CORONA-FREE FINLAND

The rationale and methods for elimination of the coronavirus epidemic in Finland

In this report, we provide a multidisciplinary rationale for the elimination of the coronavirus epidemic in Finland. By outlining the benefits and methods for eliminating the virus, we make a strong case for this as the ideal strategy for Finland to cope with the current public health and economic crisis. With many other countries in Europe and the rest of the world having decisively eliminated the virus, we believe that freeing Finland from the coronavirus would make the country healthier, safer, and economically stronger.

SUMMARY

Various restrictions introduced by the government and people's voluntary contact avoidance have allowed Finland to reduce the number of new COVID-19 cases dramatically in recent weeks. Finland must now carefully consider what strategy to pursue from now on. It is important not to waste the opportunity to eliminate the epidemic that the measures that have already been taken now offer. We encourage the Finnish government to take decisive steps to eliminate the epidemic from Finland. Elimination is a realistic and better alternative than the current less ambitious aim to only slow down the spreading of the virus.

Eliminating the epidemic means taking steps to reduce the number of new cases to zero or close to zero, combined with carefully chosen measures to subsequently maintain the new status quo. When the number of new cases has been reduced to a very low level, tracing new infections becomes easier. Once the epidemic has been eliminated nationally, it is possible to avoid its reintroduction by testing and/or quarantining persons arriving from abroad. This allows preventing new epidemic waves with moderate economic and human costs.

Several countries have successfully eliminated the epidemic, including New Zealand, Australia, Taiwan, Austria, Estonia, Iceland, Norway, Greece, Hong Kong, and also China, where the epidemic started. Finland should carefully analyze the measures that these countries have implemented and adopted those measures that suit Finnish circumstances and values the best. The government's hybrid strategy includes many of these elements already. Reducing the number of new infections close to zero is a central goal, which should not be risked by abandoning current restrictions too fast. Once the number of new cases has been reduced to zero or close to zero, it is possible to recalibrate the measures and abandon or loosen most restrictions, returning close to normality.

COVID-19 is a life-threatening disease to a considerable part of those infected, and there is still uncertainty about long-term or permanent damage that it may cause among those who survive. The epidemic has forced us to reconsider how to best reconcile the rights and interests of the individual and those of the society in an ethically sustainable way. The measures that are chosen to combat the epidemic must respect life and human rights. From the perspective of medical ethics and fundamental rights, the actions must aim to prevent deaths and people from falling ill.

If the aim is only to slow down the spread of the epidemic ("flattening the curve"), instead of decisive elimination, the situation in which heavy restriction would need to be reintroduced repeatedly could continue for years. This would perpetuate uncertainty and depress economic activities. This would result in a wave of bankruptcies and widespread unemployment and destabilization the banking sector. Also, the human cost of these economic consequences would be heavy.

When the coronavirus epidemic has been successfully eliminated and tracing potential new chains of transmission has become a routine, it is possible to return to close to normal life, with proper precautions. People will again dare to use services normally, the burden on the healthcare system is reduced, and trust in the economy returns. Those who are most vulnerable are also protected by the risk of infection being negligible in daily interactions. For Finland, it is important to belong to the group of the countries that have eliminated the virus and thus allow free travel between each other. This is important not only for citizens but also for businesses and attracting investments.

Eliminating SARS-CoV-2 is a realistic strategy that would take Finland out of the ongoing deep social and economic crisis. A country that has eliminated the epidemic is freer and richer than a country in which the epidemic continues on a slow burn, paralyzing the society and the economy. Finland has succeeded in reducing the number of infections with restrictions that are relatively moderate in international comparison, but the longer they are continued, the more expensive they become. In order to return to a state of normalcy as soon as possible, we suggest that Finland adopts the strategy of eliminating the epidemic and freeing the country from the coronavirus.

THE CURRENT STATUS AND THE GOAL OF ELIMINATION

Our vision for the near future is coronavirus-free Finland, where the risk of infections and measures to control the epidemic cause only minimal disturbance to daily life and economic activity. This can be achieved by eliminating the virus from the country nearly completely. In the following sections, we discuss the substantial benefits of this approach in terms of public health, economy, basic rights, and Finland's position in the international community. We also outline specific measures needed to eliminate the virus.

The concrete goals of elimination of coronavirus from Finland are 1) zero or nearly zero new infections, measured as absolute numbers and relative to the number of tests, 2) tracing practically all new cases to known chains of transmission that allows their containment and treatment. Thus, we do not propose a global eradication of the virus, nor rely on being able to fully eliminate it from Finland to the point of never observing another case. These would not be feasible goals in the middle of a pandemic. We refer to our strategy as *elimination* rather than *suppression* - a term often used for a carefully controlled epidemic - to highlight the importance of near-zero levels of new infections.

The coronavirus epidemic has been relatively mild in Finland, as early and widespread adoption of restrictions by the government and the people prevented a massive surge of the epidemic in spring 2020. By May 24, 307 people have died of COVID-19 in Finland out of a total population of 5.5 million, and 6,579 have tested positive. The peak of the epidemic was in early April, and the number of new infections and hospitalizations has decreased since then. Currently, the epidemic is largely over in most of the country: outside the region surrounding Helsinki, the capital, only a few cases are detected daily, and only 13 people are hospitalized for COVID-19 on May 24. In the capital region, the situation has also improved quickly, but dozens of new cases are still detected every day. In addition to regional differences, local differences within Helsinki have been substantial.

The daily SARS-CoV-2 testing in Finland is currently at the level of around 3000 per day or 0.5 per thousand people, which is similar to many countries that have eliminated the virus. However, for example, Denmark, Australia, and New Zealand test as much as two to five times more per capita than Finland. After an initial phase of testing only severe cases, tests are now available for everyone with even mild symptoms, and additional capacity exists for further expanding testing. The rate of positive results is now about 1%.

The antibody studies done by the public health officials show that only less than one percent of the Finnish population had been infected by mid-May[1]. These results are consistent with those from other European countries and cities (e.g.[2] [3] [4]). This indicates a major break from early assumptions that many modeling and simulation studies relied on: the number of detected cases does not appear to be dozens of times lower than the true number of infections, the epidemic has not become extremely widespread, and immunity in the population is very rare. This implies that the severity and mortality of the disease were widely underestimated during the early days of the pandemic. On the other hand, the slower and more restricted transmission indicates that elimination of the epidemic is not as difficult as it may have seemed.

At the core of the elimination, the strategy is a decisive reduction of new infections. The key metric for the growth or reduction of the epidemic is the effective reproductive number Reff. Keeping this number below one must be an absolute goal: when each infected person transmits the virus to less than one other person on average, the epidemic will diminish - the faster, the more Reff is below one. However, the reproductive number is a challenging metric to use in practice since it is an average over a group of people and difficult to estimate, especially in the presence of substantial local variation and low numbers of infected individuals. Thus, we do not believe that setting a specific goal for Reff is crucial, as long as the COVID-19 epidemic is clearly diminishing, and other goals and metrics are clearly defined[5]. A key to this is a situational picture created via surveillance and modeling. Accounting for local variation is essential, in addition to awareness of national and international trends.

1 THL, Weekly report of THL serological population study of the coronavirus epidemic. 2020-05-20. https://www.thl.fi/roko/cov-vaestoserologia/sero_report_weekly_en.html

2 Erikstrup, C. et al. (2020) Estimation of SARS-CoV-2 infection fatality rate by real-time antibody screening of blood donors. medRxiv 2020.04.24.20075291; DOI: https://doi.org/10.1101/2020.04.24.20075291

3 Stringhini, S. et al. (2020) Repeated seroprevalence of anti-SARS-CoV-2 IgG antibodies in a population-based sample from Geneva, Switzerland. medRxiv 2020.05.02.20088898; DOI: https://doi.org/10.1101/2020.05.02.20088898

4 https://www.fhi.no/nyheter/2020/antistoffundersokelse-koronavirus/

5 THL: Koronavirusepidemiaa seurataan monipuolisten mittareiden avulla (13.5.2020)

We believe that new coronavirus infections in Finland can be reduced to zero within a month. Despite the rapid decline in May, we are not there yet: the number of new infections should be reduced from several dozens per day to at most a few while maintaining at least the current level of testing. The 1% of positive test cases in Finland are still higher than the <0.5% level e.g., in Australia, New Zealand, and Taiwan.

In order to eliminate the virus from Finland, it is essential that clear goals are set and widely understood and adopted by the people as well as officials and organizations. Open, accurate, and timely communication of the local situation is an important way to get people to act responsibly and approve restrictions that may be needed. During spring 2020, the diligent adoption of instructions has been the key to getting the epidemic under control in Finland. Concrete goals and information about the progress towards them is essential for motivating people to eliminate coronavirus in the entire country.

THE CASE FOR ELIMINATION: MEDICINE

The novel coronavirus SARS-CoV-2 is previously unknown to humankind and has quickly become a major threat to public health. Even though the COVID-19 disease caused by the virus can be mild, many infected individuals develop a serious condition that requires hospitalization and even intensive care. Mortality is high, especially among the elderly, but fatalities have occurred among the working-age population as well. In children, the disease is often mild, although there are reports of rare but serious sequelae among young children[6].

The Characteristics of SARS-CoV-2 Infections

The mechanisms and dynamics of SARS-CoV-2 transmission are still elusive. It is increasingly clear that it does not follow the dynamics of flu epidemics, which have been used as a baseline assumption of many models and strategies during the early stages of this pandemic. A particular challenge for controlling SARS-CoV-2 is its ability to spread from infected individuals before they develop symptoms, and even from fully asymptomatic individuals who may be unaware of their infection. Another peculiar characteristic feature of this epidemic are the so-called superspreader events where one infected person can infect a large number of others[7]. Despite these challenges, classical methods for controlling epidemics, known for hundreds of years - isolation of cases and quarantine of people entering the community - have worked better than initially expected.

Without restrictions, SARS-CoV-2 would spread uncontrollably in the population due to the initial lack of immunity against this novel virus, although recent studies have suggested that immunity against other coronaviruses might offer partial protection[8]. The strength and duration of the immunity against SARS-CoV-2 following infection are still not fully known[9]. Antibody studies have shown that a relatively small proportion of the population has been infected despite the major toll that the epidemic has had on public health in many countries. In Finland, similarly to other countries with a relatively mild epidemic, the seropositivity rates have been generally below 1% [10], and those in hard-hit countries have been from 5 to 10 %, as discussed above. Recent studies show that the infection fatality rate - the proportion of infected who succumb to the disease - is around 0.7%, nearly ten-fold compared to the flu[11].

Due to the severity of the disease, Finland, as well as most other countries, have abandoned the potential strategy of achieving natural herd immunity by letting the virus spread through the population. The rapid spread of the epidemic would quickly overwhelm the healthcare system, and the already high mortality would further increase. Slowing down the spread of the virus - “flattening the curve” - was initially proposed as a reasonable alternative to the laissez-faire approach. Ideally, this would keep COVID-19 within the capacity of the health care system and thus avoid additional mortality driven by a lack of care and resources. This strategy, however, also relies on the paradigm of herd immunity, where the immunity among a large proportion of the people recovering from the disease would eventually protect the risk groups and halt the epidemic. In the case of SARS-CoV-2, herd immunity would be achieved after about 60% of the population is immune, assuming the basic reproductive number R0 equals 2.5. In Finland, this would imply a slow trickle of the epidemic over many months, if not years, and loss of as many as 33,000 lives. Thus, aiming for even a partial herd immunity by allowing the virus to

6 Toubiana, J. et al. 2020 Outbreak of Kawasaki disease in children during COVID-19 pandemic: a prospective observational study in Paris, France. medRxiv 2020.05.10.20097394; DOI: https://doi.org/10.1101/2020.05.10.20097394

7 Science, Why do some COVID-19 patients infect many others, whereas most don’t spread the virus at all?. 2020-05-19. https://www.sciencemag.org/news/2020/05/why-do-some-covid-19-patients-infect-many-others-whereas-most-don-t-spread-virus-all

8 Grifoni, A. et al. (2020) Targets of T cell responses to SARS-CoV-2 coronavirus in humans with COVID-19 disease and unexposed individuals. Science DOI: 10.1016/j.cell.2020.05.015

9 Grifoni, A. et al. (2020) Targets of T cell responses to SARS-CoV-2 coronavirus in humans with COVID-19 disease and unexposed individuals. Science DOI: 10.1016/j.cell.2020.05.015

10 THL, Weekly report of THL serological population study of the coronavirus epidemic. 2020-05-20. https://www.thl.fi/roko/cov-vaestoserologia/sero_report_weekly_en.html

11 Meyerowitz-Katz, G. & Merone, L. (2020) A systematic review and meta-analysis of published research data on COVID-19 infection-fatality rates. medRxiv 2020.05.03.20089854; DOI: https://doi.org/10.1101/2020.05.03.20089854

spread would be an unethical approach leading to intolerable human suffering and public health impact.[12]

Even a low level of SARS-CoV-2 infections among the population - far below herd immunity levels - puts lives and public health at risk. This is best avoided by eliminating the virus from the society. Given the uncertainties of the future dynamics of the epidemic, we consider this as the most ethical approach and the one with the lowest risk for public health.

The Finnish Health Care System During the Pandemic

COVID-19 is a severe disease for a substantial proportion of the infected, including people outside the risk groups of the elderly and people with certain chronic conditions[13]. Of the Finnish COVID-19 patients in intensive care, half have been below 60 years of age, and less than 40% have not had any chronic illnesses[14]. The serious and fatal cases have included relatively young and healthy adults, and loss of life for COVID-19 has been estimated to amount an average of 11 to 14 years of life[15]. In the severely affected New York City, 0.26% of the entire population has died of COVID-19, and 26% of the fatalities are under 65 years old[16]. In Sweden, the disease has been fatal to 0.04% of the entire population, including 192 people under 60, and thus far, 11 people under 18 years old have been treated in the ICU with one fatality[17]. A French estimate sets the hospitalization rate at 3.6% and the infection fatality rate at 0.7%[18]. Long-term health consequences are still unknown, but it is already known that recovery from COVID-19 can be slow, and we have learned from previous pandemics that viral infections may lead to chronic organ failures[19] [20].

Approximately one million Finns - 20% of the whole population - are at risk of developing a severe disease due to COVID-19. This includes elderly people and other people with certain predisposing health conditions. Partial isolation of people in risk groups has been advised for their own protection as long as there are active infections among the population. Should the epidemic persist, isolation would have an unbearable effect on the quality of life and physical and mental health of these people. A large part of the deceased has been in nursing homes, and their safe isolation has proven to be nearly impossible during the epidemic. There is also a high risk of hospital-acquired infections during a widespread epidemic. Patients with COVID-19 may not be appropriately isolated from others in hospital settings because of a high rate of false negatives in diagnostic tests. Altogether, we conclude that the only effective - and humane - way to protect these risk groups is to eliminate the virus from society.

A top priority of the Finnish coronavirus strategy has been to limit the burden on the healthcare system. While this aim has been achieved and all patients have received high-quality care, it would not have been possible without staff reassignments and postponing non-urgent care. Intensive care has been a critical resource during this epidemic, and the number of intensive care unit (ICU) beds had to be increased substantially to cope with the increased demand during spring 2020. Thus far, 273 COVID-19 patients have received ICU treatment across the country.[21] A large number of seriously ill COVID-19 patients have been saved by intensive care, but the treatment has often lasted for several weeks, and many of the patients are still in ICU.

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12 Bergstrom, C. T. & Dean, N. E. (2020). Opinion | What Coronavirus Herd Immunity Really Means. New York Times May 1, 2020.

13 Docherty, A.B. et al. (2020) Features of 20133 UK patients in hospital with covid-19 using the ISARIC WHO Clinical Characterisation Protocol: prospective observational cohort study. BMJ, 369, 1-12.

14 Tehohoidon tilannekuva: COVID-19 teho-osastoilla, viikkoraportti 20.5.2020

15 Hanlon, P. et al. (2020) COVID-19 – exploring the implications of long-term condition type and extent of multimorbidity on years of life lost: a modelling study; DOI: https://doi.org/10.12688/wellcomeopenres.15849.1

16 https://www1.nyc.gov/assets/doh/downloads/pdf/imm/covid-19-deaths-confirmed-probable-daily-05132020.pd

17 https://www.arcgis.com/sharing/rest/content/items/b5e7488e117749c19881cce45db13f7e/data

18 Salje, H. et al. (2020) Estimating the burden of SARS-CoV-2 in France. Science DOI: 10.1126/science.abc3517

19 Mineo, G. et al. (2012) Post-ARDS pulmonary fibrosis in patients with H1N1 pneumonia: role of follow-up CT. La radiologia medica, 117(2), 185-200; DOI: 10.1007/s11547-011-0740-3.

20 Hovi, T. et al. (1986) Outbreak of paralytic poliomyelitis in Finland: widespread circulation of antigenically altered poliovirus type 3 in a vaccinated population, The Lancet, 327(8495), 1427-1432; DOI: https://doi.org/10.1016/S0140-6736(86)91566-7

21 Tehohoidon tilannekuva: COVID-19 teho-osastoilla, viikkoraportti 20.5.2020

Knowing the increased demand for ICU capacity during the first months of the epidemic when only less than 1% of the population got infected, the reemergence of the epidemic could overwhelm the capacity of ICUs and other wards providing respiratory support. As long as the epidemic is ongoing, even a small change in its dynamics could lead to a shortage of resources, especially in more remote areas of the country where the ICU capacity is already limited. Thus, a minimal level of active infections reduces the risk of a rapid outbreak of the epidemic and also facilitates risk management of the health care system.

Even though successful control of the epidemic has reduced the number of patients in intensive care since April 2020, ongoing special arrangements and additional resources are still needed in Helsinki, the national epicenter of Finland, to maintain a sufficient capacity for COVID-19 patients. These resources are largely taken from normal functions of the healthcare system. Furthermore, people continue to avoid hospitals and clinics due to fear of contagion. This leads to constantly accumulating delays in the treatment of non-COVID-19 related diseases, with a substantial public health impact and a risk of excess mortality and morbidity. Catching up on the already existing delays in the treatment of other illnesses and elective surgeries will not be feasible as long as COVID-19 patients take up healthcare resources and staff. Furthermore, the special arrangements for healthcare staff to ensure their availability are not sustainable in the setting of a prolonged epidemic.

Thus, one of the key metrics of sufficient elimination of the epidemic should be the return of elective procedures and other non-COVID-19 related care back to normal levels. Achieving this necessitates securing not only the capacity of healthcare services but also customers' and patients' trust in their safety in clinics and hospitals.

The Future Promise of Treatments and Vaccines

Targeted treatment for COVID-19 disease is still lacking, and so far, the treatment is aimed at mitigating symptoms, sustaining life, and preventing complications as well as co-infections. However, drug discovery and repurposing studies have already shown promise, and a large number of studies are ongoing. There is hope that drugs may soon be available to shorten the course of the disease and/or prevent its most severe forms[22] [23] [24] [25].

Vaccination is believed to be the ultimate exit from the corona crisis. Given the promising early reports[26] [27], we consider it likely that within a couple of years, a vaccine will be widely available to at least mitigate the risk for the disease or its severe outcomes. While the immune response to SARS-CoV-2 appears robust and widespread[28], for coronaviruses, it is often milder and not as long-lasting as for many other viruses[29]. Thus, vaccination or the infection on itself is not guaranteed to provide full and permanent immunity. Multiple candidates for the vaccine are being tested, including in clinical trials[30], and more information about the prospects and timeline of vaccine availability can be expected relatively soon.

22 Wichmann, D. et al. (2020) Autopsy Findings and Venous Thromboembolism in Patients With COVID-19. Annals of Internal Medicine, DOI: https://doi.org/10.7326/M20-2003.

23 Duan, K. et al. (2020) Effectiveness of convalescent plasma therapy in severe COVID-19 patients. Proceedings of the National Academy of Sciences, 117 (17), 9490-9496; DOI:10.1073/pnas.2004168117

24 Hung, I. et al. (2020) Triple combination of interferon beta-1b, lopinavir–ritonavir, and ribavirin in the treatment of patients admitted to hospital with COVID-19: an open-label, randomised, phase 2 trial. The Lancet; DOI:https://doi.org/10.1016/S0140-6736(20)31042-4

25 NIH Clinical Trial Shows Remdesivir Accelerates Recovery from Advanced COVID-19. https://www.niaid.nih.gov/news-events/nih-clinical-trial-shows-remdesivir-accelerates-recovery-advanced-covid-19

26 Zhu, F. et al. (2020) Safety, tolerability, and immunogenicity of a recombinant adenovirus type-5 vectored COVID-19 vaccine: a dose-escalation, open-label, non-randomised, first-in-human trial. Science DOI: 10.1016/S0140-6736(20)31208-3

27 Chandrashekar, A et al.(2020) SARS-CoV-2 infection protects against rechallenge in rhesus macaques.Science DOI: 10.1126/science.abc4776

28 Grifoni, A. et al. (2020) Targets of T cell responses to SARS-CoV-2 coronavirus in humans with COVID-19 disease and unexposed individuals. Science DOI: 10.1016/j.cell.2020.05.015

29 Huang, A.T. et al. (2020) A systematic review of antibody mediated immunity to coronaviruses: antibody kinetics, correlates of protection, and association of antibody responses with severity of disease. medRxiv 2020.04.14.20065771; DOI: https://doi.org/10.1101/2020.04.14.20065771

30 clinicaltrials.gov

Until the vaccine is available, Finland will have to cope with other means. We should also be prepared for the worst: that even the disease does not lead to permanent immunity, and that the development of a safe and effective vaccine fails. In such a situation, the society would need to be able to manage the epidemic by other means. These include protective gear, changes in behavior, and treatments that improve the outcomes of the disease. Such measures have been effective before, for example, in the mitigation of the HIV epidemic that was particularly effective in Finland. This was achieved by widespread testing, identification of chains of transmission, and education of the public. All these approaches are key components of the elimination of SARS-CoV-2. Thus, the elimination approach will not only provide immediate relief but also prepare us for long-term management of this as well as future epidemics.

THE CASE FOR ELIMINATION: ECONOMY

The economic recession caused by the SARS-CoV-2 pandemic is the deepest since the Second World War. The International Monetary Fund (IMF) forecasts world GDP to shrink 3% in 2020. This is a substantially larger decline than that of one percent during the financial crisis in 2008-2009. The International Monetary Fund (IMF) predicts a 7.5% GDP decline in the euro area. The Finnish Institute of Economic Research forecasts that Finland's GDP declines by 8% in 2020, and an even steeper decline is possible. The decline in GDP goes together with increased unemployment and a substantial deterioration of public finances. Consequently, the future fiscal challenges related to population aging will be much harder to cope with.

The Fear of Getting Infected Paralyzes the Economy

The economy's response to the pandemic is caused by both the government's lockdown measures and people's voluntary contact avoidance. The fear of getting infected and the potential health issues caused by the disease reduce contacts. The fear and the lockdown stop economic activity in contact-intensive businesses. The amount of labor is reduced in businesses such as traffic, cultural and leisure services, hotels, and restaurants. In Finland, they cover 28% of total household consumption. The number of layoffs in the industries that produce these services is very high[31]. These industries also cover a substantial fraction of the number of employees in Finland. For example, the worst-hit industries - accommodation and food activities, wholesale and retail trade, and arts, entertainment and recreation - employed 541 000 workers, i.e., 29% of total non-government employment.

Sizable layoffs and redundancies in contact-intensive service sectors lead to a decline in household disposable income, in spite of unemployment benefits and transfers. Hence, the insurance is only partial, and the unemployed reduce their demand in the remaining sectors. Those who still have jobs also switch some demand from the affected sectors to the unaffected sectors. It is noteworthy that in this environment, a fiscal expansion will be less effective than normal since it does not affect the income generated in affected sectors. This provides the transmission channel, or cascading effect, from affected to non-affected sectors[32]. Based on the use of credit and debit card payments and the consumption weights of different goods, we estimate the direct effect has led to a decline of 25 percent of household consumption from the pre-pandemic levels.

Global Supply Chains are Disrupted, and Labor Productivity Suffers

Supply shocks include direct losses of labor inputs due to workers becoming sick or being quarantined, as well as disruption of global supply chains. Also, labor productivity may decrease. Working hours at home are not necessarily as productive as in normal circumstances. Furthermore, the closing of schools and daycare causes a negative labor supply shock as some parents have to stay at home to take care of their children, or at least reduce their hours of work. This is an additional channel through which the pandemic also hits sectors of the economy which could otherwise continue operating in full. The burden of increased parental childcare needs hits disproportionately women. At the same time, if schools and daycare remained open while the epidemic rages, the economic consequences could be considerably worse due to increased sick leaves and associated direct losses of those infected.

The volume of world trade is set to decline dramatically. This will cause an especially severe negative impact on small open economies like Finland. The US unemployment rate sky-rocketed from 3.5 percent in February to 14.7 percent in April, and it is expected to rise further in May. Increases in unemployment figures are currently more modest in the euro area than in the US. However, the pre-pandemic level of unemployment was much higher in the euro area than in the US, and the eurozone unemployment rate

31 See the report by Helsinki GSE Situation Room on April 24, 2020: https://www.helsinkigse.fi/corona/incidence-of-unemployment-caused-by-the-coronavirus-crisis/

32 Guerrieri,V., Lorenzoni, G., Straub, L. & Werning, I. (2020) Macroeconomic implications of COVID-19: Can negative supply shocks cause demand shortages?, NBER Working paper No. 26918, DOI:10.3386/w26918, https://www.nber.org/papers/w26918.

was 7.4 percent already in March. The pandemic already depressed European economies in the first quarter of the year: GDP in the eurozone declined 3.8% from the previous quarter. It is expected to decline considerably more in the second quarter.

Economy Cannot Recover as Long as the Epidemic Rages

Merely lifting off the lockdown measures will likely not substantially stimulate employment or the broader economy. Economic research on pandemics has largely established that people reduce their social interactions and economic activity independent of the lockdown[33]. Farboodi, Jarosch, and Shimer[34] use point-of-interest data to document a substantial reduction in economic activity already before the official lockdown was implemented (see the figure in their paper). As long as people face a serious health threat, they will voluntarily reduce any activities with the risk of infection. Lifting off the lockdown and other restrictions by itself will not stimulate the economy.

Economic activity and consumer demand have drastically dropped also in Sweden despite Sweden not implementing similar official lockdown measures as in Finland. Swedish credit and debit card purchases have been reduced to a similar extent as in Finland[35]. According to Nordea[36], credit and debit card purchases have been reduced more in the Uusimaa region than elsewhere in Finland, even though the lockdown measures have been identical across the whole country. Similarly, layoffs, as well as temporary furloughs, have evolved at a similar pace both in Finland and Sweden[37].

The growth in Swedish coronavirus cases has leveled off during the last few weeks. Part of this slowing down may result from increased social distancing with an associated decrease in economic activity. Therefore, a reduction in the growth rate of new cases does not necessarily imply the emergence of herd immunity nor that the epidemic is getting to its end.

The COVID-19 has also significantly increased future uncertainty: a number of important uncertainty indicators have exceeded even the peak levels observed during the financial crisis. Firms postpone recruitments and investments as they fear for new corona clusters and corresponding repeated lockdowns. Reduced investment slows down economic growth. The corona pandemic may be especially harmful to new and growing businesses[38]. The extended economic slowdown may lead to long-term unemployment if otherwise, promising businesses go bankrupt.

A fast economic recovery seems unlikely, even if the official lockdown measures were to be removed. In their baseline scenario, Vihriälä et al. (2020) forecast a 9 percent reduction in GDP in 2020. The expected growth path of the economy will drop permanently below the levels previously expected so that the pre-crisis growth path will not be attained. The crisis is prolonged, threatening permanent labor market disruptions and increased long-term and structural unemployment[39].

A prolonged crisis will necessarily lead to bankruptcies. The risk of credit defaults increases not only for banks but also more broadly in the supply chain. This may lead to harmful multiplier effects, where otherwise healthy businesses may lose their solvency. Banks are special in that their ability to provide loans

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33 Greenwood, J. et al. (2019) An Equilibrium Model of the African HIV/AIDS Epidemic. Econometrica, 87(4), 1081-1113.; Eichenbaum, M.S., Rebelo, S., Trabandt, M. (2020) The Macroeconomics of Epidemics, NBER Working paper No. 26882, DOI:10.3386/w26882, https://www.nber.org/papers/w26882.; Krueger, D., Uhlig, H., Xie, T. (2020) Macroeconomic Dynamics and Reallocation in an Epidemic,. NBER Working paper No. 27047, DOI:10.3386/w27047, https://www.nber.org/papers/w27047.

34 Farboodi, M., Jarosch, G. & Shimer, R. (2020) Internal and External Effects of Social Distancing in a Pandemic, NBER Working paper No. 27059, DOI:10.3386/w27059, https://www.nber.org/papers/w27059

35 Finnish data: Nordea (https://e-markets.nordea.com/api/research/attachment/111801) and Swedish data: Swedbank (https://research.swedbank.se/default.aspx?cdguid=7F6A7041-000D-4F65-9C89-FB3BC3DBC33D)

36 https://e-markets.nordea.com/api/research/attachment/111801

37 Situation in Finland: https://www.helsinkigse.fi/corona/koronakriisin-aiheuttaman-tyottomyyden-kohdistuminen/ Situation in Sweden: https://e-markets.nordea.com/#!/article/57281/sweden-macro-flash-swiftly-increasing-layoffs

38 Barrero, J.M., Bloom, N. & Davis, S. (2020) COVID-19 Is Also a Reallocation Shock, NBER Working paper No. 27137, DOI: 10.3386/w27137, https://www.nber.org/papers/w27137.

39 Shimer, R. (2012) Wage Rigidities and jobless recoveries. Journal of Monetary Economics, 59, 65-77; DOI: 10.1016/j.jmoneco.2012.10.024

is reduced when bankruptcies eat their capital. The credit spreads increase, further reducing business loan originations and investments. This negatively affects economic growth. In the worst-case scenario, supporting non-financial firms may not suffice, but also the banking sector may be in need of a bailout, in order to prevent a total economic meltdown, asset, and housing market crash. Nordea and Danske being international institutions may further complicate the problems in Finland, as their solvency is determined not only by their Finnish operations. Large credit losses abroad will negatively affect their ability to provide loans also in Finland.

Only Eliminating the Epidemic Would Heal the Economy

Fiscal policy may soften the demand shocks by providing unemployment benefits and other transfers, by cutting taxes and employer social contributions as well as by increasing public investments. Due to the specific transmission mechanism at play, fiscal stimulus will, however, have reduced power compared to usual recessions[40]. An important role is played by monetary policy. ECB interest rates have, however, been negative long before the crisis. Therefore, the room for monetary easing is much lower compared, for instance, to the financial crisis of 2008-2009[41]. Economic policy can only partially help to offset the negative effects of the pandemic on GDP. It cannot reverse the virus-induced loss in hours worked, or the reduction in demand due to loss of economic confidence.

As long as economic agents cannot trust social interactions to be disease-free, the economy remains depressed. If the epidemic is not eliminated, normalization of consumption habits and the economy, in general, can occur only via widespread vaccination. In the event that this takes years to happen, the economic consequence will be extremely severe.

The elimination strategy offers an alternative, where the economic challenges can be controlled. When the threat of infection surpasses, hours worked, and GDP begins to increase. Consumption demand increases as household disposable income recovers. To sum up, economic activity cannot recover in full before the virus is beaten. Eliminating the virus, therefore, provides the best approach for sustained economic recovery.

40 Guerrieri, V. et al. (2020) Macroeconomic Implications of COVID-19: Can Negative Supply Shocks Cause Demand Shortages?, NBER Working paper No. 26918, DOI: 10.3386/w26918, https://www.nber.org/papers/w26918

41 Berger, D. et al. (2020) Mortgage Prepayment and Path-Dependent Effects of Monetary Policy, NBER Working paper No. 25157, DOI: 10.3386/w25157, https://www.nber.org/papers/w25157

THE CASE FOR ELIMINATION: GLOBALIZATION

The emergence and transmission of new viruses have been part of the globalization process for centuries and longer. Recent rapid economic and population growth has pushed humans toward new regions and intensified contacts with other species. Consequently, the earth has become a "pool of pathogens" where bacteria and viruses evolve and spread fast from one population to another, the quickest via aviation.[42] This paves the way for pandemics, and the occurrence of a new pandemic was just a question of time. The preparedness of the global community has turned out to be rather poor, reinforcing the quest for more effective governance in this area.[43]

While the pandemic may have resulted from processes closely associated with globalisation, it has hit the economic aspects of globalisation hard. True, the novel coronavirus (SARS-CoV-2) pandemic has not halted world trade as such. Most world trade continues or may even be invigorated in some special areas. However, the deep global recession or depression will reduce this trade significantly.[44] Overall, the impact of the pandemic and the related economic crisis will be dramatic. Although this does not mean that globalization is cancelled or that a new era of deglobalization has begun, the pandemic and its consequences will reshape many aspects of economic globalization and how it is regulated and governed.

The impact of the pandemic on human mobility and aviation has been especially steep, as national borders have largely been closed for passenger transport. As transport begins to pick up, states will evaluate the safety of different connections. Countries that have chosen the strategy of elimination or effective suppression have started to open their borders to passengers from countries showing similarly low levels of epidemic presence. Passenger traffic between the Baltic countries is about to open up, Australia is opening routes to New Zealand, and we see similar preliminary plans in Norway and Greece, among others.

It is apparent that these epidemic-free areas will be enlarged gradually, in Europe, probably in the Schengen area in particular. It is likely that various connections will be explored at first, but in the occasion the coronavirus infections begin to increase again in some countries, these connections are likely to be shut down quickly.[45] It is, therefore, essential for Finland to become included among the virus-free countries for freer traffic, the soonest as possible. Indeed, one of the key attractions of the elimination strategy lies in its promise of early access back to global travel, even as it seems clear that no simple return to the previous era exists.

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42 Camilleri, J.A. ja Falk, J. (2009) *Worlds in Transition. Evolving Governance across a Stressed Planet*. Cheltenham: Edward Elgar, ch 9, esp. p.380.

43 See ibid.; and for the historical emergence of global health security in relation to this problematic, see Lakoff, A. (2015) "Global Health Security and the Pathogenic Imaginary". In S.Jasanoff & S-H.Kim (ed.) *Dreamscapes of Modernity: Sociotechnical Imaginaries and the Fabrication of Power*. Chicago: Chicago University Press, pp.300-20.

44 According to current uncertain forecasts, world trade is expected to fall by 13-32 percent in 2020. WTO (2020) "Trade Set to Plunge as COVID-19 Pandemic Upends Global Economy". WTO Press Release 855, https://www.wto.org/english/news_e/pres20_e/pr855_e.htm.

45 As a result of the crisis, air transport will undergo fundamental changes. Flights will become more expensive and their number will be reduced, and various restrictions, tests, and forms of social isolation will remain in place for a long time. It is possible and probable that at least some of the airlines will be nationalized and traffic on many routes will be organized by states. In addition, opening up will occur primarily between virus-free countries. For example, Justin Wastnage anticipates in his scenarios that travel will be possible mainly for people from non-corona countries. As air travel begins to recover, it will take place between areas that have been virus-free for, say, 40 days. Wastnage, J. (2020) "What Will The Airline Industry Look Like Post Covid-19? Why the Era of Cheap Flights May Be Over". Analysis, the US Studies Centre at the University of Sydney, https://www.ussc.edu.au/analysis/what-will-the-airline-industry-look-like-post-covid-19-why-the-era-of-cheap-flights-may-be-over.

THE CASE FOR ELIMINATION: THE LEGAL PERSPECTIVE

The Constitution of Finland (731/1999) guarantees the freedom and rights of the individual and promotes justice in society. The actions required to address the COVID-19 epidemic involve a number of legal considerations of a fundamental nature, as well as certain legal issues that must be tackled[46].

On March 16, 2020, the Government, in cooperation with the President of the Republic, declared a state of emergency in Finland over the COVID-19 epidemic. In the weeks and months following that declaration, the epidemic has been taken well care of with the help of restrictions imposed pursuant to the Emergency Powers Act (1555/2011). Now, in determining where to go from here, Finland stands at a watershed. The realistic strategy options for addressing the epidemic are mitigation and elimination. Choosing the appropriate strategy calls for an examination and balancing of interests from many perspectives, the perspective of law included.

The powers under the Emergency Powers Act are to be exercised on the premise that effective exercise of those powers can quickly restore normal conditions. Hence, the measures imposed under the Act must be of limited duration. The Act moreover requires the restrictive measures to be absolutely necessary and proportionate to repel the threat that gives rise to the state of the emergency question[47].

Finland has adopted a strict interpretation of the requirement of absolute necessity when it comes to fundamental rights restrictions in emergency conditions. Even when the threat in hand is a "widespread infectious disease, comparable to a particularly serious major accident," the Emergency Powers Act provides only a fairly limited scope for restrictive measures.

In our opinion, the current approach that relies on the Emergency Powers Act is not sufficient for successfully controlling the COVID-19 epidemic. Fundamental rights cannot be effectively safeguarded as long as the virus remains out of control. The Emergency Powers Act falls short of the objective because it allows only strictly prescribed derogations from fundamental rights (highly limited in substance and of only short duration).

Finland should take under consideration also the implementation of clearly delineated and temporary restrictions of fundamental rights under section 23 of the Constitution, along the lines of the restaurant closures already put in place, or the more effective use of regional measures under the Infectious Diseases Act (1227/2016) in accordance with national guidance. Based on information already available from other parts of the world, these would allow Finland, too, to eliminate the COVID-19 epidemic. Section 23 of the Constitution allows the imposition of "such provisional exceptions to basic rights and liberties that are compatible with Finland's international human rights obligations and that are deemed necessary in the case of an armed attack against Finland or *in the event of other situations of emergency, as provided by an Act, which poses a serious threat to the nation*."

A strategy of COVID-19 mitigation would put us in a situation that is untenable both legally and, more compellingly, in terms of fundamental rights. The most basic rights of the people would be put on indefinite hold. A choice to proceed in this direction would pose a genuine threat to the prohibition of retrogressive measures, for example. Allowing the epidemic to go on as at present might sap our nation of the economic and social capacity to perform its constitutional functions in the area of public benefits to promote welfare and wellbeing[48]. The fundamental rights of the least advantaged in society stand at the frontlines of risk. Key economic, social, and cultural rights are all under threat. In the longer term, liberties besides the freedom of movement are also set to become constricted. Such developments would be unacceptable in terms of fundamental and human rights. They would end up eroding the very foundation of our system of justice and, ultimately, also the legitimacy of our political and administrative system.

Based on the above, it is justified to observe that the constitutional obligation on the state progressively to promote fundamental rights also demands rapid elimination of the epidemic caused by the SARS-CoV-2 virus. Every month and year that the epidemic goes on is highly detrimental to the realisation of our most fundamental rights. Mitigation alone will keep society in a state of standstill for far too long. Consequently,

46 Pellonpää, M., Gullans, M., Pölönen, P., Tapanila, A. (2018) Euroopan ihmisoikeussopimus. 6., uudistettu p. Helsinki: Alma Talent.

47 Aine, A. (2011) Moderni kriisilainsäädäntö. Helsinki: WSOYpro.

48 Hallberg, P. ym. (2011) Perusoikeudet. 2. uud. p. Helsinki: WSOYpro.

legislation must be enacted – within a framework respectful of human rights – to enable the efficient and rapid elimination of the COVID-19 epidemic. This approach must cater for the necessary testing, tracing, isolation, and treatment both during and after the immediate elimination campaign. Society must be able to re-open, and the confidence of the people in normal civil society must be restored as quickly and as convincingly as possible. These objectives are beyond the reach of a strategy of mitigation.

The reasons enumerated above dictate that all available measures under the law must be put into place to rein in the COVID-19 epidemic. Such measures include but are not limited to the more effective use of the tools available to Regional State Administrative Agencies and the individual municipalities (like was done during the swine flu pandemic of 2009)[49]; effective (fixed-term) restrictive measures in areas hardest hit by the epidemic (clusters); the extensive use of face coverings to inhibit the spread of the virus; social distancing in public places and shared spaces; and so on. Finland already has numerous municipalities and entire regions that have successfully brought down the epidemic or kept it out altogether. In these areas, elimination measures have already worked. We must build on the good situation in these areas and accomplish the same throughout Finland. This is what the people of Finland have the right to expect, and what government in Finland has the duty to implement.

From the perspective of law, the epidemic caused by the SARS-CoV-2 virus can be eliminated using tools that are consistent with the rule of law[50]. Excellent examples of this can already be found in many countries, which share Finland's principles of democracy and the rule of law, such as South Korea, New Zealand, Austria, Greece, and Iceland. Why should we not join the ranks of these nations?

49 Lehtonen, L., Lohiniva-Kerkelä, M., Pahlman, I. (2015) Terveysoikeus. Helsinki: Talentum Pro.

50 Hallberg, P. (2019) Oikeusvaltio maailman tuulissa. Helsinki: Docendo.

METHODS FOR ELIMINATION

There are two stages in the elimination of an epidemic: 1) reducing the number of new infections decisively and rapidly to close to zero, and 2) maintaining the level of new infections very low so that practically all chains of transmission are known while the society is minimally disturbed.

It is important to note that elimination of the epidemic does not imply that once new infections have hit zero, all measures to control the epidemic can be lifted. However, these measures can be chosen carefully to have a minimal impact on people's lives and normal economic and societal activity.

On April 22, 2020, the Finnish government announced a so-called hybrid strategy for the coronavirus epidemic where the population-wide restrictions will be replaced by testing, tracing, isolation, and treatment. These methods and their extensions, applied with varying intensity for a clear goal, are, to a large extent, suitable also the reduction and maintenance phases of the elimination strategy. Thus, we do not propose a radically different toolkit than that proposed and partially already adopted by the government, but rather a more ambitious and clear execution.

The coronavirus epidemic has been successfully halted and held at bay as long as for several months in a number of countries, including New Zealand, Australia, Taiwan, Estonia, Norway, Hong Kong, Austria, Greece, Iceland, and China. In many of these countries, everyday life has returned to close to normal. These success stories provide irrefutable empirical evidence that elimination of the epidemic is possible, and this cannot be disproven by theoretical models.

As an example, Taiwan collected and implemented a list of 124 measures that includes border control for airports and harbors, new technologies for identification of cases, quarantine for potential cases, distribution of resources, education of the population, school, and daycare policies, and subsidies for companies. These measures were so effective that only six people have died out of 397 detected cases in a population of 23 million with close connections to China.[51]

The first step in the elimination of the coronavirus epidemic in Finland is the reduction of active infections to nearly zero so that practically every new case can be traced and isolated. The aforementioned benefits of the corona-free country are not achieved before this is the case, and we believe that this is possible in Finland within a few weeks. This necessitates keeping Reff well below one, as it has been in mid-May. Given the recent rapid decline in new infections, eliminating them entirely - which may have seemed unrealistic earlier - is now well within reach. Setting this as a specific goal would allow adjusting the measures accordingly.

Physical distancing and other limitations of contacts are an important approach in the elimination of the epidemic, but widespread testing and tracing will allow a targeted implementation instead of nationwide restrictions and recommendations. In large parts of the country, infections are already at a very low level, and there are areas where no cases have been observed during the entire epidemic. Widespread restrictions are necessary only until the case numbers are at the level where they can be fully traced, and the risk of contagion for an individual citizen is practically nonexistent. However, preparedness to return to population-level restrictions must be retained to allow rapid response to potential local outbreaks of the epidemic.[52]

In the long-term maintenance phase, new infections must be kept at a very low level. This requires rapid identification of new cases and tracing and isolation of practically every chain. However, perfect containment of every single new infection is not absolutely necessary: when the infection level is already very low, it is sufficient to keep the reproductive number below one to prevent a major outbreak of the epidemic. This can be achieved by cutting a sufficiently large number of chains of transmission.

It is important to note that keeping the level of new cases at or close to zero is easier than controlling them at a low but omnipresent level because high-quality tracing of the few individual cases is more feasible than

51 Wang, C. W., Ng, C.Y. & Brook, R.H. (2020) Response to COVID-19 in Taiwan Big Data Analytics, New Technology, and Proactive Testing. Jama, 323(14), 1341-1342.

52 The practical intervention measures of COVID-19 elimination (i.e., stopping the spread and crushing the curve) fall into three wide groups: (i) reduction of overall human-to-human contacts, (ii) reduction of potential for the virus to transmit via contacts, and (iii) reduction of the likelihood of healthy persons and infected carriers/patients physically contacting each other.

tracing an unknown number of infected individuals.. Finland will, in any case, need a high level of alertness and measures to prevent a second wave of the epidemic because the proportion of seropositive individuals with potential immunity in the population is extremely low.

There is no single measure that would free Finland from the coronavirus. A combination of complementary actions is needed, adopted to national circumstances ([53] [54] [55]). Efficient ways to control the coronavirus epidemic are being developed aggressively with a tremendous investment of resources worldwide. We hope that Finnish development and adoption of such measures leverage expertise across the academia as well as the private and non-profit sectors. Below, we briefly discuss the key measures.

Situational awareness

A necessity for all measures is an accurate situational picture that includes empirical data and modeling to support decision making.

Comprehensive and continuous testing, including asymptomatic individuals and e.g., sewage monitoring[56], enables surveillance of a virus that has been eliminated to levels where it becomes nearly invisible otherwise. Experiences in Singapore and South Korea highlight the importance of testing comprehensively across diverse socioeconomic groups. Finland has earlier experience of preventing the spread of the HIV epidemic among drug users.

The impact of measures is always observed with a delay, and thus rapid action is important if case numbers start to increase locally or regionally. In the case of a local outbreak, mobility data from cell phone operators[57] and metapopulation models using these may help, similar to one already being used in Norway.[58].

Protective measures

Widespread use of masks - either certified ones or home-made versions - may help to reduce transmissions[59]. Masks are already obligatory or strongly encouraged in public transport and inside stores in many countries (e.g., Germany, Czech Republic Austria, and Slovakia), and scientific support for their efficacy is strong enough to justify public health intervention measures even purely as a precautionary measure.[60] [61] [62].

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53 Hale, T. et al. (2020) Variation in Government Responses to COVID-19 Version 5.0. Blavatnik School of Government Working Paper, www.bsg.ox.ac.uk/covidtracker.

54 See pages 26-28 in Vihriälä, Vesa; Holmström, Bengt; Korkman, Sixten; Uusitalo, Roope (2020) Talouspolitiikan strategia koronakriisissä, http://urn.fi/URN:ISBN:978-952-287-898-4 (In Finnish: Economics policy strategy during the corona crisis)

55 Prather, K. A., Wang, C. C. & Schooley, R. T. (2020) Reducing transmission of SARS-CoV-2. Science 10.1126/science.abc6197

56 Peccia, J. et al. (2020) SARS-CoV-2 RNA concentrations in primary municipal sewage sludge as a leading indicator of COVID-19 outbreak dynamics. medRxiv 2020.05.19.20105999; DOI: https://www.medrxiv.org/content/10.1101/2020.05.19.20105999v1.

57 Oliver, N. et al. (2020) Mobile phone data for informing public health actions across the COVID-19 pandemic life cycle. Science DOI: 10.1126/sciadv.abc0764.

58 Folkhelseinstituttet: Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 18, p. 12. https://www.fhi.no/publ/2020/covid-19-epidemien-risikovurdering/

59 Greenhalgh, T. & Howard, J. (2020) Masks for all? The science says yes. https://www.fast.ai/2020/04/13/masks-summary/; see also Howard, J. et al. (2020) Face Masks Against COVID-19: An Evidence Review. Preprints 2020, 2020040203; DOI: 10.20944/preprints202004.0203.v1).

60 Wilson, N., et al. (2020) “The Strong Case for Mask Requirements in Public Transportation and Border Control Settings in NZ’s Current COVID-19 Pandemic Context” https://blogs.otago.ac.nz/pubhealthexpert/2020/05/11/the-strong-case-for-mask-requirements-in-public-transportation-and-border-control-settings-in-nzs-current-covid-19-pandemic-context/

61 Abaluck, J. et al. (2020) The Case for Universal Cloth Mask Adoption and Policies to Increase Supply of Medical Masks for Health Workers. SSRN 1.4.2020, https://ssrn.com/abstract=3567438

62 Howard, J. et al. (2020) Face Masks Against COVID-19: An Evidence Review. Science DOI: 10.20944/preprints202004.0203.v1

It is probable that some level of continued restrictions may be needed to reduce the number of contacts so that the reproductive number is kept low enough to prevent individual cases from leading to the second wave of an epidemic. Information about the mechanisms of SARS-CoV-2 transmission is accumulating rapidly, and it is increasingly possible to target high-risk activities by restrictions or enhanced safety measures. Identification, mitigation, and prevention of superspreader events is important and potentially highly impactful[63]. Because many transmissions derive from long-term exposure indoors,[64] for example, open office plans and crowded public transport may be problematic. Many solutions have been suggested and already partially implemented across the world, including work shifts and masks.

Testing

Extensive testing is essential and facilitates continuous monitoring of COVID-19 infections. Finland increased its testing capacity using PCR-based diagnostics (gene amplification). This capacity can be further enhanced if necessary, e.g., by exploiting the expertise and infrastructure of universities and private health centres. The private sector has invested heavily to increase capacity[65], and this can be maximised further with appropriate incentives. For example, should the state decide to implement large-scale testing and achieve a specific bulk testing capacity in 1-2 years, the associated costs per test will likely remain low, and companies can rapidly invest with confidence that the capacity will be used.

At present, sample acquisition represents a significant bottleneck in the testing process. Our extensive national network of public health centres provides an ideal framework to achieve comprehensive sampling of the entire population. Additionally, private healthcare operators and, if necessary, mobile sampling units could easily integrate with this established nationwide framework. Adequate resourcing of health centres must be guaranteed (in 2016, there were a total of 548 stations and 160 health centres in Finland). Future sample acquisition could be further simplified and streamlined by collecting saliva[66] [67].

A recent study by Wyllie et al. demonstrated that SARS-CoV-2 is more readily detectable in saliva samples compared to nasopharyngeal samples. Compared to the existing sampling strategy, which requires patients to visit a dedicated centre, saliva samples could be provided by citizens and patients without the need to leave their homes. This strategy would eliminate unnecessary contact and travel of potentially infected people, thereby reducing transmission at the earliest stage of analysis.

Continual advances in COVID19 diagnostics seek to make testing faster, and with the potential for cost-effective scale-up for mass screening. Rapid antibody-based test kits that identify the presence of viral proteins have sparked considerable interest. Some of these methods have been developed in Finland, enabling trials and the availability of tests on large-scale[68]. Such rapid test kits could also create opportunities for anonymous testing at home[69]. To date, antibody-based tests have proven to be less reliable (sensitive) than PCR-based detection. However, this is an active area of development, and a domestic manufacturer of this testing technology confirms that reliability can be optimised within a short timeframe (during the coming months). Highly scalable methods based on massive sequencing have also

63 Science, Why do some COVID-19 patients infect many others, whereas most don't spread the virus at all?. 2020-05-19. https://www.sciencemag.org/news/2020/05/why-do-some-covid-19-patients-infect-many-others-whereas-most-don-t-spread-virus-all

64 Bi, Q. et al. (2020) Epidemiology and transmission of COVID-19 in Shenzhen China: analysis of 391 cases and 1,286 of their close contacts. medRxiv 2020.03.27; DOI: https://doi.org/10.1101/2020.03.03.20028423

65 https://www.sttinfo.fi/tiedote/fimlab-lisaa-merkittavasti-koronaviruksen-testauksen-kotimaista-kapasiteettia?publisherId=12600631&releaseId=69879887

66 Wyllie, A.L. et al. (2020) Saliva is more sensitive for SARS-CoV-2 detection in COVID-19 patients than nasopharyngeal swabs. medRxiv 2020.04.16.20067835; DOI: https://doi.org/10.1101/2020.04.16.20067835

67 US Food and Drugs Administration News Release 08/05/2020: Coronavirus (COVID-19) Update: FDA Authorizes First Diagnostic Test Using At-Home Collection of Saliva Specimens, https://www.fda.gov/news-events/press-announcements/coronavirus-covid-19-update-fda-authorizes-first-diagnostic-test-using-home-collection-saliva

68 The presence of domestic companies would facilitate trials. The large-scale production of test kits would create new investments and jobs in Finland.

69 Here tests are not diagnostic tools but a measure that is used to make decisions to isolate people. Test producers often use phone applications to help in using the test and to report results to health officers.

been developed[70]. The proper certification of these tests will take time, but we predict that these evolving advances will ultimately revolutionise COVID19 diagnostics.

A high burden of infections poses significant challenges to the speed, accuracy, and capacity of tracing that follows testing. Increasing testing capacity and criteria would enhance tracing capabilities by allowing for more liberal testing of asymptomatic as well as milder cases. If tracing fails, infected carriers can also be screened from the population by a broader population-level screening, which can be extended to the entire community or in a more controlled fashion, e.g., to defined "hotspot" zones. Repeated population screening, either regionally or nationwide, could completely prevent the spread of infection. A comprehensive screening strategy would provide a credible, evidence-based public demonstration of COVID19 containment, highlighting that a small number of detectable infections is not a function of reduced testing.

Comparable strategies have been suggested by prominent experts such as Paul Romer (Nobel Laureate in Economics)[71] and the Edmond J. Safra Institute of Ethics at Harvard University[72]. It is vital to consider the opportunities and caveats involved in such strategies[73]. The reliability of coronavirus tests determines their diagnostic utility in pandemic management. False-positive results (especially at the level of population-based screening) may result in the needless isolation of healthy individuals. This disadvantage for both the individual and society must be considered when evaluating the relative merits of screening strategies.

Tests may also yield false-negative results, many of which are related to the sampling site (presence of the virus in the pharynx) and not to the sensitivity of the actual testing method used. In this case, some coronavirus carriers remain undetected. Individuals who abstain from testing pose an additional challenge[74]. Despite this, it is not necessary to find and completely isolate every infected carrier to eliminate, in effect, the virus. Elimination or effective suppression can be accomplished by neutralising a significant proportion of chains of transmission when the reproductive value remains below one ($R<1$).

The effectiveness and quality of population-based screening, logistics, and coverage could first be determined regionally. Data obtained from en masse testing would provide much-needed insights into the true extent of the pandemic, and facilitate a rapid return to pre-pandemic social and economic stability. The cost of testing is estimated to be in the order of €150M EUR per month, assuming a unit cost of 10 euros for the test and screening the entire population every ten days[75]. Conservative estimates of the negative economic costs associated with the coronavirus crisis are around 5 billion euros per month[76]. This disparity highlights the urgent need for a definitive and meaningful strategy to neutralise the related medical and economic impacts of COVID19.

Tracing and isolation

Tracing is greatly facilitated if the number of infected carriers in the population is small. Speed is critical to the tracing process to isolate and prevent further transmissions. For tracing to work effectively, it is essential to ensure adequate capacity and resources. Failures in tracing can lead to local infection clusters, which in turn will challenge the tracing ability due to the restricted time window. Because infection clusters are often regional, tracking systems have proven useful. Mobile applications designed for digital tracking enable accurate and rapid tracing[77].

Possibilities for enabling infected people to stay apart from their family or housemates should also be considered, to avoid the spread of the virus and the exposure of potential risk groups at home.

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70 https://www.notion.so/Octant-SwabSeq-Testing-9eb80e793d7e46348038aa80a5a901fd

71 https://roadmap.paulromer.net/paulromer-roadmap-report.pdf

72 Edmond, J. Safra Center of Ethics (2020) Roadmap to Pandemic Resilience, https://ethics.harvard.edu/Covid-Roadmap

73 Taipale, J., Romer, P. & Linnarsson, S. (2020) Population-scale testing can suppress the spread of COVID-19. medRxiv 2020.04.27.20078329; DOI: https://doi.org/10.1101/2020.04.27.20078329

74 Taipale, J., Romer, P. & Linnarsson, S. (2020) show that test used for screening does not need fully accurate. It can result 15% of false negatives, if 80% of people do test and act according to test result and test is repeated every 10 days.

75 This is based on the testing interval of ten days and the population size of 5.5 million.

76 This corresponds approximately 2 per cent of the annual GDP.

77 Ferretti, L. et al. (2020) Quantifying SARS-CoV-2 transmission suggests epidemic control with digital contact tracing. Science, 368(6491); DOI: 10.1126/science.abb6936.

Travel

In order to prevent the spread of the virus between countries, travel restrictions have been implemented worldwide and also within the Schengen area where movement is usually unrestricted.[78] Also, Finland closed its outer borders for non-citizens on March 19, 2020, and implemented recommendations of self-quarantine for those returning to the country from abroad. While some of the restrictions have been lifted, travel remains severely limited for non-citizens and discouraged for citizens.

After the virus has been eliminated in Finland, uncontrolled travel would likely lead to its rapid re-entry, but carefully selected measures can prevent this without the need for border closures. Multiple models for facilitating safe travel have been introduced, and many European countries that have eliminated the virus are now opening their borders for citizens of other countries with similarly low levels of active infections.[79] [80]

Air travel has been the primary mechanism for spreading the coronavirus across the globe, and the risk that it poses was noted early by the US, Canada, European countries, and others.[81] The long-distance connections that air travel creates between countries and continents allow extremely rapid spread of infectious agents.[82]

Finland must operate in close collaboration with other Schengen countries and actively participate in the development and implementation of international travel policies. The first steps to remove travel restrictions between Schengen countries that have eliminated the epidemic is already being taken[83]. Successful elimination of the virus in Finland also necessitates national policies and practices, including quarantine, testing, and protection of border control staff[84].

One possible outline of a model that would allow safe travel to Finland would be a three-tiered system as follows[85]

- Red countries with a high level of active infections: Travel would be allowed only via strict precautions, including comprehensive testing at the country of origin and in Finland, and a 14-day quarantine.
- Yellow countries with a low number of active infections: Testing at the country of origin and in Finland and surveillance would be sufficient to minimize risk.
- Green countries that have eliminated the virus: Free movement as usual for individuals without symptoms. Rapid testing could be a supplementary precaution.

These kinds of systems would require pre-screening of travellers and data of their travel history via international collaboration and exchange of information. Electronic visas, similarly to the US ESTA, might be one practical tool. Reciprocal implementations between countries may be developed, with the possibility of returning to stronger restrictions if necessary.

Travel must be controlled to some extent after the successful elimination of the epidemic in Finland, but it is noteworthy that similar measures would likely be needed for control of the epidemic e.g., at current low

78 Wells, C.R. et al. (2020) Impact of international travel and border control measures on the global spread of the novel 2019 coronavirus outbreak. Proceedings of the National Academy of Sciences, 117(13), 7504-7509; DOI: 10.1073/pnas.2002616117.

79 Australian Government, Department of Home Affairs (2020). “COVID-19 and the border”. Accessed 13.5.2020. Available at: https://covid19.homeaffairs.gov.au/

80 NZ Ministry of Health (2020). “COVID-19 – Border controls The latest border control measures relating to COVID-19”. Accessed 13.5.2020. Available at https://www.health.govt.nz/our-work/diseases-and-conditions/covid-19-novel-coronavirus/covid-19-current-situation/covid-19-border-controls

81 https://www.airport-technology.com/features/coronavirus-measures-world-airports/

82 Bar-Yam, Y. Transition to extinction: Pandemics in a connected world, New England Complex Systems Institute (July 3, 2016). https://necsi.edu/transition-to-extinction

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levels. They are, in any case, a key part of global management of the coronavirus epidemic[86], with strong worldwide incentives to build systems that allow minimally disruptive but safe travel.

Risk management

It is also possible that the epidemic re-emerges, and the number of new cases surpasses the tracing capacity. This is a risk in all strategies that aim to control the spread of the epidemic. It is inevitable that new infections will occur after the virus has been once eliminated. Constant surveillance is essential to monitor, mitigate, and eventually eliminate new outbreaks.

No strategy is a risk-free guarantee of a virus-free future. However, given appropriate vigilance and measures outlined above, elimination of the virus would not leave to a more precarious situation than alternative control of the virus at low levels of infection. On the contrary, the mechanisms and measures used for elimination would improve our preparedness to prevent and control a potential second wave. Thus, even a failure of the permanent elimination of the virus would not result in a crisis of public health or economy.

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Information

Eroon koronasta ("Get rid of the corona") working group consists of medical practitioners and experts as well as various scientists and scholars aiming at the swift and efficient elimination of SARS-CoV-2 from Finland and elsewhere.

Eroon koronasta publishes its contents via www.eroonkoronasta.fi website.