressed as quickly as possible after its onset to inform a range of nuanced and locally appropriate measures. These challenges may relate to, for example, income and housing security, age, disability, health, gender and educational equality, psychosocial and domestic wellbeing and social, cultural and religious needs. Research should also investigate the effects, proportionality and perceptions of mitigation measures during a pandemic, their communication and discourses they give rise to, as well as questions of trust and social cohesion, so that lessons can be drawn for the future. Research should also investigate and inform the development of inter-sectoral frameworks to integrate public health, social and economic considerations and support decision making and policy development during public health crises. Results should be shared at European and international levels to deepen the understanding of complex societal reactions during pandemics and inform governing bodies on how insecurities created by pandemics and containment measures can be countered through social support measures, from inclusive emergency financial aid schemes of different kinds to ad-hoc strengthening of institutions providing community support.

3. STRENGTHEN SYSTEMS FOR PREPAREDNESS AND MANAGEMENT

- **Encourage Member States to provide healthcare for all,** respecting the principles of justice and solidarity and adhering to the commitments established in the context of European fundamental rights instruments, such as the European Pillar of Social Rights, and the Sustainable Development Goals. Member States should account for the resources needed to maintain high-quality, evidence-based continuity of care of

people with other health problems, including workforce and service capacity needs, and a robust referral and diagnostics service. They should also ensure that settings that care for older adults and other vulnerable groups are better prepared for future waves of this pandemic and other pandemics.

- **Ensure robust and equitable access to critical products and services for all EU citizens and demonstrate global solidarity.** This involves pre-emptively providing criteria for the allocation, among and within Member States, of limited resources essential to manage a pandemic and mitigate harm, with due regard to the moral equality of all persons. This includes treatments and vaccines, but also specialised professionals that are in increased demand during pandemics, as well as key infrastructures, technologies and devices. Allocations should follow fair, needs-based criteria built on European values of solidarity, equity, non-discrimination and social justice, paying particular attention to disadvantaged groups, such as older adults, chronically ill and disabled persons, as well as disadvantaged regions, also beyond the EU. The complimentary concepts of 'inclusion health', where health services are operationalised to address health and social inequities, and 'linked lives', where people lead mutually influential interlocked lives, may provide useful orientating policy concepts to ensure this fairness. Prior identification and amplification of suitable laboratories, production facilities and adequate logistical workflows is recommended. Existing facilities may be repurposed in the case of emergencies to ensure the availability, affordability and accessibility to a sufficient supply of resources in all Member States. Steps should be taken to ensure that patent rights and pricing are not barriers to the availability and affordability of necessary treatments and vaccines, especially in less advantaged countries. The EU should strengthen its capacities for, and accelerate, clinical and non-clinical research and development, authorisation, manufacturing and stockpiling of medicinal products, diagnostic testing material and personal protective equipment to address supply chain dependencies and to ensure availability of critical medicinal products and services in Europe in the case of pandemics and other health crises. An EU Biomedical Advanced Research and Development Authority (*BARDA*)-like structure could serve this purpose, tailored to the European context and properly resourced. It should closely collaborate with relevant existing structures at European and national level, including relevant industries.
- **Encourage Member States to strengthen public health infrastructure as an essential part of efficient and equitable health services,** including interoperable and interconnected health information systems capable of collecting and analysing real-time and dynamic data at community, regional and national level; development of rapid and reliable testing and tracing systems supported by laboratory networks and monitoring capabilities; building public health workforce capacity to

ensure the availability of a sufficient, well trained, appropriately remunerated and motivated cohort of public health professionals and support staff; strengthening community infrastructures of social care. This will require reliable and sustainable funding streams as well as political leadership.

- **Establish systems for effective risk communication and tackling disinformation and misinformation during crises** and strengthen the ECDC's role also in this regard. Develop communication strategies for advice and policy that are evidence-based, fit for purpose, flexible and nuanced and that counter stigmatising and homogenising discourses that serve to exclude and marginalise. Both scientific advice and considerations on the values and rights at play should be communicated. Leadership by example, as well as clear, sustained and transparent communication on public health measures, including on the science underlying them, as well as on scientific uncertainties and controversies and the reasons for which advice and policy may diverge across different societies, are crucial for maintaining public trust and pro-social behaviours during a pandemic. Trust is particularly critical if the public are to have confidence in their political leaders and is especially required when onerous demands are made on personal behaviour. Simultaneously, it is recommended to follow the best available knowledge and practice to further develop policy efforts tackling disinformation and misinformation during and beyond epidemics and pandemics. Among them are 'pre-bunking' or 'inoculation' approaches to counter false claims, for example on vaccines or risk mitigation measures, and community engagement approaches involving the hesitant segments of the public through 'trust chains'. Bolstering health literacy would empower individuals to take informed health decisions during pandemics, contribute to curbing the spread of disinformation and misinformation, promote healthy lifestyles in the long term and insulate populations from underlying health conditions which make them more vulnerable to infectious disease threats.
- **Together with EU Member States, develop strategies to sustain education in all sectors** and according to the [Digital Education Plan 2021-2027](#). The closure of educational institutions touches on several key areas of society and has long-lasting social, economic, medical and psychosocial consequences. It should be carried out with utmost restraint. Solutions can include technologically supported teaching where appropriate, considering the need to overcome the 'digital divide' in technologies and competences, which causes further inequalities, and the recognised importance of human contact in settings of education. Interdisciplinary research on the negative consequences of a lockdown on education, above all of minors, should be set up, to better understand, avoid or mitigate them.
- **Encourage Member States to strengthen efforts in community involvement and organisation and support civil-society**

organisations. Good governance during and in preparing for pandemics builds on the experiences of those affected to better understand the lived realities of the crisis and uses mechanisms for participatory governance and co-creation. It also encourages community action to tackle on-the-ground problems faced during pandemics, such as purchasing aid initiatives and the ad-hoc provision of housing and sanitation solutions for those in need. It moreover acknowledges and supports the work of civil-society organisations providing a critical part of the intensified social and care work during health crises. Special attention needs to be paid to grass-roots organisations who are led by members of at-risk populations, such as older people and people living with disabilities, whose activities and voices can be significantly constrained as a consequence of the pandemic and its related response measures.

- **Foster the exploitation of the possibilities of appropriate engineering and other controls in public buildings to limit infection risk indoors** for air borne diseases, such as sufficient and effective ventilation, possibly enhanced by particle filtration and air disinfection, avoiding air recirculation and overcrowding. Such measures can help to avoid the need for applying more invasive and restrictive measures such as the closure of educational institutions and work places.

4. UPHOLD FUNDAMENTAL RIGHTS AND STRENGTHEN SOCIAL JUSTICE

- **Uphold highest standards in the protection of fundamental rights and civil liberties during pandemics**, guided by the Charter of Fundamental Rights of the European Union and the Siracusa Principles on the Limitation and Derogation Provisions in the International Covenant on Civil and Political Rights⁸⁶. In the rare case of encroachments on rights and liberties to limit harm and risks during pandemics they should be considered only with utmost care, be explicitly limited in time, continuously reviewed and justified with respect to their necessity and proportionality and lifted as soon as possible. The various efforts to develop digital tracing and tracking applications during the current pandemic and the discussions raised by them have pointed to the need for great caution in this, but also to the possibility of mitigation measures being in line with and guided by European values and fundamental rights.
- **Implement the European Pillar of Social Rights** by extending social security benefits to workers in non-standard and precarious employment and updating policies towards an appropriate acknowledgement of the value of care work; ensuring access to care services of good quality, in particular home-care and community-based services; addressing housing

⁸⁶ <https://www.icj.org/wp-content/uploads/1984/07/Siracusa-principles-ICCPR-legal-submission-1985-eng.pdf>

security to protect people without homes and in poor housing conditions; mitigating educational, domestic, sexual and gender-based risks during a pandemic; and sustainably addressing other structural inequalities and causes for poverty, disproportionately exposing particularly vulnerable groups and individuals to risks during pandemics. In view of the fact that poverty and precariousness are both a social and a medical risk factor, all relevant actors should implement appropriate short-time measures to alleviate the greatest and most immediate harms caused by a pandemic, such as emergency financial aid schemes for all persons in need, regardless of their occupational status, and implement long-term measures to alleviate poverty, precariousness and social exclusion in a sustainable manner.

5. FIND SOLIDARITY-BASED AND SUSTAINABLE WAYS OF LIVING

During the work on this joint Opinion, considerations emerged that go beyond pandemic preparedness and management in the narrow sense, but are very relevant in their context. The COVID-19 crisis can also be seen as an opportunity to address systemic issues. Therefore, we recommend the European Commission to:

- Take action in a cross-cutting manner upon the increasing body of knowledge about unsustainable ways of living, which also contribute to the emergence of epidemics and pandemics. This includes addressing the links between health crises and environmental degradation from a 'planetary health' perspective and to devise new and update existing policies in related fields, such as environmental protection, food, transport and urban planning. It also includes addressing the links between health crises, poverty and structural inequalities, expressing themselves in 'syndemic pandemics', and to devise new and update existing policies in related fields, such as employment, housing, social and economic aspects of ageing, gender and migration. A solidary and sustainable governance approach and the resulting trust in governance structures are at the core of resilience. We recommend to initiate and promote societal (including scholarly) debates about how to set conditions for strengthening systemic resilience to crises including, but not restricted to pandemics. Continuing this collaboration in 2021, it is our plan to provide a third joint advice on how Europe can develop towards stronger resilience.

Annex 1 – Methodology

This joint Opinion is a collaboration between the Group of Chief Scientific Advisors, the European Group on Ethics in Science and New Technologies (EGE), and Peter Piot as Special Advisor to European Commission President Ursula von der Leyen on the response to the coronavirus and COVID-19 – hereafter the ‘joint advisors’.

In their joint statement on scientific advice to European policy makers during the COVID-19 pandemic, the joint advisors announced to produce the current Opinion “on the management of pandemics more generally”. Work on this joint Opinion started directly following the publication of the statement on 24 June 2020.

A steering group was formed to lead the development of the joint Opinion on behalf of all joint advisors. The steering group consisted of Pearl Dykstra, Éva Kondorosi, Paul Nurse and Rolf-Dieter Heuer (GCSA); Christiane Woopen and Siobhán O'Sullivan (EGE); Peter Piot (Special Advisor to the European Commission President); and Janusz Bujnicki (former member of the Group of Chief Scientific Advisors). The work of the steering group was led by Pearl Dykstra and Christiane Woopen.

A project team consisting of staff from the SAM secretariat (supporting the GCSA), the EGE team and the team of Peter Piot was assembled to support the work of the joint advisors.

The main question to be addressed by this joint Opinion was formulated as: ‘*How can Europe ensure adequate management of and better preparedness for epidemics and pandemics?*’ The advisors agreed to build the answers to this question on lessons learned from the COVID-19 and selected previous epidemics and pandemics. A broad scope was taken to address this question, covering an extensive range of matters and disciplines to adequately cover the wide spectrum of causes, drivers, developments and consequences of epidemics and pandemics.

The steering group instructed the project team to undertake, in July and August, a rapid scoping review of existing advice on pandemic preparedness, as well as targeted rapid evidence reviews of diverse areas where lessons could be learned from the COVID-19 pandemic and earlier epidemics or pandemics. These reviews covered searches in databases for academic literature and ‘grey literature’ (e.g. official reports), web searches, as well as suggestions and contributions by the advisors. All input was assessed and synthesised by the project team to inform the deliberations of the steering group, and formed the basis for this joint Opinion. At the instructions of the steering group, the project team undertook further targeted rapid evidence reviews when additional considerations emerged during the elaboration of the joint Opinion.

Developing this Opinion during the ongoing COVID-19 pandemic meant working with the rapidly evolving nature of the still limited understanding of and tentative

conclusions about the pandemic, the effectiveness of responses to it, and the consequences thereof. New evidence and insights are continuously developed and updated, which are published with some delay in peer-reviewed literature. The project team therefore also assessed – throughout the development of the joint Opinion – pre-prints and online articles, including blog-posts by researchers and scholars, which could provide insightful preliminary information.

Simultaneously in July, the steering group requested SAPEA to identify experts from a wide range of disciplines who could be consulted to fill knowledge gaps, identify key evidence and ‘fact-check’ drafts. To this end, SAPEA launched a call for nominations of experts, which was open until the end of August. Based on the results of this call for nominations, expert elicitation took place during October in a distributed manner and in writing. Experts were directly contacted by the joint advisors or, under the direction of the steering group, by the project team on an individual basis. They were requested to contribute insights and evidence on targeted questions to inform the deliberations of the joint advisors. A draft of the Opinion, as well as the final agreed recommendations, was sent to a diverse group of experts for their insights and for fact-checking. A list of consulted experts providing significant input can be found in Annex 2.

In October, a draft of this joint Opinion was also shared with relevant European Commission policy makers, in particular in DG SANTE, so it could already inform the development of a package of legislative proposals to strengthen the health security framework for a better EU coordination of preparedness and response to serious cross-border health threats. At the same time, the policy makers were requested to fact-check the policy context section of the Opinion.

The Opinion was endorsed by all joint advisors and published on 11 November 2020.

Annex 2 – Experts consulted

The following experts contributed to this Opinion with valuable insights and comments, informing the deliberations of the joint advisors. They were identified through a call for nominations by SAPEA and were contacted either directly by the joint advisors, or by the project team on their behalf.

Cox	Rebecca	Head Influenza Center, University of Bergen and Haukeland University Hospital
Few	Roger	Professor in the School of International Development, University of East Anglia
Koopmans	Marion	Professor, Head of the Department of Viroscience, Erasmus Medical Center
Lagadec	Patrick	Consultant on crisis intelligence and leadership in volatile contexts
Łosiewicz	Małgorzata	Professor, Head of the Institute of Media, Journalism and Social Communication, University of Gdansk
McKee	Martin	Professor of European Public Health at the London School of Hygiene and Tropical Medicine
Meyer-Hermann	Michael	Head of the Systems Immunology Department at the Helmholtz Centre for Infection Research
Priesemann	Viola	Max Planck Research Group Leader Neural Systems Theory, MPI for Dynamics and Self-Organization
Simonsen	Lone	Professor, Population Health Sciences, Roskilde University
Usonis	Vytautas	Professor, Clinic of Children Diseases, Vilnius University, Faculty of Medicine
Walsh	Kieran	Professor of Ageing and Public Policy and Director of the Irish Centre for Social Gerontology, NUI Galway

Annex 3 – References

- Abbey, E. J., Khalifa, B. A. A., Oduwole, M. O., Ayeh, S. K., Nudotor, R. D., Salia, E. L., ... Karakousis, P. C. (2020). The Global Health Security Index is not predictive of coronavirus pandemic responses among Organization for Economic Cooperation and Development countries. *PLOS ONE*, *15*(10), e0239398. Retrieved from <https://doi.org/10.1371/journal.pone.0239398>
- Adalja, A. A., Watson, M., Toner, E. S., Cicero, A., & Inglesby, T. V. (2018). The Characteristics of Pandemic Pathogens. *Johns Hopkins Center for Health Security*, 1–17. Retrieved from https://www.centerforhealthsecurity.org/our-work/pubs_archive/pubs-pdfs/2018/180510-pandemic-pathogens-report.pdf
- AGE Platform Europe. (2020). COVID-19 and human rights concerns for older persons. *AGE Platform Europe a.i.s.b.l., Brussels*. Updated 18th May 2020.
- Aishworiya, R., & Kang, Y. Q. (2020). Including Children with Developmental Disabilities in the Equation During this COVID-19 Pandemic. *Journal of Autism and Developmental Disorders*. <https://doi.org/10.1007/s10803-020-04670-6>
- Amer, F., Hammoud, S., Farran, B., Boncz, I., & Endrei, D. (2020). Assessment of Countries' Preparedness and Lockdown Effectiveness in Fighting COVID-19. *Disaster Medicine and Public Health Preparedness*, 1–8. <https://doi.org/DOI: 10.1017/dmp.2020.217>
- Anderson, D. E., Tan, C. W., Chia, W. N., Young, B. E., Linster, M., Low, J. H., ... Wang, L.-F. (2020). Lack of cross-neutralization by SARS patient sera towards SARS-CoV-2. *Emerging Microbes & Infections*, *9*(1), 900–902. <https://doi.org/10.1080/22221751.2020.1761267>
- Andrew, A., Cattan, S., Costa-Dias, M., Farquharson, C., Kraftman, L., Krutikova, S., ... Sevilla, A. (2020). Learning during the lockdown: real-time data on children's experiences during home learning. *Ifs*, 1–24.
- Anwar, A., Anwar, S., Ayub, M., Nawaz, F., Hyder, S., Khan, N., & Malik, I. (2019). Climate Change and Infectious Diseases: Evidence from Highly Vulnerable Countries. *Iranian Journal of Public Health*, *48*(12), 2187–2195.
- Armocida, B., Formenti, B., Ussai, S., Palestra, F., & Missoni, E. (2020). The Italian health system and the COVID-19 challenge. *The Lancet Public Health*. [https://doi.org/10.1016/S2468-2667\(20\)30074-8](https://doi.org/10.1016/S2468-2667(20)30074-8)
- Azcona, G., Bhatt, A., Davies, S., Harman, S., Smith, J., & Wenham, C. (2020). Spotlight on Gender, Covid-19 and the SDGs: Will the Pandemic Derail Hard-Won Progress on Gender Equality? *Spotlight on the SDGs*, 31. Retrieved from <https://www.unwomen.org/-/media/headquarters/attachments/sections/library/publications/2020/spotlight-on-gender-covid-19-and-the-sdgs-en.pdf?la=en&vs=5013%0Ahttps://www.unwomen.org/en/digital-library/publications/2020/07/spotlight-on-gender-covid-19-and-t>
- Bambra, C. (2013). In defence of (social) democracy: on health inequalities and the welfare state. *Journal of Epidemiology and Community Health*, *67*(9), 713 LP-714. <https://doi.org/10.1136/jech-2013-202937>
- Bambra, C., Riordan, R., Ford, J., & Matthews, F. (2020). The COVID-19 pandemic and health inequalities. *Journal of Epidemiology and Community Health*, *74*(11), 964–968. <https://doi.org/10.1136/jech-2020-214401>
- Barde, R. (2004). Plague in San Francisco: An essay review. *Journal of the History of Medicine and Allied Sciences*, *59*(3), 463–470. <https://doi.org/10.1093/jhmas/jrh104>

- Bavel, J. J. V., Baicker, K., Boggio, P. S., Capraro, V., Cichocka, A., Cikara, M., ... Willer, R. (2020). Using social and behavioural science to support COVID-19 pandemic response. *Nature Human Behaviour*, 4(5), 460–471. <https://doi.org/10.1038/s41562-020-0884-z>
- Bechini, A., Boccalini, S., Ninci, A., Zanobini, P., Sartor, G., Bonaccorsi, G., ... Bonanni, P. (2019). Childhood vaccination coverage in Europe: impact of different public health policies. *Expert Review of Vaccines*, 18(7), 693–701. <https://doi.org/10.1080/14760584.2019.1639502>
- Beigel, J. H., Tomashek, K. M., Dodd, L. E., Mehta, A. K., Zingman, B. S., Kalil, A. C., ... Lane, H. C. (2020). Remdesivir for the Treatment of Covid-19 — Preliminary Report. *New England Journal of Medicine*. <https://doi.org/10.1056/nejmoa2007764>
- Belot, M., & Webbink, D. (2010). Do teacher strikes harm educational attainment of students? *Labour*, 24(4), 391–406. <https://doi.org/10.1111/j.1467-9914.2010.00494.x>
- Betcherman, G., Giannakopoulos, N., Laliotis, I., Pantelaiou, I., Testaverde, M., & Tzimas, G. (2020). Reacting Quickly and Protecting Jobs: The Short-Term Impacts of the COVID-19 Lockdown on the Greek Labor Market. *Policy Research Working Papers*. The World Bank. <https://doi.org/doi:10.1596/1813-9450-9356>
- Biddlestone, M., Green, R., & Douglas, K. M. (2020). Cultural orientation, power, belief in conspiracy theories, and intentions to reduce the spread of COVID-19. *British Journal of Social Psychology*, 59(3), 663–673. <https://doi.org/10.1111/bjso.12397>
- Blaskó, Z., Papadimitriou, E., & Manca, A. R. (2020). How will the COVID-19 crisis affect existing gender divides in Europe. *Publications Office of the European Union, Luxembourg, JRC120525*(EUR 30181 EN). <https://doi.org/10.2760/37511>
- Blundell, R., Costa Dias, M., Joyce, R., & Xu, X. (2020). COVID-19 and Inequalities. *Fiscal Studies*, 41(2), 291–319.
- Boetto, E., Golinelli, D., Carullo, G., & Fantini, M. P. (2020). Frauds in scientific research and how to possibly overcome them. *Journal of Medical Ethics*, medethics-2020-106639. <https://doi.org/10.1136/medethics-2020-106639>
- Bol, T. (2020). Inequality in homeschooling during the Corona crisis in the Netherlands. First results from the LISS Panel. *First Results from the LISS Panel, Available at: Osf. Io/Preprints/Socarxiv/Hf32q* (Accessed 3 May 2020). <https://doi.org/10.31235/osf.io/hf32q>
- Botelho, J., & Schulenburg, H. (2020). The Role of Integrative and Conjugative Elements in Antibiotic Resistance Evolution. *Trends in Microbiology*. <https://doi.org/https://doi.org/10.1016/j.tim.2020.05.011>
- Boucaud-Maitre, D., Villeneuve, R., & Tabue-Teguo, M. (2020). Post-containment management of nursing homes: a new public health concern. *European Geriatric Medicine*, 11(4), 707–708. <https://doi.org/10.1007/s41999-020-00328-9>
- Bramstedt, K. A. (2020). The carnage of substandard research during the COVID-19 pandemic: a call for quality. *Journal of Medical Ethics*, medethics-2020-106494. <https://doi.org/10.1136/medethics-2020-106494>
- Brandily, P., Brebion, C., Briole, S., & Khoury, L. (2020). A Poorly Understood Disease? The Unequal Distribution of Excess Mortality Due to COVID-19 Across French Municipalities. *SSRN Electronic Journal*. <https://doi.org/10.1101/2020.07.09.20149955>
- Bristielle, A. (2020). " Bas Les Masques!": Sociologie Des Militants Anti-Masques.
- Brooks, S. K., Webster, R. K., Smith, L. E., Woodland, L., Wessely, S., Greenberg, N., & Rubin, G. J. (2020). The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *The Lancet*, 395(10227), 912–920. [https://doi.org/https://doi.org/10.1016/S0140-6736\(20\)30460-8](https://doi.org/https://doi.org/10.1016/S0140-6736(20)30460-8)

- Brouard, S., Vasilopoulos, P., & Becher, M. (2020). Sociodemographic and psychological correlates of compliance with the Covid-19 public health measures in France. *Canadian Journal of Political Science*, 253–258. <https://doi.org/10.1017/S0008423920000335>
- Bruinen de Bruin, Y., Lequarre, A. S., McCourt, J., Clevestig, P., Pigazzani, F., Zare Jeddi, M., ... Goulart, M. (2020). Initial impacts of global risk mitigation measures taken during the combatting of the COVID-19 pandemic. *Safety Science*, 128(April), 104773. <https://doi.org/10.1016/j.ssci.2020.104773>
- Bruns, A., Harrington, S., & Hurcombe, E. (2020). 'Corona? 5G? or both?': the dynamics of COVID-19/5G conspiracy theories on Facebook. *Media International Australia*, 177(1), 12–29. <https://doi.org/10.1177/1329878X20946113>
- Budd, J., Miller, B. S., Manning, E. M., Lampos, V., Zhuang, M., Edelstein, M., ... McKendry, R. A. (2020). Digital technologies in the public-health response to COVID-19. *Nature Medicine*, 26(8), 1183–1192. <https://doi.org/10.1038/s41591-020-1011-4>
- Buheji, M., da Costa Cunha, K., Beka, G., Mavrić, B., Leandro do Carmo de Souza, Y., Souza da Costa Silva, S., ... Chetia Yein, T. (2020). The Extent of COVID-19 Pandemic Socio-Economic Impact on Global Poverty. *A Global Integrative Multidisciplinary Review. American Journal of Economics*, 10(4), 213–224. <https://doi.org/10.5923/j.economics.20201004.02>
- Bukuluki, P., Mwenyango, H., Katongole, S. P., Sidhva, D., & Palattiyil, G. (2020). The socio-economic and psychosocial impact of Covid-19 pandemic on urban refugees in Uganda. *Social Sciences & Humanities Open*, 2(1), 100045. <https://doi.org/https://doi.org/10.1016/j.ssaho.2020.100045>
- Callaway, E., Ledford, H., & Mallapaty, S. (2020). Six months of coronavirus: the mysteries scientists are still racing to solve. *Nature*, 583(7815), 178–179. <https://doi.org/10.1038/d41586-020-01989-z>
- Cameron, E. E., Nuzzo, J. B., & Bell, J. A. (2019). GHS Index - Global Helath Security Index - Building Collective Action and Accountability. *October 2019*.
- Caminade, C., McIntyre, K. M., & Jones, A. E. (2019). Impact of recent and future climate change on vector-borne diseases. *Annals of the New York Academy of Sciences*, 1436(1), 157–173. <https://doi.org/10.1111/nyas.13950>
- Cancer Action Network. (2020). COVID-19 Pandemic Impact on Cancer Patients and Survivors: Survey Findings Summary, 1–5.
- Cao, W. C., Liu, W., Zhang, P. H., Zhang, F., & Richardus, J. H. (2007). Disappearance of antibodies to SARS-associated coronavirus after recovery. *New England Journal of Medicine*, 357(11), 1162–1163. <https://doi.org/10.1056/NEJMc070348>
- Carrieri, D., Peccatori, F. A., & Boniolo, G. (2020). COVID-19: a plea to protect the older population. *International Journal for Equity in Health*, 19(1), 72. <https://doi.org/10.1186/s12939-020-01193-5>
- Cassini, A., Högberg, L. D., Plachouras, D., Quattrocchi, A., Hoxha, A., Simonsen, G. S., ... Hopkins, S. (2019). Attributable deaths and disability-adjusted life-years caused by infections with antibiotic-resistant bacteria in the EU and the European Economic Area in 2015: a population-level modelling analysis. *The Lancet Infectious Diseases*, 19(1), 56–66. [https://doi.org/10.1016/S1473-3099\(18\)30605-4](https://doi.org/10.1016/S1473-3099(18)30605-4)
- Chevance, A., Gourion, D., Hoertel, N., Llorca, P.-M., Thomas, P., Bocher, R., ... Gaillard, R. (2020). Ensuring mental health care during the SARS-CoV-2 epidemic in France: A narrative review. *L'Encéphale*, 46(3), 193–201. <https://doi.org/https://doi.org/10.1016/j.encep.2020.04.005>
- Chu, D. K., Akl, E. A., Duda, S., Solo, K., Yaacoub, S., Schünemann, H. J., ... Reinap, M. (2020). 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*, 395(10242), 1973–1987. [https://doi.org/10.1016/S0140-6736\(20\)31142-9](https://doi.org/10.1016/S0140-6736(20)31142-9)

- Chung, R. Y.-N., & Li, M. M. (2020). Anti-Chinese sentiment during the 2019-nCoV outbreak. *The Lancet*, 395(10225), 686–687. [https://doi.org/https://doi.org/10.1016/S0140-6736\(20\)30358-5](https://doi.org/https://doi.org/10.1016/S0140-6736(20)30358-5)
- Contreras, S., Dehning, J., Loidolt, M., Spitzner, F. P., Urrea-Quintero, J. H., Mohr, S. B., ... Priesemann, V. (2020). The challenges of containing SARS-CoV-2 via test-trace-and-isolate. *ArXiv Preprint ArXiv:2009.05732*.
- Cook, J., & Lewandowsky, S. (2011). *The debunking handbook. Scientist*. University of Queensland St. Lucia, Australia.
- Cox, R. J., & Brokstad, K. A. (2020). Not just antibodies: B cells and T cells mediate immunity to COVID-19. *Nature Reviews Immunology*, 20(10), 581–582. <https://doi.org/10.1038/s41577-020-00436-4>
- Crețan, R., & Light, D. (2020). COVID-19 in Romania: transnational labour, geopolitics, and the Roma 'outsiders.' *Eurasian Geography and Economics*, 1–14. <https://doi.org/10.1080/15387216.2020.1780929>
- Czymara, C. S., Langenkamp, A., & Cano, T. (2020). Cause for concerns: gender inequality in experiencing the COVID-19 lockdown in Germany. *European Societies*, 1–14. <https://doi.org/10.1080/14616696.2020.1808692>
- Dahlgren, G., & Whitehead, M. (2007). European strategies for tackling social inequities in health: Levelling up Part 2. *Copenhagen, Denmark*. Retrieved from https://www.euro.who.int/__data/assets/pdf_file/0018/103824/E89384.pdf
- Davies, S. E., & Bennett, B. (2016). A gendered human rights analysis of Ebola and Zika: Locating gender in global health emergencies. *International Affairs*, 92(5), 1041–1060. <https://doi.org/10.1111/1468-2346.12704>
- Davis, J. S., Ferreira, D., Denholm, J. T., & Tong, S. Y. C. (2020). Clinical trials for the prevention and treatment of COVID-19: current state of play. *Medical Journal of Australia*, 213(2), 86–93. <https://doi.org/https://doi.org/10.5694/mja2.50673>
- de Pedraza, P., Guzi, M., & Tijdens, K. (2020). Life Dissatisfaction and Anxiety in COVID-19 pandemic. <https://doi.org/10.2760/755327>
- DeBiasi, R. L., & Delaney, M. (2020). Symptomatic and Asymptomatic Viral Shedding in Pediatric Patients Infected With Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2): Under the Surface. *JAMA Pediatrics*. <https://doi.org/10.1001/jamapediatrics.2020.3996>
- Dehning, J., Zierenberg, J., Spitzner, F. P., Wibral, M., Neto, J. P., Wilczek, M., & Priesemann, V. (2020). Inferring change points in the spread of COVID-19 reveals the effectiveness of interventions. *Science*, 369(6500), eabb9789. <https://doi.org/10.1126/science.abb9789>
- Devi, S. (2020). US public health budget cuts in the face of COVID-19. *The Lancet Infectious Diseases*, 20(4), 415. [https://doi.org/10.1016/S1473-3099\(20\)30182-1](https://doi.org/10.1016/S1473-3099(20)30182-1)
- Devine, D., Gaskell, J., Jennings, W., & Stoker, G. (2020). Trust and the Coronavirus Pandemic: What are the Consequences of and for Trust? An Early Review of the Literature. *Political Studies Review*, 1–12. <https://doi.org/10.1177/1478929920948684>
- Dinis-Oliveira, R. J. (2020). COVID-19 research: pandemic versus “paperdemic”, integrity, values and risks of the “speed science.” *Forensic Sciences Research*, 5(2), 174–187. <https://doi.org/10.1080/20961790.2020.1767754>
- Dobson, A. P., Pimm, S. L., Hannah, L., Kaufman, L., Ahumada, J. A., Ando, A. W., ... Va, M. M. (2020). Ecology and economics for pandemic prevention: Investments to prevent tropical deforestation and to limit wildlife trade will protect against future zoonosis outbreaks. *Science*, 369(6502), 379 LP-381. <https://doi.org/10.1126/science.abc3189>
- Dubey, S., Biswas, P., Ghosh, R., Chatterjee, S., Dubey, M. J., Chatterjee, S., ... Lavie, C. J. (2020). Psychosocial impact of COVID-19. *Diabetes & Metabolic Syndrome: Clinical*

- Research & Reviews*, 14(5), 779–788.
<https://doi.org/https://doi.org/10.1016/j.dsx.2020.05.035>
- Duffy, S. (2018). Why are RNA virus mutation rates so damn high? *PLoS Biology*, 16(8), e3000003–e3000003. <https://doi.org/10.1371/journal.pbio.3000003>
- ECDC & ASEF: European Centre for Disease Prevention and Control & Asia-Europe Foundation. (2016). How Can We Be Better Prepared for the Next Global Health Threat? Planning and Implementing Emergency Risk Communication. In *Workshop Report* (pp. 1–53).
- ECDC: European Centre for Disease Prevention and Control. (2018a). EU Laboratory Capability Monitoring System (EULabCap) Report on 2016 survey of EU/EEA country capabilities and capacities EU Laboratory Capability Monitoring System (EULabCap). ECDC.
- ECDC: European Centre for Disease Prevention and Control. (2018b). The use of evidence in decision-making during public health emergencies, 22. Retrieved from www.ecdc.europa.eu
- ECDC: European Centre for Disease Prevention and Control. (2020a). Contact tracing for COVID-19 : current evidence options for scale-up and an assessment of resources needed. In *ECDC, Technical Report* (pp. 1–9). Stockholm.
- ECDC: European Centre for Disease Prevention and Control. (2020b). 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 Key messages. Retrieved from <https://www.ecdc.europa.eu/sites/default/files/documents/Medically-and-socially-vulnerable-populations-COVID-19.pdf>
- ECDC: European Centre for Disease Prevention and Control. (2020c). Population-wide testing of SARS-CoV-2: country experiences and potential approaches in the EU/EEA and the UK.
- Eichelberger, L. (2007). SARS and New York’s Chinatown: The politics of risk and blame during an epidemic of fear. *Social Science and Medicine*, 65(6), 1284–1295. <https://doi.org/10.1016/j.socscimed.2007.04.022>
- El-Khatib, Z., Jacobs, G. B., Ikomey, G. M., & Neogi, U. (2020). The disproportionate effect of COVID-19 mortality on ethnic minorities: Genetics or health inequalities? *EClinicalMedicine*, 23, 100430. <https://doi.org/10.1016/j.eclinm.2020.100430>
- EGE: European Group on Ethics in Science and New Technologies. (2018). Future of Work, Future of Society. *EGE Opinions and Statements*. <https://doi.org/10.2777/029088>
- EGE: European Group on Ethics in Science and New Technologies. (2020). Statement on European Solidarity and the Protection of Fundamental Rights in the COVID-19 Pandemic. *EGE Opinions and Statements, April*, 1–4. Retrieved from <https://ec.europa.eu/info/publications/future-work-future->
- Fana, M., Tolan, S., Torrejón, S., & Brancati, U. (2020). The COVID confinement measures and EU labour markets. *European Commission*. Joint Research Centre (Seville site).
- Fancourt, D., Steptoe, A., & Wright, L. (2020). The Cummings effect: politics, trust, and behaviours during the COVID-19 pandemic. *The Lancet*, 396(10249), 464–465. [https://doi.org/10.1016/S0140-6736\(20\)31690-1](https://doi.org/10.1016/S0140-6736(20)31690-1)
- Fegert, J. M., Vitiello, B., Plener, P. L., & Clemens, V. (2020). Challenges and burden of the Coronavirus 2019 (COVID-19) pandemic for child and adolescent mental health: a narrative review to highlight clinical and research needs in the acute phase and the long return to normality. *Child and Adolescent Psychiatry and Mental Health*, 14, 20. <https://doi.org/10.1186/s13034-020-00329-3>
- Feral-Pierssens, A.-L., Claret, P.-G., & Chouihed, T. (2020). Collateral damage of the COVID-19 outbreak: expression of concern. *European Journal of Emergency Medicine : Official Journal of the European Society for Emergency Medicine*, 27(4), 233–234.

<https://doi.org/10.1097/MEJ.0000000000000717>

- Few, R., Chhotray, V., Tebboth, M., Forster, J., White, C., Armijos, T., & Shelton, C. (2020). COVID-19 Crisis: Lessons for Recovery. What can we learn from existing research on the long-term aspects of disaster risk and recovery?
- Fletcher, J. R. (2020). Chronological quarantine and ageism: COVID-19 and gerontology's relationship with age categorisation. *Ageing and Society*, 1–14. <https://doi.org/DOI:10.1017/S0144686X20001324>
- Fouque, F., & Reeder, J. C. (2019). Impact of past and on-going changes on climate and weather on vector-borne diseases transmission: a look at the evidence. *Infectious Diseases of Poverty*, 8(1), 51. <https://doi.org/10.1186/s40249-019-0565-1>
- Freeman, D., Waite, F., Rosebrock, L., Petit, A., Causier, C., East, A., ... Lambe, S. (2020). Coronavirus Conspiracy Beliefs, Mistrust, and Compliance with Government Guidelines in England. *Psychological Medicine*. <https://doi.org/10.1017/S0033291720001890>
- French, J., Deshpande, S., Evans, W., & Obregon, R. (2020). Key guidelines in developing a pre-emptive COVID-19 vaccination uptake promotion strategy. *International Journal of Environmental Research and Public Health*, 17(16), 1–14. <https://doi.org/10.3390/ijerph17165893>
- Frutos, R., Lopez Roig, M., Serra-Cobo, J., & Devaux, C. A. (2020). COVID-19: The Conjunction of Events Leading to the Coronavirus Pandemic and Lessons to Learn for Future Threats. *Frontiers in Medicine*, 7(May), 1–5. <https://doi.org/10.3389/fmed.2020.00223>
- Gandhi, M., Yokoe, D. S., & Havlir, D. V. (2020). Asymptomatic Transmission, the Achilles' Heel of Current Strategies to Control Covid-19. *The New England Journal of Medicine*, 382(22), 2158–2160. <https://doi.org/10.1056/NEJMe2009758>
- Ganyani, T., Kremer, C., Chen, D., Torneri, A., Faes, C., Wallinga, J., & Hens, N. (2020). Estimating the generation interval for COVID-19 based on symptom onset data. *MedRxiv*.
- Gausman, J., & Langer, A. (2020). Sex and Gender Disparities in the COVID-19 Pandemic. *Journal of Women's Health*, 29(4), 465–466. <https://doi.org/10.1089/jwh.2020.8472>
- Ghanchi, A. (2020). Adaptation of the National Plan for the Prevention and Fight against Pandemic Influenza to the 2020 COVID-19 epidemic in France. *Disaster Medicine and Public Health Preparedness*, 1–3. <https://doi.org/10.1017/dmp.2020.82>
- Gibb, R., Redding, D. W., Chin, K. Q., Donnelly, C. A., Blackburn, T. M., Newbold, T., & Jones, K. E. (2020). Zoonotic host diversity increases in human-dominated ecosystems. *Nature*, 584(7821), 398–402. <https://doi.org/10.1038/s41586-020-2562-8>
- Goldman, M., & Silva, M. (2020). Reflections on the Collaborative Fight Against COVID-19. *Frontiers in Medicine*, 7(September), 565. <https://doi.org/10.3389/fmed.2020.00565>
- Gottdenker, N. L., Streicker, D. G., Faust, C. L., & Carroll, C. R. (2014). Anthropogenic Land Use Change and Infectious Diseases: A Review of the Evidence. *EcoHealth*, 11(4), 619–632. <https://doi.org/10.1007/s10393-014-0941-z>
- Gousseff, M., Penot, P., Gallay, L., Batisse, D., Benech, N., Bouiller, K., ... Botelho-Nevers, E. (2020). Clinical recurrences of COVID-19 symptoms after recovery: Viral relapse, reinfection or inflammatory rebound? *Journal of Infection*, 81, 816–846. <https://doi.org/10.1016/j.jinf.2020.06.073>
- Gover, A. R., Harper, S. B., & Langton, L. (2020). Anti-Asian Hate Crime During the COVID-19 Pandemic: Exploring the Reproduction of Inequality. *American Journal of Criminal Justice*, 45(4), 647–667. <https://doi.org/10.1007/s12103-020-09545-1>
- GPMB: Global Preparedness Monitoring Board. (2019). A world at risk: annual report on global preparedness for health emergencies. Geneva: World Health Organization. Licence: CC BY-NC-SA 3.0 IGO.

- Greenhalgh, T., Schmid, M. B., Cypionka, T., Bassler, D., & Gruer, L. (2020). Face masks for the public during the covid-19 crisis. *Bmj*, 369.
- Grifoni, A., Weiskopf, D., Ramirez, S. I., Mateus, J., Dan, J. M., Moderbacher, C. R., ... Sette, A. (2020). Targets of T Cell Responses to SARS-CoV-2 Coronavirus in Humans with COVID-19 Disease and Unexposed Individuals. *Cell*, 181(7), 1489–1501.e15. <https://doi.org/10.1016/j.cell.2020.05.015>
- Hall, L. M. C., & Henderson-Begg, S. K. (2006). Hypermutable bacteria isolated from humans – a critical analysis. *Microbiology*, 152(9), 2505–2514. <https://doi.org/https://doi.org/10.1099/mic.0.29079-0>
- Hawkins, A., Graham, C. R., & Barbour, M. K. (2012). “Everybody is their own Island” Teacher disconnection in a virtual school. *International Review of Research in Open and Distance Learning*, 13(2), 124–144. <https://doi.org/10.19173/irrodl.v13i2.967>
- Heald-Sargent, T., Muller, W. J., Zheng, X., Rippe, J., Patel, A. B., & Kocielek, L. K. (2020). Age-Related Differences in Nasopharyngeal Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) Levels in Patients With Mild to Moderate Coronavirus Disease 2019 (COVID-19). *JAMA Pediatrics*, 174(9), 902–903. <https://doi.org/10.1001/jamapediatrics.2020.3651>
- Hicks, A., & Few, R. (2015). Trajectories of social vulnerability during the Soufrière Hills volcanic crisis. *Journal of Applied Volcanology*, 4(1), 10. <https://doi.org/10.1186/s13617-015-0029-7>
- Holmes, E. A., O’Connor, R. C., Perry, V. H., Tracey, I., Wessely, S., Arseneault, L., ... Bullmore, E. (2020). Multidisciplinary research priorities for the COVID-19 pandemic: a call for action for mental health science. *The Lancet Psychiatry*, 7(6), 547–560. [https://doi.org/10.1016/S2215-0366\(20\)30168-1](https://doi.org/10.1016/S2215-0366(20)30168-1)
- ICNARC: Intensive Care National Audit & Research Centre. (2020). ICNARC report on COVID-19 in critical care : England , Wales and Northern Ireland. *ICNARC COVID-19 Study Case Mix Programme Database*.
- ILO: International Labour Organization. (2020a). Global impact and policy recommendations (COVID-19 and the world of work), 18 March, 1–15. Retrieved from <http://www.ilo.org/global/topics/coronavirus/impacts-and-responses/lang--en/index.htm>
- ILO: International Labour Organization. (2020b). ILO Monitor: COVID-19 and the world of work. *Third edition* (Vol. 29 April). Updated estimates and analysis [https://www.ilo.org/wcmsp5/groups/public ...](https://www.ilo.org/wcmsp5/groups/public...)
- IPBES: Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. (2020). Workshop Report on Biodiversity and Pandemics of the Intergovernmental Platform on Biodiversity and Ecosystem Services. Daszak, P., das Neves, C., Amuasi, J., Hayman, D., Kuiken, T., Roche, B., Zambrana-Torrel, C., Buss, P., Dundarova, H., Feferholtz, Y., Foldvari, G., Igbinosa, E., Junglen, S., Liu, Q., Suzan, G., Uhart, M., Wannous, C., Woolaston, K., Mosig Reidl, P., O’Brien, K., Pascual, U., Stoett, P., Li, H., Ngo, H. T., Bonn, Germany. <https://doi.org/10.5281/zenodo.4147318>
- Jæger, M. M., & Blaabæk, E. H. (2020). Inequality in learning opportunities during Covid-19: Evidence from library takeout. *Research in Social Stratification and Mobility*, 68, 100524. <https://doi.org/10.1016/j.rssm.2020.100524>
- Jeyanathan, M., Afkhami, S., Smail, F., Miller, M. S., Lichty, B. D., & Xing, Z. (2020). Immunological considerations for COVID-19 vaccine strategies. *Nature Reviews Immunology*, 20(10), 615–632. <https://doi.org/10.1038/s41577-020-00434-6>
- Johansen, K., Bresseur, D., MacDonald, N., Nohynek, H., Vandeputte, J., Wood, D., & Neels, P. (2016). Where are we in our understanding of the association between narcolepsy and one of the 2009 adjuvanted influenza A (H1N1) vaccines? *Biologicals*, 44(4), 276–280. <https://doi.org/https://doi.org/10.1016/j.biologicals.2016.04.007>
- Jolley, D., & Douglas, K. M. (2017). Prevention is better than cure: Addressing anti-vaccine

- conspiracy theories. *Journal of Applied Social Psychology*, 47(8), 459–469.
<https://doi.org/10.1111/jasp.12453>
- Jones, K. E., Patel, N. G., Levy, M. A., Storeygard, A., Balk, D., Gittleman, J. L., & Daszak, P. (2008). Global trends in emerging infectious diseases. *Nature*, 451(7181), 990–993. <https://doi.org/10.1038/nature06536>
- Jones, T. C., Mühlmann, B., & Veith et al., T. (2020). An analysis of SARS-CoV-2 viral load by patient age. <http://medrxiv.org/lookup/doi/10.1101/2020.06.08.20125484>. (Accessed 20 August 2020).
- Kelman, I. (2020). COVID-19: what is the disaster? *Social Anthropology*, 28(2), 296–297. <https://doi.org/10.1111/1469-8676.12890>
- Kinner, S. A., Young, J. T., Snow, K., Southalan, L., Lopez-Acuña, D., Ferreira-Borges, C., & O'Moore, É. (2020). Prisons and custodial settings are part of a comprehensive response to COVID-19. *The Lancet Public Health*, 5(4), e188–e189. [https://doi.org/https://doi.org/10.1016/S2468-2667\(20\)30058-X](https://doi.org/https://doi.org/10.1016/S2468-2667(20)30058-X)
- Kittel, B., Kritzinger, S., Boomgaarden, H., Prainsack, B., Eberl, J.-M., Kalleitner, F., ... Schlogl, L. (2020). The Austrian Corona Panel Project: monitoring individual and societal dynamics amidst the COVID-19 crisis. *European Political Science*, 1–27. <https://doi.org/10.1057/s41304-020-00294-7>
- Klein, E. Y., Van Boeckel, T. P., Martinez, E. M., Pant, S., Gandra, S., Levin, S. A., ... Laxminarayan, R. (2018). Global increase and geographic convergence in antibiotic consumption between 2000 and 2015. *Proceedings of the National Academy of Sciences*, 115(15), E3463 LP-E3470. <https://doi.org/10.1073/pnas.1717295115>
- Klein, S. L., Dhakal, S., Ursin, R. L., Deshpande, S., Sandberg, K., & Mauvais-Jarvis, F. (2020). Biological sex impacts COVID-19 outcomes. *PLOS Pathogens*, 16(6), e1008570.
- Kontis, V., Bennett, J. E., Rashid, T., Parks, R. M., Pearson-Stuttard, J., Guillot, M., ... Ezzati, M. (2020). Magnitude, demographics and dynamics of the impact of the first phase of the Covid-19 pandemic on all-cause mortality in 17 industrialised countries. *MedRxiv*, 2020.07.26.20161570.
- Kuiper, M. E., de Bruijn, A. L., Reinders Folmer, C., Olthuis, E., Brownlee, M., Kooistra, E. B., ... van Rooij, B. (2020). The Intelligent Lockdown: Compliance with COVID-19 Mitigation Measures in the Netherlands. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3598215>
- Laato, S., Islam, A. K. M. N., Islam, M. N., & Whelan, E. (2020). What drives unverified information sharing and cyberchondria during the COVID-19 pandemic? *European Journal of Information Systems*, 29(3), 288–305. <https://doi.org/10.1080/0960085X.2020.1770632>
- Lai, J., Ma, S., Wang, Y., Cai, Z., Hu, J., Wei, N., ... Hu, S. (2020). Factors Associated With Mental Health Outcomes Among Health Care Workers Exposed to Coronavirus Disease 2019. *JAMA Network Open*, 3(3), e203976–e203976. <https://doi.org/10.1001/jamanetworkopen.2020.3976>
- Lee, V. J., Aguilera, X., Heymann, D. L., Wilder-Smith, A., Lee, V. J., Heymann, D. L., ... Yeo, W. Q. (2020). Preparedness for emerging epidemic threats: a Lancet Infectious Diseases Commission. *The Lancet Infectious Diseases*, 20(1), 17–19. [https://doi.org/10.1016/S1473-3099\(19\)30674-7](https://doi.org/10.1016/S1473-3099(19)30674-7)
- Legido-Quigley, H., Mateos-García, J. T., Campos, V. R., Gea-Sánchez, M., Muntaner, C., & McKee, M. (2020). The resilience of the Spanish health system against the COVID-19 pandemic. *The Lancet Public Health*, 5(5), e251–e252. [https://doi.org/https://doi.org/10.1016/S2468-2667\(20\)30060-8](https://doi.org/https://doi.org/10.1016/S2468-2667(20)30060-8)
- Lewandowsky, S., & Cook, J. (2020). The conspiracy theory handbook, 1–12.
- Liem, A., Wang, C., Wariyanti, Y., Latkin, C. A., & Hall, B. J. (2020). The neglected health of

- international migrant workers in the COVID-19 epidemic. *The Lancet Psychiatry*, 7(4), e20. [https://doi.org/https://doi.org/10.1016/S2215-0366\(20\)30076-6](https://doi.org/https://doi.org/10.1016/S2215-0366(20)30076-6)
- Loewenthal, G., Abadi, S., Avram, O., Halabi, K., Ecker, N., Nagar, N., ... Pupko, T. (2020). COVID-19 pandemic-related lockdown: response time is more important than its strictness. *MedRxiv*, 2020.06.11.20128520.
- London, A. J., & Kimmelman, J. (2020). Against pandemic research exceptionalism. *Science*, 368(6490), 476–477. <https://doi.org/10.1126/science.abc1731>
- Lozano, R., Fullman, N., Mumford, J. E., Knight, M., Barthelemy, C. M., Abbafati, C., ... Murray, C. J. L. (2020). Measuring universal health coverage based on an index of effective coverage of health services in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *The Lancet*. [https://doi.org/10.1016/S0140-6736\(20\)30750-9](https://doi.org/10.1016/S0140-6736(20)30750-9)
- Lu, R., Zhao, X., Li, J., Niu, P., Yang, B., Wu, H., ... Tan, W. (2020). Genomic characterisation and epidemiology of 2019 novel coronavirus: implications for virus origins and receptor binding. *The Lancet*, 395(10224), 565–574. [https://doi.org/https://doi.org/10.1016/S0140-6736\(20\)30251-8](https://doi.org/https://doi.org/10.1016/S0140-6736(20)30251-8)
- Luckman, A., Zeitoun, H., Isoni, A., Loomes, G., Vlaev, I., & Read, D. (2020). Risk compensation during COVID-19: The impact of face mask usage on social distancing. <https://doi.org/https://doi.org/10.31219/osf.io/rb8he>
- Lurie, N., Saville, M., Hatchett, R., & Halton, J. (2020). Developing Covid-19 Vaccines at Pandemic Speed. *New England Journal of Medicine*, 382(21), 1969–1973. <https://doi.org/10.1056/nejmp2005630>
- Lynch, J. (2020). Health Equity, Social Policy, and Promoting Recovery from COVID-19. *Journal of Health Politics, Policy and Law*, 28(8641518). <https://doi.org/10.1215/03616878-8641518>
- Maher, P. J., MacCarron, P., & Quayle, M. (2020). Mapping public health responses with attitude networks: the emergence of opinion-based groups in the UK's early COVID-19 response phase. *British Journal of Social Psychology*, 59(3), 641–652. <https://doi.org/10.1111/bjso.12396>
- Mair, D., Smillie, L., La Placa, G., Schwendinger, F., Raykovska, M., Pasztor, Z., & van Bavel, R. (2019). Understanding our political nature: How to put knowledge and reason at the heart of political decision-making. <https://doi.org/10.2760/374191>
- Marchiori, M. (2020). COVID-19 and the Social Distancing Paradox: dangers and solutions. *ArXiv Preprint ArXiv:2005.12446*. Retrieved from <http://arxiv.org/abs/2005.12446>
- Maringe, C., Spicer, J., Morris, M., Purushotham, A., Nolte, E., Sullivan, R., ... Aggarwal, A. (2020). The impact of the COVID-19 pandemic on cancer deaths due to delays in diagnosis in England, UK: a national, population-based, modelling study. *The Lancet Oncology*, 21(8), 1023–1034. [https://doi.org/https://doi.org/10.1016/S1470-2045\(20\)30388-0](https://doi.org/https://doi.org/10.1016/S1470-2045(20)30388-0)
- Marston, H. D., Paules, C. I., & Fauci, A. S. (2017). The critical role of biomedical research in pandemic preparedness. *JAMA - Journal of the American Medical Association*, 318(18), 1757–1758. <https://doi.org/10.1001/jama.2017.15033>
- Matache, M., & Bhabha, J. (2020). Anti-Roma racism is spiraling during COVID-19 pandemic. *Health and Human Rights*, 22(1), 379–382.
- McCloskey, B., Dar, O., Zumla, A., & Heymann, D. L. (2014). Emerging infectious diseases and pandemic potential: Status quo and reducing risk of global spread. *The Lancet Infectious Diseases*, 14(10), 1001–1010. [https://doi.org/10.1016/S1473-3099\(14\)70846-1](https://doi.org/10.1016/S1473-3099(14)70846-1)
- McLaren, H. J., Wong, K. R., Nguyen, K. N., & Mahamadachchi, K. N. D. (2020). Covid-19 and women's triple burden: Vignettes from Sri Lanka, Malaysia, Vietnam and Australia. *Social Sciences*, 9(5). <https://doi.org/10.3390/SOCSCI9050087>

- Mendes, L. (2020). How Can We Quarantine Without a Home? Responses of Activism and Urban Social Movements in Times of COVID-19 Pandemic Crisis in Lisbon. *Tijdschrift Voor Economische En Sociale Geografie*, 111(3), 318–332. <https://doi.org/10.1111/tesg.12450>
- Mondelli, M. U., Colaneri, M., Seminari, E. M., Baldanti, F., & Bruno, R. (2020). Low risk of SARS-CoV-2 transmission by fomites in real-life conditions. *The Lancet Infectious Diseases*, 3099(20), 30678. [https://doi.org/10.1016/S1473-3099\(20\)30678-2](https://doi.org/10.1016/S1473-3099(20)30678-2)
- Moon, S., Leigh, J., Woskie, L., Checchi, F., Dzau, V., Fallah, M., ... Jha, A. K. (2017). Post-Ebola reforms: Ample analysis, inadequate action. *BMJ (Online)*, 356, 1–8. <https://doi.org/10.1136/bmj.j280>
- Morawska, L., Tang, J. W., Bahnfleth, W., Bluysen, P. M., Boerstra, A., Buonanno, G., ... Yao, M. (2020). How can airborne transmission of COVID-19 indoors be minimised? *Environment International*, 142(April). <https://doi.org/10.1016/j.envint.2020.105832>
- Moreira, D. N., & Pinto da Costa, M. (2020). The impact of the Covid-19 pandemic in the precipitation of intimate partner violence. *International Journal of Law and Psychiatry*, 71, 101606. <https://doi.org/https://doi.org/10.1016/j.ijlp.2020.101606>
- Morgan, C., & Rose, N. (2020). Multidisciplinary research priorities for the COVID-19 pandemic. *The Lancet. Psychiatry*, 7(7), e33–e33. [https://doi.org/10.1016/S2215-0366\(20\)30230-3](https://doi.org/10.1016/S2215-0366(20)30230-3)
- Morlacco, A., Motterle, G., & Zattoni, F. (2020). The multifaceted long-term effects of the COVID-19 pandemic on urology. *Nature Reviews Urology*, 17(7), 365–367. <https://doi.org/10.1038/s41585-020-0331-y>
- Morse, S. S., Mazet, J. A. K., Woolhouse, M., Parrish, C. R., Carroll, D., Karesh, W. B., ... Daszak, P. (2012). Prediction and prevention of the next pandemic zoonosis. *The Lancet*, 380(9857), 1956–1965. [https://doi.org/10.1016/S0140-6736\(12\)61684-5](https://doi.org/10.1016/S0140-6736(12)61684-5)
- Mushi, V., & Shao, M. (2020). Tailoring of the ongoing water, sanitation and hygiene interventions for prevention and control of COVID-19. *Tropical Medicine and Health*, 48(1), 47. <https://doi.org/10.1186/s41182-020-00236-5>
- NASEM: National Academies of Sciences, Engineering, and Medicine. (2017). *Integrating Clinical Research into Epidemic Response: The Ebola Experience*. (G. Keusch, K. McAdam, P. A. Cuff, M. Mancher, & E. R. Busta, Eds.). Washington, DC: The National Academies Press. <https://doi.org/10.17226/24739>
- Nava, A., Shimabukuro, J. S., Chmura, A. A., & Luz, S. L. B. (2017). The impact of global environmental changes on infectious disease emergence with a focus on risks for Brazil. *ILAR Journal*, 58(3), 393–400. <https://doi.org/10.1093/ilar/ilx034>
- Newton, K. (2020). Government Communications, Political Trust and Compliant Social Behaviour: The Politics of Covid-19 in Britain. *Political Quarterly*, 91(3), 502–513. <https://doi.org/10.1111/1467-923X.12901>
- Nicola, M., Alsafi, Z., Sohrabi, C., Kerwan, A., Al-Jabir, A., Iosifidis, C., ... Agha, R. (2020). The socio-economic implications of the coronavirus pandemic (COVID-19): A review. *International Journal of Surgery (London, England)*, 78, 185–193. <https://doi.org/10.1016/j.ijvsu.2020.04.018>
- Nuzzo, J. B., Mullen, L., Snyder, M., Cicero, A., & Inglesby, T. V. (2019). *Preparedness for a high-impact respiratory pathogen pandemic*. Retrieved from https://apps.who.int/gpmb/assets/thematic_papers/tr-6.pdf
- O' Neil, J. (2014). Review on Antibiotic resistance. Antimicrobial Resistance : Tackling a crisis for the health and wealth of nations. *Health and Wealth Nations*, (December), 1–16.
- OECD: Organisation for Economic Co-operation and Development. (2020a). COVID-19 Crisis Response in South East European Economies.
- OECD: Organisation for Economic Co-operation and Development. (2020b). How prepared

are teachers and schools to face the changes to learning caused by the coronavirus pandemic? *Teaching in Focus*, (32), 6.

- OHCHR, IOM, UNHCR, & WHO: Office of the United Nations High Commissioner for Human Rights, International Organization for Migration, United Nations High Commissioner for Refugees & World Health Organization. (2020). Joint press release: the rights and health of refugees, migrants and stateless must be protected in COVID-19 response.
- Oikkonen, V. (2017). Affect, technoscience and textual analysis: Interrogating the affective dynamics of the Zika epidemic through media texts. *Social Studies of Science*, 47(5), 681–702. <https://doi.org/10.1177/0306312717723760>
- Oreffice, S., & Quintana-Domeque, C. (2020). Gender inequality in COVID-19 times: Evidence from UK Prolific participants.
- Pak, A., Adegboye, O. A., Adekunle, A. I., Rahman, K. M., McBryde, E. S., & Eisen, D. P. (2020). Economic Consequences of the COVID-19 Outbreak: the Need for Epidemic Preparedness. *Frontiers in Public Health*, 8(May), 1–4. <https://doi.org/10.3389/fpubh.2020.00241>
- Pan, D., Sze, S., Minhas, J. S., Bangash, M. N., Pareek, N., Divall, P., ... Pareek, M. (2020). The impact of ethnicity on clinical outcomes in COVID-19: A systematic review. *EClinicalMedicine*, 23, 100404. <https://doi.org/10.1016/j.eclinm.2020.100404>
- Park, J. J. H., Declodt, E. H., Rayner, C. R., Cotton, M., & Mills, E. J. (2020). Clinical trials of disease stages in COVID 19: complicated and often misinterpreted. *The Lancet Global Health*, 8(10), e1249–e1250. [https://doi.org/https://doi.org/10.1016/S2214-109X\(20\)30365-X](https://doi.org/https://doi.org/10.1016/S2214-109X(20)30365-X)
- Partridge, S. R., Kwong, S. M., Firth, N., & Jensen, S. O. (2018). Mobile Genetic Elements Associated with Antimicrobial Resistance. *Clinical Microbiology Reviews*, 31(4), e00088–17. <https://doi.org/10.1128/CMR.00088-17>
- Patel, J. A., Nielsen, F. B. H., Badiani, A. A., Assi, S., Unadkat, V. A., Patel, B., ... Wardle, H. (2020). Poverty, inequality and COVID-19: the forgotten vulnerable. *Public Health*, 183, 110–111. <https://doi.org/https://doi.org/10.1016/j.puhe.2020.05.006>
- Peeples, L. (2020). Face masks: what the data say. *Nature*, 573(7772), 24–26. <https://doi.org/10.1038/d41586-020-02801-8>
- Pessoa-Amorim, G., Camm, C. F., Gajendragadkar, P., De Maria, G. L., Arsac, C., Laroche, C., ... Casadei, B. (2020). Admission of patients with STEMI since the outbreak of the COVID-19 pandemic: a survey by the European Society of Cardiology. *European Heart Journal - Quality of Care and Clinical Outcomes*, 6(3), 210–216. <https://doi.org/10.1093/ehjqcco/qcaa046>
- Petersen, E., Petrosillo, N., Koopmans, M., Beeching, N., Di Caro, A., Gkrania-Klotsas, E., ... Storgaard, M. (2018). Emerging infections—an increasingly important topic: review by the Emerging Infections Task Force. *Clinical Microbiology and Infection*, 24(4), 369–375. <https://doi.org/https://doi.org/10.1016/j.cmi.2017.10.035>
- Pfefferbaum, B., & North, C. S. (2020). Mental Health and the Covid-19 Pandemic. *New England Journal of Medicine*, 383(6), 510–512. <https://doi.org/10.1056/NEJMp2008017>
- Plohl, N., & Musil, B. (2020). Modeling compliance with COVID-19 prevention guidelines: the critical role of trust in science. *Psychology, Health and Medicine*, 00(00), 1–12. <https://doi.org/10.1080/13548506.2020.1772988>
- Prainsack, B. (2020). Solidarity in Times of Pandemics. *Democratic Theory*, 7(2), 124–133. <https://doi.org/10.3167/dt.2020.070215>
- Richardson, D., Cebotari, V., Carraro, A., & Damoah, K. A. (2020). Supporting Families and Children Beyond COVID-19: Social protection in Southern and Eastern Europe and Central Asia.

- Ryan, N. E., & El Ayadi, A. M. (2020). A call for a gender-responsive, intersectional approach to address COVID-19. *Global Public Health, 15*(9), 1404–1412. <https://doi.org/10.1080/17441692.2020.1791214>
- SAPEA: Science Advice for Policy by European Academies. (2019). Transforming the Future of Ageing. *Berlin*. <https://doi.org/10.26356/ageing>
- Setti, L., Passarini, F., De Gennaro, G., Barbieri, P., Perrone, M. G., Borelli, M., ... Miani, A. (2020). Airborne transmission route of covid-19: Why 2 meters/6 feet of inter-personal distance could not be enough. *International Journal of Environmental Research and Public Health, 17*(8). <https://doi.org/10.3390/ijerph17082932>
- Sharp, C., Nelson, J., Lucas, M., Julius, J., Mccrone, T., & Sims, D. (2020). Schools' responses to Covid-19: The challenges facing schools and pupils in September 2020, (September), 72.
- Sharpless, N. E. (2020). COVID-19 and cancer. *Science, 368*(6497), 1290 LP-1290. <https://doi.org/10.1126/science.abd3377>
- Shimizu, K. (2020). 2019-nCoV, fake news, and racism. *The Lancet, 395*(10225), 685–686. [https://doi.org/https://doi.org/10.1016/S0140-6736\(20\)30357-3](https://doi.org/https://doi.org/10.1016/S0140-6736(20)30357-3)
- Silverman, M., Sibbald, R., & Stranges, S. (2020). Ethics of COVID-19-related school closures. *Canadian Journal of Public Health, 111*(4), 462–465. <https://doi.org/10.17269/s41997-020-00396-1>
- Simpson, S., Kaufmann, M. C., Glozman, V., & Chakrabarti, A. (2020). Disease X: accelerating the development of medical countermeasures for the next pandemic. *The Lancet Infectious Diseases*. Elsevier Ltd. [https://doi.org/10.1016/S1473-3099\(20\)30123-7](https://doi.org/10.1016/S1473-3099(20)30123-7)
- Smith, K. F., Goldberg, M., Rosenthal, S., Carlson, L., Chen, J., Chen, C., & Ramachandran, S. (2014). Global rise in human infectious disease outbreaks. *Journal of the Royal Society Interface, 11*(101), 1–6. <https://doi.org/10.1098/rsif.2014.0950>
- Sokol, M., & Pataccini, L. (2020). Winners And Losers In Coronavirus Times: Financialisation, Financial Chains and Emerging Economic Geographies of The Covid-19 Pandemic. *Tijdschrift Voor Economische En Sociale Geografie, 111*(3), 401–415. <https://doi.org/10.1111/tesg.12433>
- Søreide, K., Hallet, J., Matthews, J. B., Schnitzbauer, A. A., Line, P. D., Lai, P. B. S., ... Lorenzon, L. (2020). Immediate and long-term impact of the COVID-19 pandemic on delivery of surgical services. *BJS (British Journal of Surgery), 107*(10), 1250–1261. <https://doi.org/10.1002/bjs.11670>
- Spellberg, B., Haddix, M., Lee, R., Butler-Wu, S., Holtom, P., Yee, H., & Gounder, P. (2020). Community Prevalence of SARS-CoV-2 among Patients with Influenza-like Illnesses Presenting to a Los Angeles Medical Center in March 2020. *JAMA - Journal of the American Medical Association, 323*(19), 1966–1967. <https://doi.org/10.1001/jama.2020.4958>
- Stephen, C. (2020). Rethinking pandemic preparedness in the Anthropocene. *Healthcare Management Forum, 33*(4), 153–157. <https://doi.org/10.1177/0840470419867347>
- Stodel, E. J., Thompson, T. L., & MacDonald, C. J. (2006). Learners' perspectives on what is missing from online learning: Interpretations through the community of inquiry framework. *International Review of Research in Open and Distance Learning, 7*(3). <https://doi.org/10.19173/irrodl.v7i3.325>
- Stowe, J., Tessier, E., Zhao, H., Guy, R., Muller-Pebody, B., Zambon, M., ... Lopez Bernal, J. (2020). Interactions between SARS-CoV-2 and Influenza and the impact of coinfection on disease severity: A test negative design. *MedRxiv*, 2020.09.18.20189647.
- Swinford, E., Galucia, N., & Morrow-Howell, N. (2020). Applying Gerontological Social Work Perspectives to the Coronavirus Pandemic. *Journal of Gerontological Social Work, 1*–11. <https://doi.org/10.1080/01634372.2020.1766628>

- Taylor, L. H., Latham, S. M., & Woolhouse, M. E. J. (2001). Risk factors for human disease emergence. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 356(1411), 983–989. <https://doi.org/10.1098/rstb.2001.0888>
- The RECOVERY Collaborative Group. (2020). Dexamethasone in Hospitalized Patients with Covid-19 — Preliminary Report. *New England Journal of Medicine*. <https://doi.org/10.1056/nejmoa2021436>
- Tomczyk, S., Rahn, M., & Schmidt, S. (2020). Social Distancing and Stigma: Association Between Compliance With Behavioral Recommendations, Risk Perception, and Stigmatizing Attitudes During the COVID-19 Outbreak. *Frontiers in Psychology*, 11(August), 1–9. <https://doi.org/10.3389/fpsyg.2020.01821>
- Tsai, J., & Wilson, M. (2020). COVID-19: a potential public health problem for homeless populations. *The Lancet Public Health*, 5(4), e186–e187. [https://doi.org/https://doi.org/10.1016/S2468-2667\(20\)30053-0](https://doi.org/https://doi.org/10.1016/S2468-2667(20)30053-0)
- UN: United Nations. (2020). A UN framework for the immediate socio-economic response to COVID-19. *United Nations*, (April).
- UNEP: United Nations Environment Programme. (2020). Preventing the Next Pandemic: Zoonotic diseases and how to break the chain of transmission. *Nairobi, Kenya*.
- van Doremalen, N., Bushmaker, T., Morris, D. H., Holbrook, M. G., Gamble, A., Williamson, B. N., ... Munster, V. J. (2020). Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1. *New England Journal of Medicine*, 382(16), 1564–1567. <https://doi.org/10.1056/NEJMc2004973>
- Waits, A., Emelyanova, A., Oksanen, A., Abass, K., & Rautio, A. (2018). Human infectious diseases and the changing climate in the Arctic. *Environment International*, 121, 703–713. <https://doi.org/https://doi.org/10.1016/j.envint.2018.09.042>
- Wang, G., Zhang, Y., Zhao, J., Zhang, J., & Jiang, F. (2020). Mitigate the effects of home confinement on children during the COVID-19 outbreak. *The Lancet*, 395(10228), 945–947. [https://doi.org/https://doi.org/10.1016/S0140-6736\(20\)30547-X](https://doi.org/https://doi.org/10.1016/S0140-6736(20)30547-X)
- Wang, S., Chen, X., Li, Y., Luu, C., Yan, R., & Madrisotti, F. (2020). 'I'm more afraid of racism than of the virus!': racism awareness and resistance among Chinese migrants and their descendants in France during the Covid-19 pandemic. *European Societies*, 1–22. <https://doi.org/10.1080/14616696.2020.1836384>
- Weber, D. J., Sickbert-Bennett, E. E., Kanamori, H., & Rutala, W. A. (2019). New and emerging infectious diseases (Ebola, Middle Eastern respiratory syndrome coronavirus, carbapenem-resistant Enterobacteriaceae, Candida auris): Focus on environmental survival and germicide susceptibility. *American Journal of Infection Control*, 47, A29–A38. <https://doi.org/10.1016/j.ajic.2019.03.004>
- Webster, P. (2020). Canada and COVID-19: learning from SARS. *The Lancet*, 395(10228), 936–937. [https://doi.org/10.1016/S0140-6736\(20\)30670-X](https://doi.org/10.1016/S0140-6736(20)30670-X)
- WHO: World Health Organization. (2016). Guidance for managing ethical issues in infectious disease outbreaks. *World Health Organisation*.
- WHO: World Health Organization. (2017). Tokyo declaration on Universal health coverage: all together to accelerate progress toward UHC. In *High-level Forum on Universal Health Coverage, Tokyo*.
- WHO: World Health Organization. (2020). A Coordinated Global Research Roadmap: 2019 Novel Coronavirus. *R&D Blueprint*. Retrieved from <http://dx.doi.org/10.1038/s41591-020-0935-z>
- Wieler, L., Rexroth, U., & Gottschalk, R. (2020). Emerging COVID-19 success story: Germany's strong enabling environment - Our World in Data. *Our World in Data*.
- Williams, C. C., & Kayaoglu, A. (2020). COVID-19 and undeclared work: impacts and policy responses in Europe. *Service Industries Journal*, 40(13–14), 914–931. <https://doi.org/10.1080/02642069.2020.1757073>

- Wolf, J., Bruno, S., Eichberg, M., Jannat, R., Rudo, S., VanRheenen, S., & Collier, B. A. (2020). Applying lessons from the Ebola vaccine experience for SARS-CoV-2 and other epidemic pathogens. *Npj Vaccines*, 5(1). <https://doi.org/10.1038/s41541-020-0204-7>
- Wolf, L. J., Haddock, G., Manstead, A. S. R., & Maio, G. R. (2020). The importance of (shared) human values for containing the COVID-19 pandemic. *British Journal of Social Psychology*, 59(3), 618–627. <https://doi.org/10.1111/bjso.12401>
- Wolfe, N. D., Dunavan, C. P., & Diamond, J. (2007). Origins of major human infectious diseases. *Nature*, 447(7142), 279–283. <https://doi.org/10.1038/nature05775>
- Woolhouse, M. E. J., & Gowtage-Sequeria, S. (2005). Host range and emerging and reemerging pathogens. *Emerging Infectious Diseases*, 11(12), 1842–1847. <https://doi.org/10.3201/eid1112.050997>
- World Bank. (2020). World Bank East Asia and Pacific Economic Update, April 2020 : East Asia and Pacific in the Time of COVID-19. *The World Bank*. <https://doi.org/10.1596/978-1-4648-1565-2>
- Yao, H., Chen, J.-H., & Xu, Y.-F. (2020). Patients with mental health disorders in the COVID-19 epidemic. *The Lancet Psychiatry*, 7(4), e21. [https://doi.org/10.1016/S2215-0366\(20\)30090-0](https://doi.org/10.1016/S2215-0366(20)30090-0)
- Yerkes, M., Andre, S., Besamusca, J., Remery, C., van der Zwan, R., Kruijen, P., ... de Beer, P. (2020). Werkende ouders in tijden van Corona. Meer maar ook minder genderongelijkheid.
- Zhang, H., & Shaw, R. (2020). Identifying research trends and gaps in the context of covid-19. *International Journal of Environmental Research and Public Health*, 17(10). <https://doi.org/10.3390/ijerph17103370>
- Zhang, J., Ding, D., Huang, X., Zhang, J., Chen, D., Fu, P., ... Tao, Z. (2020). Differentiation of COVID-19 from seasonal influenza: A multicenter comparative study. *Journal of Medical Virology*. <https://doi.org/10.1002/jmv.26469>
- Zhang, J., Litvinova, M., Liang, Y., Wang, Y., Wang, W., Zhao, S., ... Yu, H. (2020). Changes in contact patterns shape the dynamics of the COVID-19 outbreak in China. *Science*, 368(6498), 1481 LP-1486. <https://doi.org/10.1126/science.abb8001>

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Epidemics and pandemics have shaped human history and will continue to do so. The COVID-19 crisis has shown that there is need to understand how Europe can ensure better management of and preparedness for them. This joint advice builds on lessons learned from the current and from previous pandemics. It analyses their complexity, drawing on insights from research and scholarship and taking European values and respect for fundamental rights as critical orientation.

It is developed jointly by the European Commission's independent Group of Chief Scientific Advisors, the European Group on Ethics in Science and New Technologies (EGE) and Peter Piot, Special Advisor to the President of the European Commission on the response to COVID-19.

Their recommendations include strengthened European and global solidarity and coordination in governance, research and community efforts to improve pandemic preparedness and management. This should address all aspects and causes of pandemics in their complex interplay, from biomedical and health to social and environmental ones. The advice covers efforts to prevent and pre-empt future pandemics; more coordinated response structures and mechanisms; the strengthening of essential systems, including healthcare, supply chains, public health, information and education; and protecting fundamental rights and social justice.

Studies and reports

