December 18th 2020.

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RE: Expert Report Covid-19 – Province of Quebec

You have mandated me on November 5th 2020 to prepare an expert report in the fields of medicine, infectiology, health economics and public health in relation to an legal procedure to be filed in court.

You will find below the responses to the questions that you have put forward to me.

Expert Report on the COVID-19 Epidemic Response in Quebec, Canada

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December 18, 2020

Table of Contents

A. Does Covid-19 pose a real or imminent serious threat to the health of the population?

The mortality danger from COVID-19 infection varies substantially by age and a few chronic disease indicators.[1] For a majority of the population, including the vast majority of children and young adults, COVID-19 infection poses less of a mortality risk than seasonal influenza. By contrast, for older populations – especially those with severe comorbid chronic conditions – COVID-19 infection does pose a high risk of mortality, on the order of a 5% mortality rate.

The best evidence on the infection fatality rate from SARS-CoV-12 infection (that is, the fraction of infected people who die due to the infection) comes from seroprevalence studies. The definition of seroprevalence of COVID -19 is the fraction of people within a population who have specific antibodies against SARS-CoV-2 in their bloodstream. Seroprevalence studies provide better evidence on the total number of people who have been infected than do case reports or a positive reverse transcriptase- polymerase chain reaction (RT-PCR) test counts; these both miss infected people who are not identified by the public health authorities or do not volunteer for RT- PCR testing. Because they ignore unreported cases in the denominator, fatality rate estimates based on case reports or positive test counts are substantially biased upwards.

According to a meta- analysis [2] by Dr. John Ioannidis of every seroprevalence study conducted with a supporting scientific paper (74 estimates from 61 studies and 51 different localities around the world), the median infection survival rate from COVID-19 infection is 99.77%. For COVID-19 patients under 70, the meta- analysis finds an infection survival rate of 99.95%. A newly released meta-analysis[3] by scientists independent of Dr. Ioannidis' group, reaches qualitatively similar conclusions.

A recent CDC report[4] found that there were between six and 24 times more SARS-CoV-2 infections than cases reported between March and May 2020. This study is based on serological analysis of blood samples incidentally collected by commercial laboratories in 10 cities nationwide. Although the CDC does not provide the infection fatality rate estimate implied by their seroprevalence studies, in contrast to the study by Dr. Ioannidis above.

In September 2020, the CDC updated its current best estimate of the infection fatality ratio- the ratio of deaths to the total number of people infected- for various age groups.[5] The CDC estimates that the infection fatality ratio for people ages 0-19 years is .00003, meaning infected children have a 99.997% survival after infection. The CDC's best estimate of the infection

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[1] Public Health England (2020) Disparities in the Risk and Outcomes of COVID-19. August 2020. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/908434/Disparities_in_the_risk_and_outcomes_of_COVID_August_2020_update.pdf

[2] John P.A. Ioannidis , *The Infection Fatality Rate of COVID- 19 Inferred from Seroprevalence Data*, Bulletin of the World Health Organization BLT 20.265892.

[3] Andrew T. Levin, et al., *Assessing the Age Specificity of Infection Fatality Rate for COVID- 19: Meta-Analysis & Public Policy Implications* (Aug. 14,2020)MEDRXIV, http://bit.ly/3gplolV.

[4] Fiona P. Havers, et al., *Seroprevalence of Antibodies to SARS-CoV-2 in 10 Sites in the United States, March 23-May 12, 2020* (Jul. 21, 2020) JAMA INTERN MED., https://bit.ly/3goZUgy.

[5] COVID- 19 Pandemic Planning Scenarios, Centers for Disease Control and Prevention, https://www.cdc.gov/coronavirus/2019-ncov/hep/planning-scenarios.html.

fatality rate for people aged 20-49 years is .0002, meaning that young adults have a 99.98% survival following infection. The CDC's best estimate of the infection fatality rate for people age 50-69 years is .005, meaning this age group has a 99.5% survival. The CDC's best estimate of infection fatality rate for people ages 70+ years is .054, meaning seniors have a 94.6% survival.

The mortality risk for those infected with SARS-CoV-2 is not the same for all patients. Older patients are at higher risk of death if infected, while younger patients face a vanishingly small risk. The best advice on age-specific infection fatality rates comes again from seroprevalence studies. Three such studies (of which I am currently aware) provide age-specific infection fatality rate estimates. The CDC's current best estimates are that the symptomatic fatality rate from COVID- 19 among patients less than 50 years old is 0.05%, or 5 in 10,000; 0.2% for patients between ages 50 and 64; and 1.3% for patients 65 and above. The infection fatality rates are lower than these numbers since only a fraction of patients are symptomatic.

A study of the seroprevalence of COVID-19 in Geneva, Switzerland (published in the *Lancet*)[6] provides a detailed age break down of the infection survival rate in a preprint companion paper[7] 99.9984% for patients 5 to 9 years old; 99.99968% for patients 10 to 19 years old; 99.991% for patients 20 to 49 years old; 99.86% for patients 50 to 64 years old; and 94.6% for patients aged over 65 years.

I estimated the age-specific infection fatality rates from the Santa Clara County seroprevalence study[8] data (for which I am the senior investigator). The infection survival is 100% among people between 0 and 19 years (there were no deaths in Santa Clara in that age range up to that date); 99.987% for people between 20 and 39 years; 99.84% for people between 40 and 69 years; and 98.7% for people above 70 years. In fact, in all of California[9] up through August 20, there have been only two deaths among COVID-19 patients below age 18. 74.2% of all COVID-19 related deaths occurred in patients 65 and older.

While I am not aware of a serosurvey available for Quebec, it is clear that the age gradient in COVID-19 mortality found everywhere else applies. Population fatality rate estimates[10] are available at the Institut national de santé publique du Québec.[11] For those aged 90 and up, the population mortality rate from COVID-19 was 2.8% for women and 2.4% for men. For those 80-89, the population mortality rate from COVID-19 was 0.8% for women and 1.1% for men, For those 70-79, the population mortality rate from COVID-19 was 0.15% for women and 0.21% for men. For those 60-69, the population mortality rate was 0.03% for women and 0.047% for

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[6] Silvia Stringhini, et al., *Seroprevalence of Anti-SARS-CoV-2 lgG Antibodies in Geneva, Switzerland (SEROCoV-POP): A Population Based Study* (June 11,2020) THE LANCET, https://bit.ly/3187S13.
[7] Francisco Perez-Saez, et al. *Serology- Informed Estimates of SARS-COV-2 Infection Fatality Risk in Geneva, Switzerland* (June 15,2020) OSF PREPRINTS, http://osf.io/wdbpe/.
[8] Eran Bendavid, et al., *COVID- 19 Antibody Seroprevalence in Santa Clara County, California* (April 30,2020) MEDRXIV, https://bit.ly/2EuLIFK.
[9] COVID- 19, *Cases and Deaths Associated with COVID-19 by Age Group in California* (Aug. 20,2020) CAL. DEPT. OF PUB. HEALTH, https://bit.ly/31inK9q [accessed Aug. 22,2020].
[10] Public Health England (2020) Disparities in the Risk and Outcomes of COVID-19. August 2020. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/908434/Disparities_in_the_risk_and_outcomes_of_COVID_August_2020_update.pdf
[11] INSPQ (2020) Données COVID-19 par âge et sexe au Québec. https://www.inspq.qc.ca/covid-19/donnees/age-sexe

men. The population fatality rate declines from there for those under 60, with no COVID-19 deaths whatsoever for people 29 and under.[12]

In addition to the risk posed by old age, COVID-19 infection poses an elevated mortality risk for people with certain chronic conditions, like diabetes. We now have good evidence on the relative risk posed by the incidence of chronic conditions, so we know that among common conditions, age is the single most important risk factor. For instance, a 65-year-old obese individual has about the same COVID-19 mortality risk conditional upon infection as a 70-year-old non-obese individual.

In summary, Covid-19 does not pose a real or imminent serious threat to the health of the population in general but only to the health of a specific part of the population – the elderly and a limited number of people with certain chronic conditions. Age is the single most important risk factor, with a worldwide 99.95% infection survival rate for people under 70 and 95% infection survival rate for people aged 70 years or more.

B. What are the principles govern good health policy and public health practice?

The principles of good public health[13] and health policy[14] practice predate the epidemic. While the topic is voluminous, there are a few principles that are particularly relevant to COVID-19 policy making, and include the following guidelines for decision makers:

- Consider both the costs *and* benefits of alternative policies, choosing policies that appropriately balance the two.
- Account for uncertainty in the projected costs and benefits of policy options.
- Account for the strength of the scientific evidence.
- Be constrained in policy making by democratic norms and ethical principles.
- Choose policies that treat people in society equitably, and in particular eschew policies that disproportionately favor richer members of society over poorer members.

Sound health policy decision making requires a careful evaluation of both the costs and benefits over both the long and short term. The nature of these costs and benefits considered should be broadly considered, including physical costs (such as enhanced risk of mortality and morbidity from all sources), psychological harms (such as increased rates of depression and suicidality), as well as the economic damage (such as increased joblessness, closed businesses, and reduced income).

The costs and benefits of every potential policy involves some degree of uncertainty, including

[12] The population fatality rate is an underestimate of the infection fatality rate. The denominator in these calculations include the entire population of Quebec, not just those infected with the SARS-CoV-2 virus. I included these to provide evidence from Quebec regarding the age-gradient in COVID-19 fatality risk.

[13] Public Health Leadership Society (2002) Principles of the Ethical Practice of Public Health. American Public Health Association. https://www.apha.org/-/media/files/pdf/membergroups/ethics/ethics_brochure.ashx

[14] Bhattacharya J, Hyde T, Tu P. Health Economics, London: Palgrave-MacMillan, (2013).

lockdowns. In the face of uncertainty, public health decision making should be based on the best available evidence regarding the most likely outcomes once a policy is introduced. Public health decision making should eschew decision making based on worst-case or best-case assumptions about the outcomes that may happen if alternate policies are adopted. It is particularly bad practice to make decisions that assume worst case scenarios regarding the costs of a policy and best-case scenarios regarding the benefits of a policy, or vice versa. So, for instance, it is poor public health practice to assume that lockdowns, if implemented will have a dramatic effect on disease transmission and mortality with no consideration of the harms associated with lockdowns.[15]

In addition to the costs and benefits, public health policy must consider the strength of the scientific evidence regarding the measure in achieving the aims it proposes. Of course, without solid scientific evidence in favor of a policy – especially one with enormous costs – its imposition by a government on a population would be unethical. The greater the potential harms from the policy on some part of the population, the greater the evidentiary standard required to establish its necessity.

There are other ethical norms and standards as well to which public health decision making should abide. Public health decision-makers must limit themselves to interventions that respect human rights, broadly considered. Among the rights that public health decisions should not violate in a democratic society, include the right to free speech and assembly, the right to the protection of property, the right to high quality education for children, the right to health care, the right to pursue a healthy life, and the right to worship. Any restriction on these rights must be proportionate, temporary, and tailored to be minimally invasive to achieve a legitimate goal of the government.

In a democratic society, measures taken by the government, must respect the law. The constitution is the test of the legality of decisions made by a democratic government. There must be a rational link between the measures taken and the goals that the government has. Preferred measures must are those that least infringe upon liberties and freedoms of citizens. This is the fundamental difference between a free society and a dictatorship. This must not be seen as a negative limit on the government to act to "save lives", but as our basic understanding of the clear and undeniable benefits of freedoms and liberties on all aspects of human life.

Finally, equity is a key principle of public health. Public health officials must consider whether the harms of a policy like lockdowns fall disproportionately on the poor, on minority populations, or on others who are of low socio-economic status. Similarly, policies that accrue benefits disproportionately to the rich, to majority populations, and to people of high socio-economic status should be redesigned to rather promote equity in public health decision making.

In summary, sound public health practice adheres to key principles aimed at grounding policy in good science, respecting human rights and democratic norms, appropriately accounting for costs

[15] In Quebec, unfortunately, the national director of public health, Dr. Horacio Arruda, has explicitly adopted the view that planning should consider only the worst case scenario regarding disease spread. See Assemblee Nationale du Quebec (2020) Conférence de presse de M. François Legault, premier ministre et Mme Danielle McCann, ministre de la Santé et des Services sociaux. March 23, 2020. http://www.assnat.qc.ca/fr/actualites-salle-presse/conferences-points-presse/ConferencePointPresse-58419.html

and benefits of policies and uncertainty in outcomes, treating people equitably, as well as other principles not discussed here.

C. Are the lockdowns (including, but not limited to, shelter-in-place orders and forced quarantines, business, cultural, sports and religious service restrictions and closures, restrictions on in-person schooling, restrictions on private gatherings, travel restrictions across provinces, restrictions on children playing together and scholastic sport, and the arbitrary designation of businesses into 'essential' and 'non-essential') necessary to maintain and enhance the health and well-being of the general population?

Since the available epidemiological literature often tends to group many of the items in the list above under the moniker of "lockdown" or "non-pharmaceutical intervention (NPI)" we will consider the evidence related to the items together based on the criteria for good public health practice we discussed above.

Theoretical Considerations. The theoretical models used to justify lockdowns – compartmental or SEIR models – do not predict a decrease in the total number of infected people but rather a shift in the timing of infections.

Compartmental models work by envisioning a population exposed to a new pathogen like the SARS-CoV-2 virus. In the simplest versions of these models, everyone in the population are initially susceptible to infection. The epidemic starts with one person being infected and in turn infecting other people in the pool of susceptible people. Many infected people recover from the disease and – because of immunity induced by infection – are no longer susceptible. Over time, the population of susceptible people diminishes to the point where a newly infected person infects one or fewer people, and the epidemic declines.

In models like this, which are in common use to forecast the COVID-19 epidemic, lockdowns play a role of dampening the number of interactions between susceptible people and infected people, slowing the growth of the epidemic. However, unless the number of infections are reduced to zero – a result clearly not in evidence in the COVID-19 epidemic – the disease continues to spread in the population.

The clear theoretical implication from these models is that lockdowns delay infections into the future, rather than prevent them from occurring altogether.[16] But society-wide lockdowns are not a tool of disease eradication, and in fact have never in history eradicated a disease. This benefit – a theoretical delay in the incidence of cases – should be counted against the harms from lockdowns, some of which are described below.

What is the evidence that these theoretical models provide accurate forecasts of the future path of the pandemic? Unfortunately, their track record is poor. According to a comprehensive

[16] Chikina M and Pegden W (2020) A Call to Honesty in Pandemic Modeling. *Medium*. https://medium.com/@wpegden/a-call-to-honesty-in-pandemic-modeling-5c156686a64b

evaluation of the performance of these models by an international group of statisticians and mathematicians, their poor performance stems from a wide variety of problems, including: [17]

> Poor data input, wrong modeling assumptions, high sensitivity of estimates, lack of incorporation of epidemiological features, poor past evidence on effects of available interventions, lack of transparency, errors, lack of determinacy, looking at only one or a few dimensions of the problem at hand, lack of expertise in crucial disciplines, groupthink and bandwagon effects and selective reporting are some of the causes of these failures.

Given this poor track record in prediction, extreme caution should be exercised by public health decision makers in using compartment models to forecast the future direction of the pandemic and in predicting the effects of policy interventions such as lockdowns on COVID-19 outcomes such as mortality and hospitalization.[18]

Empirical Literature on Lockdown Benefits. In the case of lockdowns and social distancing interventions, there is no existing randomized study – the gold standard study type in clinical therapeutics and public health interventions – that has evaluated the efficacy or costs of these measures. Scientific experts have argued for the necessity and feasibility of such randomized evaluation of restricting schools, universities, and workplaces, banning public gatherings, and the like.[19] If one were to view these lockdowns and activity restrictions as a medical intervention, it would be unethical to implement them in the absence of randomized evidence in support of their efficacy.

In the absence of such evidence, scientists and public health officials tend to rely on studies that are less rigorous than randomized trials in establishing causal links between the intervention and outcomes, including event studies and other observational studies. In the case of the lockdowns, the evidence from these sources is decidedly mixed. Evidence from the draconian lockdown order in China – including home and centralized quarantine, severe travel restrictions, cordon sanitaire, mandated centralized symptom reporting, and other interventions inconsistent with democratic norms – suggests that lockdowns can "temporarily" reduce spread of the virus.[20] Evidence from the early days of the epidemic (March and early April 2020) in the US found that states that imposed strict stay-at-home orders had a slower growth in the epidemic that states that did not over that short period of time.[21]

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[17] Ioannidis JPA, Cripps S, Tanner MA. Forecasting for COVID-19 has failed. Int J Forecast. 2020 Aug 25. doi: 10.1016/j.ijforecast.2020.08.004. Epub ahead of print. PMID: 32863495; PMCID: PMC7447267.

[18] Chin V, Ioannidis J, Tanner M, Cripps S. (2020) Effects of Non-Pharmaceutical Interventions on COVID-19: A Tale of Three Models. medRxiv. https://www.medrxiv.org/content/10.1101/2020.07.22.20160341v2

[19] Cristea, I. A., Naudet, F., & Ioannidis, J. P. A. (2020). Preserving equipoise and performing randomized trials for COVID-19 social distancing interventions. *Epidemiology and Psychiatric Sciences*. https://doi.org/10.1017/S2045796020000992

[20] Pan A, Liu L, Wang C, et al. Association of Public Health Interventions With the Epidemiology of the COVID-19 Outbreak in Wuhan, China. *JAMA.* 2020;323(19):1915–1923. doi:10.1001/jama.2020.6130

[21] Mark N Lurie, Joe Silva, Rachel R Yorlets, Jun Tao, Philip A Chan, Coronavirus Disease 2019 Epidemic Doubling Time in the United States Before and During Stay-at-Home Restrictions, The Journal of Infectious Diseases, Volume 222, Issue 10, 15 November 2020, Pages 1601–1606, https://doi.org/10.1093/infdis/jiaa491; The article also had a correction appended. Mark N Lurie, Joe Silva, Rachel R Yorlets, Jun Tao, Philip A Chan,

The problem with these event studies is that they cannot be used to forecast the effect of imposing less strict lockdowns (such as restrictions on businesses and gatherings). Focused as they are on quarantine or stay-at-home orders and the draconian policies imposed during the early epidemic in China, they represent a best case for the effectiveness of lockdowns. More importantly, they only measure the effect of lockdown on the speed of disease spread in the short run and should not be used to forecast the effect of lockdown on long run epidemic outcomes, since the theoretical literature strongly cautions against it. Recall that in those models, lockdowns push cases into the future; they do not prevent them altogether.

In fact, there are many possible reasons why the number of cases might change over time outside of lockdowns, and these should be accounted for in any accurate estimation of lockdown effects. Perhaps most importantly, these simple event studies do not account for the environmental, epidemiological, and economic factors that impact disease spread, imputing changes in the track of the epidemic almost entirely to policy interventions. There are many possible reasons why the number of cases might change over time outside of lockdowns, and these should be accounted for in any accurate estimation of lockdown effects. For instance, there is evidence that COVID-19 infection rates are increased during cold weather seasons.[22, 23] It is striking that the recent sharp rise in COVID-19 cases in California corresponds with colder weather, despite the continuing lockdowns. Even authors who favor lockdowns as a policy option in summarizing this evidence agree that seasonality plays an important role in case spread:[24]

> "A convincing argument that weather influences COVID-19 can be formulated in three parts: (1) experiment data suggest SARS-CoV-2 persistence on surfaces or in the air is sensitive to temperature, humidity, and ultraviolet light; (2) other environmentally sensitive respiratory viruses are seasonal, and more common in winter; and therefore, (3) climatic effects could be protective over space (hot, dry places might have less transmission) and time (summer might see reduced transmission compared to winter)."

This is not to say that other factors play no role, but rather that seasonality should be accounted for in any analysis of case spread. Studies decomposing lockdown effects should also account for the fact that, even in the absence of policy interventions, people change their behavior to protect themselves from disease risk if they perceive the danger from infection to be high.[25]

Corrigendum to: COVID-19 Epidemic Doubling Time in the United States Before and During Stay-at-Home Restrictions, The Journal of Infectious Diseases, Volume 222, Issue 10, 15 November 2020, Page 1758, https://doi.org/10.1093/infdis/jiaa506

[22] Araujo MB and Naimi B (2020) Spread of SARS-CoV-2 Coronavirus Likely Constrained by Climate. medRxiv. https://www.medrxiv.org/content/10.1101/2020.03.12.20034728v3.article-info

[23] Sajadi, Mohammad M. and Habibzadeh, Parham and Vintzileos, Augustin and Shokouhi, Shervin and Miralles-Wilhelm, Fernando and Amoroso, Anthony, Temperature, Humidity and Latitude Analysis to Predict Potential Spread and Seasonality for COVID-19 (March 5, 2020). Available at SSRN: https://ssrn.com/abstract=3550308 or http://dx.doi.org/10.2139/ssrn.3550308

[24] Carson CJ, Gomez ACR, Shweta B, and Ryan SJ (2020) "Misconceptions about Weather and Seasonality Must not Misguide COVID-19 Response" Nature Communications 11: 4312. https://doi.org/10.1038/s41467-020-18150-z

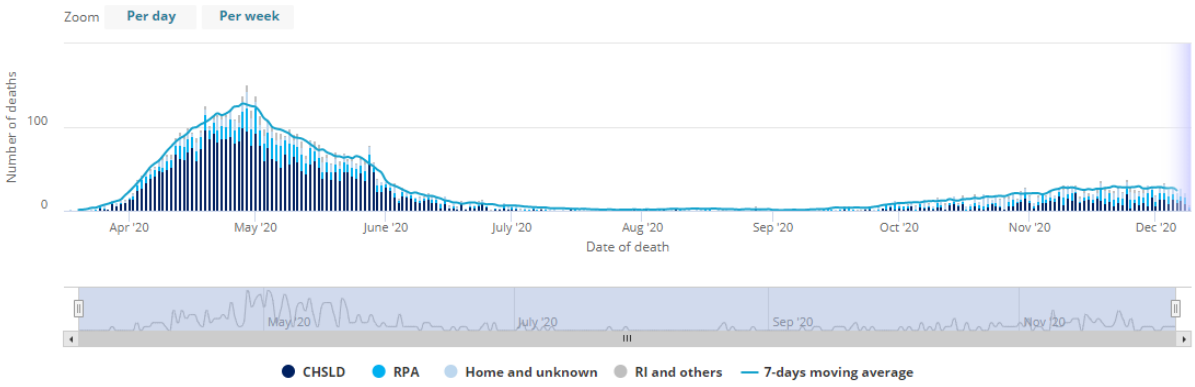
[25] Yoo BK, Kasajima M, Bhattacharya J. (2020) "Public Avoidance and the Epidemiology of novel H1N1 Influenza A." National Bureau of Economic Research Working Paper #15752. DOI 10.3386/w15752. https://www.nber.org/papers/w15752

The best studies, which account for environmental, epidemiological, and economic factors alongside policy interventions conclude that the mortality from COVID-19 infection in different regions is not primarily driven by policy decisions like lockdowns, but rather by other factors specific to each region.[26] A comprehensive international cross-country study, analyzing data from the first 8 months of the pandemic, concluded that:[27]

> Countries that already experienced a stagnation or regression of life expectancy, with high income and non-communicable disease rates, had the highest price to pay. This burden was not alleviated by more stringent public decisions. Inherent factors have predetermined the Covid-19 mortality: understanding them may improve prevention strategies by increasing population resilience through better physical fitness and immunity.

In other words, countries that had a population predisposed to poor COVID-19 infection outcomes, including countries that had an older population or a more obese population, tended to have worse outcomes irrespective of whatever lockdown policies they implemented.

It is striking that Quebec has seen a surge in COVID-19 cases and deaths since October, despite maintaining its strict lockdown throughout the summer. The continuing lockdowns and activity restrictions very clearly did not prevent the second wave, and indeed the lockdowns during the first wave likely increased the size of this second wave relative to what it otherwise would have been.[28]



[26] Atkeson A, Kopecky K, Zha T. (2020) "Four Stylized Facts about COVID-19" National Bureau of Economic Research Working Paper #27719. DOI 10.3386/w27719. https://www.nber.org/papers/w27719

[27] De Larochelambert Q, Marc A, Antero J, Le Bourg E, and Toussaint JF. (2020) Covid-19 Mortality: A Matter of Vulnerability Among Nations Facing Limited Margins of Adaptation. Front. Public Health, 19 November 2020 | https://doi.org/10.3389/fpubh.2020.604339

[28] Quebec Public Health (2020) Data on COVID-19 in Quebec. https://www.quebec.ca/en/health/health-issues/a-z/2019-coronavirus/situation-coronavirus-in-quebec/#c75848 (accessed 10 Dec. 2020)

D. What are the harms of lockdowns and governmental actions aiming to slow down the propagation of the disease on the health of the population?

While the evidence on the benefits of lockdowns in equivocal, the harms of the lockdown are manifold and devastating. The effects on the health of populations, in particular, warrants careful attention, since they can be compared directly against the harms from COVID-19 infection. The COVID-19 lockdowns have often featured the cessation of elective and other medical services to keep hospital and health care systems available for COVID-19 patients. Naturally, patients who skip medical services will suffer adverse health consequences as a result. The empirical evidence support these ideas includes documentation for plummeting childhood vaccination rates[29], worse cardiovascular disease outcomes (in part because patients delayed necessary cardiac care)[30], less cancer screening[31], and deteriorating mental health[32], to name a few.

In addition to the physical health harms from lockdown, there has been immense psychological harm. The social isolation induced by lockdown has led to a sharp rise in opioid and drug-related overdoses[33], similar to the "deaths of despair" that occurred in the wake of the 2008 Great Recession.[34] Social isolation of the elderly has contributed to a sharp rise in dementia-related deaths around the country.[35] For children, the cessation of in-person schooling since the spring has led to "catastrophic" learning losses[36], with severe projected adverse consequences for affected students' life spans.[37] According to a US CDC estimate, one in four young adults seriously considered suicide this past June.[38] Among 25 to 44-year olds, the US CDC reports a 26% increase in excess all-cause mortality relative to past years, though fewer than 5% of 2020

[29] CDC (2020) Effects of the COVID-19 Pandemic on Routine Pediatric Vaccine Ordering and Administration — United States, 2020. MMWR. 69(19): 591-3. https://www.cdc.gov/mmwr/volumes/69/wr/mm6919e2.htm

[30] Ball S, Banerjee A, Berry C, et alMonitoring indirect impact of COVID-19 pandemic on services for cardiovascular diseases in the UKHeart Published Online First: 05 October 2020. doi: 10.1136/heartjnl-2020-317870

[31] Rutter MD, Brookes M, Lee TJ, et alImpact of the COVID-19 pandemic on UK endoscopic activity and cancer detection: a National Endoscopy Database AnalysisGut Published Online First: 20 July 2020. doi: 10.1136/gutjnl-2020-322179

[32] Vizard T, Davis J, White E, Beynon B (2020) Coronavirus and depression in adults, Great Britain: June 2020. Office for National Statistics, UK. https://www.ons.gov.uk/peoplepopulationandcommunity/wellbeing/articles/coronavirusanddepressioninadultsgreatbritain/june2020

[33] American Medical Association (2020) Issue Brief: Reports of Increases in Opioid- and Other Drug Related Overdose and Other Concerns During COVID Pandemic. AMA Advocacy Resource Center. Oct. 31, 2020. https://www.ama-assn.org/system/files/2020-11/issue-brief-increases-in-opioid-related-overdose.pdf

[34] Deaton A and Case A (2020) Deaths of Despair and the Future of Capitalism. Princeton University Press. March 17, 2020.

[35] Alzheimer's Impact Movement (2020) The 2020 COVID-19 Pandemic and Dementia: Deaths Above Average. https://www.scribd.com/document/483085777/Dementia-Deaths-Above-Average-State-by-State-Table

[36] Center for Research on Education Outcomes (2020) Estimates of Learning Loss in the 2019-2020 School Year. CREO Stanford University. October 2020. https://credo.stanford.edu/sites/g/files/sbiybj6481/f/short_brief_on_learning_loss_final_v.3.pdf

[37] Christakis DA, Van Cleve W, Zimmerman FJ. Estimation of US Children's Educational Attainment and Years of Life Lost Associated With Primary School Closures During the Coronavirus Disease 2019 Pandemic. JAMA Netw Open. 2020;3(11):e2028786. doi:10.1001/jamanetworkopen.2020.28786

[38] Czeisler MÉ , Lane RI, Petrosky E, et al. Mental Health, Substance Use, and Suicidal Ideation During the COVID-19 Pandemic — United States, June 24–30, 2020. MMWR Morb Mortal Wkly Rep 2020;69:1049–1057. DOI: http://dx.doi.org/10.15585/mmwr.mm6932a1

deaths have been due to COVID-19.[39, 40]

While the lockdowns result in direct harms for the health of populations where they are implemented, they also have devastating indirect consequences as a result of a collapse in worldwide economic outcomes, with a particularly large and negative effect on poor countries.[41] This economic harm translates directly into health harm, as large populations are no longer able to feed themselves due to poverty. The UN estimates that an additional 130 million poor people will be at risk of starvation as a consequence of the economic collapse caused by the lockdowns – predicting a famine of "biblical" proportions.[42] Estimates suggest that an additional 400,000 people will die from inadequate tuberculosis treatment as a consequence of diversion of resources away from TB identification and treatment.[43] Vaccination campaigns in rich and poor countries that address diseases like diphtheria and polio have been suspended due to the lockdowns.[44] According to a recent editorial in the journal *Nature*, the COVID-19 focus is "fuelling a resurgence of AIDS, malaria, and tuberculosis" around the world.[45]

E. Are the harms of the lockdowns equitably distributed?

The harms of lockdown are unequally distributed. In the US, for instance, economists have found that only 37% of jobs in the US can be performed wholly on-line, and high-paying jobs are overrepresented among that set.[46] By declaring janitors, store clerks, meat packers, postal workers, and other blue-collar workers as "essential" workers in most states, regardless of whether they qualify as high COVID mortality risk, the lockdowns have failed to shield the vulnerable in these occupations. The same is true in Canada as well. Canada has the highest unemployment rate in the G7.[47] The impact of this unemployment has fallen most severely on younger and less well-

[39] Rossen LM, Branum AM, Ahmad FB, Sutton P, Anderson RN. Excess Deaths Associated with COVID-19, by Age and Race and Ethnicity — United States, January 26–October 3, 2020. MMWR Morb Mortal Wkly Rep 2020;69:1522–1527. DOI: http://dx.doi.org/10.15585/mmwr.mm6942e2

[40] CDC (2020) Provisional COVID-19 Death Counts by Sex, Age, and State. https://data.cdc.gov/NCHS/Provisional-COVID-19-Death-Counts-by-Sex-Age-and-S/9bhg-hcku

[41] Bhattacharya J and Packalen M (2020) Focused COVID-19 Restrictions will Save Lives in Poor Countries. Financial Post. July 3, 2020. https://financialpost.com/opinion/focused-covid-19-restrictions-will-save-lives-in-poor-countries

[42] Dowsett C (2020) As famines of 'biblical proportion' loom, Security Council urged to 'act fast'. UN News. April 21, 2020. https://news.un.org/en/story/2020/04/1062272

[43] McKie R (2020) Covid set to cause 400,000 surge in TB deaths as medics diverted. The Guardian. Nov. 8, 2020. https://www.theguardian.com/world/2020/nov/08/covid-set-to-cause-400000-surge-in-tb-deaths-as-medics-diverted

[44] GAVI (2020) At least 80 million children at risk of disease as COVID-19 disrupts vaccination efforts, warn Gavi, WHO and UNICEF. May 22, 2020. https://www.gavi.org/news/media-room/least-80-million-children-risk-disease-covid-19-disrupts-vaccination-efforts

[45] Nature (2020) How to stop COVID-19 fuelling a resurgence of AIDS, malaria and tuberculosis. Nature 584: 169. August 12, 2020. doi: https://doi.org/10.1038/d41586-020-02334-0

[46] Dingel JI and Neiman B (2020) How Many Jobs Can Be Done at Home? National Bureau of Economic Research Working Paper #26948. April 2020

[47] Goldsetein L (2020) We're Number One! Highest Unemployment Rate in the G7. Toronto Sun. Sept. 30, 2020. https://torontosun.com/opinion/columnists/goldstein-were-number-one-highest-unemployment-rate-in-the-g7

educated workers.[48]

The economic dislocation from the lockdowns has increased the number of households where young adults who have lost their jobs co-reside with vulnerable older parents[49], which may increase the risk of COVID-related death.[50] Lockdowns thus fail the test of imposing costs and conferring benefits equitably.[51]

F. What is the magnitude of the risk children pose in disease spread? Is there any rationale for lockdown related restrictions on children?

The overwhelming weight of scientific data suggests that the risk of transmission of the virus from younger people aged 18 and below to older people is small or negligible, and the risk of transmission from people 18 to 25 to older people is small relative to the risk of transmission from people older than 25 to others older than 25.

The most important evidence on childhood spread of the disease comes from a study conducted in Iceland and published in the New England Journal of Medicine[52]. The data for this study come from Iceland's systematic screening of its population to check for the distribution of the virus in the community. This is the most important study on this topic because it is the only one that definitively establishes the direction of spread of virus from contact to contact. The study reports on both a population-representative sample and a sample of people who were tested because of the presence of symptoms consistent with COVID-19 infection. The study team isolated SARS-CoV-2 virus samples from every positive case, sequenced the genome of the virus for every case and tracked the mutation patterns in the virus. This analysis, along with contact tracing data, allowed the study team to identify definitively who passed the virus to whom. There have been hundreds of minor mutations of the virus identified, which typically do not alter the function of the virus much, but which provide a unique fingerprint, of sorts, that makes it possible to tell whether two patients could possibly have passed the virus to one another. From this analysis, the senior author of the study, Dr. Kari Stefansson, concluded[53] that "[E]ven if children do get infected, they are less likely to transmit the disease to others than adults. We have not found a single instance of a child infecting parents. There is amazing diversity in the way in which we

[48] Beland LP, Brodeur A, Mikola D, and Wright T. (2020) Here's how the coronavirus is affecting Canada's labour market. The Conversation. May 13, 2020. https://theconversation.com/heres-how-the-coronavirus-is-affecting-canadas-labour-market-137749

[49] Evandrou M, Falkingham J, Qin M, and Vlachantoni A (2020) Changing Living Arrangements, Family Dynamics and Stress During Lockdown: Evidence from Four Birth Cohorts in the UK. University of Southampton Eprint Soton. https://eprints.soton.ac.uk/443865/1/family_dynamics_during_covid_19_final.pdf

[50] Fenoll AA & Grossbard S (2020) Intergenerational residence patterns and Covid-19 fatalities in the EU and the US, Economics & Human Biology, 39. https://doi.org/10.1016/j.ehb.2020.100934.

[51] Kulldorff M and Gupta S. (2020) Canada's COVID-19 strategy is an assault on the working class. Toronto Sun. Nov. 29, 2020. https://torontosun.com/opinion/columnists/opinion-canadas-covid-19-strategy-is-an-assault-on-the-working-class

[52] Daniel F. Gudbjartsson, Ph.D., Agnar Helgason, Ph.D., et al., *Spread of SARS-CoV-2 in the Icelandic Population*, The New England Journal of Medicine, https://www.nejm.org/doi/full/10.1056/NEJMoa2006100 (June 11, 2020).

[53] Roger Highfield, *Coronavirus: Hunting Down COVID-10,* Science Museum Group, https://www.sciencemuseumgroup.org.uk/blog/hunting-down-covid-19/ (April 27, 2020).

react to the virus."

Though the Iceland survey is the only definitive study, there are a number of others that use contact tracing methods to investigate the role of children in disease spread. The bulk of such studies conclude that children play a small role, consistent with the Iceland data. A French study[54], conducted by scientists at the L'Institut Pasteur, examined data from late April 2020 on schoolteachers, students, and their parents in Crepy-en-Valois in France. The schools in France were closed from the end of January on, at first because of a February holiday and then the late February lockdown. The authors found three cases among kids in January using antibody tests but found no evidence of virus spread to other children or teachers from those early cases. Any spread between the end of January and the end of April (when the authors collected samples) must have occurred during the lockdown. The kids who tested antibody positive at the end of April, because of the circumstances of the lockdown, must have become positive from a source other than their school. The main contacts of the young children were their parents, of whom 61% were positive, which is consistent with parent to child spread. Also consistent is the fact that only 6.9% of parents tested positive in April for the virus among the children who were antibody negative. The authors' main conclusion[55] from these facts is that parents were the source of infections in school children; children were not the source. This finding mirrors the conclusion from the Icelandic study that the disease spreads less easily from children to adults than it does from adults to adults.

Researchers in Ireland conducted a similar study[56] which analyzed 1,160 children and adults in Ireland who were physically present in a school at some time between March 1st and March 13th where a COVID-19 case was identified. (Schools were closed in Ireland on March 12th). The authors found 3 children (all between 10 and 15 years old) and 3 adults who had COVID-19 infections. Their study followed students and families after the school closures to see if there was any evidence of disease spread from these identified cases. All six patients had confirmed cases of COVID-19 disease but were found to have contracted the virus from contacts outside of the school setting. Despite identifying a total of 722 contacts, the study authors reported finding no instance of an infected child infecting another child. The infected adults, by contrast, had many fewer contacts – 102 – but did pass on the infection to a few adult contacts. This, despite the fact, that the infected children engaged in "music lessons (woodwind instruments) and choir practice, both of which are high-risk activities for transmission." *Ibid*

A report[57] by the ministry of health in the Netherlands, based on contact tracing data, finds almost no disease spread by infected patients 20 years and under at all, and only limited spread by adults 20-25 to others outside their own age category. The authors of the study concluded:

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[54] Arnaud Fontanet, MD, DrPH, Rebecca Grant, et al., *SARS-CoV-2 Infection in Primary Schools in Northern France: A Retrospective Cohort Study in an Area of High Transmission,* Institut Pasteur, https://www.pasteur.fr/fr/file/35404/download (last visited July 9, 2020).

[55] *COVID-19 In Primary Schools: No Significant Transmission among Children or From Students to Teachers,* Institut Pasteur, https://www.pasteur.fr/en/press-area/press-documents/covid-19-primary-schools-no-significant-transmission-among-children-students-teachers (June 23, 2020).

[56] Laura Heavey, Geraldine Casey, et al., *No Evidence of Secondary Transmission of COVID-19 from Children Attending School in Ireland, 2020,* Eurosurveillance, https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2020.25.21.2000903#html_fulltext (May 28, 2020).

[57] *Children and COVID-19,* National Institute for Public Health and the Environment, https://www.rivm.nl/en/novel-coronavirus-covid-19/children-and-covid-19 (July 2, 2020).

"Data from the Netherlands also confirms the current understanding: that children play a minor role in the spread of the novel coronavirus. The virus is mainly spread between adults and from adult family members to children. The spread of COVID-19 among children or from children to adults is less common."

A German[58] study reports a strikingly similar finding on the likelihood of pediatric disease spread. The German Society for Pediatric Infectious Diseases collected on all children and adolescents admitted to a hospital for COVID-19 treatment between mid-March and early May 2020 – 128 patients in all, admitted to 66 different hospitals. The authors were able to find the source of infection for 38% of these patients, which turned out to be a parent 85% of the time. Though the authors document a limitation of small sample size, they conclude that "In contrast to other epidemic viral respiratory infections, the primary source of infection with SARS-CoV-2 appears not to be other children." The authors reported a single death among these 128 pediatric patients.

One of the largest studies in the world on coronavirus in schools, carried out in 100 institutions in the UK, recently confirmed that "there is very little evidence that the virus is transmitted" in schools.[59] Indeed, the president of the Royal College of Pediatrics and Child Health and a member of the government advisory group Sage confirmed that "there is very little evidence that the virus is transmitted in schools" based on this extensive study.

A study of 23 family disease clusters in Greece, published on Aug. 7th in the *Journal of Medical Virology*, found that in 91% of the clusters, an adult was the first person to be infected. Their contact tracing effort attempted to clarify the direction of disease spread by careful questioning about the relative timing of the development of symptoms. They found no evidence of either child-to-adult spread, or even child-to-child. They concluded that "[w]hile children become infected by SARS-CoV-2, they do not appear to transmit infection to others. Furthermore, children more frequently have an asymptomatic or mild course compared to adults."[60]

A study by the Federal Office of Public Health of Switzerland analyzed 793 cases reported by Swiss doctors in late July 2020.[61] The reports included the place where each patient most likely contracted the infection. The most common source of infection was at home, with 27.2% tracing their disease there. School, by contrast, consisted of only 0.3% of the infections; only two of the 793 cases could be tracked to a school. There are some limitations though of this study: first, it is a contact tracing study without genetic sequencing verification so the usual caveat applies; and second, the report provides no details about the age of the cases, so it is not possible to separately glean the disease acquisition frequencies for children and adults; and third, only summer schools

[58] Armann, J. P., Diffloth, N., Simon, A., Doenhardt, M., Hufnagel, M., Trotter, A., Schneider, D., Hübner, J., & Berner, R. (2020). Hospital Admission in Children and Adolescents With COVID-19. Deutsches Arzteblatt international, 117(21), 373–374. https://doi.org/10.3238/arztebl.2020.0373

[59] Sian Griffiths, *Pupils pose little risk of spreading COVID*, The Sunday Times (Aug. 9, 2020), available at https://www.thetimes.co.uk/article/pupils-pose-no-risk-of-spreading-covid-27q6zfd9l.

[60] Helena C. Maltezou Rengina Vorou Kalliopi Papadima, et al. (2020) "Transmission dynamics of SARS-CoV-2 within families with children in Greece: a study of 23 clusters" Journal of Medical Virology, https://doi.org/10.1002/jmv.26394 (accessed August 12, 2020).

[61] Office fédéral de la santé publique OFSP (2020) "Rectificatif : les lieux de contamination sont les contextes familiaux et non les boîtes de nuit" Aug. 2, 2020. available at https://www.bag.admin.ch/bag/fr/home/das-bag/aktuell/news/news-02-08-2020.html

were in session during this time period. Nevertheless, the results strongly suggest that schools are a minor source of community spread of the infection.

A recent South Korean contact tracing study[62] was cited in the New York Times as providing evidence that "Older Children Spread the Coronavirus Just as Much as Adults." Contrary to the interpretation of the NYT headline, the pattern of evidence reported in the study does not imply that older children spread the corona virus as much as adults. A follow-on paper on South Korean case study, reanalyzing the same data set, the same patients, and published in the *Archives of Disease in Childhood*, clarified the direction of transmission of disease by focusing only on cases without "shared exposure" to a positive case.[63] The idea in this reanalysis paper is to exclude from consideration situations where two people who are infected share a third contact who is also infected, since it is possible that third contact infected both the original two people. Using this method, the authors found a single case (out of 107 pediatric index cases and 248 household members who also tested positive) of a child passing on the disease to another household member – another child. They find no instances of a child passing the disease to an adult.

This reanalysis of the South Korean paper is instructive, and the lesson should be clear. Correlation studies and anecdotes that do not distinguish the direction of spread of disease provide no information whatsoever about the safety (or lack thereof) of school reopening. In every single instance, when a more careful analysis that identifies the direction of spread (such as this South Korean study) is conducted, the analysis finds that children pose a negligible risk of spreading the disease to adults, both at school and at home.

There are other contact tracing-based studies that have attempted to reach conclusions about the role of children in spreading the epidemic that suffer from the same problem as the original South Korean study referenced above. For instance, a pre-print study from the Italian province of Trento[64] reported on 2,812 cases who reported 6,690 contacts. Though there were only 14 children among these cases, the authors nevertheless conclude that they transmitted the disease at a high rate, infecting 11 of their 49 contacts, nearly all within the same household. This represents only a small fraction of cases and contacts that the authors analyzed, so numerically it is incorrect to conclude that children played a key role in the spread of the epidemic. Furthermore, unlike the Icelandic study, the Italian study cannot distinguish a child infecting a contact from the contact infecting the child. To my knowledge, nearly every contact-tracing based study of the role of children in the epidemic – with the Icelandic study and reanalysis of the South Korean study cited above as notable exceptions – suffers from this same problem.

A recent report, published in the *Journal of Pediatrics* and entitled "Pediatric SARS-CoV-2:

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[62] Park YJ, Choe YJ, Park O, Park SY, Kim YM, Kim J, et al. "Contact tracing during coronavirus disease outbreak, South Korea, 2020," *Emerg Infect Dis.* (Oct. 2020), available at https://doi.org/10.3201/eid2610.201315 (accessed online July 27, 2020),

[63] Kim J, Choe YJ, Lee J, et al., *Role of children in household transmission of COVID-19,* ARCHIVES OF DISEASE IN CHILDHOOD (August 7, 2020), available at doi: 10.1136/archdischild-2020-319910

[64] Pirous Fateh-Moghadam, Laura Battisti, Silvia Molinaro, Steno Fontanari, Gabriele Dallago, Nancy Binkin, Mariagrazia Zuccali (2020) "Contact tracing during Phase I of the COVID-19 pandemic in the Province of Trento, Italy: key findings and recommendations" medRxiv preprint, DOI: https://doi.org/10.1101/2020.07.16.20127357. (accessed online Aug. 6, 2020)

Clinical Presentation, Infectivity, and Immune Responses", measured the concentration of the SARS-CoV-2 virus in the nasopharynx of children who showed symptoms consistent with COVID-19 infection.[65] The report found that the viral load in pediatric patients with symptoms (typically mild symptoms) was higher than adult hospitalized patients with severe COVID-19 disease. This is consistent with reports from earlier in the epidemic, which found similarly high viral loads in children.[66] Many news media reports of the *Journal of Pediatrics* study extrapolated beyond the results of the study, with alarming headlines saying that children are "silent spreaders" of SARS-CoV-2.[67]

These media reports are misleading because the presence of virus in the nasopharynx is not synonymous with the transmissibility of the virus. The PCR test which checks for the presence of the virus registers false-positive results in the presence of non-viable, non-infectious, viral particles.[68,69,70] So even a high viral load is not evidence of infectivity.[71] The *Journal of Pediatrics* study itself appropriately lists the fact that their study does not assess the transmissibility of the virus as a limitation of the study. The only way to check for infectivity is to conduct a careful study of actual transmission of the virus, of the sort reported in the Icelandic contact tracing/viral mutation analysis referenced earlier.[72]

Another approach to this topic involves analyzing the effect of actual school closures on the spread of the epidemic within a country. If children play a role as a key vector of the epidemic, then one would expect that countries that closed schools would see a significant effect of this policy on disease spread. In fact, the opposite is the case. Studies from around the world that

[65] Lael Yonker et al. (2020) "Pediatric SARS-CoV-2: Clinical Presentation, Infectivity, and Immune Responses." *The Journal of Pediatrics* DOI: 10.1016/j.jpeds.2020.08.037 https://www.jpeds.com/article/S0022-3476(20)31023-4/fulltext

[66] Terry C Jones et al. (2020) "An Analysis of SARS-CoV-2 Viral Load by Patient Age" medRxiv. doi:https://doi.org/10.1101/2020.06.08.20125484. https://www.medrxiv.org/content/10.1101/2020.06.08.20125484v1

[67] Science Daily (2020) "Researchers show children are silent spreaders of virus that causes COVID-19" Press release, August 20, 2020. https://www.sciencedaily.com/releases/2020/08/200820102442.htm

[68] Kucirka LM, Lauer SA, Laeyendecker O, et al. (2020) Variation in False-Negative Rate of Reverse Transcriptase Polymerase Chain Reaction–Based SARS-CoV-2 Tests by Time Since Exposure. *Annals of Internal Medicine*. https://doi.org/10.7326/M20-1495

[69] Lan L, Xu D, Ye G, et al. (2020) Positive RT-PCR Test Results in Patients Recovered From COVID-19. JAMA. 2020;323(15):1502–1503. doi:10.1001/jama.2020.2783

[70] Cohen AN, Kessel B (2020) False positives in reverse transcription PCR testing for SARS-CoV-2. medRxiv 2020.04.26.20080911; doi: https://doi.org/10.1101/2020.04.26.20080911. Accessed 7/22/2020.

[71] Gavin Joynt and William Wu (2020) "Understanding COVID-19: what does viral RNA load really mean?" Lancet Infectious Diseases 20(6): P635-6. DOI:https://doi.org/10.1016/S1473-3099(20)30237-1 https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(20)30237-1/fulltext

[72] Daniel F. Gudbjartsson, Ph.D., Agnar Helgason, Ph.D., et al., Spread of SARS-CoV-2 in the Icelandic Population, The New England Journal of Medicine, https://www.nejm.org/doi/full/10.1056/NEJMoa2006100 (June 11, 2020).

have examined school closures (including Japan[73], New South Wales[74], and Sweden/Finland[75]) find little or no effect of school closure on disease spread. The studies encompass closures of both elementary schools and high schools. A study[76] analyzing the Swedish experience concluded that there was there was no additional risk to elderly people cohabiting with school age children up to age 16, despite the fact that Swedish schools were kept open throughout the epidemic. A systematic review of this evidence[77] concluded that even though it may be possible for children to be infected with the virus and even transmit it, "[o]pening up schools and kindergartens is unlikely to impact COVID-19 mortality rates in older people."

One purported counterexample to this evidence that has received widespread attention involves the reopening of schools in Israel in the early summer.[78] While the Israeli opening of schools is cited as a counterexample to the many other studies showing the negligible risk of transmitting COVID-19 by children, the Israeli reports suggest it was a unique circumstance, with children crowded into a small closed space and few precautions taken against disease spread. The New York Times story cited above provides an illustrative anecdote of symptomatic teachers passing the virus to their students. And the primary source of disease spread at the Gymnasia Rehavia high school was a single symptomatic teacher infecting colleagues and students. Additionally, an analysis of cell-phone mobility data, conducted by Dr. Scott Atlas, shows that by the end of May, Israel had returned to pre-pandemic norms.[79] Contemporary reports, which emphasize the success of Israel in controlling the epidemic, suggest that Israelis reduced adherence to other mitigation measures as well. The cases that arose in Israeli schools are more likely a reflection of pre-existing community spread of the virus, rather than as a cause.

Thus, with no careful study to back it, and several lines of evidence that complicate any causal inference, the role of school opening in the resurgence of COVID-19 cases in Israel is not established. If there is a lesson to be learned, it is that schools can be opened safely for in-person learning if reasonable precautions – specific to the circumstances of each school – are taken. In the Israeli case, as with much of the anecdotal evidence cited, no viral sequencing analysis was conducted to verify the direction of disease spread. A report in *Science* emphasizes that no causal connection should be inferred from the correlation between Israeli school openings and the rise

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[73] Kentaro Iwata, Asako Doi, and Chisato Miyakoshi (2020) "Was school closure effective in mitigating coronavirus disease 2019 (COVID-19)? Time series analysis using Bayesian inference" *International Journal of Infectious Diseases*. DOI: https://doi.org/10.1016/j.ijid.2020.07.052 (accessed online Aug. 6, 2020).

[74] Kristine Macartney, Helen Quinn, Alexis Pillsbury, et al. (2020) "Transmission of SARS-CoV-2 in Australian Educational Settings: A Prospective Cohort Study" *The Lancet Child & Adolescent Health*. DOI: https://doi.org/10.1016/S2352-4642(20)30251-0 (accessed online Aug. 6, 2020)

[75] Public Health Agency of Sweden (2020) "COVID-19 in Schoolchildren: A Comparison between Finland and Sweden" https://www.folkhalsomyndigheten.se/contentassets/c1b78bffbfde4a7899eb0d8ffdb57b09/covid-19-school-aged-children.pdf (accessed online Aug. 6, 2020)

[76] Brandén, Maria; Aradhya, Siddartha; Kolk, Martin; Härkönen, Juho; Drefahl, Sven; Malmberg, Bo; et al. (2020): Residential Context and COVID-19 Mortality among the Elderly in Stockholm: A population-based, observational study. Stockholm Research Reports in Demography. Preprint. https://doi.org/10.17045/sthlmuni.12612947.v1 (accessed online Aug. 6, 2020)

[77] Jonas Ludvigsson (2020) "Children are Unlikely to be the Main Drivers of the COVID-19 Pandemic – A Systematic Review" *Acta Paediatrica*, DOI: 10.1111/apa.15371 (accessed online Aug. 6, 2020).

[78] Isabel Kershner and Pan Belluck (2020) "When COVID Subsided, Israel Reopened Its Schools. It Didn't Go Well." New York Times. Aug. 4, 2020. https://www.nytimes.com/2020/08/04/world/middleeast/coronavirus-israel-schools-reopen.html (Accessed online Aug. 6, 2020)

[79] Personal communication.

in cases there: "In Israel, infections among children increased steadily after schools opened. That paralleled a rise in cases nationwide, but it's not clear whether the country's rising caseload contributed to the increase within schools or vice versa."

Another purported counter example comes from the experience with the epidemic at an overnight camp in Georgia.[80] The summer camp anecdote is no analogy for schools. There, the kids were older, they slept together in crowded cabins, and engaged in lots of singing and screaming. Many of the children who developed symptoms did so within two days of arriving at the camp. Since the time between viral exposure and symptom development is typically longer than two days, this suggests strongly that many of the children in the camp were infected prior to their arrival at the camp. Some developed cases more than two weeks after leaving the camp. Since symptom development – if it happens at all – is typically within two weeks of infection, this leaves open the possibility that the campers were exposed at home. Since this outbreak corresponds to a time when community spread was common in Georgia, these are not just theoretical possibilities, and indeed likely. Finally, as with many of the correlational contact tracing studies, there is no indication of whether the transmission was from staff to student, or student to student.

In sharp contrast with the Georgia summer camp report, a large study of 1,900 children attending an urban summer schools in Barcelona, Spain over a five-week period found only 39 new index cases (30 pediatric).[81] The setting was chosen because the investigators viewed it as a model for what to expect from school openings in the fall. These kids had 253 contacts in total, of whom, only 12 developed an infection – a secondary attack rate of 4.7%. The low secondary attack rate was similar for children of all ages attending the programs, ranging up to 17 years-old. The investigators attributed the success in controlling the spread of the disease to frequent hand washing by the children and to organizing the children into "bubbles" so that the kids interacted with the same group of children all day long.

A recent and comprehensive official report by Public Health England of the role of English schools, which were reopened on June 1, 2020 despite high community case numbers, in spreading the pandemic.[82] The author of this report found that cases and outbreaks were "uncommon across all educational settings" and that "[s]taff members had an increased risk of SARS-CoV-2 infections compared to students in any educational setting, and the majority of cases linked to outbreaks were in staff." In response to this study, UK education minister Gavin Williamson said "The latest research, which is expected to be published later this year – one of the largest studies on the coronavirus in schools in the world – makes it clear there is little

[80] Caitlin McGabe, *Latest Research Points to Children Carrying, Transmitting Coronavirus*, THE WALL STREET JOURNAL (Aug. 9, 2020), available at https://www.wsj.com/articles/latest-research-points-to-children-carrying-transmitting-coronavirus-11596978001?st=4rrxzoyo0jou5ns&reflink=article_email_share.
[81] Oriel Guell (2020) *Major coronavirus study in Spanish summer camps shows low transmission among children*. El Pais. (Aug. 26, 2020) available at https://english.elpais.com/society/2020-08-26/major-coronavirus-study-in-spanish-summer-camps-shows-low-transmission-among-children.html
[82] Sharif Ismail et al. (2020) "SARS-CoV-2 infection and transmission in educational settings: cross-sectional analysis of clusters and outbreaks in England" Public Health England, Aug. 12, 2020 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/911267/School_Outbreaks_Analysis.pdf

evidence that the virus is transmitted at school."[83]

The overwhelming bulk of scientific studies that have examined the topic – including the best studies, which take pains to distinguish correlation from causation – find that children play a limited role in spreading COVID-19 infection to adults and that children themselves face minimal risk of poor outcomes if they should become infected.

In summary, Canadian responses to the epidemic have included many limits on the activities of children, including but not limited to closures of schools, limitations to in class teaching, suspension or limits of sports and activities, and restricted contact with friends. Given the evidence cited here, these policies are inconsistent with the principle that public health decisions must be grounded in good scientific evidence.

G. Do Restrictions on the Activities of Young Adults Play an Important Role in Disease Spread? Do Young adults face particular harms from the lockdown restrictions?

Unlike children, young adults who are infected – especially early in infection – spread disease as efficiently older adults. However, they are harmed by infection much less than older adults. Young adults face a very low mortality risk from COVID-19 infection – an infection survival rate of 99.98% for people aged 20-49, according the US CDC.[84]

By contrast, young adults face enormous harm from lockdowns. Indicators of psychological harm have also increased sharply in prevalence in this group. According to a US CDC survey, one in four young adults aged 18 to 24 years seriously considered suicide.[85] Other harms include lost educational opportunities with colleges and universities shutting down or providing only online classes and catastrophically high unemployment and economic dislocation.[86] Ironically, the lockdowns themselves have thus increased the risk of COVID-19 faced by older populations by increasing the number of households where young adults who have lost their jobs co-reside with vulnerable older parents[87], which increases the risk of COVID-related death.[88]

For young adults then, the harms from lockdowns are substantially greater than the harms from

[83] Peter Walker (2020) "Little Evidence COVID Spreads in Schools, says Gavin Williamson" *The Guardian*, Aug. 10, 2020. https://www.theguardian.com/world/2020/aug/10/little-evidence-covid-spreads-in-schools-says-gavin-williamson

[84] COVID- 19 Pandemic Planning Scenarios, Centers for Disease Control and Prevention, https://www.cdc.gov/coronavirus/2019-ncov/hep/planning-scenarios.html.

[85] Czeisler MÉ , Lane RI, Petrosky E, et al. Mental Health, Substance Use, and Suicidal Ideation During the COVID-19 Pandemic — United States, June 24–30, 2020. MMWR Morb Mortal Wkly Rep 2020;69:1049–1057. DOI: http://dx.doi.org/10.15585/mmwr.mm6932a1external icon

[86] Sharp A. (2020) Youth unemployment rate spikes amid pandemic. Canada's National Observer. May 8, 2020. https://www.nationalobserver.com/2020/05/08/news/youth-unemployment-rate-spikes-amid-pandemic

[87] Evandrou M, Falkingham J, Qin M, and Vlachantoni A (2020) Changing Living Arrangements, Family Dynamics and Stress During Lockdown: Evidence from Four Birth Cohorts in the UK. University of Southampton Eprint Soton. https://eprints.soton.ac.uk/443865/1/family_dynamics_during_covid_19_final.pdf

[88] Fenoll AA & Grossbard S (2020) Intergenerational residence patterns and Covid-19 fatalities in the EU and the US, Economics & Human Biology, 39. https://doi.org/10.1016/j.ehb.2020.100934.

COVID. Viewed as a medical treatment, lockdowns imposed on younger populations violates the ethical principle that medical actions should do no harm to the patient. Unlike, chemotherapy for cancer, which induces a short-term harm to a patient in exchange for a potential longer-term benefit, lockdowns cause long lasting harm to young adults with little to no long-lasting benefit.

H. Can religious services be held safely? Are there particular benefits that derive from communal singing?

Religious activity is essential to a meaningful life for many Canadians, and the free exercise of religion is guaranteed by the country's constitution. Because assembly for religious practice is so important to so many, rather than recommending that religious assembly be canceled during the pandemic, the World Health Organization has provided guidance for religious assembly in the context of COVID-19.[89] The US CDC provides similar guidance and is instructive in the North American context.

The CDC guidance for communities of faith starts by recognizing the particular importance that religious communities should be permitted to gather for worship.[90] The CDC document cites the First Amendment right to the free exercise of religion, and reminds state and local authorities to account for this right in decision making about permitting religious communities to meet. Similar guarantees are present in the Canadian constitution, as these involve fundamental human rights. The recommendations in the CDC guidance include: (1) communication with local public health authorities regarding in person service plans; (2) protection for staff who are at higher risk for severe illness, including older staff members and those with underlying medical conditions; (3) encouragement of the congregation and staff to engage in hygienic hand washing practices; (4) encourage the congregation and staff to wear masks when social distancing is difficult, (5) promote six-foot social distancing during worship and reduce physical contact (shaking hands, hugging); (6) disinfection and cleaning of the worship space before and after each service; (7) minimize sharing of worship materials and shared food; (8) encourage staff and congregants with symptoms consistent with COVID-19 infection or at high mortality risk given infection (e.g. elderly congregants and those with relevant comorbid conditions) to stay home; and (9) post signs and messages to communicate information about practices that can lead to disease spread. The CDC document is pointedly silent on singing during worship and does not make any explicit recommendations regarding communal singing. These guidelines require social distancing, which can reduce the likelihood of disease spread, but do not require – as Quebec does[91] -- a limitation to a fixed number of people in a service regardless of the size of the church, which has

[89] World Health Organization (2020) Practical Considerations and Recommendations for Religious Leaders and Faith-Based Communities in the Context of COVID-19. https://www.who.int/publications/i/item/practical-considerations-and-recommendations-for-religious-leaders-and-faith-based-communities-in-the-context-of-covid-19
[90] US Centers for Disease Control (2020) Considerations for Communities of Faith. https://www.cdc.gov/coronavirus/2019-ncov/community/faith-based.html
[91] Gloutnay F. (2020) Quebec government limits churches to 50 people, 25 in riskier regions. Catholic News Service. Sept. 22, 2020. https://www.catholicnews.com/quebec-government-limits-churches-to-50-people-25-in-riskier-regions/

no scientific justification.

By following these guidelines, churches, mosques, synagogues, and other religious assemblies can safely hold indoor worship services, with minimal effect on the spread of COVID-19 disease.

Against the cost of a marginal increase in disease spread (a harm that can be mitigated by following safety protocols), should be considered the overwhelming evidence that church attendance provides psychological benefits for attendees. A comprehensive meta-analysis of the literature found evidence of improved mental health from religiosity (typically defined to encompass church attendance).[92] This is consistent with the broader literature on the psychological benefits of membership in voluntary associations as way to alleviate psychological distress.[93] The evidence suggesting psychological benefits of church attendance (including reductions in rates of depression) are particularly strong for adolescents.[94] Church attendance reduces stress and allostatic load (a term indicating stress endured over a long period of time),[95] which can cause both psychological and physical harms, including higher incidence of chronic disease and higher mortality.[96] There is also evidence in the medical literature regarding the particular psychological benefits provided by communal singing in the process of worship.[97,] Communal singing provides a sense of belonging and connectedness that is crucially important in the life of many believers, with measurable effects on mental health.[98,99,100]

Of course, the spiritual benefits of in-person religious observance are personal to every member of the religious communities and should not be discounted even if they are not discretely measurable in terms of health benefits. For many believers, faith provides purpose in life.

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[92] Hackney, C. H., & Sanders, G. S. (2003). Religiosity and Mental Health: A Meta-Analysis of Recent Studies. Journal for the Scientific Study of Religion, 42(1), 43–55. https://doi.org/10.1111/1468-5906.t01-1-00160

[93] Rietschlin, J. (1998). Voluntary Association Membership and Psychological Distress. Journal of Health and Social Behavior, 39(4), 348–355. https://doi.org/10.2307/2676343

[94] Demir, M., & Urberg, K. A. (2004). Church attendance and well-being among adolescents. Journal of Beliefs and Values, 25(1), 63–68. https://doi.org/10.1080/1361767042000198951

[95] Bruce, M. A., Martins, D., Duru, K., Beech, B. M., Sims, M., Harawa, N., Vargas, R., Kermah, D., Nicholas, S. B., Brown, A., & Norris, K. C. (2017). Church attendance, allostatic load and mortality in middle aged adults. PLOS ONE, 12(5), e0177618. https://doi.org/10.1371/journal.pone.0177618

[96] Juster, R. P., McEwen, B. S., & Lupien, S. J. (2010). Allostatic load biomarkers of chronic stress and impact on health and cognition. In Neuroscience and Biobehavioral Reviews (Vol. 35, Issue 1, pp. 2–16). Pergamon. https://doi.org/10.1016/j.neubiorev.2009.10.002

[97] Shakespeare T & Whieldon A (2017) Sing Your Heart Out: community singing as part of mental health recovery. *Medical Humanities*, 44(3) http://dx.doi.org/10.1136/medhum-2017-011195

[98] Clift S , Hancox G , Morrison I , et al . Choral singing and psychological wellbeing: quantitative and qualitative findings from english choirs in a cross-national survey. *J Applied Arts & Health* 2010;1:19–34.doi:10.1386/jaah.1.1.19/1

[99] Clift S , Morrison I . Group singing fosters mental health and wellbeing: findings from the East Kent 'singing for health' network project. *Mental Health and Social Inclusion* 2011;15:88–97.doi:10.1108/20428301111140930

[100] Livesey L , Morrison I , Clift S , et al . Benefits of choral singing for social and mental wellbeing: qualitative findings from a cross-national survey of choir members. *J Public Ment Health* 2012;11:10–26.doi:10.1108/17465721211207275

I. Can restaurants and bars be opened safely to customers? Are there particular benefits that derive from eating in community?

Quebec is the home to a vibrant restaurant and food service industry, including world-class eateries, bars, and cafes. It is an important industry that provides entrepreneurial and employment opportunities that benefit the people of Quebec in many ways, including providing psychologically important opportunities to eat together with friends and family. These facilities remain closed throughout Quebec despite the reservations of Quebec' public health director, Dr. Horacio Arruda, who cites evidence that restaurants are not a major source of COVID-19 disease spread in Quebec.[101] These closure orders are not scientifically justified.

If restaurants, bars, etc. adhere to basic safety protocols promulgated by public health agencies throughout Canada (the protocols in Alberta are a typical example[102]), they can operate with in person service safely. The recommendations include the following (among other items not listed here): (1) discourage patrons from congregating together while waiting for seating; (2) limit party size at tables and require a 2 meter distance between each dining party; (3) provide for physical barriers between tables when 2 meter distance is impossible; (4) use contactless payments and avoid cash payments where possible; (5) clean menus between uses or use paper menus; (6) avoid singing, or provide physical distancing between singers and patrons; (7) all employees must wear acceptable face covering at all times; (8) frequent sanitizing of surfaces, (9) encourage symptom checking of potential patrons and do not serve patrons who have symptoms consistent with COVID-19 disease.

In New York City, where a similar set of recommendations were in place for restaurants and bars restaurants which were permitted to operate for in-person dining (until a new closure order[103] was put in place effective Dec. 14, 2020), a detailed contact tracing report found that restaurants and bars in New York City only account for 1.4% of the COVID spread. In that study, private gatherings at home account for 74% of the COVID spread.[104]

This finding should not be surprising. The scientific evidence now strongly suggests that COVID-19 infected individuals who are asymptomatic (that is, show no symptoms of a respiratory infection) are more than an order of magnitude less likely spread the disease to even close contacts than symptomatic COVID-19 patients. Requiring a check of potential patrons for symptoms consistent with COVID-19 disease, permitting only people without symptoms to enter the premises and dine indoors, thus suffices to sharply curb the probability of disease spread during the in-person dining experience. A meta-analysis of 54 studies from around the world

[101] Silva V (2020) Quebec's Top Doctor Wasn't the One Behind Restaurant Closures. Dec. 10, 2020. https://montreal.eater.com/2020/12/10/22167312/arruda-didnt-recommend-restaurants-close-coronavirus-pandemic-quebec

[102] Alberta Public Health (2020) COVID-19 Information: Guidance for restaurants, cafes, pubs, and bars. September 2020.

[103] Klein C. (2020) New York City Indoor Dining Will Shut Down Again. *Intelligencer*. Dec. 11, 2020. https://nymag.com/intelligencer/2020/12/new-york-city-indoor-dining-to-shut-down-again-over-covid-19.html

[104] Adams E and Warerkar T (2020) Restaurants and Bars Account for 1.4 Percent of COVID-19 Spread in New York. Dec. 11, 2020. https://ny.eater.com/2020/12/11/22169841/restaurants-and-bars-coronavirus-spread-data-new-york

found that within households – where none of the safeguards that restaurants are required to apply are typically applied – symptomatic patients passed on the disease to household members in 18% of instances, while asymptomatic patients passed on the disease to household members in 0.7% of instances.[105] A large study of 10 million residents of Wuhan, China, all tested for the presence of the virus, found a total of 300 total cases, all asymptomatic. A comprehensive contact tracing effort identified 1,174 close contacts of these patients, none of whom tested positive for the virus.[106] This is consistent with a vanishingly low level of asymptomatic spread of the disease. While theoretical modeling work from earlier in the epidemic (including some of my own published research[107]) predicts some level of asymptomatic disease spread, the empirical evidence at this point later in the epidemic strongly shows very little evidence that this is an important empirical reality. So as long as restaurants follow guidelines to exclude potential symptomatic diners, in-person dining can occur safely.

Against these data regarding the negligible risks of COVID-19 transmission in indoor dining (in a restaurant following guidelines) should be considered the substantial evidence that social eating provides significant and tangible psychological and physiological benefits for diners that are lost through the imposition of such scientifically and epidemiologically unjustified blanket and untargeted bans. Those who eat socially more often feel happier and are more satisfied with life, are more trusting of others, are more engaged with their local communities, and have more friends they can depend on for support; path analysis suggests that the causal connection runs from eating together to bondedness rather than the other way around.[108] Dining together reduces people's perceptions of inequality and contributes to a view of those of different races, genders and socioeconomic backgrounds as more equal than in other social scenarios.[109] And a comprehensive survey of 17,612 men and 19,581 women over the age of 65 found that eating alone has been linked to a higher incidence of depression among adults, particularly those who live alone.[110] Eliminating the possibility of indoor dining, no matter the precautions taken, reduces or eliminates these important benefits.

J. Can gyms, martial arts studios, and other venues offering opportunities for physical activities open with minimal risk of disease spread? Are there particular benefits to health that derive from access to such facilities?

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[105] (Madewell ZJ, Yang Y, Longini IM, Halloran ME, Dean NE. Household Transmission of SARS-CoV-2: A Systematic Review and Meta-analysis. *JAMA Netw Open*. 2020;3(12):e2031756. doi:10.1001/jamanetworkopen.2020.31756)

[106] (Cao, S., Gan, Y., Wang, C. et al. Post-lockdown SARS-CoV-2 nucleic acid screening in nearly ten million residents of Wuhan, China. *Nat Commun* 11, 5917 (2020). https://doi.org/10.1038/s41467-020-19802-w)

[107] (Peirlinck et al., *op cit*.)

[108] (Dunbar, *Breaking Bread: the Functions of Social Eating*, *Adaptive Human Behavior and Physiology* (*available at* https://link.springer.com/article/10.1007/s40750-017-0061-4)).

[109] (Julier, *Eating Together: Food, Friendship and Inequality*, The University of Illinois Press (2014)).

[110] Tani, et al, *Eating alone and depression in older men and women by cohabitation status: the JAGES longitudinal survey*, *Age Ageing* 44(6) 1019-1026 (2015) (*available at* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4621239/).

Gyms, martial arts studios, dance studios, and other venues offering opportunities physical activities are important to many Canadians as a way of staying physically fit and healthy. Despite the importance of these venues to public health, in much of Canada, Quebec included, the lockdown orders have ordered them to stay closed for extended periods during the past months. These orders are unjustified.

First, though Quebec premier Francois Legault has asserted that opening gyms poses particular risk to disease spread, to my knowledge the public health authorities in Quebec have provided no studies – based on contact tracing or other data – to document this statement in Quebec.[111] There is one report of a "super-spreader" event that occurred in a gym in Ontario in October.[112] In that case, there was a spinning class, with stationary bicycles with wheels that in theory could aerosolize the virus. If that is true, the right remedy is to limit indoor spin classes or require physical barriers between bicycles, not to shutter gyms and fitness venues altogether. In the CBC story reporting on this event cited one infectious disease expert who admitted that gyms are not high-risk environments:

> Dr. Ilan Schwartz, an infectious disease expert with the University of Alberta, said spin classes may pose more risk than other group settings because of the bikes themselves. In theory, the rapidly spinning wheels could aerosolize droplets by flinging them farther distances.
>
> "I haven't seen any studies of this, but theoretically it makes sense," he said.
>
> "I think going to the gym isn't necessarily high-risk, unless individuals are close together and there's poor ventilation. But there might be specific circumstances that could make it higher-risk, where something with fast, moving parts [or] a rapidly moving fan can generate aerosols as well."

Compared with this sort of anecdotal evidence, there are more systematic data from other localities that suggest that physical fitness centers play a limited role in disease spread.[113] In a sophisticated study published in *Nature* analyzing the relationship between mobility of populations, super-spreader events and disease risk, the authors conclude that restricting occupancy in public venues is the best approach to limiting the risk of disease spread, while lockdowns aimed at general mobility restrictions work less well.[114] They find that fitness centers do not pose a very high risk of disease spread relative to other public venues.

Second, guidelines disseminated by public health agencies around Canada provide discrete steps

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[111] Laframboise K (2020) Quebec gym owners, clients who flout COVID-19 red zone rules will face fines: Legault. *Global News*. October 27, 2020. https://globalnews.ca/news/7425270/quebec-gyms-coronavirus-red-zones-fines/

[112] Zuber MC. (2020) Heavier breathing, spewing droplets, poor ventilation add to gyms' superspreading risk. CBC. October 15, 2020. https://www.cbc.ca/news/health/gyms-superspreading-events-covid-19-1.5763297

[113] UK Office for National Statistics (2020) Which occupations have the highest potential exposure to the coronavirus (COVID-19)? May 11, 2020. https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/articles/whichoccupationshavethehighestpotentialexposuretothecoronaviruscovid19/2020-05-11

[114] Chang S, Pierson E, Koh PW, Gerardin J, Redbird B, Grusky D, Leskovec J. Mobility network models of COVID-19 explain inequities and inform reopening. Nature. 2020 Nov 10. doi: 10.1038/s41586-020-2923-3. Epub ahead of print. PMID: 33171481.

that fitness centers can take to reduce the risk of spread of the disease at these centers.[115] These steps include physical distancing requirements, physical barriers, ventilation requirements, symptom checking, cleaning requirements, and face masks when physical distancing is impossible. Given the findings in the scientific literature, these requirements – if implemented appropriately – are sufficient to limit the probability of disease spread at fitness centers.

Third, closing fitness centers reduces the ability of the population to engage in activities that maintain physical fitness, and thus increase the risk of poor outcomes if a COVID-19 infection were to occur. For example, obesity is a risk factor for mortality from COVID-19 infection. Regular exercise is essential for patients with type 2 diabetes[116] or cardiovascular disease[117] to maintain their health. Exercise also provides people with anxiety, depression, and stress-related disorders with an important avenue to address these problems.[118, 119] The negligible benefits of closing fitness centers in terms of slowing disease spread should be balanced against the health benefits of these centers for people who frequent them.

In summary, if fitness centers take standard precautions as recommended by Canadian public health agencies (symptom checking, good ventilation, physical barriers, etc.) the risk of COVID-19 disease spread from their operation is small. The most comprehensive studies confirm that fitness centers play a small role in disease spread. And finally, there are considerable harms to health – both physical and psychological health – from reducing the availability of venues for physical fitness for the population.

K. Do other measures exist that would achieve the goal of the government to protect the population from the Covid-19, but that would have less or no impairments on the freedoms and liberties of the population? If yes, what are they?

Yes. The Great Barrington Declaration, of which I am a primary coauthor, describes an alternate policy of focused protection. This policy would lead to less COVID-related death and less non-COVID related deaths than the current government policy. The coauthors of the Declaration include Prof. Martin Kulldorff of Harvard University and Prof. Sunetra Gupta of Oxford University. Over 12,000 epidemiologists and public health professionals, and 35,000 medical professionals have co-signed the declaration. The text of the Great Barrington Declaration is

[115] Government of Canada (2020) Community-based measures to mitigate the spread of coronavirus disease (COVID-19) in Canada. October 15, 2020. https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/health-professionals/public-health-measures-mitigate-covid-19.html#_Community_gathering_spaces

[116] Kirwan JP, Sacks J, Nieuwoudt S. The essential role of exercise in the management of type 2 diabetes. Cleve Clin J Med. 2017 Jul;84(7 Suppl 1):S15-S21. doi: 10.3949/ccjm.84.s1.03. PMID: 28708479; PMCID: PMC5846677.

[117] Nystoriak MA and Bhatnagar A (2020) Cardiovascular Effects and Benefits of Exercise. Front. Cardiovasc. Med., 28 September 2018 | https://doi.org/10.3389/fcvm.2018.00135

[118] Craft, Lynette L., and Frank M. Perna. "The Benefits of Exercise for the Clinically Depressed." Primary care companion to the Journal of clinical psychiatry vol. 6,3 (2004): 104-111. doi:10.4088/pcc.v06n0301

[119] Stubbs B, Vancampfort D, Rosenbaum S, Firth J, Cosco T, Veronese N, Salum GA, Schuch FB. An examination of the anxiolytic effects of exercise for people with anxiety and stress-related disorders: A meta-analysis. Psychiatry Res. 2017 Mar;249:102-108. doi: 10.1016/j.psychres.2016.12.020. Epub 2017 Jan 6. PMID: 28088704.

copied immediately below.[120]

> "As infectious disease epidemiologists and public health scientists we have grave concerns about the damaging physical and mental health impacts of the prevailing COVID-19 policies and recommend an approach we call Focused Protection.
>
> Coming from both the left and right, and around the world, we have devoted our careers to protecting people. Current lockdown policies are producing devastating effects on short and long-term public health. The results (to name a few) include lower childhood vaccination rates, worsening cardiovascular disease outcomes, fewer cancer screenings and deteriorating mental health – leading to greater excess mortality in years to come, with the working class and younger members of society carrying the heaviest burden. Keeping students out of school is a grave injustice.
>
> Keeping these measures in place until a vaccine is available will cause irreparable damage, with the underprivileged disproportionately harmed.
>
> Fortunately, our understanding of the virus is growing. We know that vulnerability to death from COVID-19 is more than a thousand-fold higher in the old and infirm than the young. Indeed, for children, COVID-19 is less dangerous than many other harms, including influenza.
>
> As immunity builds in the population, the risk of infection to all – including the vulnerable – falls. We know that all populations will eventually reach herd immunity – i.e. the point at which the rate of new infections is stable – and that this can be assisted by (but is not dependent upon) a vaccine. Our goal should therefore be to minimize mortality and social harm until we reach herd immunity.
>
> The most compassionate approach that balances the risks and benefits of reaching herd immunity, is to allow those who are at minimal risk of death to live their lives normally to build up immunity to the virus through natural infection, while better protecting those who are at highest risk. We call this Focused Protection.
>
> Adopting measures to protect the vulnerable should be the central aim of public health responses to COVID-19. By way of example, nursing homes should use staff with acquired immunity and perform frequent PCR testing of other staff and all visitors. Staff rotation should be minimized. Retired people living at home should have groceries and other essentials delivered to their home. When possible, they should meet family members outside rather than inside. A comprehensive and detailed list of measures, including approaches to multi-generational households, can be implemented, and is well within the scope and capability of public health professionals.

[120] Bhattacharya J, Gupta S, Kulldorff M (2020) Great Barrington Declaration. https://gbdeclaration.org

> Those who are not vulnerable should immediately be allowed to resume life as normal. Simple hygiene measures, such as hand washing and staying home when sick should be practiced by everyone to reduce the herd immunity threshold. Schools and universities should be open for in-person teaching. Extracurricular activities, such as sports, should be resumed. Young low-risk adults should work normally, rather than from home. Restaurants and other businesses should open. Arts, music, sport and other cultural activities should resume. People who are more at risk may participate if they wish, while society as a whole enjoys the protection conferred upon the vulnerable by those who have built up herd immunity."

The Great Barrington Declaration provides concrete suggestions for a strategy of focused protection. This includes a (non-comprehensive) suite of policies aimed at protecting people who are particularly vulnerable (e.g. the elderly) to mortality from COVID-19 infection. These policies differ depending on the particular living situation of vulnerable people. The current policies have failed to protect the vulnerable, as is evidence by the large fraction of the COVID-19 deaths among the elderly in Canada. There have been many unnecessary deaths, and especially among the urban working class and poor.[121] Concrete examples of these failures include:

- Requiring older "essential" workers and members of the working class that cannot afford not to work to be put in work situations where they may be exposed to the virus.

- Failure to protect nursing home residents from exposure to the virus from staff members, visitors, and other residents.[122]

- No provision for elderly people living in multi-generational homes to be shielded should a family member be exposed to the virus.

Focused protection of the vulnerable provides a better alternative to lockdown to protect the vulnerable. Below, in Section M, I outline ideas for focused protection.

In summary, the Great Barrington Declaration offers a policy alternative to lockdowns that reduces COVID-19 related mortality among the vulnerable via overwhelm resources devoted focused protection where they live. For the non-vulnerable, the lifting of lockdowns provides an enormous benefit for physical and psychological health – including mortality risk – that offsets the harm from potential COVID-19 infection.

[121] Kulldorff M and Gupta S (2020) Canada's COVID-19 strategy is an assault on the working class. Toronto Sun. Nov. 29, 2020. https://torontosun.com/opinion/columnists/opinion-canadas-covid-19-strategy-is-an-assault-on-the-working-class

[122] Kwiatkowski M, Nadolny TL, Priest J, Stucka M (2020) 'A National Disgrace': 40,600 deaths tied to US Nursing Homes. USA Today. June 1, 2020. https://www.usatoday.com/story/news/investigations/2020/06/01/coronavirus-nursing-home-deaths-top-40-600/5273075002/

L. Is there immunity obtained after being infected and cured from Covid-19?

Yes. The scientific evidence is overwhelming that there is lasting immunity after SARS-CoV-2 infection among people who recover from the infection.

First, SARS-CoV-2 is a coronavirus and humans been exposed to coronaviruses for millenia. Immunologists reviewing this evidence of immunity after coronavirus infection argue that we should use this knowledge to set prior expectations about human immune response to SARS-CoV-2 infection, and these priors suggest a robust and long-lasting immune response. In the *Journal of Immunology*, immunologist Nicole Baumgarth and her colleagues write:[123]

> "[W]e argue that the normal cadence by which we discuss science with our colleagues failed to properly convey likelihoods of the immune response to SARS-CoV-2 to the public and the media. As a result, biologically implausible outcomes were given equal weight as the principles set by decades of viral immunology. Unsurprisingly, questionable results and alarmist news media articles have filled the void. We suggest an emphasis on setting expectations based on prior findings while avoiding the overused approach of assuming nothing. After reviewing Ab-mediated immunity after coronavirus and other acute viral infections, we posit that, with few exceptions, the development of protective humoral immunity of more than a year is the norm. Immunity to SARS-CoV-2 is likely to follow the same pattern."

The direct evidence in favor of a robust and long-lasting immune response is also overwhelming. In a paper published in the journal *Immunity*, immunologist Deepta Bhattacharya (no relation) and his colleagues show that recovered COVID-19 patients show "durable antibody production for at least 5-7 months after infection."[124] Several other studies, published in prominent immunology journals, confirm this report and show that the vast majority of people who are infected produce specific antibodies in response to the infection, which confer immunity or substantial protection against reinfection.[125, 126]

Over time, as is the normal course of an infection, the specific antibodies to SARS-CoV-2 infection fade. The immune memory persists in dormant or resting cells, called memory cells, who do not actively secrete antibodies, but nevertheless continue to provide lasting protection against SARS-CoV-2 infection. This is entirely consistent with a typical immune response to a challenge by a virus like SARS-CoV-2. Viral infections are most often addressed through CD8 T cells, which do not produce antibody, but rather directly eliminate virus-infected cells to shortcut viral replication. Indeed, SARS-CoV-2 specific CD4 and CD8 T cells have been detected in

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[123] Baumgarth N, Nikolich-Zugich J, Lee FEH, Bhattacharya D. (2020) Antibody Responses to SARS-CoV-2: Let's Stick to Known Knowns.

[124] Ripperger TJ et al. (2020) Orthogonal SARS-CoV-2 Serological Assays Enable Surveillance of Low-Prevalence Communities and Reveal Durable Humoral Immunity. *Immunity* 53, 925–933. Nov. 17, 2020. https://doi.org/10.1016/j.immuni.2020.10.004

[125] Ni, Ling, et al. (2020) "Detection of SARS-CoV-2-specific humoral and cellular immunity in COVID-19 convalescent individuals." *Immunity*. https://doi.org/10.1016/j.immuni.2020.04.023

[126] Moderbacher CR et al. "Antigen-specific adaptive immunity to SARS-CoV-2 in acute COVID-19 and associations with age and disease severity." Cell 183.4 (2020): 996-1012. DOI:https://doi.org/10.1016/j.cell.2020.09.038

convalescent patients.[127]

This T-cell mediated immunity is also long lasting. A preprint study released last month documents this fact, and the title of the piece summarizes its result: "Robust SARS-CoV-2 specific T-cell Immunity is Maintained at Six Months Following Primary Infection."[128] Another pre-print released last month identifies long-lasting protection after SARS-CoV-2 infection from memory B-cells, which can produce specific antibodies in response to reinfection by the virus.[129]

Finally, it is apparently the case that many individuals who have not been infected by SARS-CoV-2 possess T-cells that recognize it and can neutralize cells infected by the virus. The hypothesized mechanism involves infection by other coronaviruses, which share some molecular structural properties with SARS-CoV-2. A separate study published in Nature found both CD4 and CD8 T cells which provide recognize (and hence attack) regions of the SARS-CoV-2 virus in both convalescent patients and patients who had previously been infected with other coronaviruses including SARS-CoV-1, seventeen years after infection.[130] Summarizing this evidence, Francis Collins (Director of the National Institutes of Health) writes:

> Much of the study on the immune response to SARS-CoV-2, the novel coronavirus that causes COVID-19, has focused on the production of antibodies. But, in fact, immune cells known as memory T cells also play an important role in the ability of our immune systems to protect us against many viral infections, including—it now appears—COVID-19…This might potentially explain why some people seem to fend off the virus and may be less susceptible to becoming severely ill with COVID-19.

All these conclusions are well reflected in the fact that that despite millions of people infected worldwide to date after 10 months living with the virus, we have seen only a handful of patients who re-tested positive after being discharged, all of whom showed no evidence of being contagious and all presented milder symptoms. In a fascinating study of an outbreak of SARS-CoV-2 in a tightly packed fishery vessel where 85% of the crew became infected, all of crew who had previously been infected escaped reinfection.[131] The scientific evidence thus strongly suggests that recovery from SARS-Cov-2 infection will provide lasting protection against reinfection, either complete immunity or protection that makes a severe reinfection extremely unlikely.

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[127] *Ibid*.

[128] Zuo J et al. (2020) Robust SARS-CoV-2-specific T-cell immunity is maintained at 6 months following primary infection. medRxiv. doi: https://doi.org/10.1101/2020.11.01.362319

[129] Dan JM et al. (2020) Immunological memory to SARS-CoV-2 assessed for greater than six months after infection. medRxiv. doi: https://doi.org/10.1101/2020.11.15.383323

[130] Le Bert, N., Tan, A.T., Kunasegaran, K. et al. (2020) SARS-CoV-2-specific T cell immunity in cases of COVID-19 and SARS, and uninfected controls. Nature 584, 457–462. https://doi.org/10.1038/s41586-020-2550-z

[131] Addetia A, Crawford KHD, Dingens A, Zhu H, Roychoudhury P, Huang ML, Jerome KR, Bloom JD, Greninger AL. Neutralizing Antibodies Correlate with Protection from SARS-CoV-2 in Humans during a Fishery Vessel Outbreak with a High Attack Rate. J Clin Microbiol. 2020 Oct 21;58(11):e02107-20. doi: 10.1128/JCM.02107-20. PMID: 32826322; PMCID: PMC7587101.

M. What is herd immunity? What is the most effective way to reduce harm until endemic equilibrium?

Herd immunity – also known as endemic equilibrium – occurs when enough people have immunity so that most infected people cannot find new uninfected people to infect, leading to the end of the epidemic/pandemic. This means that the epidemic/pandemic will end before everyone is infected, although it will continue in endemic form with low rates of infections. Herd immunity is a scientifically proven phenomenon. Sooner or later, herd immunity will be reached either through natural infection or through a combination of vaccinations and natural infection.

To protect the vulnerable elderly living in nursing homes and other care settings, a focused protection strategy would include frequent testing of nursing home staff members that are not already immune, testing of visitors, and less staff rotation so that residents only interact with a limited number of staff people. COVID-19 infected individuals, in hospital, should not be sent to nursing homes, and all new residents should be tested. Sequestering of care home residents who have COVID-19 is also important.

To protect older people living at home, during high transmission times, older people should be offered home delivery of groceries and other essentials. When seeing friends and relatives, it is best to do it outdoors. Testing should be available for relatives and friends who want to visit. Free N95 masks should be provided for when they cannot avoid potential exposure.

Focused protection requires protecting protect older people still in the work force. People in their 60s are at somewhat high risk, and many are still in the workforce. Those that can work from home should be allowed to do so. For example, teachers in their 60s could teach online courses, or help fellow teachers with grading exams, essays and homework. Those that cannot work from home should be funded to take a 3 to 6-month sabbatical. In addition, workplace disability laws should require employers to provide reasonable accommodations to protect high COVID19 risk workers without losing their jobs.

Focused protection also requires protecting elderly people living in multigenerational homes. University closures and the economic displacement caused by lockdowns has led millions of young adults to live with older parents, increasing regular close interactions across generations. We know that older people living with working-age adults have higher COVID-19 risk than older people living with other older people. There is no further excess risk if also living with children though. This is the toughest challenge, and family specific solutions must be found. If the working-age household members can work from home, they can isolate together. If that is not possible, the older family member might temporarily be able to live with an older friend or sibling, with whom they can self-isolate together during the height of community transmission. As a last resort, empty hotel rooms could be used for temporary housing.

Focused protection also requires guarding younger people with chronic conditions like diabetes, severe asthma, or obesity that place them at higher mortality risk should they become infected. The focused protection plan for these individuals is the same as that for the elderly and will vary depending upon their living circumstance.

The imminent deployment of an effective SARS-CoV-2 vaccine – if people who are most vulnerable are prioritized for inoculation -- offers an opportunity for near perfect focused protection. For this population, the harms from COVID-19 infection are far greater than the possible harms from vaccination.

Effective focused protection reduces the number of people who will need hospitalization for COVID-19 infection, since hospitalization risk, like mortality risk, rises sharply with patient age.[132] Thus, if effective focused protection is implemented, the probability of overcrowded hospital systems is greatly reduced.[133]

Lockdowns actually extend the time that vulnerable are at risk of infection, by delaying infections into the future, lockdowns delay the establishment of herd immunity in a population. Focused protection of the vulnerable is possible but without an effective vaccination campaign, requires vigilance which cannot be maintained forever.

In summary, replacing a lockdown policy with a policy of focused protection of the vulnerable would greatly reduce the lockdown harms for less vulnerable populations, while protecting the vulnerable from COVID-19 risk. The concrete suggestions outlined here are not comprehensive, and with the advent of a safe and effective vaccine in December 2020, there should be no controversy over whether this policy is possible. It is a failure of public health officials in Quebec that they have not engaged in developing strategies like those listed here. Reducing the risk of harm to the vulnerable and non-vulnerable alike from infectious (COVID-19 related) and non-infectious (lockdown related) causes should be the goal of public health policy. An aim that focuses solely on slowing disease spread – lockdown – ultimately increases both COVID-19 related and lockdown harms relative to a policy of focused protection.

N. How to you explain that there were more deaths in March and April 2020 than now? What has changed?

COVID-19 case fatality rates have been dropping steadily since the disease emerged. Peer-reviewed studies document these trends.[134] One study in England found that "30-day mortality peaked for people admitted to critical care in early April. There was subsequently a sustained decrease in mortality risk until the end of the study period" in late June. This trend was found for people of all age groups, and survived adjustment for patient characteristics, which strongly suggests an improvement in treatment and patient management as the cause.[135]

Ventilator protocols which were used during the early days of the epidemic were too aggressive, with physicians too quick to place patients on mechanical ventilation. In those early days, nearly 90% of all COVID-19 patients on mechanical ventilation died. New discoveries about the use of

[132] US Centers for Disease Control (2020) COVID-19 Hospitalization and Death by Age. Aug. 18, 2020. https://www.cdc.gov/coronavirus/2019-ncov/covid-data/investigations-discovery/hospitalization-death-by-age.html
[133] Chikina M, Pegden W. Modeling strict age-targeted mitigation strategies for COVID-19. PLoS One. 2020 Jul 24;15(7):e0236237. doi: 10.1371/journal.pone.0236237. PMID: 32706809; PMCID: PMC7380601.
[134] Brumfiel G. (2020) Studies Point To Big Drop In COVID-19 Death Rates. NPR. October 20, 2020. https://www.npr.org/sections/health-shots/2020/10/20/925441975/studies-point-to-big-drop-in-covid-19-death-rates
[135] Dennis JM, McGovern AP, Vollmer SJ, Mateen BA. Improving Survival of Critical Care Patients With Coronavirus Disease 2019 in England: A National Cohort Study, March to June 2020. Crit Care Med. 2020 Oct 26. doi: 10.1097/CCM.0000000000004747. Epub ahead of print. PMID: 33105150.

histamine blockers in conjunction with ventilators contribute to improved survival of hospitalized COVID-19 patients.[136, 137] Separately, there were particular problems in the care of elderly COVID-19 patients in state run nursing homes in Quebec during the early days of the epidemic, where some COVID-19 patients were neglected and died from thirst and hunger.[138] Quebec also did very poorly because the government failed to protect the vulnerable population in the CHSLD by sending COVID infected patients to nursing homes that were unable to isolate them from the rest of the population, greatly increasing patient mortality.[139]

Addressing this neglect certainly contributed to improved outcomes in Quebec. The discovery that a deadly immune over-reaction to SARS-CoV-2 infection in some patients could be modulated by dexamethasone has greatly improved patient outcomes.[140, 141] There has also been an improved understanding of the pathophysiological reasons why some patients progress to more severe outcomes from SARS-CoV-2 infection, while others do not.[142] So, the improvements in outcomes for COVID-19 patients derive from multiple sources. In summary, COVID-19 infection is less deadly than it was when it arrived in North America in winter 2020.

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[136] Hogan Ii RB, Hogan Iii RB, Cannon T, Rappai M, Studdard J, Paul D, Dooley TP. Dual-histamine receptor blockade with cetirizine - famotidine reduces pulmonary symptoms in COVID-19 patients. Pulm Pharmacol Ther. 2020 Aug;63:101942. doi: 10.1016/j.pupt.2020.101942. Epub 2020 Aug 29. PMID: 32871242; PMCID: PMC7455799.

[137] Janowitz T, Gablenz E, Pattinson D, Wang TC, Conigliaro J, Tracey K, Tuveson D. Famotidine use and quantitative symptom tracking for COVID-19 in non-hospitalised patients: a case series. Gut. 2020 Sep;69(9):1592-1597. doi: 10.1136/gutjnl-2020-321852. Epub 2020 Jun 4. PMID: 32499303; PMCID: PMC7299656.

[138] Richer J. (2020) Aînés affamés et déshydratés: «ils ont crevé de faim». Journal de Montreal. April 23, 2020. https://www.journaldemontreal.com/2020/04/23/aines-affames-et-deshydrates

[139] Quebec Ombudsman (2020) COVID-19 in CHSLDs during the first wave of the pandemic. Learning from the crisis and moving to uphold the rights and dignity of CHSLD residents. Dec. 10, 2020. https://protecteurducitoyen.qc.ca/sites/default/files/pdf/rapports_speciaux/progress-report-chslds-covid-19.pdf

[140] RECOVERY Collaborative Group, Horby P, Lim WS, Emberson JR, Mafham M, Bell JL, Linsell L, Staplin N, Brightling C, Ustianowski A, Elmahi E, Prudon B, Green C, Felton T, Chadwick D, Rege K, Fegan C, Chappell LC, Faust SN, Jaki T, Jeffery K, Montgomery A, Rowan K, Juszczak E, Baillie JK, Haynes R, Landray MJ. Dexamethasone in Hospitalized Patients with Covid-19 - Preliminary Report. N Engl J Med. 2020 Jul 17:NEJMoa2021436. doi: 10.1056/NEJMoa2021436. Epub ahead of print. PMID: 32678530; PMCID: PMC7383595.

[141] Tomazini BM, Maia IS, Cavalcanti AB, Berwanger O, Rosa RG, Veiga VC, Avezum A, Lopes RD, Bueno FR, Silva MVAO, Baldassare FP, Costa ELV, Moura RAB, Honorato MO, Costa AN, Damiani LP, Lisboa T, Kawano-Dourado L, Zampieri FG, Olivato GB, Righy C, Amendola CP, Roepke RML, Freitas DHM, Forte DN, Freitas FGR, Fernandes CCF, Melro LMG, Junior GFS, Morais DC, Zung S, Machado FR, Azevedo LCP; COALITION COVID-19 Brazil III Investigators. Effect of Dexamethasone on Days Alive and Ventilator-Free in Patients With Moderate or Severe Acute Respiratory Distress Syndrome and COVID-19: The CoDEX Randomized Clinical Trial. JAMA. 2020 Oct 6;324(13):1307-1316. doi: 10.1001/jama.2020.17021. PMID: 32876695; PMCID: PMC7489411.

[142] McCullough, Peter A et al. "Pathophysiological Basis and Rationale for Early Outpatient Treatment of SARS-CoV-2 (COVID-19) Infection." The American journal of medicine, S0002-9343(20)30673-2. 7 Aug. 2020, doi:10.1016/j.amjmed.2020.07.003

O. What are RT-PCR tests? Are they useful knowing that Quebec is using a cycle threshold of 45 cycles?

The RT-PCR test for the SARS-CoV-2 virus is at the heart of the testing system adopted by Canada. The RT-PCR tests, as used in most laboratories in Quebec, likely registers a positive test result even for non-infectious viral fragments. The RT-PCR test amplifies the virus – if present – by a process of repeated doubling the concentration of viral genetic material. If the viral load is small, many doublings are required before it is possible to detect the virus.

The problem arises from the fact that the implementation of the RT-PCR test for COVID-19 requires that clinical laboratories decide in advance how many doubling of the genetic material they will require before deciding that a sample is negative for the presence of the virus. This threshold, known as the "cycle time" of the test, determines both the rate at which a positive test result will be returned when the original sample does not include viral concentrations in sufficient amount to be infectious (hereafter, the functional false positive rate), and the rate at which a negative test result will be returned when the original sample does include viral concentrations in sufficient amount to be infectious (hereafter, the functional false negative rate).

A higher cycle time threshold – requiring more doublings before declaring a negative test result – increases the functional false positive rate of the RT-PCR test because even if a non-infectious viral load is present in the sample obtained from the patient, a large number of permitted doublings could amplify whatever is present such that the test result is positive.

The RT-PCR test is commonly known in the scientific literature as the gold standard to check for the presence of the SARS-CoV-2 virus. This is true, but beside the point. The important question is not whether RT-PCR is a "gold standard" test for viral presence, but rather whether it is a gold standard test for determining whether a patient is infectious, which it is not. Rather, the gold standard test for infectivity involves checking whether a sample taken from the nasopharynx of a patient can infect, in vitro, a cell culture. Infectious samples are known as "culture positive", while non-infectious samples are known as "culture negative". From an epidemiological point of view, infectivity measurement is more important than a measurement of whether the virus is present, since it is possible for a patient to have non-viable viral fragments present, a positive PCR test, and yet not be infectious.

The relevant question then, is whether the RT-PCR test is sufficiently accurate to use as a tool to decide whether to sharply curtail the normal activities of millions of people living in Quebec, imposing untold harm on them related to the lockdown, and the unfortunate answer is no.

A systematic review of the literature on cycle time thresholds for the SARS-CoV-2 RT-PCR tests (encompassing 25 different published studies on the topic) concludes that "A binary Yes/No approach to the interpretation of RT-PCR unvalidated against viral culture will result in false positives with segregation of large numbers of people who are no longer infectious and hence not a threat to public health." [143] Scientific evidence that the test on which the California Blueprint for reopening is based – the RT-PCR test for the presence of the SARS-CoV-2 virus – will often

[143] (T. Jefferson, et al., *Viral Cultures for COVID-19 Infectivity Assessment – A Systematic Review (Update 3)* (Sept. 3, 2020), medRxiv, https://www.medrxiv.org/content/10.1101/2020.08.04.20167932v3.full.pdf.)

generate a positive result even when an individual is not infectious (that is, does not pose a danger of infecting other people). The difficulty is that the RT-PCR test permits too many doubling cycles of viral particles before declaring a negative test. The functional false positive rate increases with the number of cycles (known as a Ct value) required to produce a positive result.

According to a careful study published in *Eurosurveillance* (a top journal in the field of epidemiology), if 27 cycles are needed for a positive test, the false positive rate is 34%; if 32 cycles are needed for a positive test, the false positive rate is 72%, and if 37 cycles are need for a positive test, the false positive rate is 92%.[144] If more than 40 cycles are needed for a positive test, the functional false-positive rate is nearly 100%.

This error in the test is a major problem for Quebec, since the public health authority tracks cases per capita and percent positivity of test results to measure the spread of the disease in the population. Both of these measures depend on the accuracy of the RT-PCR tests to determine whether an individual is infected with the virus. The PCR test's inaccuracies imply that the criteria for reopening do not reflect the risk of community spread of the virus because a high case count or positivity rate may be due instead to functional false positive outcomes. Given this scientific evidence, it is certain that lockdowns are being imposed – along with their attendant costs– even when the risk of community spread of COVID-19 does not warrant it.

In summary, the scientific literature establishes the importance of cycle time thresholds in interpreting RT-PCR SARS-CoV-2 results to establish the infectivity of the samples;[145] A reliance on a test that is run for 45 cycles – a procedure that is recommended by the National Institute of Public Health in Quebec and followed by the Public Health Laboratory of Quebec[146] – is certain to produce a very large proportion of false positive outcomes. Lockdowns that are imposed on the basis of case counts derived from PCR tests will be only marginally related to the threat posed by the spread of the SARS-CoV-2 virus.

P. What do you think about the strategy to wait for a vaccine to be given to the whole population in order to mitigate the propagation of the virus?

Though the lockdowns should have been abandoned much earlier, with the advent of several new vaccines the end is finally at hand. The imminent dissemination of several safe and effective vaccines can provide a path out of this situation within the next two months, but only if we understand their proper use and avoid some dangerous pitfalls. The release of an extremely positive report on the new Pfizer mRNA vaccine suggests that we now have a vaccine that can

[144] Singanayagam A, Patel M, Charlett A, Lopez Bernal J, Saliba V, Ellis J, et al. Duration of infectiousness and correlation with RT-PCR cycle threshold values in cases of COVID-19, England, January to May 2020. Eurosurveillance. 2020;25(32):2001483. 2020

[145] Rita Jaafar, Sarah Aherfi, Nathalie Wurtz, Clio Grimaldier, Thuan Van Hoang, Philippe Colson, Didier Raoult, Bernard La Scola, Correlation Between 3790 Quantitative Polymerase Chain Reaction–Positives Samples and Positive Cell Cultures, Including 1941 Severe Acute Respiratory Syndrome Coronavirus 2 Isolates, Clinical Infectious Diseases, , ciaa1491, https://doi.org/10.1093/cid/ciaa1491

[146] Désautels L (2020) Rechece du SARS-CoV-2 par RT-PCR avec detection en temps reel. Version 3. Laboratoire de Sante Publique du Quebec. https://inspq.qc.ca/sites/default/files/demandes_acces/pr-bm-131.pdf

end the epidemic quickly.[147] The Great Barrington Declaration, provides the key idea of avoiding pitfalls: focused protection of people who face a high risk of mortality should they become infected by COVID-19.

While some have criticized the focused protection ideas that are at the heart of the Great Barrington Declaration as infeasible, with the vaccine imminently available, this criticism is no longer viable. There are 2.4 million people living in Canada who are 75+ years old and hence at higher risk for mortality from SARS-CoV-2 infection.[148] The Canadian government has finalized agreements so that there are enough doses for at least 2 million people by the end of March 2021.[149]

The vaccine trial data suggest that inoculation provides no additional protection for people who previously had COVID-19 infection. This result is not surprising since natural immunity after recovery is known to be robust.[150,151,152] Not vaccinating the recovered will preserve doses for the vulnerable and still susceptible.

With a 90%+ efficacy rate in protecting against COVID-19 symptoms, we will achieve near-perfect focused protection. At that point, the lockdown should end immediately and forever. For the rest of the population, and for the poor in particular, the lockdowns harms far outstrip the harms from natural infection. [153]

An alternate plan envisions near-universal vaccination before a resumption of normal life. Logistically, this plan is challenging, as it may take until late 2021 to secure enough doses for the whole Canadian population.[154] This strategy will inflict six months or more of continuing lockdown harms. There are other problems. The vaccine trials did not include children, so we do not know if it is safe to vaccinate them.

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[147] Polack FP, Thomas SJ, Kitchin N, Absalon J, Gurtman A, Lockhart S, Perez JL, Pérez Marc G, Moreira ED, Zerbini C, Bailey R, Swanson KA, Roychoudhury S, Koury K, Li P, Kalina WV, Cooper D, Frenck RW Jr, Hammitt LL, Türeci Ö, Nell H, Schaefer A, Ünal S, Tresnan DB, Mather S, Dormitzer PR, Şahin U, Jansen KU, Gruber WC; C4591001 Clinical Trial Group. Safety and Efficacy of the BNT162b2 mRNA Covid-19 Vaccine. N Engl J Med. 2020 Dec 10. doi: 10.1056/NEJMoa2034577. Epub ahead of print. PMID: 33301246.

[148] Statistics Canada (2020) Demographic Estimates by Age and Sex, Provinces and Territories. July 1, 2020. https://www150.statcan.gc.ca/n1/pub/71-607-x/71-607-x2020018-eng.htm

[149] Nassar HM (2020) Canada to Begin Receiving COVID-19 Vaccines This Month. City News. Dec. 7, 2020. https://montreal.citynews.ca/2020/12/07/canada-begin-receiving-covid-19-vaccines-december/

[150] Ni, Ling, et al. (2020) "Detection of SARS-CoV-2-specific humoral and cellular immunity in COVID-19 convalescent individuals." *Immunity*. https://doi.org/10.1016/j.immuni.2020.04.023

[151] Moderbacher CR et al. "Antigen-specific adaptive immunity to SARS-CoV-2 in acute COVID-19 and associations with age and disease severity." Cell 183.4 (2020): 996-1012. DOI:https://doi.org/10.1016/j.cell.2020.09.038

[152] Zuo J et al. (2020) Robust SARS-CoV-2-specific T-cell immunity is maintained at 6 months following primary infection. medRxiv. doi: https://doi.org/10.1101/2020.11.01.362319

[153] Broadbent A, Walker D, Chalkdou K, Sullivan R, and Glassman A. (2020) Lockdown is not egalitarian: the costs fall on the global poor. Lancet 396(10243):P21-22. July 4, 2020. DOI:https://doi.org/10.1016/S0140-6736(20)31422-7

[154] Higgins-Dunn N (2020) Trump Covid vaccine chief Slaoui says everyone in U.S. could be immunized by June. CNBC. Dec. 1, 2020. https://www.cnbc.com/2020/12/01/trump-covid-vaccine-chief-says-everyone-in-us-could-be-immunized-by-june.html

A second alternate plan envisions mandatory vaccination for the entire Canadian population with severe limitations imposed on activities by non-vaccinated citizens (ie going to work, theaters, cinemas). This plan is unethical and unneeded. The new vaccine has some side common effects after injection (including short-term pain at the injection site, fever, fatigue, and headache) as well as some uncommon serious adverse events. Vaccinating the entire population will undoubtedly lead to substantial number of people to experience these negative consequences. Against these negative consequences should be weighed the benefits of preventing COVID-19 infection. For the vulnerable, it is ethical to recommend vaccination since the balance of vaccine benefits and harms militates strongly in favor of vaccination – for them, the mortality risk from COVID-19 infection is high. For the rest of the population, and for children in particular, vaccination may not provide a net private benefit. For this reason, the World Health Organization recommends against mandatory COVID-19 vaccination.[155]

Focused protection is the best strategy for using the vaccine. A combination of vaccine-induced immunity among the vulnerable and natural-immunity among the non-vulnerable will provide a solid wall of protection against a repeat of the epidemic in 2021. For the vulnerable, the vaccine will protect against COVID, and for the non-vulnerable, the end of the epidemic will end lockdown harms.

Q. Does Covid-19 infection commonly lead to longer term extra-respiratory consequences? If yes, of what nature and what degree?

It is true that non-lethal extra-respiratory consequences of COVID-19 infection are possible and have been reported in the literature.[156] Among the extra-respiratory consequences that have been reported include myocarditis, clotting irregularities, and a poorly-defined group of non-specific symptoms (e.g. extended periods of fatigue, muscle aches, and difficulty concentrating) dubbed "long-COVID."[157]

The literature on this subject is still in its infancy and there is little that is firmly known about the frequency, severity, and duration of extra-respiratory consequences of COVID-19 infection. The US Centers for Disease Control website provides some guidance that provides this context:[158]

> While most persons with COVID-19 recover and return to normal health, some patients can have symptoms that can last for weeks or even months after recovery from acute illness. Even people who are not hospitalized and who have mild illness can experience persistent or late symptoms. Multi-year studies are underway to further investigate. CDC continues to work to identify how common these symptoms are, who is most likely to get them, and

[155] Reuters (2020) WHO does not envisage COVID-19 vaccines being made mandatory. Dec. 7, 2020. https://news.yahoo.com/does-not-envisage-covid-19-175726903.html
[156] Carfì A, Bernabei R, Landi F, for the Gemelli Against COVID-19 Post-Acute Care Study Group. Persistent Symptoms in Patients After Acute COVID-19. *JAMA*. 2020;324(6):603–605. doi:10.1001/jama.2020.12603
[157] Mahase E. Covid-19: What do we know about "long covid"? BMJ. 2020 Jul 14;370:m2815. doi: 10.1136/bmj.m2815. PMID: 32665317.
[158] CDC (2020) Long-Term Effects of COVID-19. https://www.cdc.gov/coronavirus/2019-ncov/long-term-effects.html (accessed Dec. 7, 2020)

> whether these symptoms eventually resolve… More serious long-term complications appear to be less common but have been reported…The long-term significance of these effects is not yet known. CDC will continue actively investigation and provide updates as new data emerge, which can inform COVID-19 clinical care as well as the public health response to COVID-19.

A recently released "living review" of the literature on the long-term consequences of COVID-19 infection comprehensively surveys the rapidly growing literature on this subject, with a focus on higher quality studies with at least 100 participants. The conclusion from this review is that the scientific literature on the subject is of uniformly poor quality, with a specific problem of not providing any guidance on how common or long-lasting are the extra-respiratory of COVID-19 infection:[159]

> The quality of evidence was low, with a high risk of bias and heterogeneity in prevalence. The incorporated studies demonstrated limited external validity, a lack of control subjects, and inconsistent data collection methods. Few studies were conducted in primary care, no studies focused solely on children, and no studies were set in low- and middle-income countries… Our findings suggest that long covid is a complex, heterogeneous condition; however, the limited evidence base currently precludes a precise definition of its symptoms and prevalence.

Even if much more were known about these conditions, and it was established that the long-term effects of COVID-19 infection were common and severe, a policy of lockdown would not be justified. The premise that lockdowns that lockdowns prevent COVID-19 infections in the long run – is not true and runs counter to both theoretical analyses and empirical analyses of the effect of lockdowns, as I describe in Section C.

In summary, much of what is known about these extra-respiratory consequences of COVID-19 infection is speculative and under active study by the scientific community. By contrast, the lockdown harms documented below are already occurring, of a large magnitude, and subject to much less uncertainty.

[159] Michelen M et al. (2020) Characterizing long-term covid-19: a rapid living systematic review. medRxiv. https://www.medrxiv.org/content/10.1101/2020.12.08.20246025v1

I remain available to answer any other further question that the court or yourselves might entertain in the future regarding this report.

I remain very respectfully yours,

Dr. Jay Bhattacharya

COSIGNER DECLARATION

I have read Dr. Jay Bhattacharya's above report relating to Covid-19 and the Province of Quebec and I agree with the content of the said report and the conclusions that he is drawing.

Signed on December ___ 2020,

Dr. Ron Brown

COSIGNER DECLARATION

I have read Dr. Jay Bhattacharya's above report relating to Covid-19 and the Province of Quebec and I agree with the content of the said report and the conclusions that he is drawing.

Signed on December ___ 2020,

Dr. Simon Thornley

COSIGNER DECLARATION

I have read Dr. Jay Bhattacharya's above report relating to Covid-19 and the Province of Quebec and I agree with the content of the said report and the conclusions that he is drawing.

Signed on December ___ 2020,

Dr. Rodney Sturdivant

COSIGNER DECLARATION

I have read Dr. Jay Bhattacharya's above report relating to Covid-19 and the Province of Quebec and I agree with the content of the said report and the conclusions that he is drawing.

Signed on December ___ 2020,

Dr. Roger Hodkinson

MODEL ESTABLISHED BY THE MINISTER OF JUSTICE

Declaration regarding the carrying out of
the mission of an expert
(article 235 C.C.P.)

I declare that I will carry out my mission as an expert with objectivity, impartiality and rigour. To enlighten the court in making its decision, I will give my opinion on the basis of my qualifications concerning the points submitted to me, taking into account the facts relating to the dispute or, if my services are required as a court bailiff, I will make an ascertainment describing the materials facts or situation of which I have personal knowledge.

I will, on request, provide the court and the parties with details on my professional qualifications, the progress of my work and, if applicable, the instructions received from a party. I will also comply with the time limits given to me and, if necessary, request the directives from the court that are necessary to carry out my mission.

_____
Dr. Jay Bhattacharya, M.D., Ph.D.
Signature

Professor of Medicine, Stanford University

_____
Title
December 18th 2020

MODEL ESTABLISHED BY THE MINISTER OF JUSTICE

Declaration regarding the carrying out of
the mission of an expert
(article 235 C.C.P.)

I declare that I will carry out my mission as an expert with objectivity, impartiality and rigour. To enlighten the court in making its decision, I will give my opinion on the basis of my qualifications concerning the points submitted to me, taking into account the facts relating to the dispute or, if my services are required as a court bailiff, I will make an ascertainment describing the materials facts or situation of which I have personal knowledge.

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_____
Dr. Ron Brown
Signature

_____
Title
December ___th 2020

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Dr. Rodney Sturdivant
Signature

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Title
December ___th 2020

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(article 235 C.C.P.)

I declare that I will carry out my mission as an expert with objectivity, impartiality and rigour. To enlighten the court in making its decision, I will give my opinion on the basis of my qualifications concerning the points submitted to me, taking into account the facts relating to the dispute or, if my services are required as a court bailiff, I will make an ascertainment describing the materials facts or situation of which I have personal knowledge.

I will, on request, provide the court and the parties with details on my professional qualifications, the progress of my work and, if applicable, the instructions received from a party. I will also comply with the time limits given to me and, if necessary, request the directives from the court that are necessary to carry out my mission.

_____
Dr. Simon Thornley
Signature

_____
Title
December ___th 2020

MODEL ESTABLISHED BY THE MINISTER OF JUSTICE

Declaration regarding the carrying out of
the mission of an expert
(article 235 C.C.P.)

I declare that I will carry out my mission as an expert with objectivity, impartiality and rigour. To enlighten the court in making its decision, I will give my opinion on the basis of my qualifications concerning the points submitted to me, taking into account the facts relating to the dispute or, if my services are required as a court bailiff, I will make an ascertainment describing the materials facts or situation of which I have personal knowledge.

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_____
Dr. Roger Hodkinson
Signature

_____
Title
December ___th 2020