How a Novel Virus Up-ended the Modern World, Part Two:

The Societal Responses and Effects

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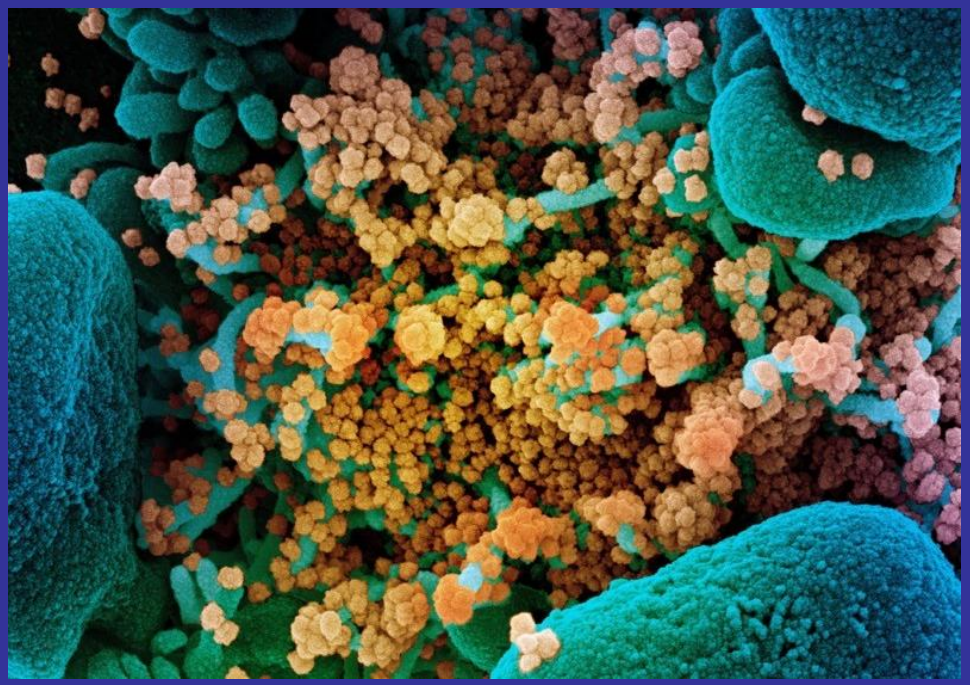


Coronavirus particles (orange) on human cells (blue).

[1]

This is my layperson's review of what has happened over the past year.

- Others view the pandemic response quite differently:
  - What Went Wrong: Corona and the World after the Full Stop
    (Dr Carlo Caduff, Medical Anthropology Quarterly)
    - https://anthrosource.onlinelibrary.wiley.com/doi/10.1111/maq.12599
    - Reader in Global Health & Social Medicine, King's College London (UK)

- Caduff's key point: SARS2 & the lockdown disproportionately affected those who were already vulnerable from age, class, & race
- Note that the facts are not updated—it mentions 'only' 300,000 dead, while we have had > 2,000,000 die
- Note, too, that the stance places less value on human life than does the predominant public health approach

The material requires two talks.

- **Part One**: ***The SARS2 Virus*** **[09 Dec 2020]**
  - **The biological background, virus structure, virus behaviour**

- **Part Two**: ***The Societal Responses and Effects*** **[today]**
  - **Reminders from Part One (with Annex A on infection curves)**
  - **Societal background**
  - **Public health response (with Annex B on masks)**
  - **Medical response**
  - **Economic effects**
  - **Social effects**

After the talk I added an annex to address select comments and questions.

In case some need to leave early, these are the key points.

- The pandemic rolls on despite the recent start of vaccination—we'll likely get Wave 3 in most places
- Globally, we'll likely pass 100 M cases & 2 M deaths by 31 Jan, 200 M cases & 3 M deaths by 31 Mar even with distribution & acceptance of vaccines
- While elders are hit very hard, young people are also dying & many may have long-term health problems
- We were not ready & won't be ready for the next huge challenge without radically different planning

What you might wish to do to protect yourself from SARS2. [2]

- **Distancing & masking, even at home if a resident is infected, & limited time with others (< 30 min)**
- **Get a pulse oximeter / watch for cyanosis & shortness of breath → hospital if you develop low O_2**
- **Ask your doctor EARLY about for prophylactic monoclonal antibodies (IV infusion only, likely in hospital as an outpatient)**
- **Get enough sleep (7+ h), especially early at night for slow-wave sleep, possibly with melatonin**

- **Take supplements with your doctor's approval**
  - **Vitamin C for prevention**
  - **~4,000 IU vitamin D for prevention & ~50,000 IU for early treatment (1 week) (likely with magnesium)**
  - **Zinc (< 40 mg/d | zinc citrate is 31% Zn, so 50 mg tablet = 15 mg Zn)**
- **Raise body temperature slightly (~39°C) to simulate low-grade fever & follow by short cold exposure**
- **Ventilate & purify household air**
- **Isolate if infected**

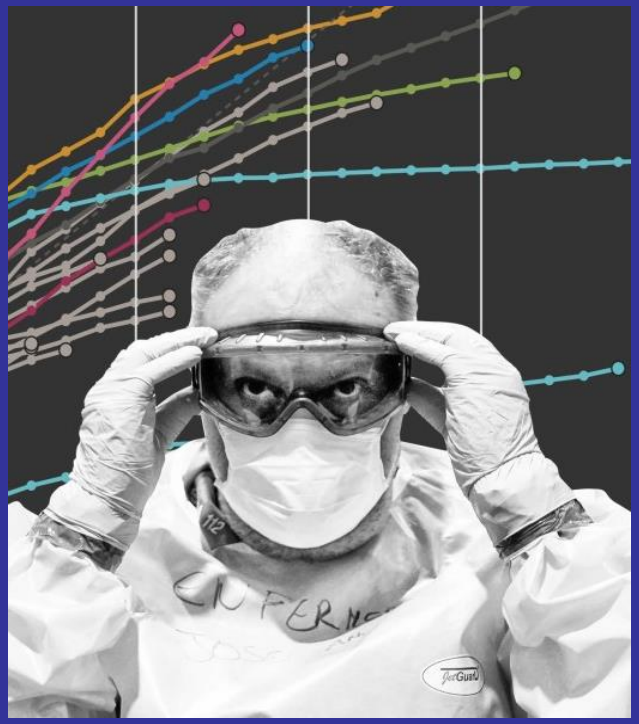
"It's an extraordinary virus, the likes of which I've never, ever seen, & I've been doing this now for almost 40 years." Dr Anthony Fauci [158]

1. **SARS2 was out in China in November & in the rest of the world by January**
2. **COVID19 can look different from person to person**
3. **People can be infectious without symptoms**
4. **Masks work, especially when combined with social distancing & hand-washing**
5. **The virus can spread in the air**

6. Super-spreaders are driving infections
7. Not everyone hospitalized needs a ventilator
8. Illness is worse with diabetes, heart disease, or cancer
9. It's also a bigger risk if you are pregnant
10. Kids are far less likely to get seriously sick
11. We still don't know how long immunity lasts, but there is reason to be hopeful
12. The coronavirus will continue to mutate
13. In USA, Blacks, Latins, & Native Americans are dying at higher rates

Reminders from Part One: Caveats still hold.

- Science: exploding even faster
- Infodemic: still raging
- Data in pandemics: unreliable
  - Diagnosis & reporting are hard
  - More infected = worse data
  - Further in the past = worse data



Gowned healthcare worker in front of country case graphs [3]

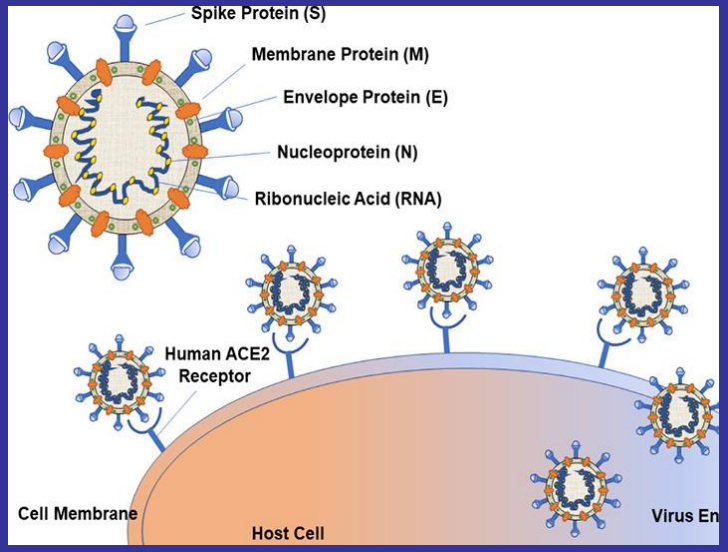
A new caveat: non-deterministic complexity with human behaviour.

- **Unlike viruses (quasi-life), people behave, often unpredictably or illogically**
- **It became predictable that infection would spread from one region to another as people continued to travel**

Some professional sports went ahead without fans [5]

Emergence of the novel virus.

- SARS2 emerged from the biological soup in late 2019
- It spread worldwide quickly by air transport



Coronavirus particle & cell entry mechanism [5]

The virus overwhelmed us.

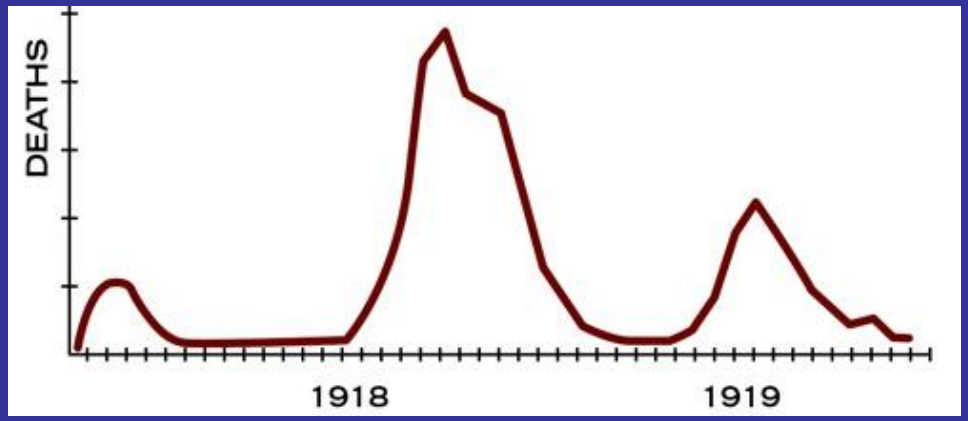
- **SARS2 has spread to 219 countries & territories, & all continents** [6, 7]
- **Even remote places have not escaped: Arctic Islands, Antarctica, Vanuatu** [6]
- **Dozens of ships were affected at sea** [8, 9]

SARS2 has gone almost everywhere

[10]

We've been experiencing a pandemic, with several waves since January 2020.

- Infections spread in repeated waves
- Modelling predicts severity, speed, duration:
  - Initial population, innate immunity, vaccination, incubation, R_0, recovery period, case fatality rate, public health measures [11]



[12]

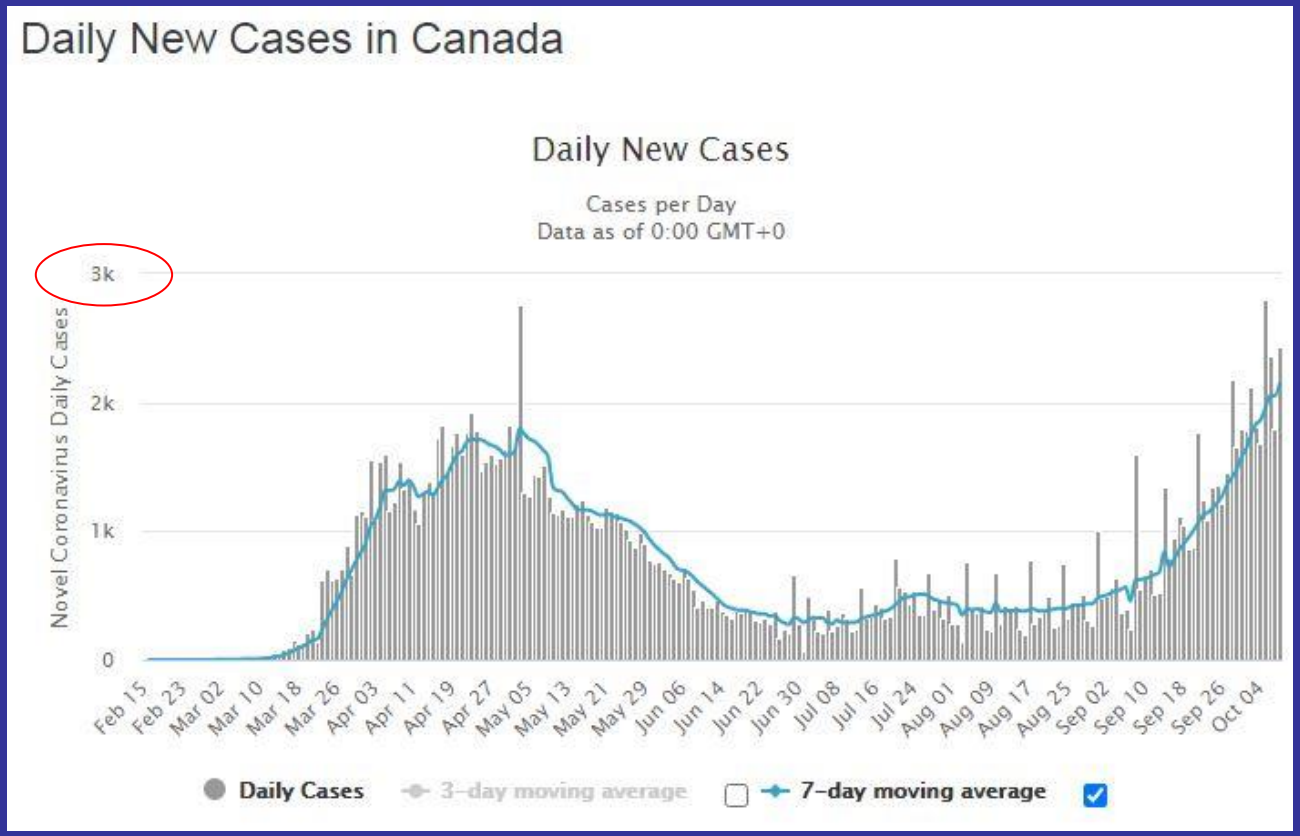
Waves of H1N1 influenza in USA in the early 20th Century

Countries had varied experiences.
[See Annex A on infection curves.]

Death rate:

372/M

19 Dec



09 Oct

[6]

- **Canada had a long outbreak that really did not end before a 2nd wave began in fall**

Severity of illness varied widely.

- Epicentres: factories & long-term care homes
- Contributing factors to illness & death:
  - Age
  - Infirmity & nutritional status
  - Working conditions
  - Multiple work sites
  - Understaffing
  - Lack of procedures
  - Lack of protective equipment

Caring for a long-term-care patient [13]

As more victims emerged, we found it's much more than a disease of the elderly.

- **<u>The American experience</u>:**
  - **Elders (65+): ~80% of deaths**
  - **Young adults: July may have been the deadliest month in modern America**
    - **20-year average dead ~16,000 vs ~11,000**
  - **Aged 25 to 44: March to the end of July saw ~12,000 more deaths than expected based on historical norms** [14]

Societal Background:
We have a complex human society.

- **Population: ~7.8 B** [15]
  - **~7% of all who have lived in the last 50 ky, so huge numbers could be affected by SARS2** [16]
  - **~82 M more people yearly despite ~58 M deaths** [17, 18]
- **Industrial Age: reliant on machines & science**
  - **We're in the Anthropocene Epoch because of widespread & enormous impact on Earth** [19]

- **Complex politics: 195 countries, with ~45 more territories, many aiming at recognition** [20]
- **Global economic activity: ~US$88 trillion in (GDP) in 2019 before the pandemic** [21]
  - **~US$11,240 in GDP per person**
- **Cities: ~55% of us are close together** [22, 23]

- **Consumption: we appropriate > 25% of global annual net primary production** [24, 25]
  - **We've cut down ~50% of forests since the start of civilization** [26]
- **Pollution: we were putting ~33 Gt of greenhouse gas (CO_2-equivalent) into the air annually** [27, 28, 29]
  - **Accounting for land use change, our contribution is closer to 43 Gt** [30]

Clear-cut in British Columbia [31]

- **Even within countries, things vary:**
  - **Belief systems**
  - **Standards of behaviour**
  - **Levels of education**
  - **Entitlements**
  - **Social supports (safety nets)**
  - **Levels of trust**

Diversity in human populations [32]

***Population** is controlled either*
by enlightenment & self-regulation
or by famine, violence, & disease

[33]

Public Health Response: Governance of society in a pandemic.

- **Main goals:**
  - **For public health (PH)—not having to treat patients in hospital systems**
  - **For medical care (MC)—not having deaths**
  - **For society—equitably maintaining sufficient economic activity to support the PH & MC goals**

Preparedness for a pandemic.

- Many countries had inadequate epidemic response plans [34]
- After pandemic scares in 2003 (SARS1), 2009 (H1N1 influenza), & 2013 (MERS), many countries wrote or revised their plans
- Canada created a national public health agency (PHAC) in 2004 [35]

- **Some plans were shelved & readiness not maintained because of cost-cutting & bad risk analysis**
- **In many places, there is no surge capacity because of the economic cult of efficiency**
  - **If resources aren't in use, they're wasted, so they're cut**
- **In 2019, we were not ready for a pandemic** [34]

[36]

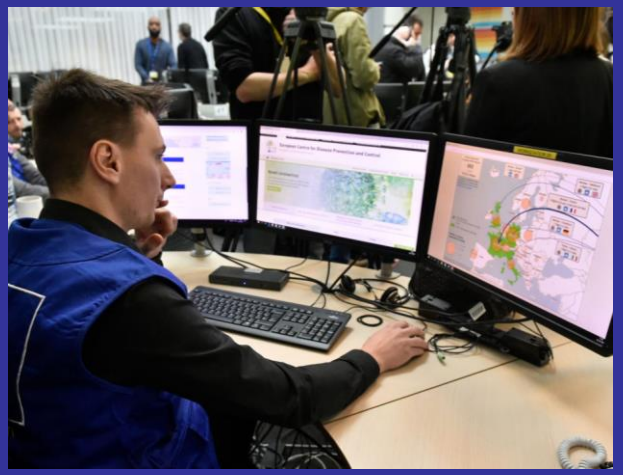
Dealing with a patient surge

Global Health Security Index to evaluate preparedness.

- Prevention
- Detection & Reporting
- Rapid Response
- Health System
- Compliance with International Norms
- Risk Environment [37]

Plans must provide sufficient procedures & quantities of many things.

- Trained staff
- Chains of command & communication
- Detection systems
- Essential services
- Protective equipment
- Protective social measures



Trying to co-ordinate response in Europe [38]

- **Patient transport**
- **Treatment capacity using medication & mechanical intervention**
- **Housing for patients & families, including:**
  - **Quarantine if exposed, isolation if infected**
  - **Accommodation for support people**
- **Research & development capacity for novel solutions**

- Disposal of fatalities
- Reintegration of recovered patients
- Societal recovery measures
- Monitoring systems
- Balance between protection from infection & disruption from controls

[39]

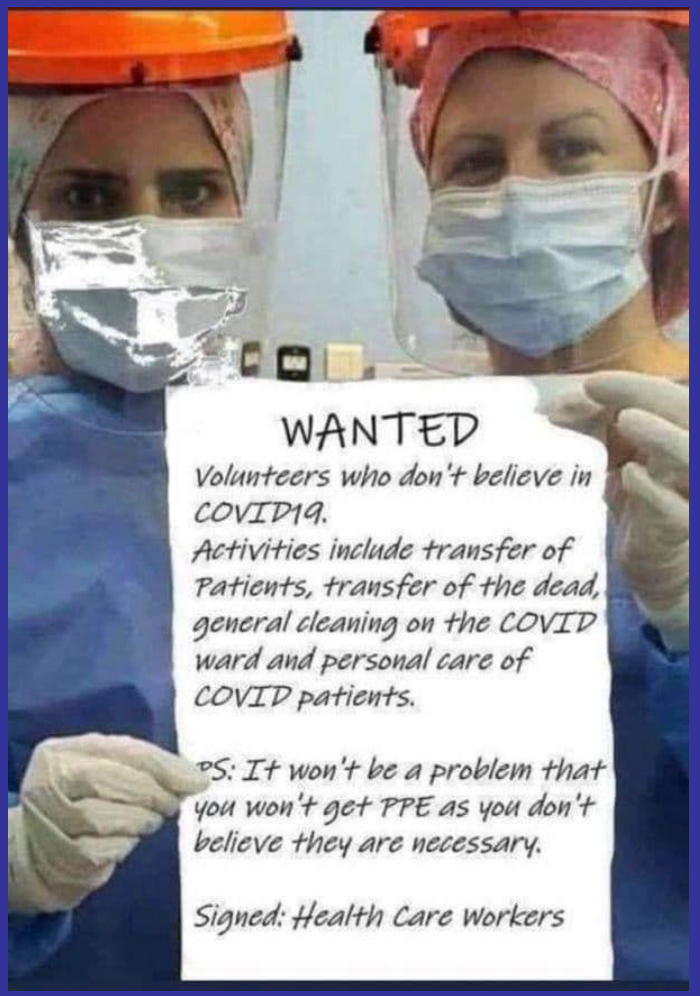
Trying to keep up with burial of victims in Indonesia

In this event…

- **Common response principles: absent**
- **Inadequacies: communications, public services, public messaging, social controls**
  - **Political meddling, disorganization, & neglect of public-health data management mean the country is flying blind** [40]
- **Shortages: masks, ventilators, intensive care unit (ICU) beds, isolation beds, technicians, nurses, doctors, cleaners, etc.**
- **Collectively, we failed & got overwhelmed**

We started with denial.

- **Some said:**
  - **It is a hoax**
  - **It is not a serious threat**
  - **It only affects the elderly & frail**
  - **It is not spreading**
  - **It will go away**
  - **It is not airborne**



Inviting volunteers to deal with SARS2 [41]

The PH responses to SARS2.

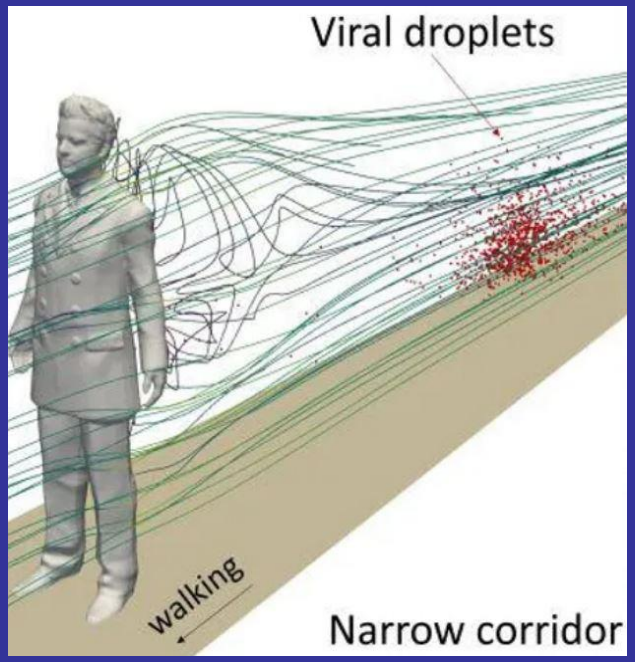
- As SARS2 was novel, initial reaction had to be based on past experience
  - SARS2 was said to transmit via droplets emitted via coughing & sneezing [42]
  - Touching surfaces covered with virions (fomites) was said to put virions on the hands, from which they transferred to the victim by touch of the eyes, nose, or mouth [43]

Droplets from coughing without a mask

Droplets from coughing with a one-layer mask [44]

Airborne transmission finally got accepted.

- Miasmas (bad airs) used to be blamed for infectious disease [45]
- Once bacteria were found, PH officials fought to get people to control disease with cleaning & waste disposal
- Size & characteristics of pathogens matter
  - At first, few wanted to admit that airborne transmission of SARS2 was possible [46]



[47]

The cloud behind a person in a hallway

As it spread, PH officials began to convince politicians to act.

- Most places started social controls:
  - PH messaging on personal behaviour
  - Border closures & quarantine after entry
  - Non-essential business closures
  - Cancellation of events with crowds
  - Monitoring of forehead temperatures
  - Provision of hand sanitizer, physical distancing markers, isolating barriers

PH messaging was basic.

- **In 1918-19, scientists, physicians, & PH officials believed *Bacillus influenzae** was the agent** [48]

  * Pfeiffer's bacillus, now called *Haemophilus influenzae*

- **As the 1918-19 influenza pandemic, people were told to use 5 main ways to prevent infection**
  - **Cover your cough**
  - **Wash your hands**
  - **Do not spit**
  - **Wear a mask**
  - **Be outside as much as possible** [49]
- **See Annex B for more on masks**

Crowd in New York City in 1918 [50]

PH message in Thailand

THE NEW NORMAL

World Health Organization
Western Pacific Region

To stop the spread of #COVID19, we all need to play our part.

Some of us—including people at risk of more severe disease—rely, in part, on other people taking the right actions.

Help protect those who need it most:

Feel sick:	stay home unless seeking urgent medical care
Face:	avoid touching it
Elbow:	cough into it
Hands:	clean them often
Keep distance:	at least 1 metre from others
Space:	avoid crowded places and limit time in enclosed spaces
Clean:	frequently touched objects and surfaces regularly

2 July 2020

[51]

Additions to public health advice.

- Once RNA testing became available in January, officials opened testing centres to determine who had SARS2 [52]
- In the absence of a vaccine, officials in most countries started lockdowns
  - Closed schools, sporting events, theatres, retail stores, restaurants, offices, etc. [53]
- Hospitals cut elective diagnostics & surgeries [54]

PH measures became stricter as infection worsened & hospitals filled.

- People were asked to remain in their homes except for essential trips
- Parks & recreation facilities were closed or required to limit attendance
- Schools were closed in most countries during the first wave of the pandemic
  - Schools have been foci of infection in Israel & other locations [55]

- **People were asked to stay 2 m apart when out for essential reasons** [56]
- **People did a lot more disinfection**
- **Restaurants were often closed or limited to take-out or delivered meals** [57]

[58]

Cleaning a hospital hallway

- People were asked to limit the number of others with whom they came in close contact
  - We created “bubbles” of social interaction [59]
- Anyone testing positive or showing symptoms without a positive test was asked to self-isolate for 14 d [60]
- Those in close contact with someone who tested positive had to quarantine for 14 d [60]
- Sometimes curfews were imposed

Contact tracing & quarantine can work if infection isn't out of control.

Bach Mai Hospital, Hanoi, Vietnam, Mar 2020 [61]

- **3 cases led to 3 clusters of infection**
- **Contact tracing, symptom screening, & testing for 495 people, with limited quarantine**
- **27 staff in the catering company tested positive**
- **The entire BMH staff (7,664) was put under quarantine**
- **Contact tracing led to 52,239 more people quarantined**
- **After 3 weeks, the hospital outbreak was contained**
- **Rapid screening of cases, extensive testing, contact tracing, quarantine, & distancing prevented community transmission**

Controls lessened infection or public pressure grew & controls were curbed.

- By early summer in the Northern Hemisphere, Wave 1 was waning
- As people again congregated, infection rose again by late summer
- As schools reopened, Wave 2 hit hard
- Despite 1.5 M dead by September & rapidly rising infection rates, political opposition got more intense & controls remained lax

Meanwhile, efforts against spread of the virus broadened.

- Increased research, especially on vaccines & medications [62]
- Personal protective equipment (PPE) for healthcare workers, but others too
  - Masks, gowns, gloves, & face shields

[63]

Getting ready for construction work

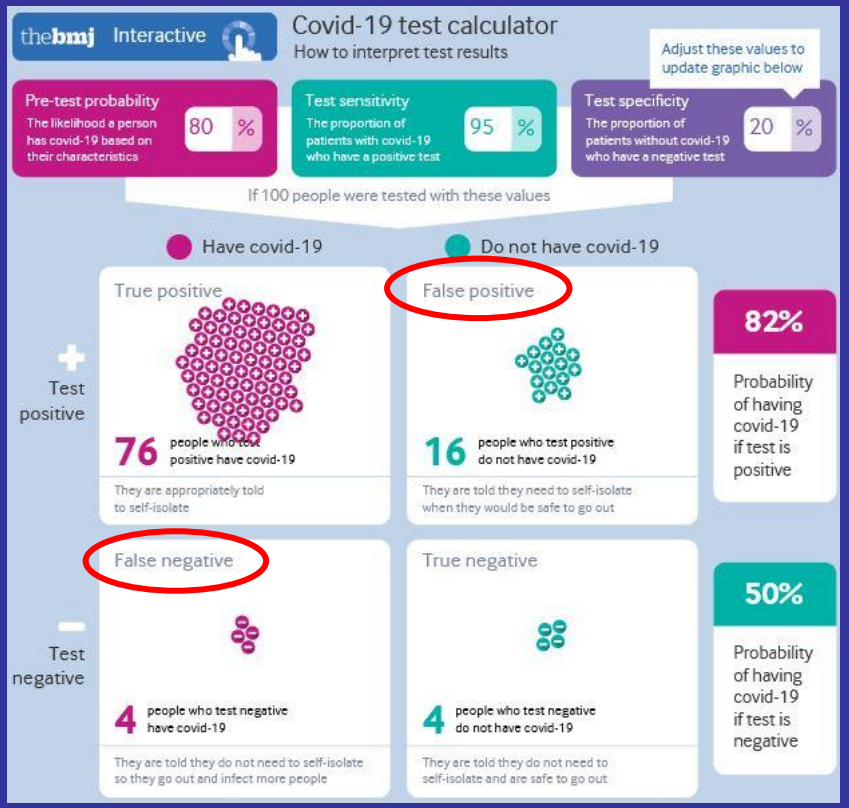
Detection of infection was improved.

- **Polymerase chain reaction (PCR)*: testing increased**
  - **Likely false negative rate: 2 to 29%** [64]
  - **Likely false positive rate: 0.8% to 4.0%** [65]
- **Positive results: more weight than negative tests because of high specificity for viral RNA but moderate sensitivity** [64]
- **Negative results: need to be followed by monitoring, possibly re-testing**

***a.k.a. reverse transcriptase PCR or real time PCR (RT-PCR) and as nucleic acid amplification test (NAAT)**

- **Rapid RNA antigen tests: developed & approved; giving results in ~20 min** [66]
  - **False positive rate (FPR) : ~5%** [67]
  - **False negative rate (FNR): ~25% (highly varied)** [68]
- **Blood antibody tests: accuracy time-dependent**
  - **Week 1 FNR 70%, Week 2 FNR 30%, Week 3 FNR 10%**
  - **Week 4 FPR: 2% (perhaps up to 20%)**
  - **Week 4 FNR: 1% (perhaps up to 8%)** [69, 70]
- **Asymptomatic carriers: high frequency (~40 to 80%) finally acknowledged** [71, 72]

- **False negatives:**
  - **Undetected cases**
  - **Spread of infection**
  - **Illness**
  - **Death**
  - **Loss of employees**
  - **Societal disruption** [73]



Sorting true & false positive & negatives test results

64]

- **False positives:**
  - **Psycho-damage from fear of infecting others or stigma**
  - **Potential exposure to infection in hospital**
  - **Cancelling or putting off treatment for other illnesses**
  - **Income losses, cancelled travel, & stress from isolation**
  - **Wasted spending & effort for testing & tracing**
  - **Workplace disruption & financial loss**
  - **Misplaced spending if a new test shows good well by identifying negative reference samples as positive**
  - **Unwarranted policies on lockdowns & school closures**
  - **Increased depression & domestic violence** [68, 74]

Interpreting test results in more complex than might at first appear.

- **Positive predictive value (PPV): varies with disease prevalence**
  - **PPV is % of positive results that are true positives**
  - **As prevalence falls, false positives rise**
- **Interpreting test results: care providers need to consider local prevalence** [67]
  - **Those who don't understand the calculations should avoid leaping to conclusions**

We're still studying routes of infection.

- Airborne transmission: accepted in July given indisputable evidence [75]
- N95 masks: recommended as useful to prevent inhalation & exhalation [76]
- Limited supply of N95 masks: use limited to healthcare workers & to decontaminate used masks [77, 78]
- Face shields: recommended for healthcare workers [78] but sometimes also used by the public

[79]

Breathing protection

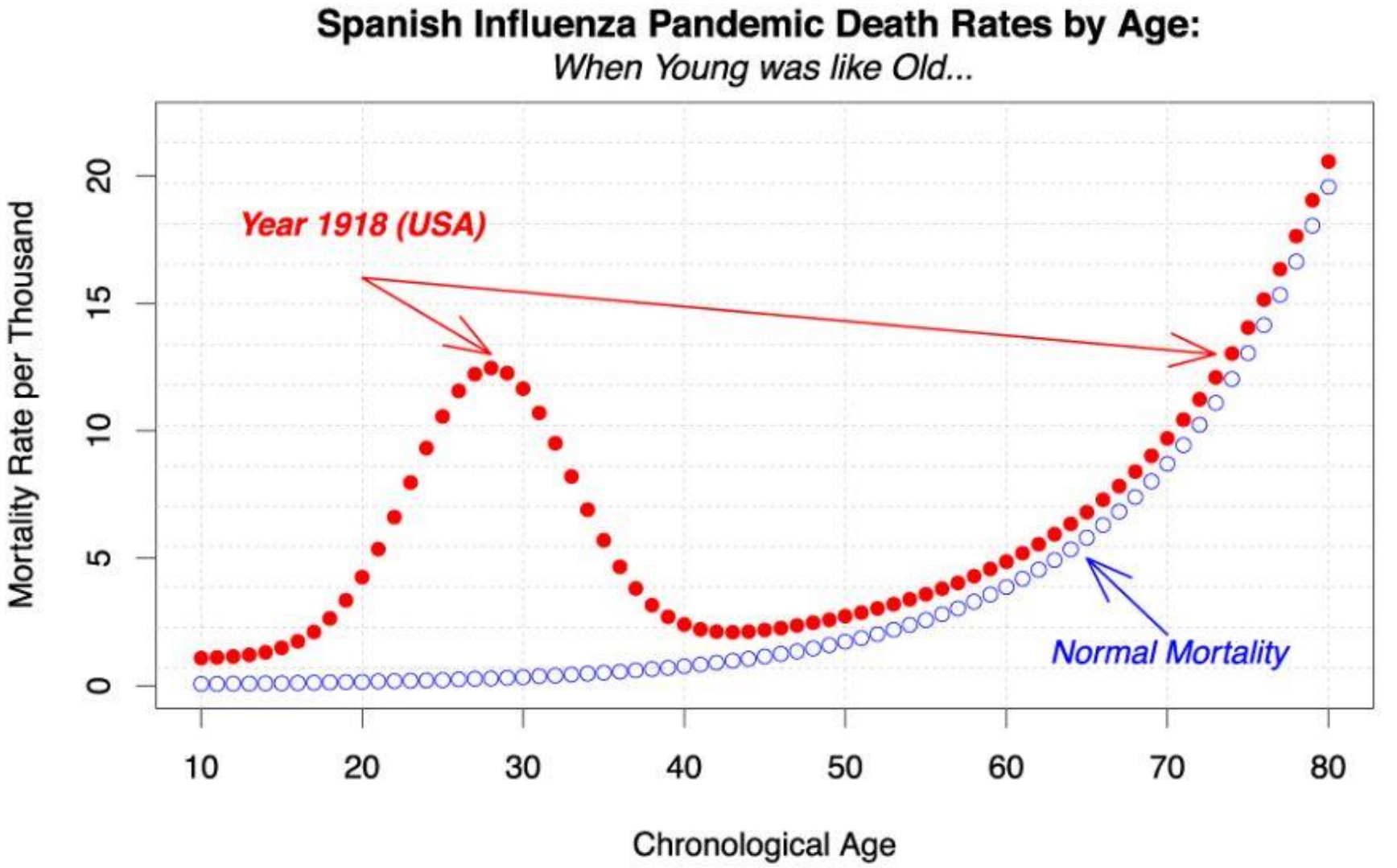
[80]

Face shield

Current public health advice.

- Non-medical masks are recommended for all when physical distancing can't be maintained
- Once masks were introduced, they were quickly resented by some, & eventually protests began to erupt [81]
- As of December 2020, there is little PH advice on increasing ventilation (keeping windows open or running intake fans), or filtering air inside buildings & transport vehicles, which are critical [82]

- With lockdown fatigue, business closures, travel restrictions, school closures, & loss of income were resisted, as they were in 1918-19
- Long-standing refusal to admit the need for air filtration continued
- Excess deaths gradually became more widely acknowledged as a good indicator of how bad the outbreaks were in various jurisdictions
  - Deaths from illnesses that couldn't be treated because of COVID19 are still caused by the virus

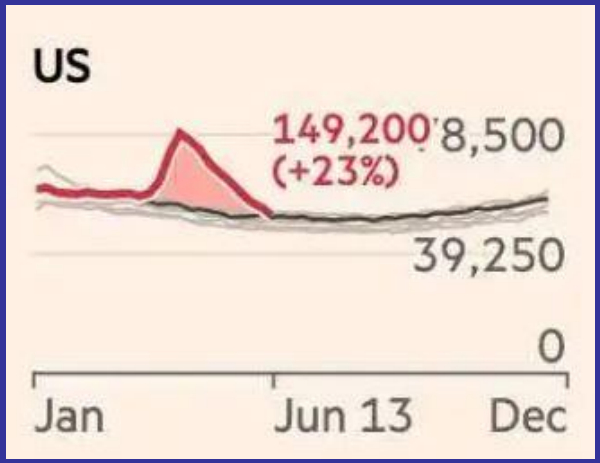

Spanish Influenza Pandemic Death Rates by Age:
When Young was like Old...
Mortality Rate per Thousand
0
5
10
15
20
Year 1918 (USA)
Normal Mortality
10
20
30
40
50
60
70
80
Chronological Age

[83]

- **Some say PH measures have been drastic, massive, & unprecedented, with many aspects of life coming to a standstill under lockdown** [84]
- **However, we've never before had 7.8 B people with the degree of mobility & trade that we had been enjoying**

Excess deaths.

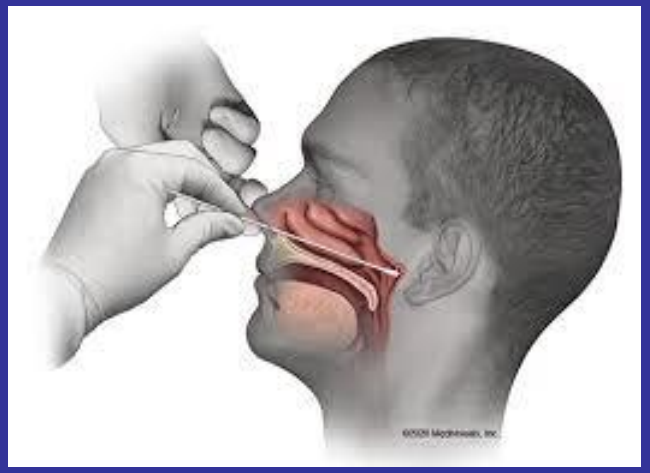
- While people debated whether SARS2 was a hoax, & struggled to count the deaths, it was clear some places were suffering
- At least one place, New Zealand, had lower overall mortality (~10%) because of lockdown [85]



[86]

Medical Response:
Detection of infection.

- At first, with little laboratory testing capacity, physicians often resorted to declaring cases ‘presumptive’
- Testing capacity was expanded, though tests are still being rationed
- Detecting infection proved difficult, time-consuming, and costly



Swabbing to test for SARS2

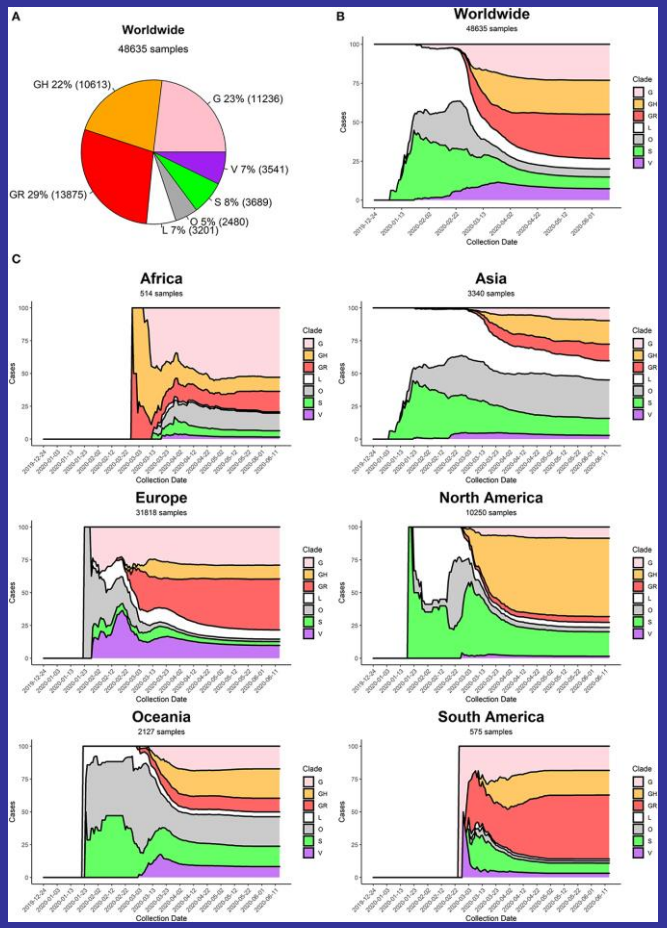
[87]

Detecting & counting cases & deaths proved difficult.

- **Coding death: difficult & unreliable**
  - **It wasn't clear what was a SARS2 death** [88]
  - **New ICD-10 codes were needed** [89]
  - **Death from COVID19 while ill with another disease or with COVID19 as a result of another disease** [90]
  - **Reported COVID19 deaths underestimated the death toll & such deaths were only ~67% of excess deaths in USA last spring** [91]

The medical race to save lives & prevent disability became a marathon.

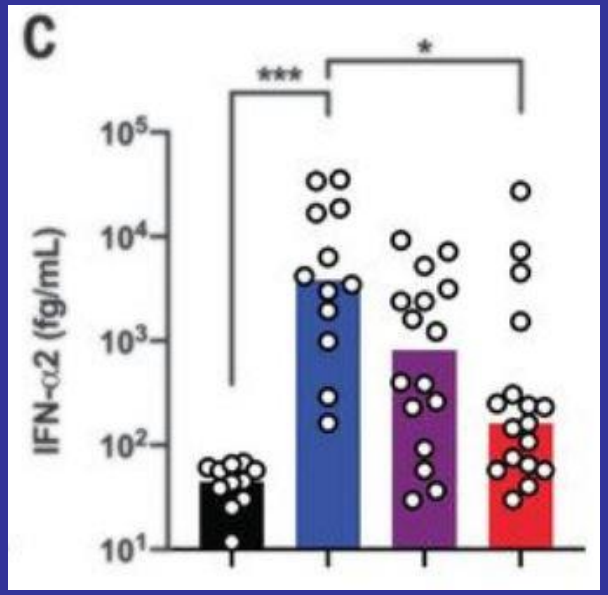
- Virulence: little changed, even in the evolving strains
- Low blood oxygen: oxygen supplementation instead of ventilation
- Affected organs: many organs other than the lungs
- COVID19: now known to be a vascular disease



[92]

Some strains of SARS2

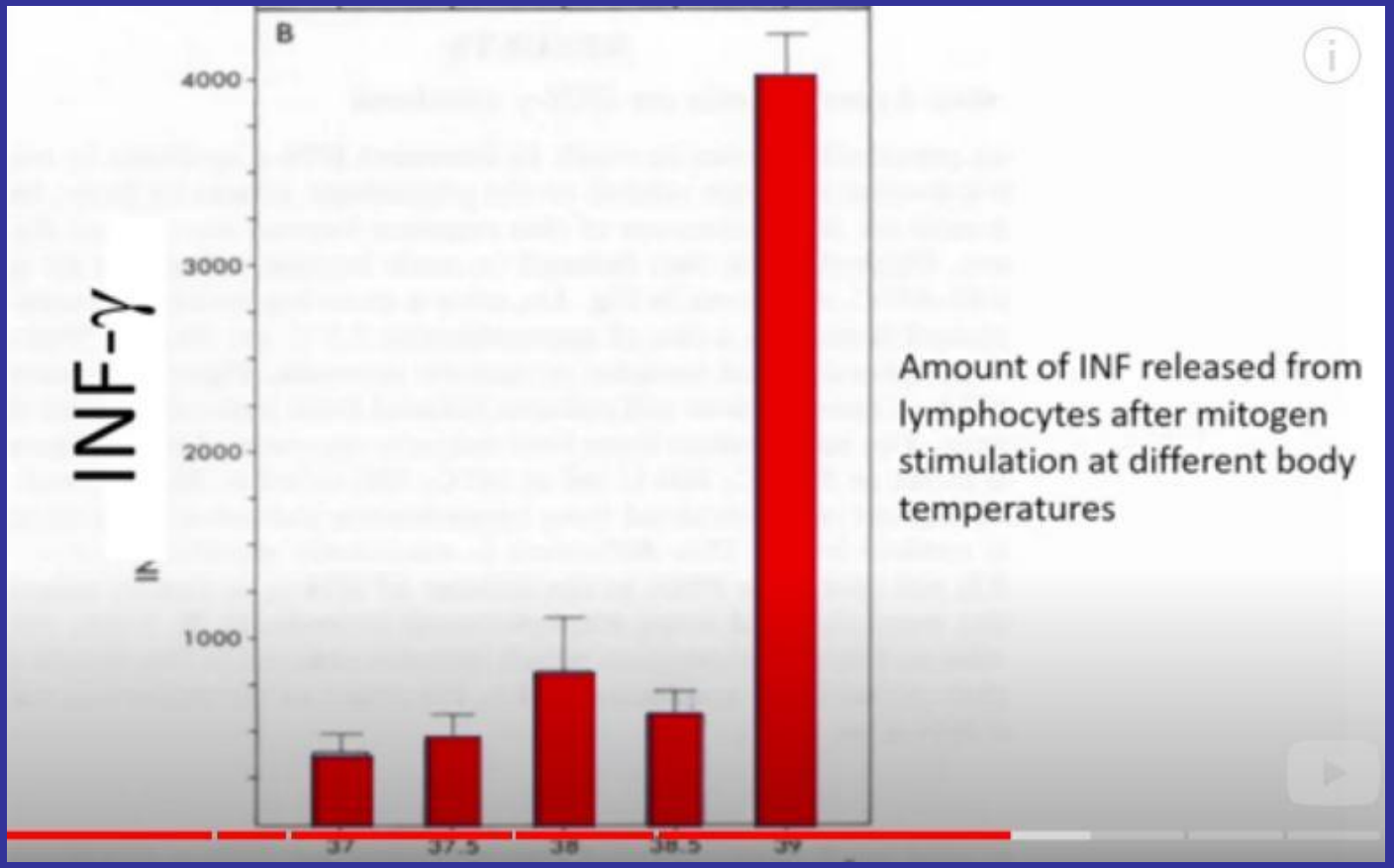
- **Immune system: disrupted, especially interferons** [93]
- **Natural interferon: those with mutations that reduce production get sickest** [94]
- **Ethnic groups: affected differently**
  - **Evidence from USA was shown in Part One (see slide 77 for some from Canada)**



Interferon-α2 concentration in blood [93]

COVID19 severity: Black = healthy (control) | Blue = mild/moderate | Purple = severe | Red = critical

- **<u>Hyperthermia</u>: enough to generate sweating, simulating low-grade fever, for ~20 minutes can stimulate some interferons** [2, 95]

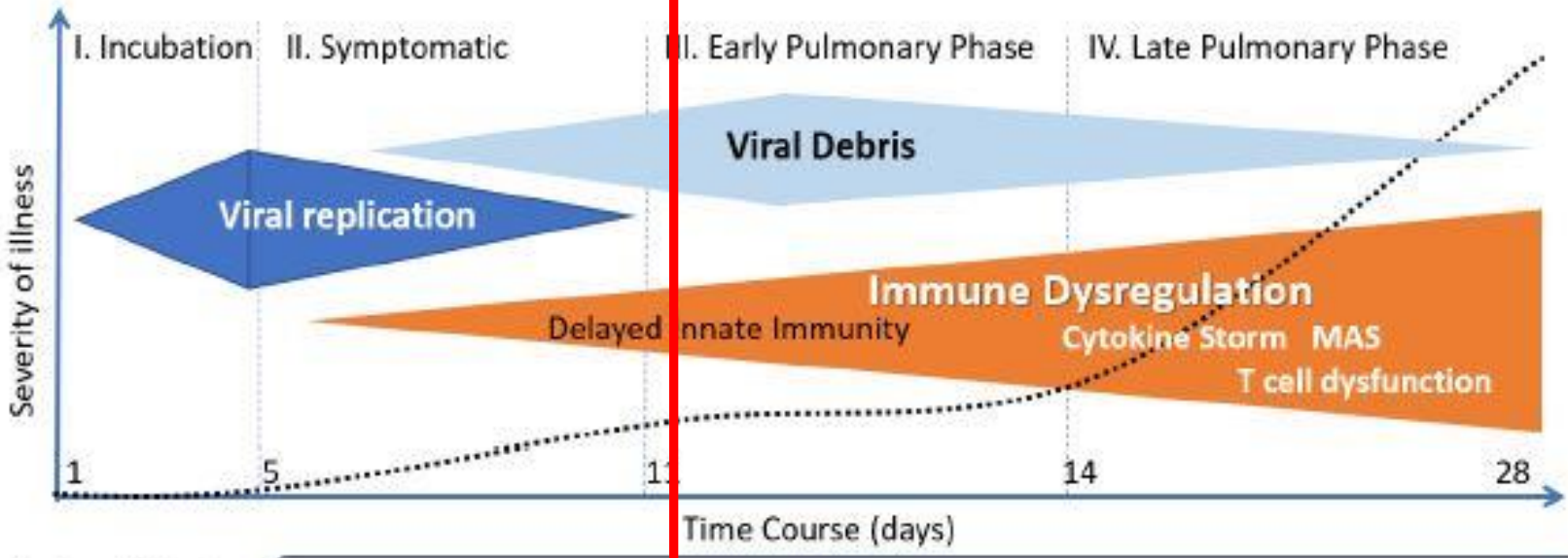


[95]

Treatment of patients.

- **Care protocols: being formalized** [96, 97, 98, 99]
- **Medication: needed for nutrition, fever, pain, blood coagulation, inflammation, secondary infection**
  - **Vitamin C, thiamine (vitamin B1)**
  - **Low-molecular-weight heparin**
  - **Steroids (e.g., dexamethasone, methylprednisolone, hydrocortisone)**
  - **Monoclonal antibodies (e.g., bamlanivimab, casirivimab, imdevimab)** [100]

Figure 1. The course of COVID-19 and General Approach to treatment



Ground-glass infiltrates	+	++	+++	++++
Clinical Symptoms	Fever, malaise, cough, headache, diarrhea	SOB – Mild hypoxia ≤4 L/min N/C & aSat < 94%	Progressive hypoxia	
Treatment approach	Antiviral Rx	Anti-inflammatory Rx		
Potential therapies	? Interferon-α	Methylprednisolone 40mg q 12 inc. to 80 mg q 12 if reqd.		
	ASA	Enoxaparin 60 mg/day	Enoxaparin 1mg/kg s/c q 12	
	IVERMECTIN 12mg	IVERMECTIN 12mg x 2		
	Quercetin + Zinc + Vit C + Vit D	Quercetin + Zinc + Vitamin D + IV Vitamin C		

[96]

- **Current rough rule: 1,000 people → 100 infections → 20 hospitalizations → 5 ICU patients → 1-3 deaths**

[101]

Busy intensive care unit (ICU) in Delhi, India

Deaths continue to mount, but the case fatality rate has dropped from ~4 to ~ 3. [4]

- **Hospitals & cemeteries: Germany & Italy are storing bodies in shipping containers** [102]

- **Elders: US lost > 0.3% of elders, who are 23.8% of population:**
  - **> 32,000 age 55-64 (~23.7 M total) 0.14%**
  - **> 56,000 age 65-74 (~32.7 M total) 0.17%**
  - **> 71,000 age 75-84 (~16.4 M total) 0.43%**
  - **> 83,000 age 85+ (~6.8 M total) 1.22%** [103, 104]

[102]

Bodies in storage at a German cemetery

Dealing with elders and other requiring long-term care remains problematic.

- Even before SARS2, extended care was economically challenging
- Now, under-staffing, limited hours for workers, & inadequate protective equipment & procedures all contributed to high death rates (~50% of all deaths)

Long-term-care residents are often subject to poor care and living conditions [105]

What we don't know remains substantial.

- **Natural immunity: may wane quickly, though antibodies can last at least 8 months** [106]
- **Recent cold virus infection: may lessen illness**
- **Mixed evidence:**
  - **Convalescent plasma** [107]
  - **Chloroquine or hydroxychloroquine with azithromycin (possibly related to dosing)** [108]
  - **Antivirals (e.g., remdesivir, ivermectin, lopinavir/ritonavir)** [109]

Prone positioning may help with survival.

- **Prone positioning: standard practice for patients with severe acute respiratory distress syndrome (ARDS) who are ventilated**
  - **Sometimes now used for SARS2 patients who are breathing spontaneously & not intubated**
  - **Randomized controlled trials: still needed** [110]

COVID19 patient prone in an ICU

[110]

Dealing with patient surges.

- **Hospital at home: a safe, effective alternative for other diseases has proved good for select SARS2 patients** [111]
- **Re-purposing wards: reallocating beds & staff, even whole hospitals, increases COVID19 care capacity** [112]
- **Nightingale hospitals: temporary hospitals increase surge capacity for SARS2 patients or uninfected patients** [113]
- **Isolation centres: places where people with positive tests can safely isolate away from their families** [114 * incl. Cdn. list]

Nightingale hospital in UK

[113]

Prevention by vaccination.

- Began in December 2020
- In August, Russia approved Sputnik V (a.k.a. Gam-COVID-Vac by Gamelaya), using an adenovirus [115, 116]
- China has BBIBP-CorV (by Sinopharm) & CoronaVac (by Sinovac), using inactivated SARS2 [117]
- mRNA vaccines now widely approved include tozinameran (by Pfizer–BioNTech), mRNA-1273 (by Moderna), & AZD1222 (by Oxford & AstraZeneca) [117]
- There has been concern about slow roll-out

There are many types of vaccine & firms trying to get them to market.

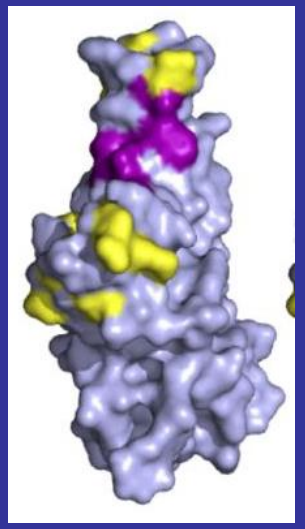
Approaches to make a COVID-19 vaccine

	mRNA Vaccine	Viral Vector Vaccine	Protein Subunit Vaccine	DNA Plasmid Vaccine	Inactivated Virus Vaccine
Goal	Deliver COVID-19 mRNA code, to immune system cells	Use another harmless virus, to deliver the vaccine	Inject COVID-19 antigens to elicit an immune response	Deliver DNA plasmid to cells, for the body to produce COVID-19 antigens	Grow copies of the virus, and then kill them, so they can't cause harm
Time to Market & Ability to Scale	*Fast*	Medium	Slower	*Fast*	Slower
Active Firms & Institutions	Moderna, BioNTech/ Pfizer	J&J, AstraZeneca/ Oxford University, CanSino, Gamaleya	Sanofi/GSK, Novavax	Inovio Pharma	Sinovac, Beijing Inst. of Bio. Products
Generating Neutralizing Antibodies?	Yes	Yes	Yes	Mostly	Mostly
Generating T-Cell Response?	Yes	Yes	Yes	Limited Disclosures	Limited Disclosures

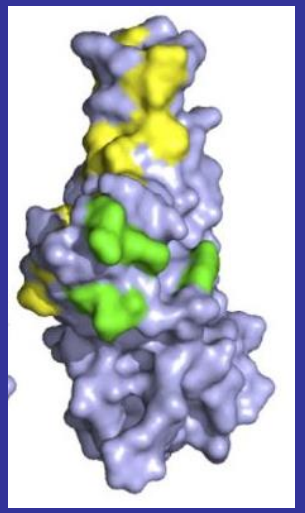
Source: TD Asset Management

[118]

- We don't know if SARS2 will evolve to evade antibodies, but results shows the spike protein RNA can likely change to evade antibodies [119]
- The current wave may start to come under control by mid-2021 [120]
- We can't yet calculate how many will have to be vaccinated or recovered for herd immunity to protect the unexposed [121]



Changes in the spike



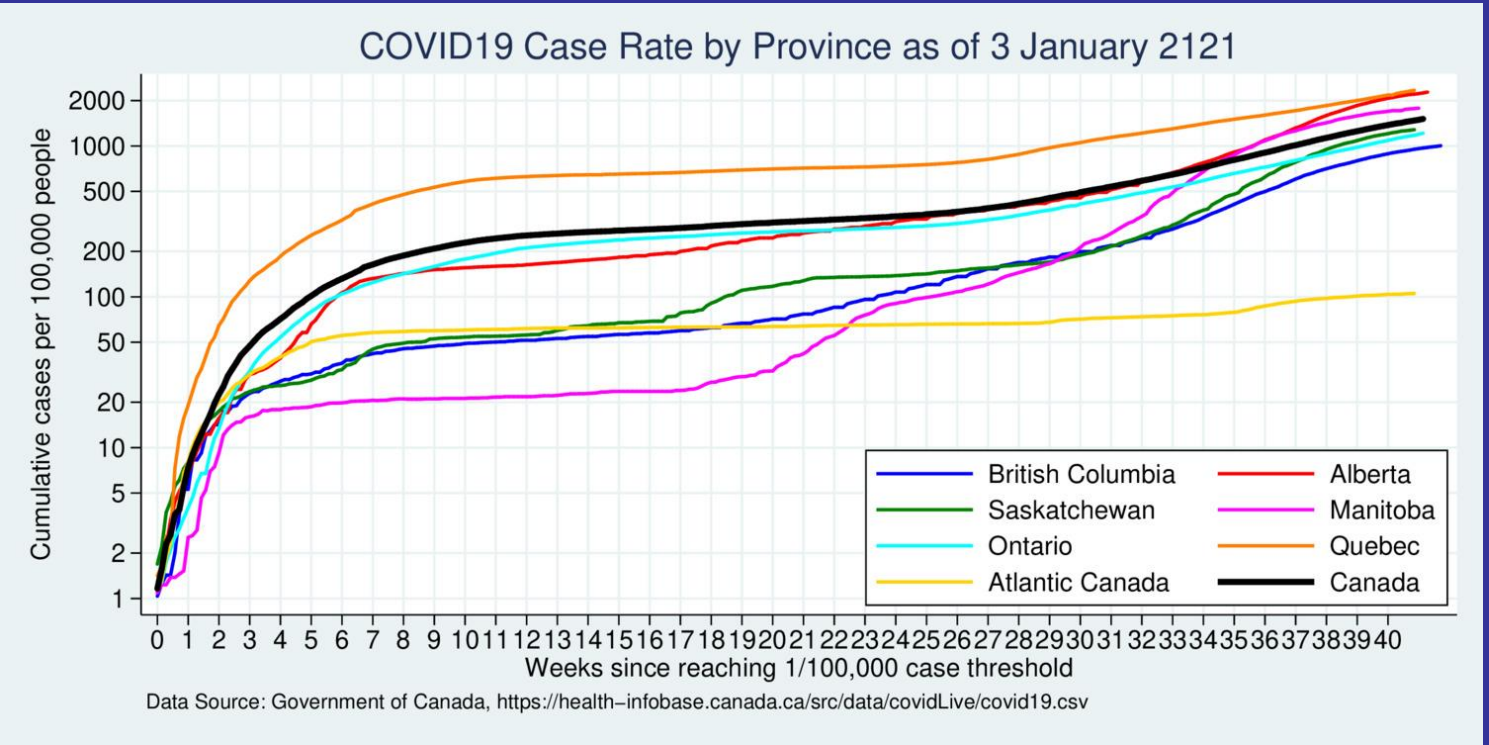
[119]

Supplements to reduce susceptibility.

- **Nutrients: often depleted in high-risk groups**
  - **Vitamin C (water-soluble antioxidant with anti-inflammatory properties that influences immunity & vascular integrity)** [122]
  - **Vitamin D (fat-soluble steroid that modulates innate immune cells & promotes better immunologic response)** [123]
  - **Zinc (antioxidant & anti–inflammatory involved in innate & acquired antiviral immune response)** [124]
- **Supplementation: raises blood levels of all 3**

Infection curves in Canadian provinces. [See Annex A on infection curves.]

- Each province was its own reporting centre
- Each province had a unique curve
- Population-adjusted severity fascinates



[125]

There have been many lessons learned, but we'll still struggle next time.

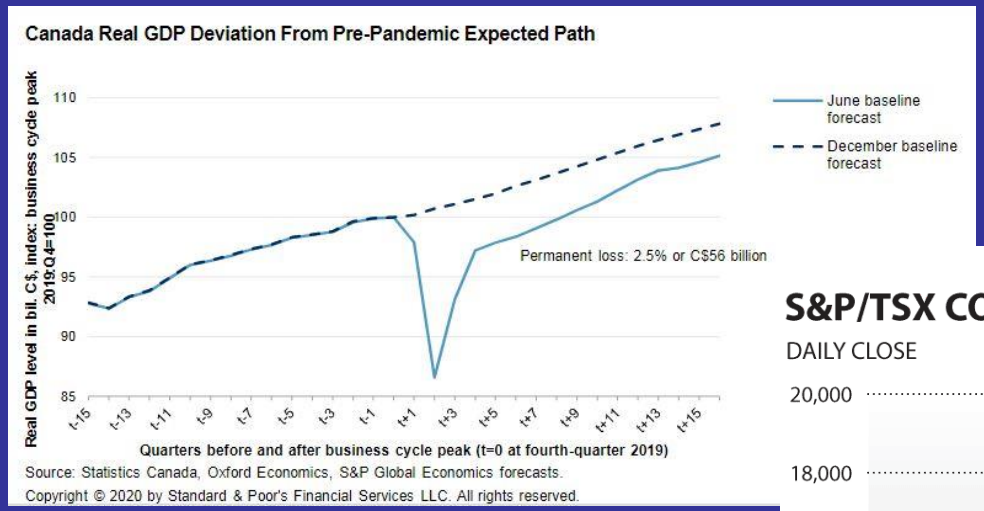
- **Infection curve differences: varying levels of PH measure comprehensiveness & compliance are suspected** [126]
  - **Business, school, transit, & park closures**
  - **Physical distancing, hand-washing, mask-wearing**
- **Pre-existing conditions: suboptimal health had become common**
- **Unknowns: many things remain completely unknown despite intensive investigation** [84]

Economic Effects:
Closure on non-essential places.

- **Essential services: now recognized**
  - Healthcare, municipal services, grocers, banks, liquor stores, fuel stations…
- **Nonessential hospital services: cut back**
  - Diagnostic testing, elective surgeries
- **Closures: common**
  - Airports, ports, roads, bridges, passenger rail lines, schools, places of worship, restaurants, stadiums, gyms, theatres, retail stores…

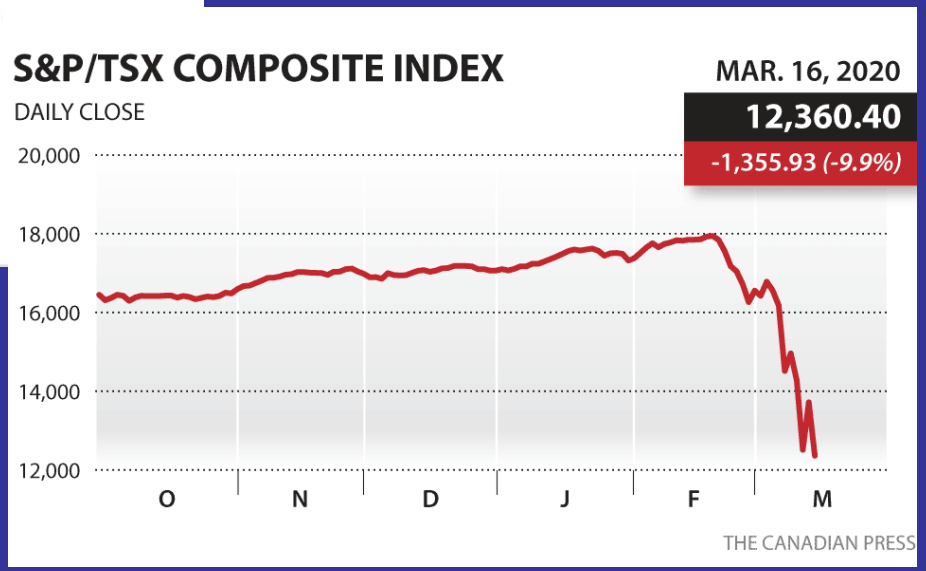
As economic activity was slowed by PH measures, GDP fell sharply.

- The drop in GDP in most countries was mirrored by falling stock markets



GDP in Canada

[127]

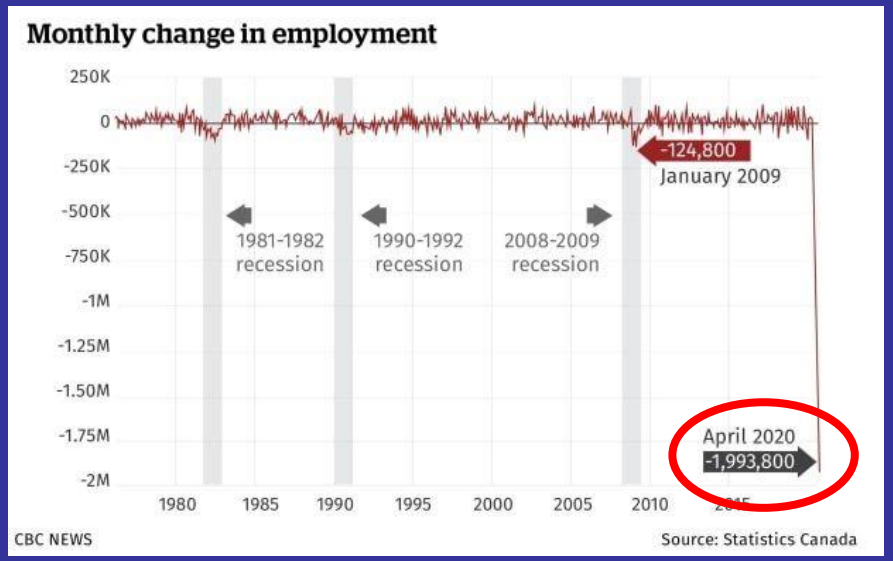


[128]

Canadian stock market

Various parts of society were affected quite differently.

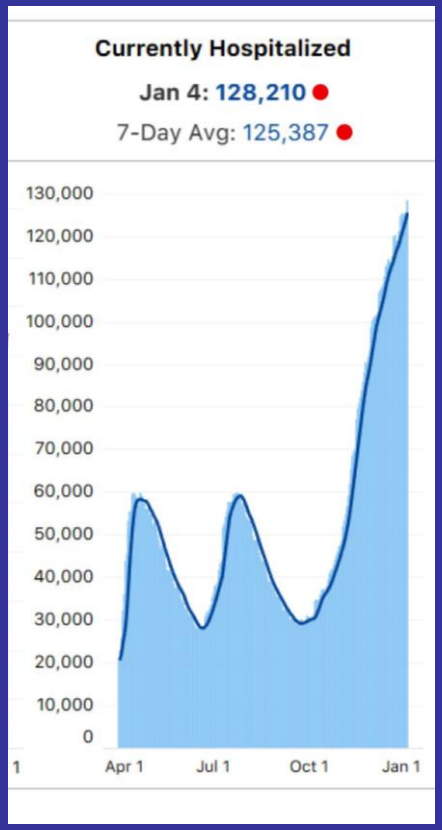
- She-cession: job losses hit women hardest
  - 45% of the drop in hours worked was for women, but women will only get 35% of the recovery [129]
- Small business: saw income drastically cut [130]
- Renters: evictions
- Landlords: lost income



[131]

Job loss in Canada 1975 to 2020

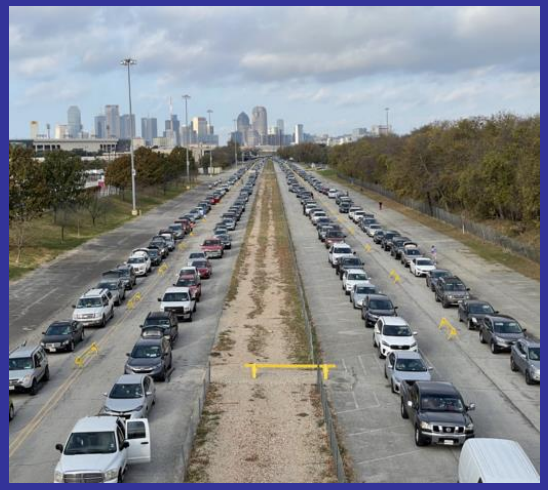
- **Hospitals: swamped, often without enough ventilators & protective equipment**
- **Citizens: lost to premature death**
- **Families: grieving, often alone**
- **Mental/physical health: suffered from stress, inactivity, & postponed care**



Hospital use in USA [132]

Free markets aren't meant for pandemics.

- Without government aid, people often had to use food banks (1/3 in USA, 1/7 in Canada)
- Many businesses of all sizes in Canada got bailouts or failed [130]
  - Many small businesses had income down > 40% [130]
  - Often, all staff were laid off from small businesses [130]
- Huge government deficits with less taxation & more spending

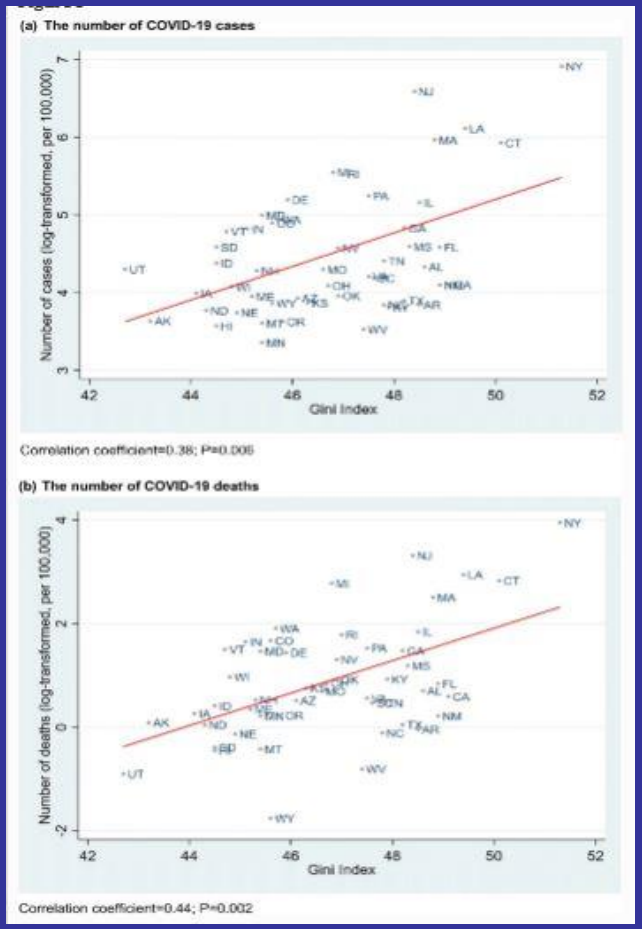


Vehicles waiting to visit a Texas food bank [133]

Within particular nations, the poor were hit hard, but rich nations fared worst overall.

- **Higher income inequality is correlated with more cases & deaths per million** [134]
- **Continental case rates varied:**

Cases/M	Pop'n	Cases	Continent
4.18	579	24.2	North America
3.30	739	24.4	Europe
3.10	423	13.3	South America
0.46	4,582	21.0	Asia
0.24	1,216	2.9	Africa
0.13	38	0.05	Oceania [64, 135]



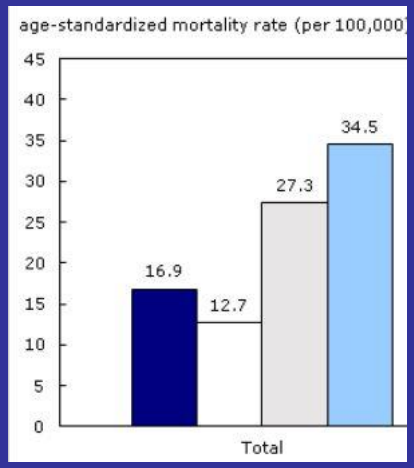
Positive correlation of Gini co-efficient & infection [134]

Economic activity recovered slowly.

- Canadian economy: down 7.5% in March & 11.6% in April [130]
- Canadian GDP: up 1.2% in August (4th monthly rise, but still 5% below Feb [130]
- Consumers: bought on-line & got essentials in person—some hoarded
- Minorities: pre-existing inequities in society intensified; overcrowding & working conditions may be causative [136]

[137]

Toilet paper supply depleted



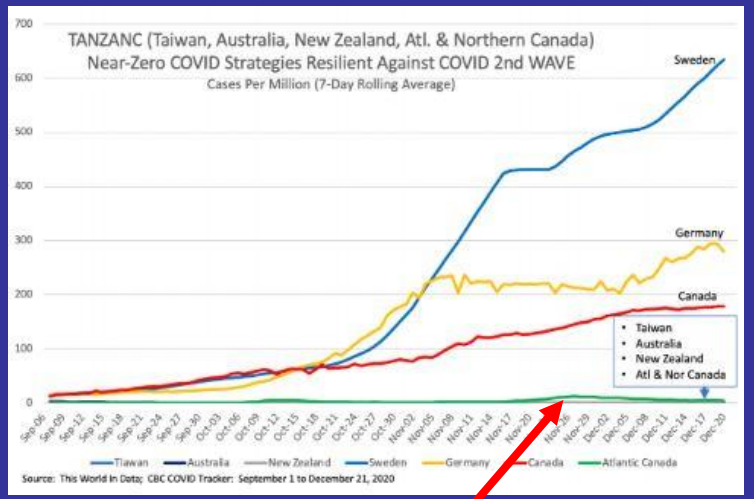
[136]

Mortality among minorities

Proportion of neighbourhood as visible minorities: Dark blue < 1% | White 1-10% | Grey 11-25% | Light blue > 25%

Hard border closures worked.

- **Atlantic Bubble**:
  - protected 4 provinces
  - 7-d avg of 4 cases/M (Dec 2020) vs 187 in rest of Canada (ROC)
  - -4.6% 2020 GDP forecast (Dec 2020) vs -5.8% in ROC
  - 78% satisfaction with PH measures (Dec 2020) vs 57% in ROC
- **Near-zero COVID19 policies**: fared better with Wave 2 [138]

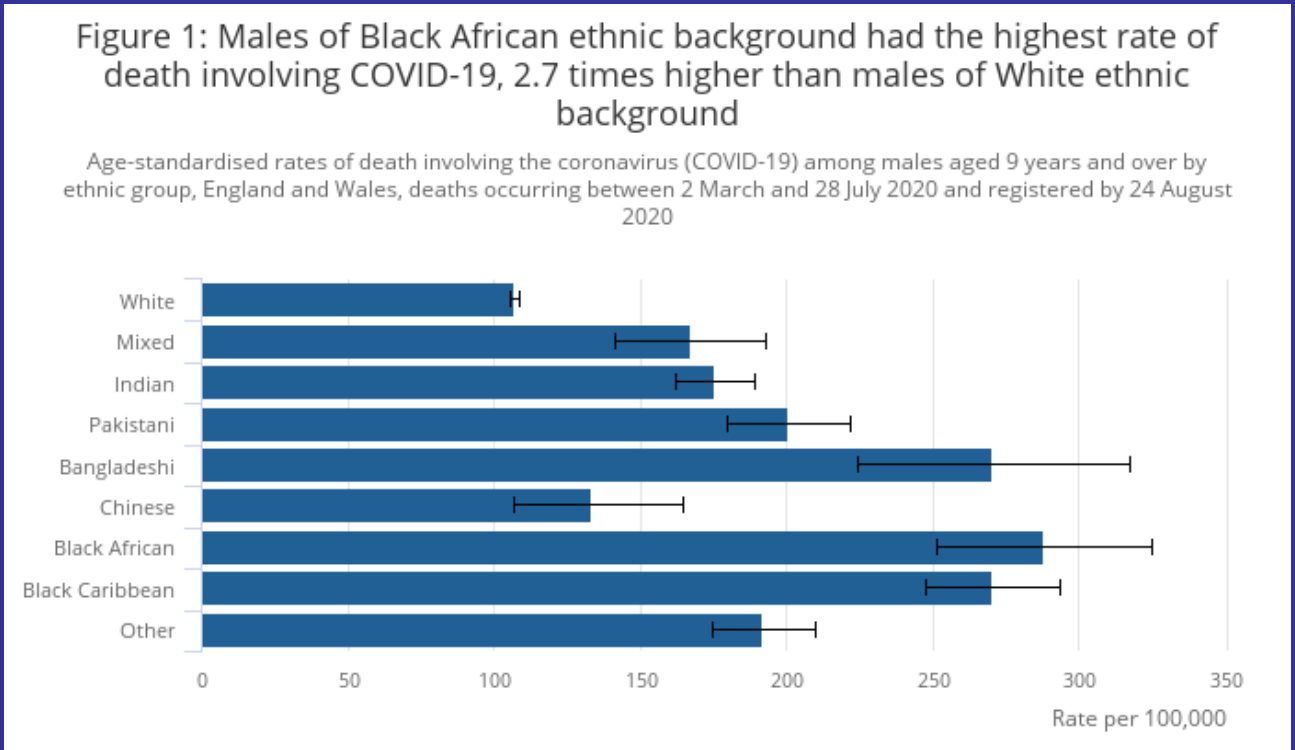


[138]

Atlantic & northern Canada have much less infection in Wave 2

Inequalities mattered & were heightened.

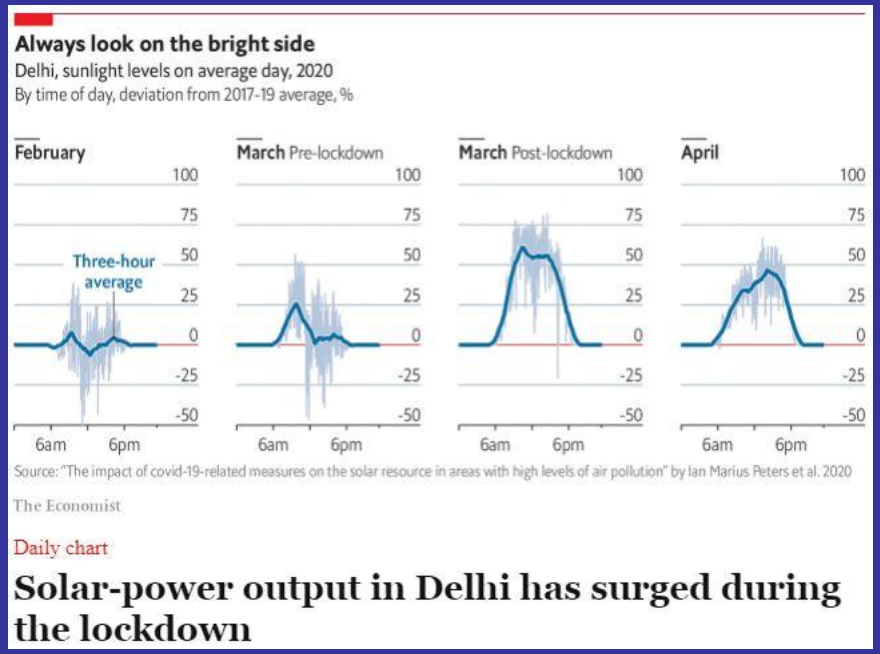
- **Minorities often had more infection & death**
- **PH controls pushed societies near collapse from unemployment, debt, poverty, hunger, misery** [84, 139]



[140]

Less production & travel has lessened air pollution noticeably.

- Particulate matter: fell dramatically with lockdowns; associated deaths likely dropped



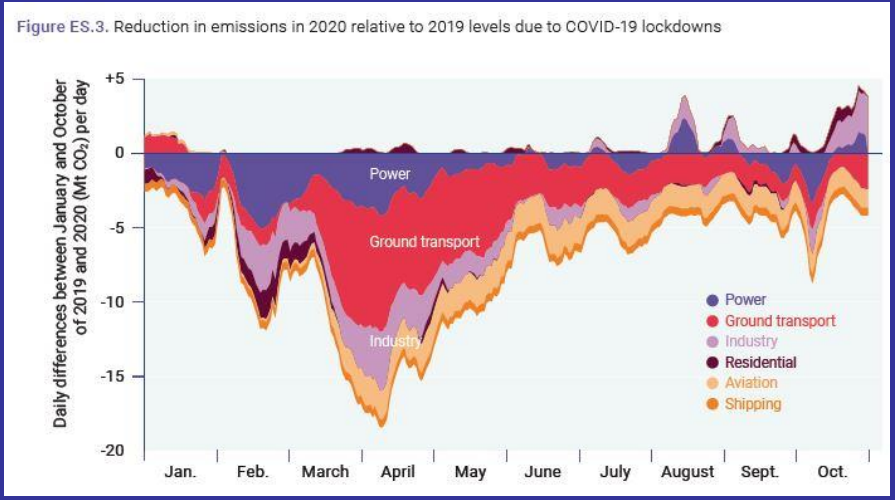
[141]

Air pollution down in India in April & through August [142]

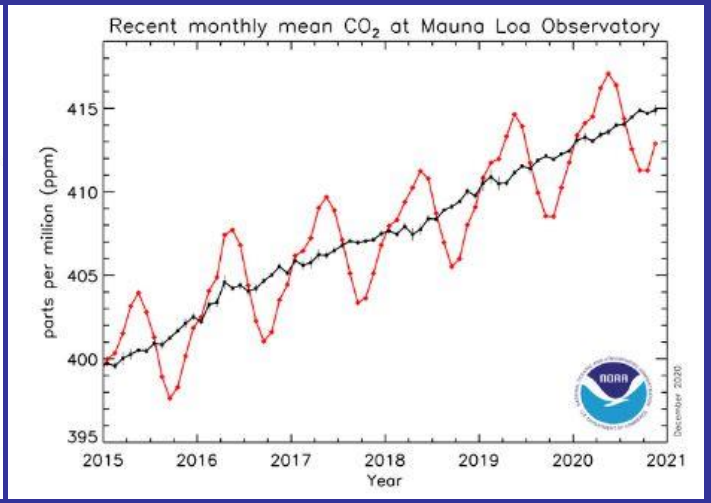
Greenhouse gas emissions fell, though atmospheric concentrations didn't.

- CO_2 emissions may fall ~7% (± 5), non-CO_2 less
  - Reduction in 2020 GHG emissions is likely to be much larger than the 1.2% fall in the 2008/9 financial crisis [143]
- CO_2 at Mauna Loa were up 2.64 ppm at 412.89 ppm in November 2020 vs 410.25 ppm in 2019 [144]

[143]



[144]

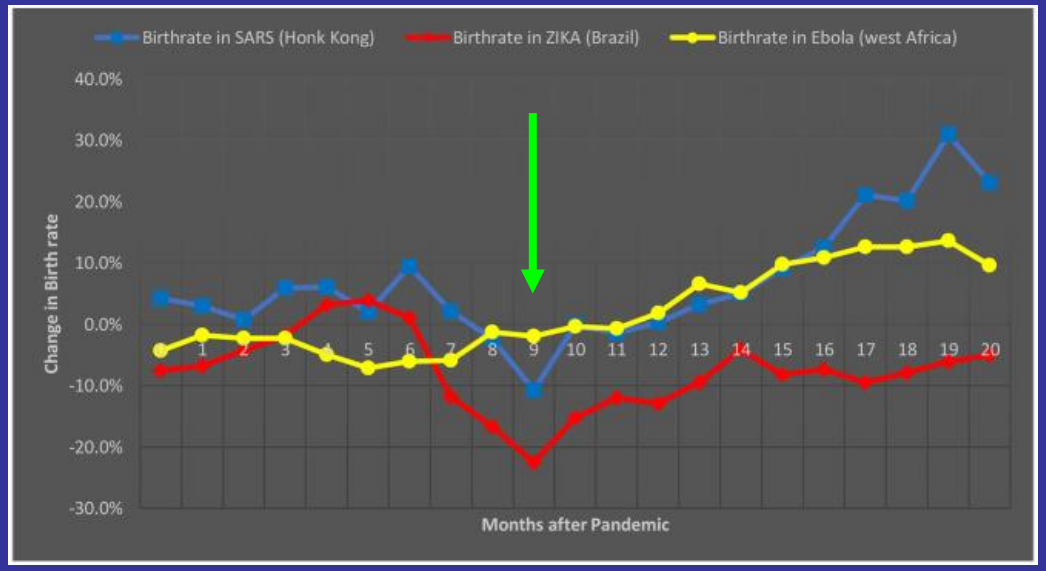


Population growth will show a brief hiatus.

- **World all-cause annual fatality rate: will likely double for a short time** [145]
- **World annual birth rate: may fall but recover** [146]

Birthrate during SARS1 (blue), Zika (red), Ebola (yellow)

Green marker = 9 months



[146]

Food insecurity worsened, but global supplies weren't compromised.

- **Food insecurity: worsened from food supply disruptions, less food production, income loss**
  - **137 M more people faced food insecurity (up ~80%)**
- **Global food prices: stable**
- **Food prices: inflation from supply disruptions, devaluations, and other factors**
- **Global grain markets: remain well supplied, with stable prices ~10% higher than in January 2020** [147]
- **No new major famines…yet** [148]

Wood product shortages have emerged.

- In Canada, at least, the supply chain for wood products was compromised
- Demand for renovations to provide work-at-home spaces depleted stock
- Wood prices rose
- The cost of the average new home rose by ~$30,000 [149]

Retailers have been able to raise wood prices [149]

Government spending surged as private spending shrank.

- Tax cuts
- Tax deferrals
- Tax filing extensions
- Accelerated tax refunds
- Loss carry-backs
- Business income support
- Business loans
- Commercial rent support
- Investment incentives
- Employment incentives
- Medical care
- Rent subsidies
- Personal income support
- Expanded social benefits
- Reduced sales tax [150]

Reopening requires many steps, but they only succeed if taken at the right time.

- Social bubbles can be expanded
- Bars & restaurants can be opened, sometimes with reduced capacity and/or more ventilation
- Entertainment venues can be opened with reduced capacity
- Professional sports can be opened with fewer or no spectators
- Places that opened too early had a prolonged Wave 1 or the start of Wave 2

SARS2 is our most expensive pandemic.

- **SARS2 (2020-):**
  - **~$9 T SARS2 cost so far** [151]
  - **~0.025% dead so far (2 M of 7.8 B)**
  - **It is by no means over yet**
- **Other recent pandemics:**
  less widespread, less effect

~$40 B SARS1 (2003) **~$40 B H5N1 flu (2006)**

~$45 B H1N1 flu (2009) **~$55 B Ebola (2014)** [151]

- **H1N1 flu (1918-20) [“Spanish flu”]:**
  - **~$1 T cost [6% of ~6 T/y GDP in $2019]**
  - **3 y of H1N1 flu = loss of ~2.25% of population (40 M of 1.8 B)**
  - **5 y of World War I = combat deaths of ~0.5% of population (9 M of 1.8 B)** [152, 153]

Those discounting the deaths aren't valuing life with the usual ~$0.5 M/person-years.

Hypothetical 1 million US deaths **[current deaths ~3 M/y]**

- **Life expectancy for 2020 would drop by 2.9 y**
- **Each death = loss of 11.7 y of expected life**
- **Elders (> 80) would lose 0.2 y expected life, much more at younger ages**
- **Mortality < for 1918-19 flu & closer to the opioid & HIV/AIDS epidemics, but concentrated in time**
- **Averting such deaths would be > $10 T & much more than the drop in GDP so far** [154]

Societal Effects:
Major changes.

- Working from home: a new norm
- Essential workers: getting bonus pay
- Education challenge: remote learning
- Income adequacy: government aid essential
- Healthcare: hospital avoidance (nosocomial infection); waiting rooms are time-wasters
- Long-haul victims (~10%): burden for years [99]
- SARS2 integration into our genes: unknown [155]

There has been some real abuse & much imagined.

- Some countries used the threat of SARS2 have imposed or deepened authoritarianism
  - Brazil, Cambodia, Chile, Hungary, Israel, Jordan, Philippines
- Some citizens have felt their inalienable rights have been breached unreasonably
  - Canada, UK, USA [156]

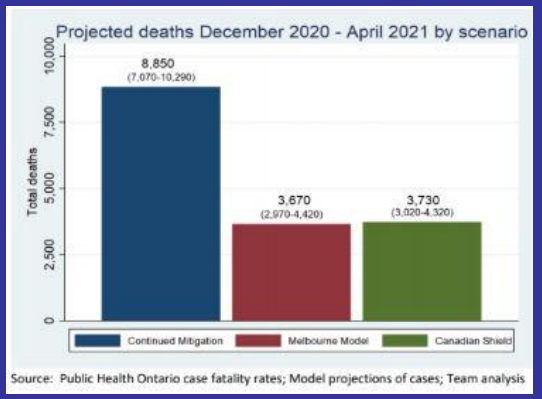
"COVID19 is dominating every aspect of life." Dr Mark Lipsitch [157]

- Viruses don't care who you are or what you believe, but they can benefit from how you act
- Wishful thinking doesn't work
- Masks do work

  (Some argue they don't—see mask annex)
- Virus spread is what's bad for the economy
- SARS2 has changed economies, educational systems, sports, entertainment, & the arts

In December, some dissatisfied leaders proposed a new strategy: the Canadian Shield.

- **Goal**: shield us & our economy from SARS2 & unintended consequences of PH measures
- **Benchmarks**: -5,000 deaths, +$37 B GDP, +320,000 jobs
- **Key actions**:
  - Hard lockdown until cases are low enough for testing, contact tracing, & isolation to work
  - Relax only when new cases steadily decline 17-25% per wk
  - Assist individuals, businesses, & communities most affected [138]



> 50% fewer deaths expected from lockdown [138]

What we might conclude…thus far.

- Healthcare systems: at risk from under-funding & privatization, which matters because systems that function well will save lives & reduce suffering
- Economic systems: at risk from myopia & short-term focus, which matters because systems that function well will be sustainable
- "This pandemic will haunt us all for decades in ways that we can barely imagine at this point" [84]
- We had better become better at evaluating, preparing for, & responding to threats or…

--- Fin ---

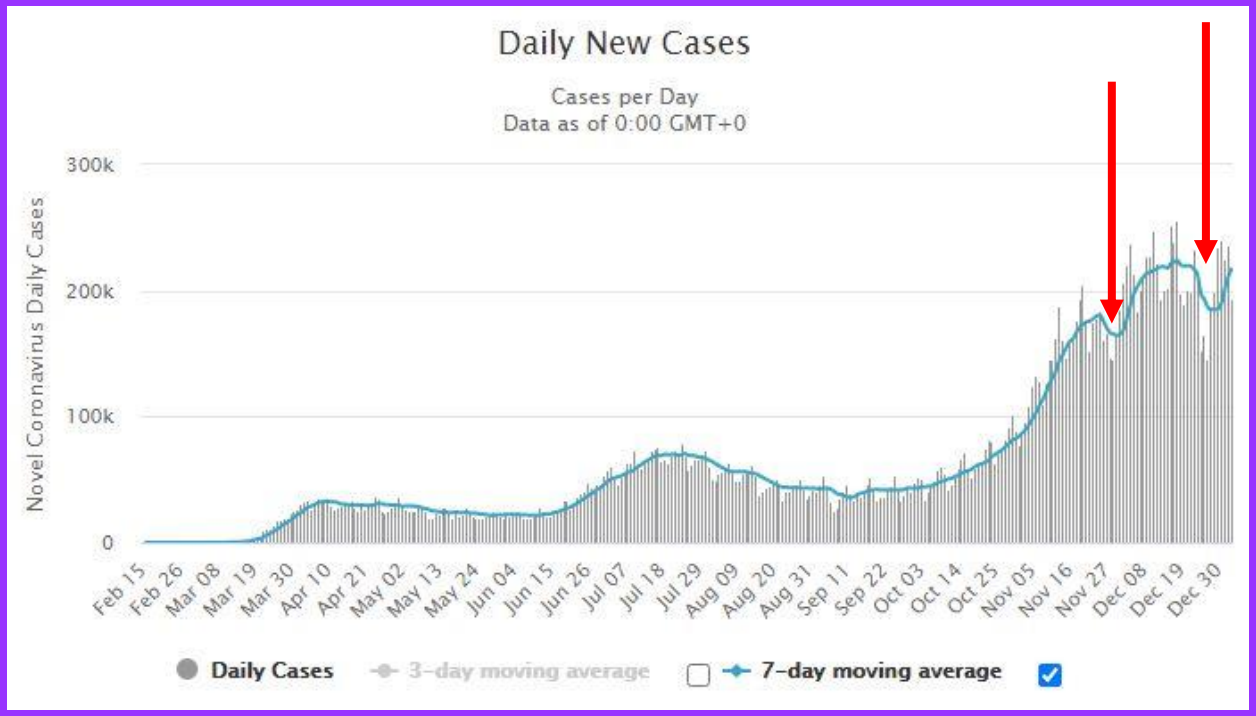
Annex A: Infection curves.

- **USA has struggled from the start, with wave building on wave, & is by far the worst affected**

Death rate:

1,089/M

04 Jan 2021



04 Jan 2021

[a1]

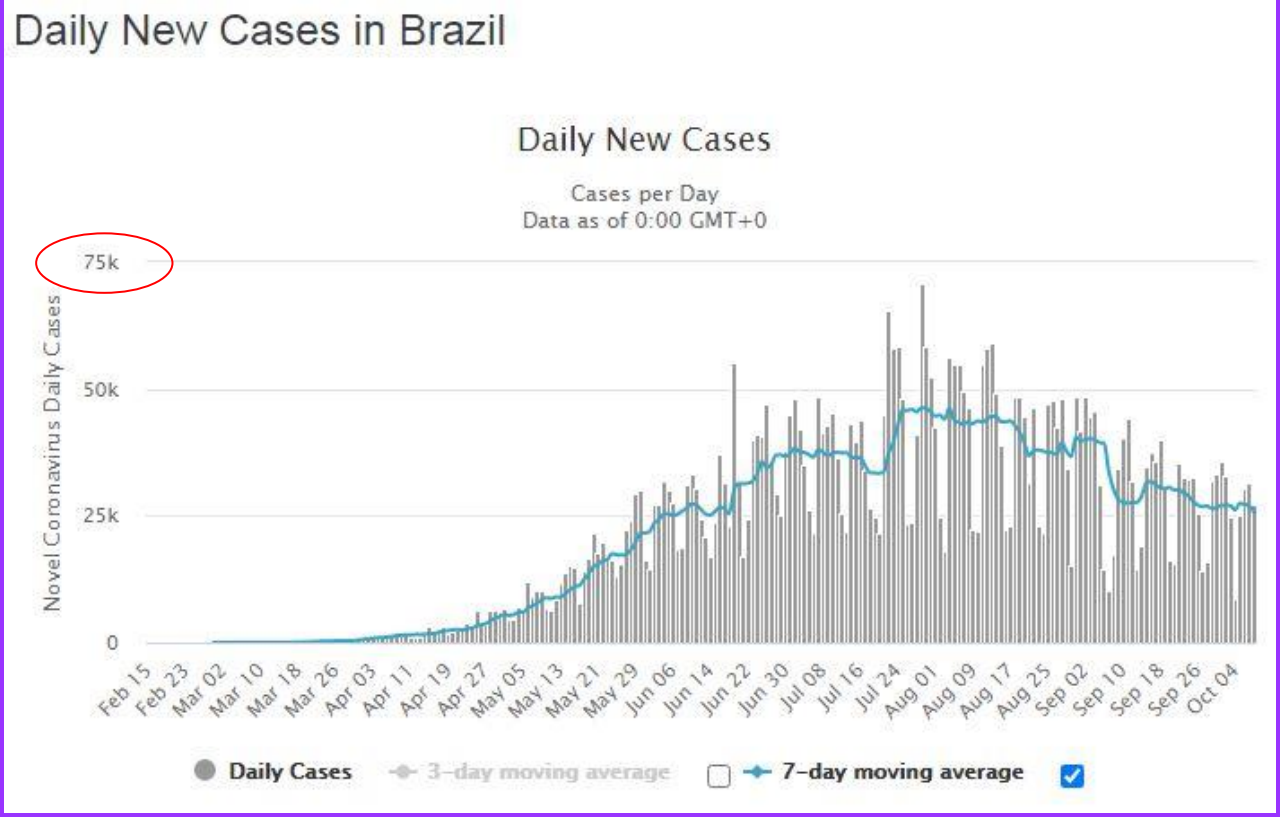
Note the pronounced "holiday effect"—it is likely because of reduced staffing & demand

- **As seems common to the situation in tropical areas, Brazil had a prolonged severe outbreak**

Death rate:

871/M

19 Dec



09 Oct

[a1]

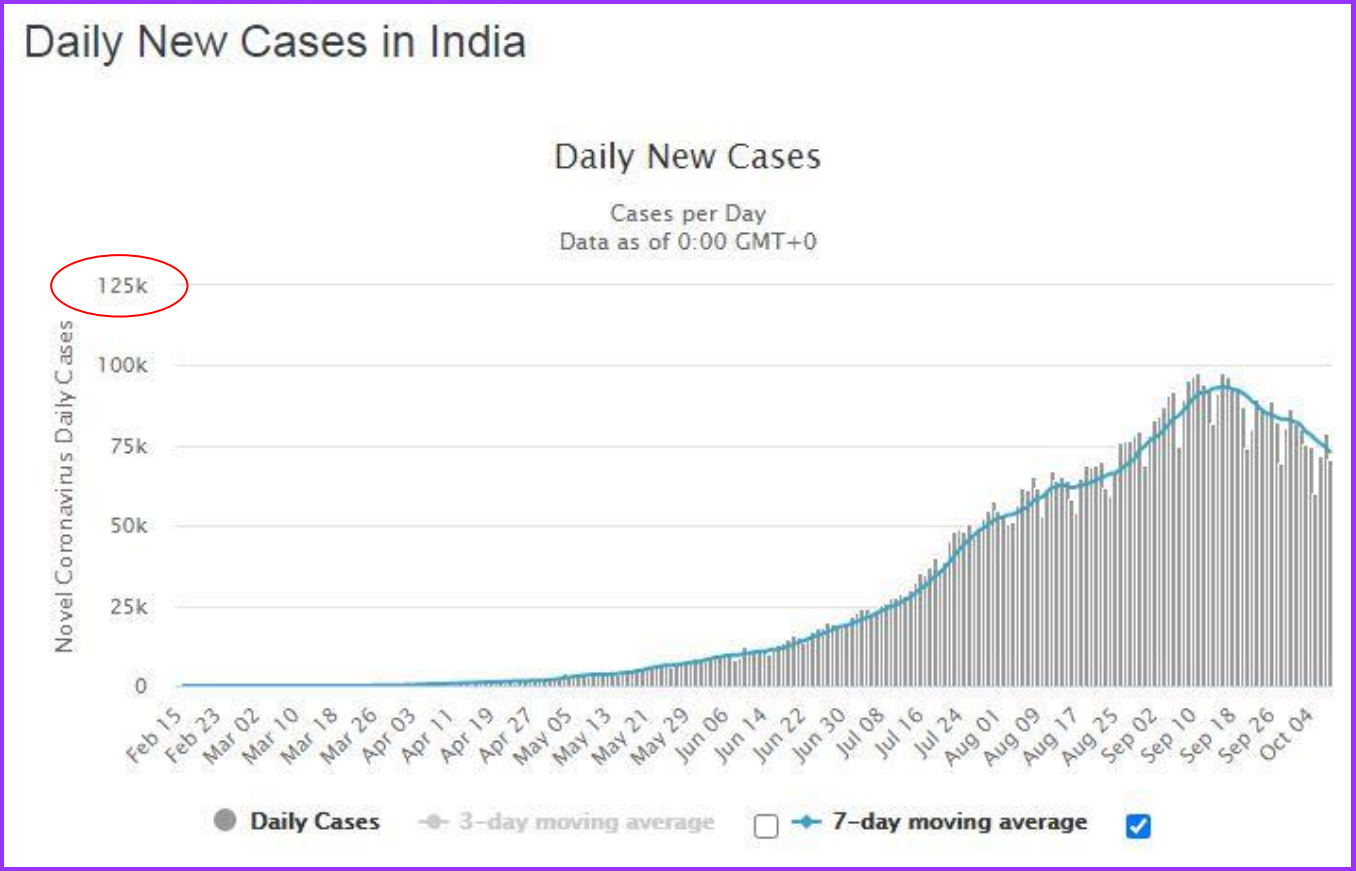
Note the pronounced "weekend effect" that is widespread in such curves—it is likely because of reduced staffing & demand

- **India had a prolonged outbreak after a brief lockdown they realized they couldn't maintain**

Death rate:

105/M

19 Dec



09 Oct

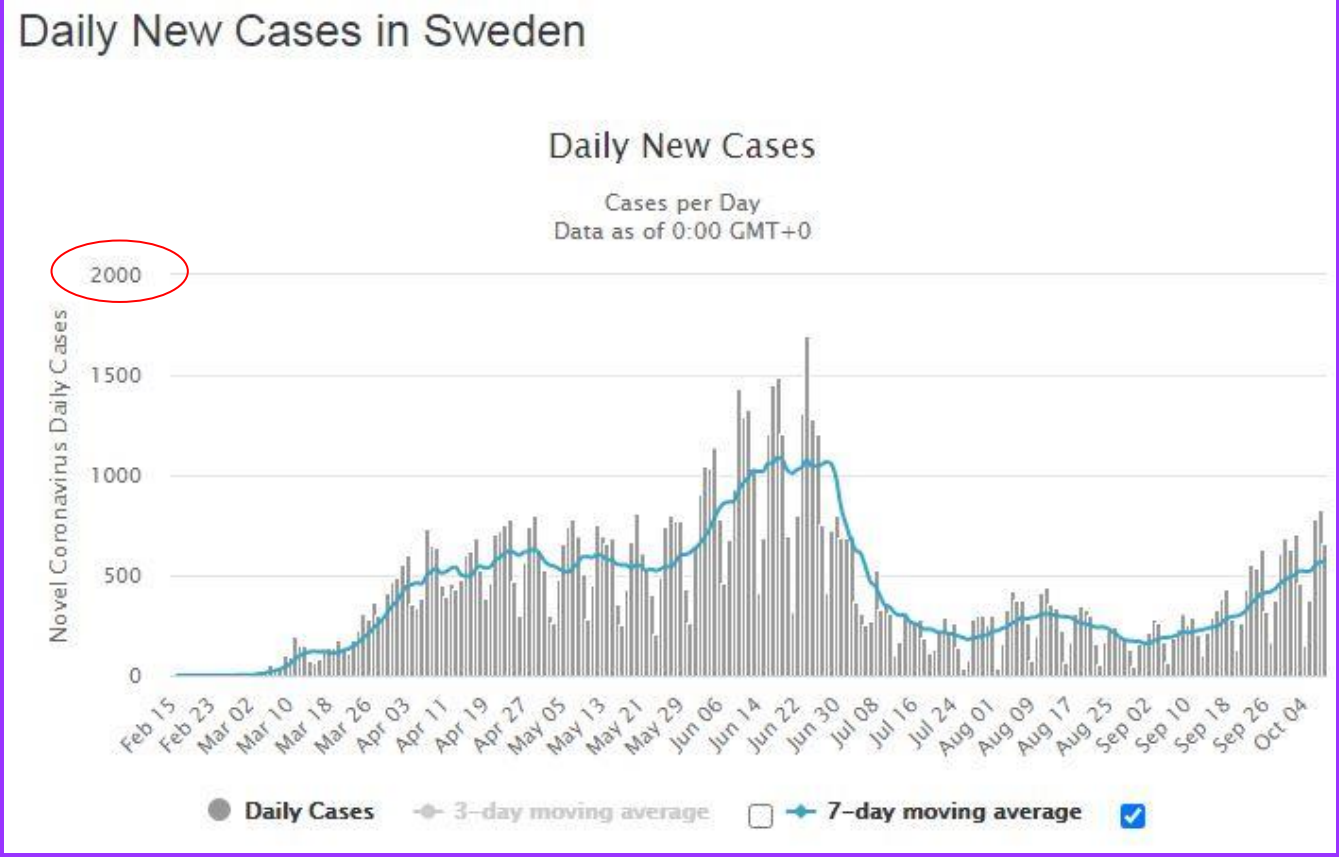
[a1]

- **Sweden used limited social controls & had a prolonged outbreak**

Death rate:

789/M

19 Dec



09 Oct

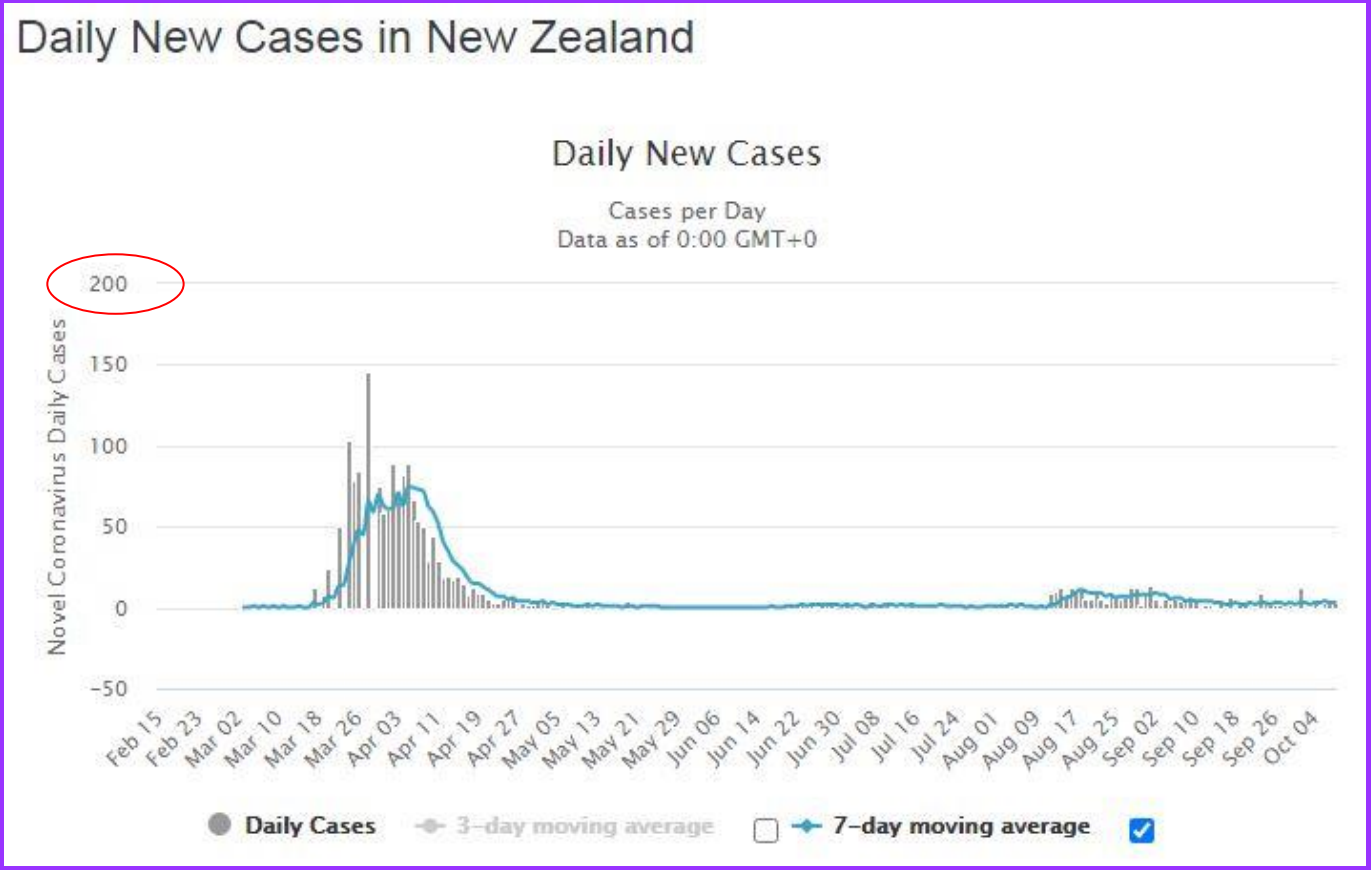
[a1]

- **New Zealand clamped down early & was quickly able to keep infection low**

Death rate:

5/M

19 Dec



09 Oct

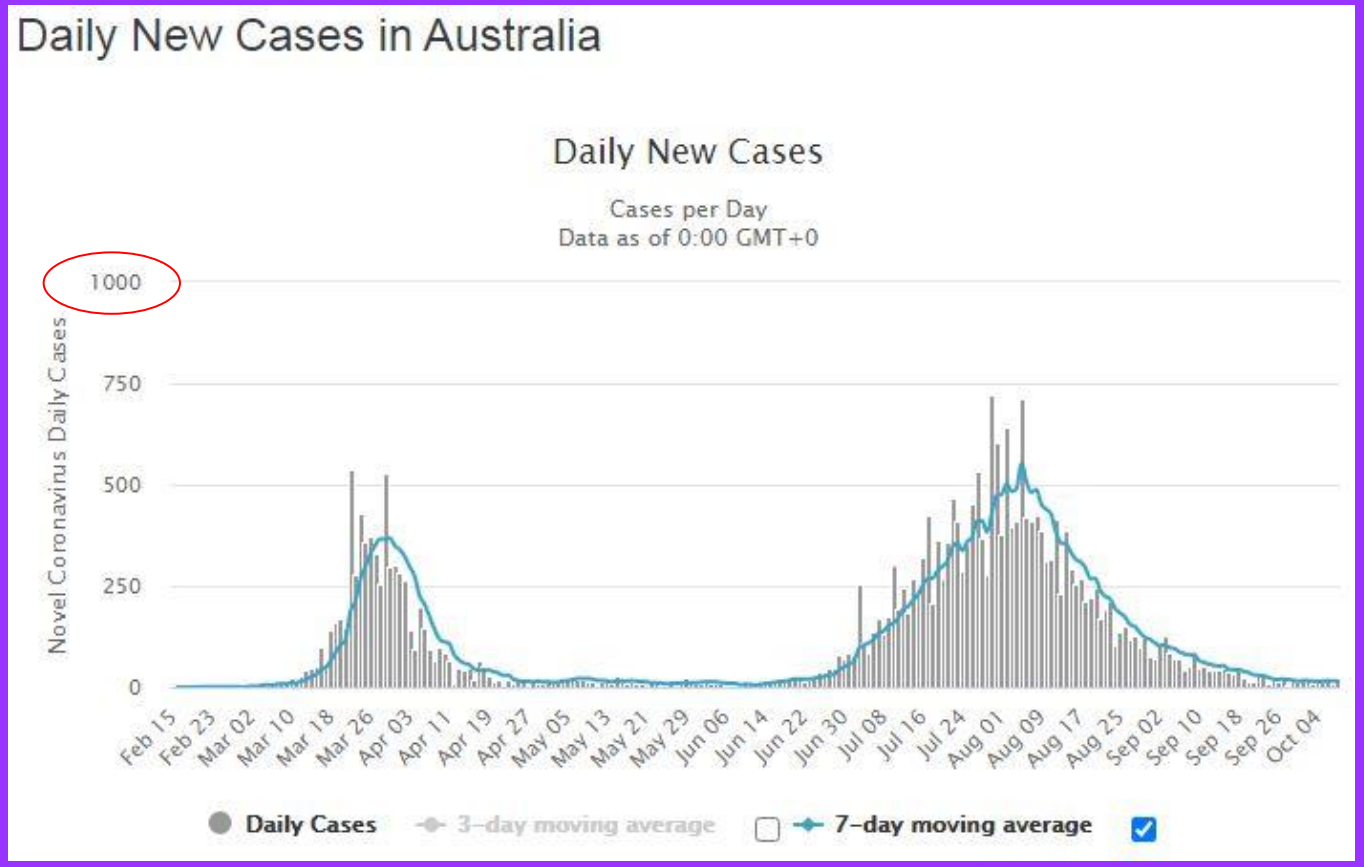
[a1]

- **Australia had 2 months with low infection, relaxed in late fall, then had a 2nd longer wave in winter**

Death rate:

35/M

19 Dec



09 Oct

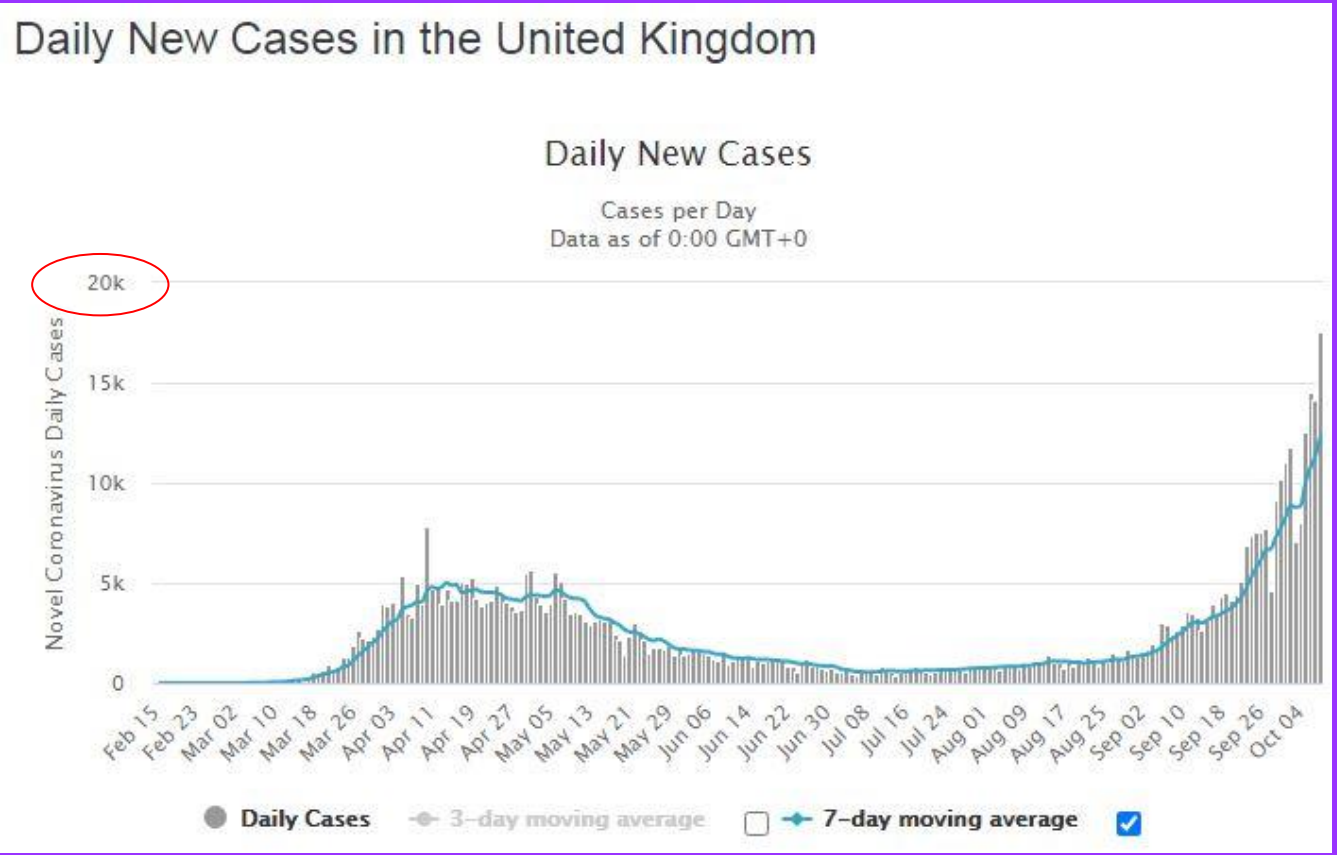
[a1]

- **UK went into its 2nd wave in early September following relaxation of controls & a more infectious variant is involved** [a211, a312, a4WHOv]

Death rate:

986/M

19 Dec



09 Oct

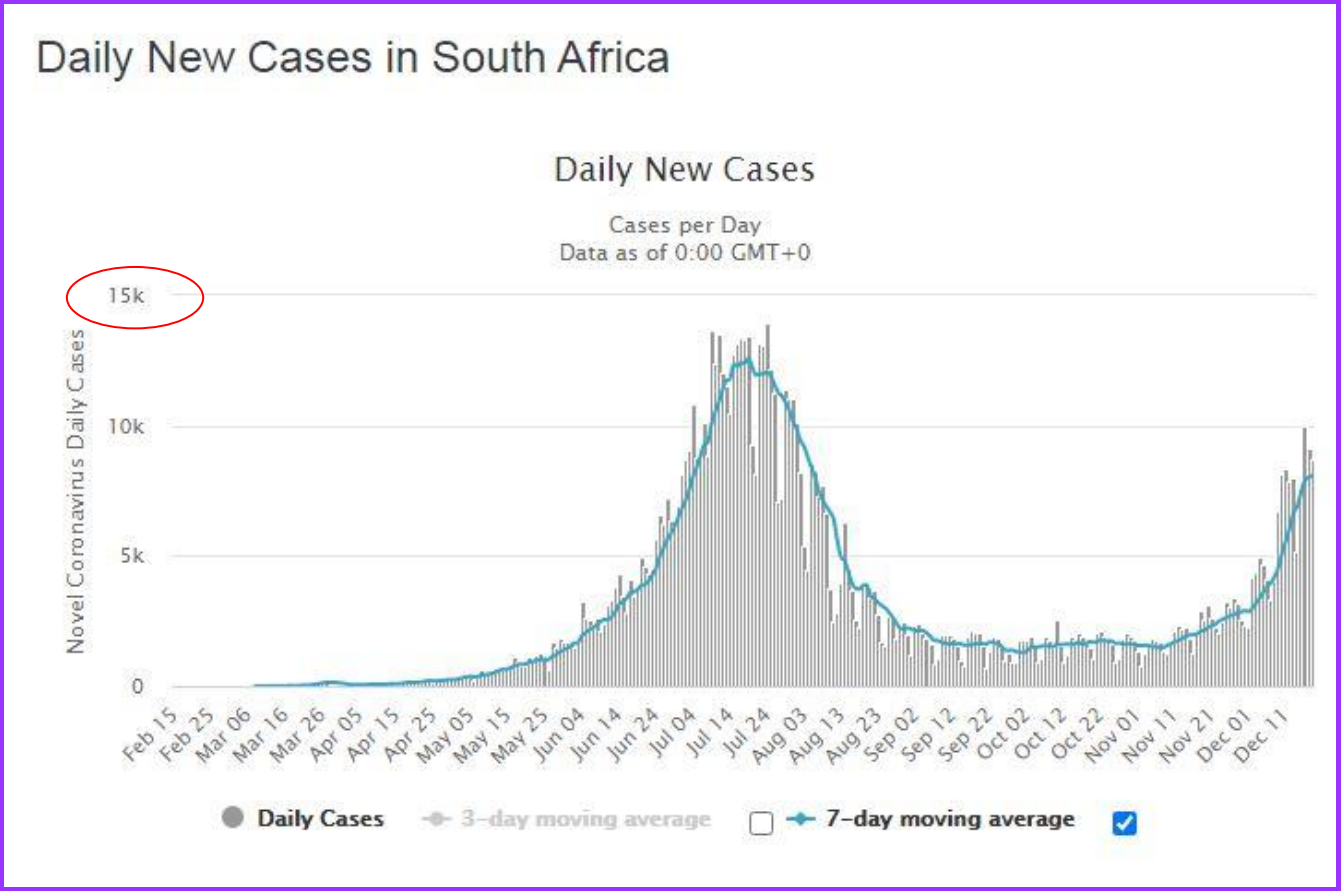
[a1]

- **South Africa has had one of the highest infection rates in Africa, but a typical case fatality rates in resolved cases (CFR_{res}): 3.1%** [a54, a613]

Death rate:

407/M

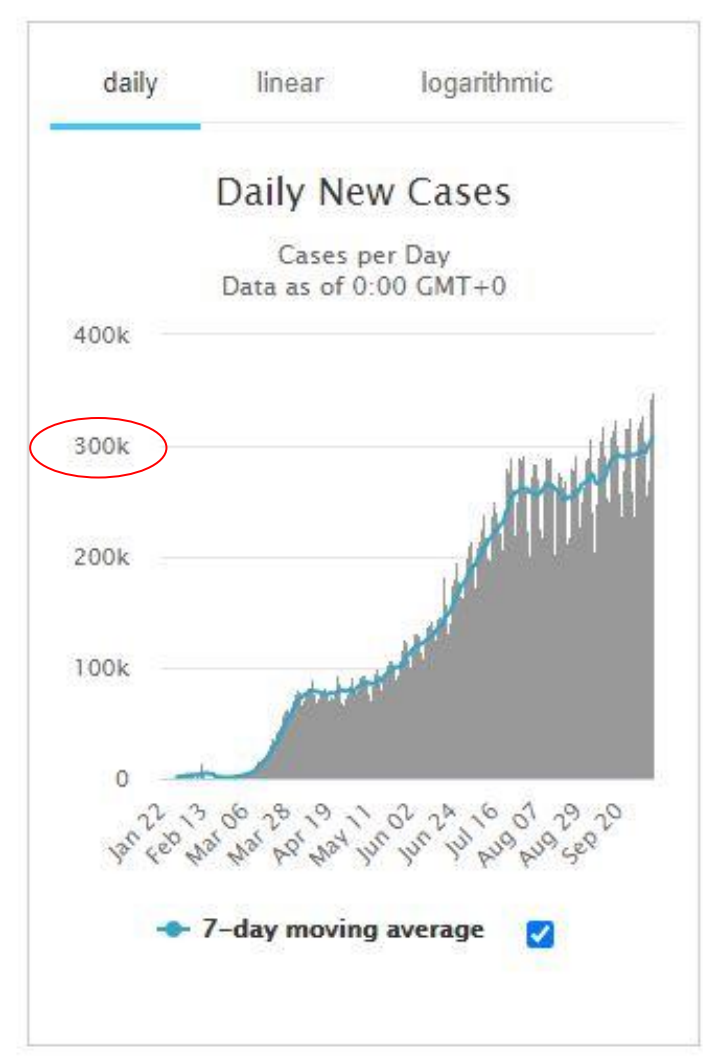
19 Dec



19 Dec

[a1]

- **With so many concurrent & successive epidemics, the World curve has continued up**



Death rate:

216/M

CFR_{res}: 3.2%

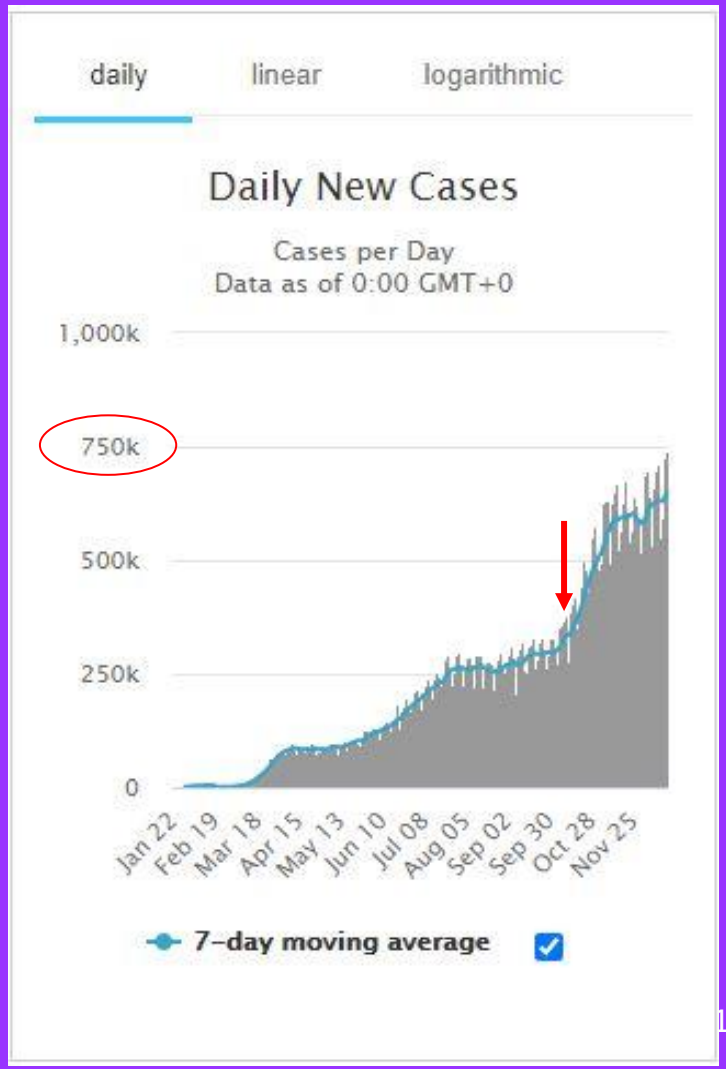
19 Dec

< 9 Oct

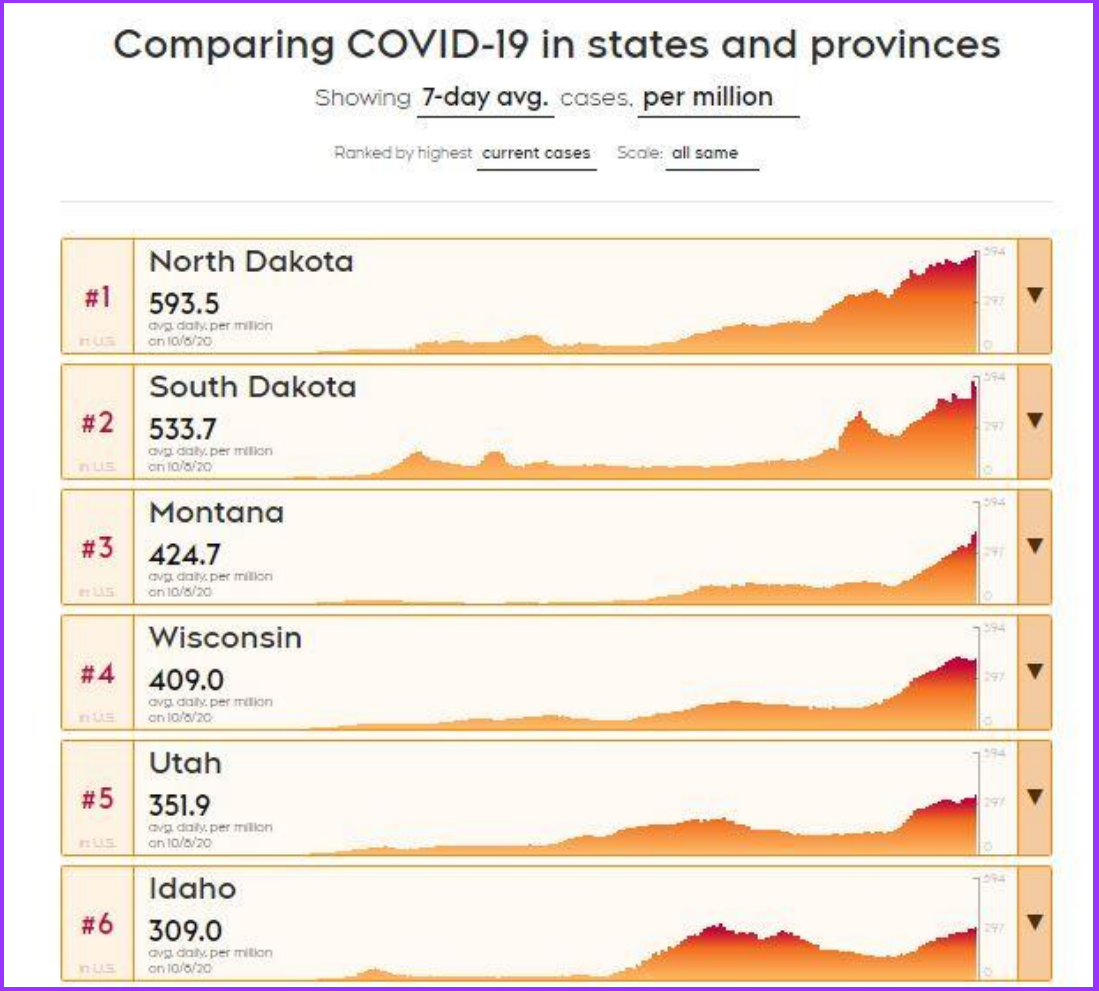
320 k

19 Dec >

645 k

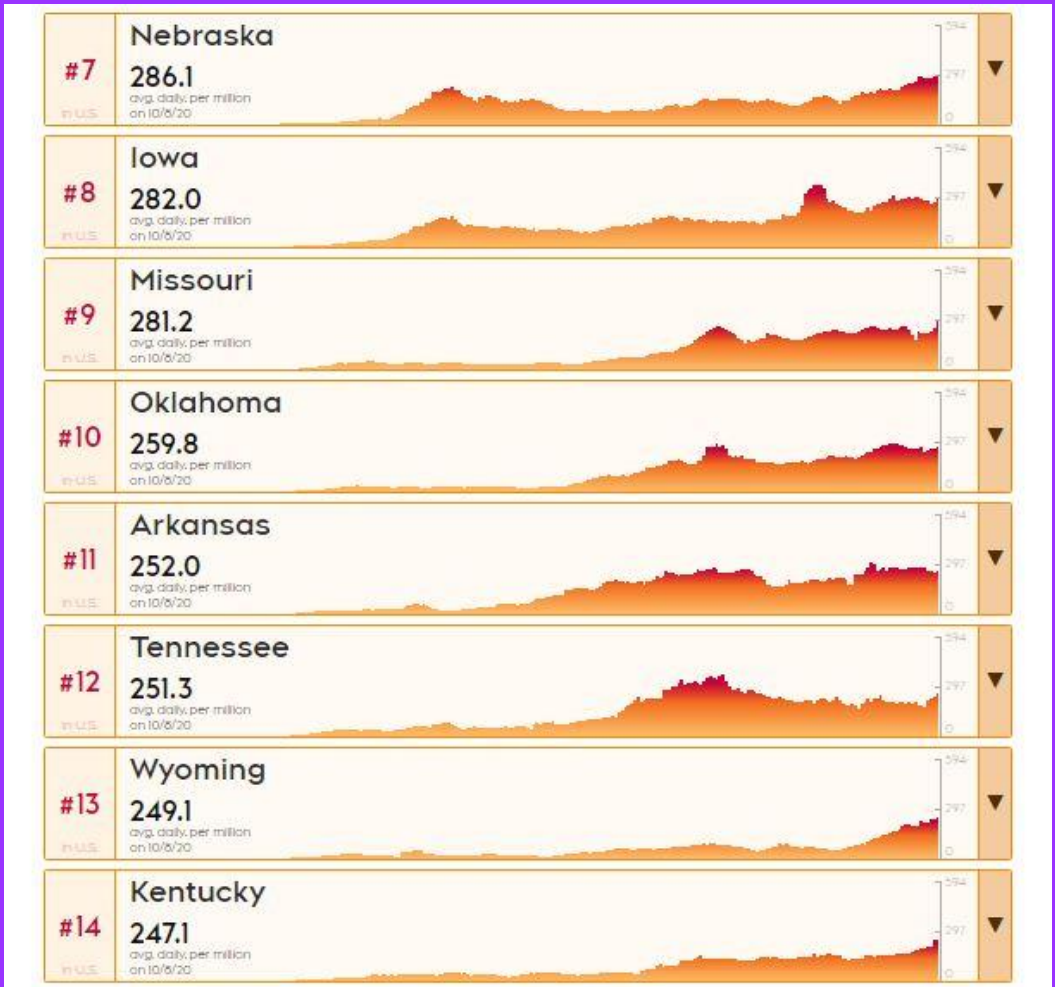


[a1]

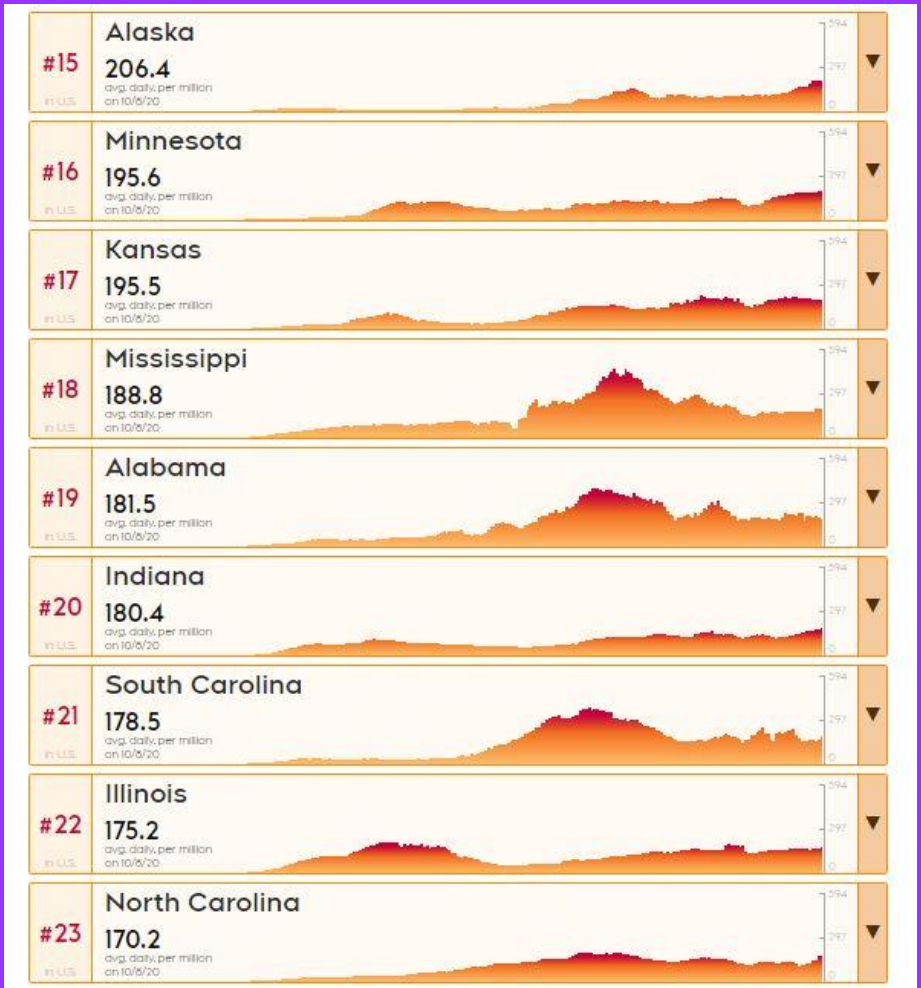


[a7]

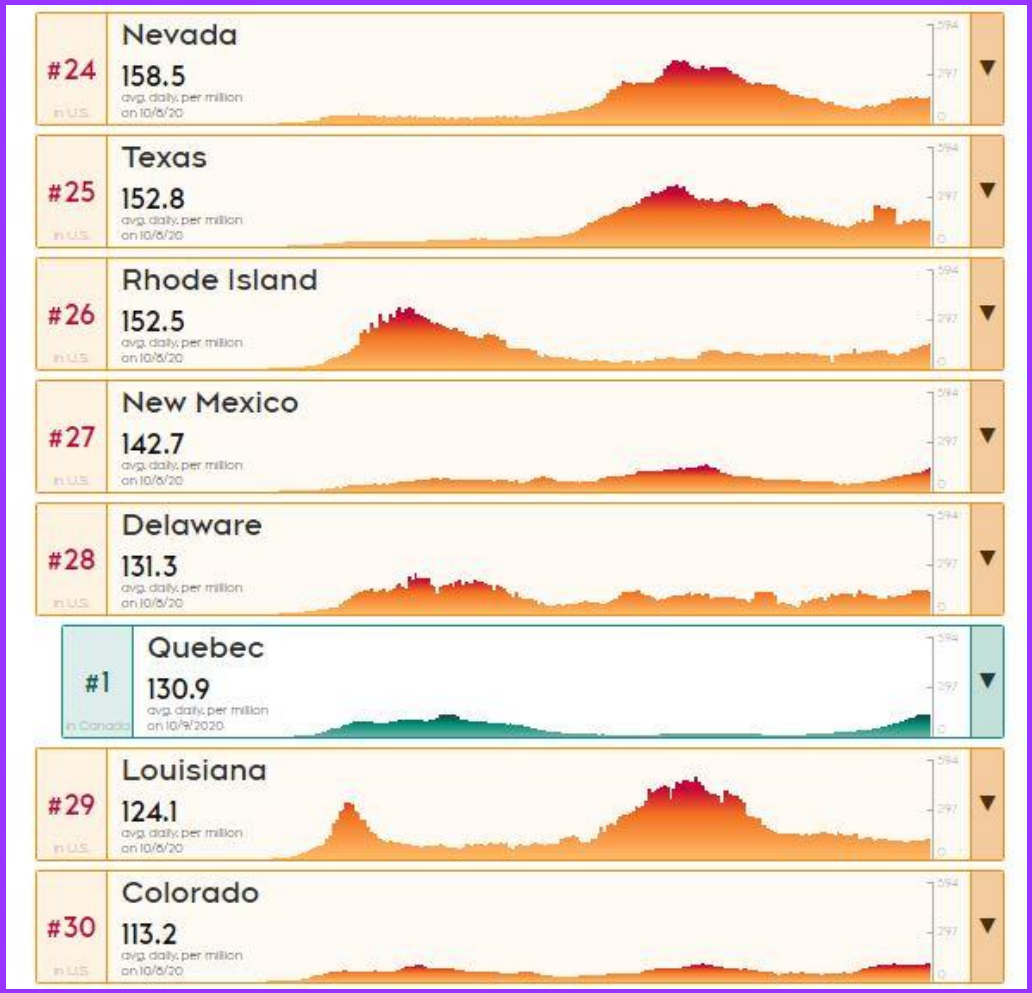
- **In early October, North & South Dakota had the highest 7-day case rates (> 500), but by early January they had gone back into the pack**


#7
Nebraska
286.1
avg. daily per million
on 10/8/20
#8
Iowa
282.0
avg. daily per million
on 10/8/20
#9
Missouri
281.2
avg. daily per million
on 10/8/20
#10
Oklahoma
259.8
avg. daily per million
on 10/8/20
#11
Arkansas
252.0
avg. daily per million
on 10/8/20
#12
Tennessee
251.3
avg. daily per million
on 10/8/20
#13
Wyoming
249.1
avg. daily per million
on 10/8/20
#14
Kentucky
247.1
avg. daily per million
on 10/8/20

[a7]

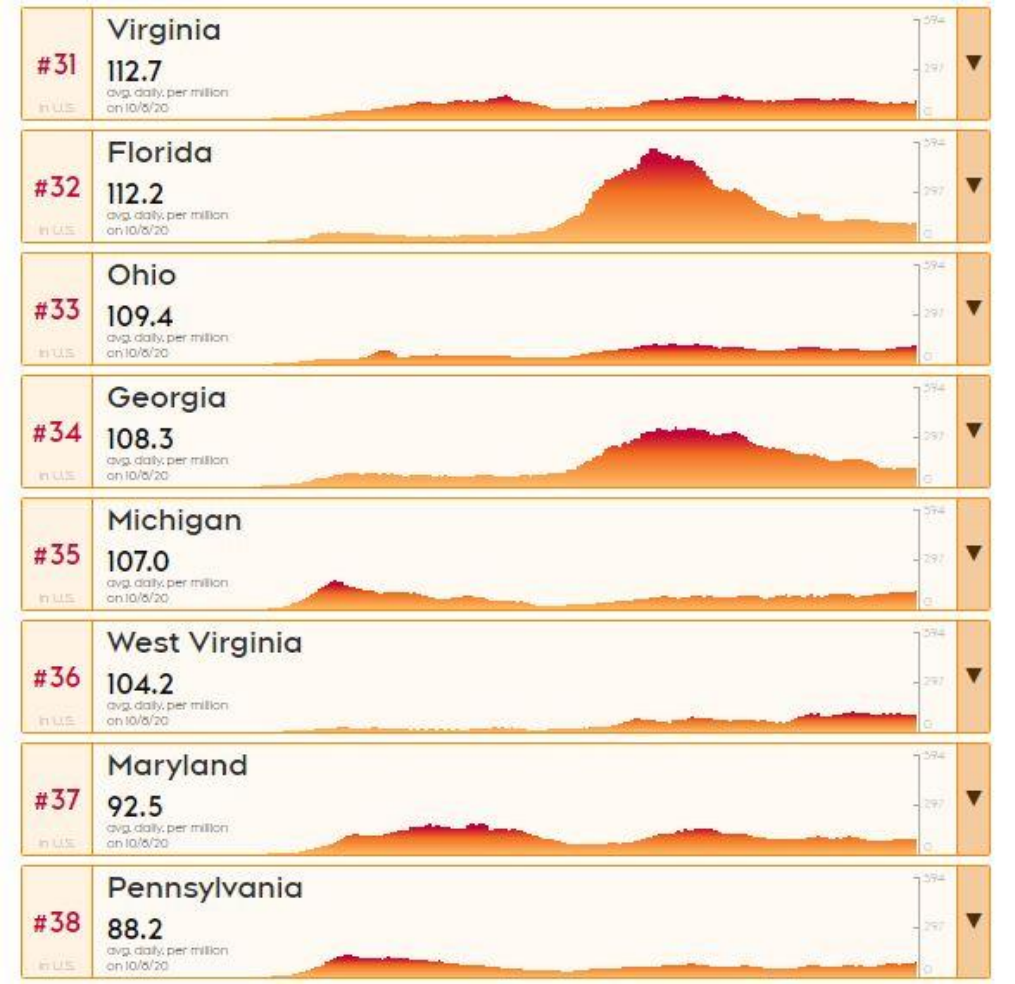

#15
Alaska
206.4
avg. daily per million
on 10/6/20
#16
Minnesota
195.6
avg. daily per million
on 10/6/20
#17
Kansas
195.5
avg. daily per million
on 10/6/20
#18
Mississippi
188.8
avg. daily per million
on 10/6/20
#19
Alabama
181.5
avg. daily per million
on 10/6/20
#20
Indiana
180.4
avg. daily per million
on 10/6/20
#21
South Carolina
178.5
avg. daily per million
on 10/6/20
#22
Illinois
175.2
avg. daily per million
on 10/6/20
#23
North Carolina
170.2
avg. daily per million
on 10/6/20

[a7]

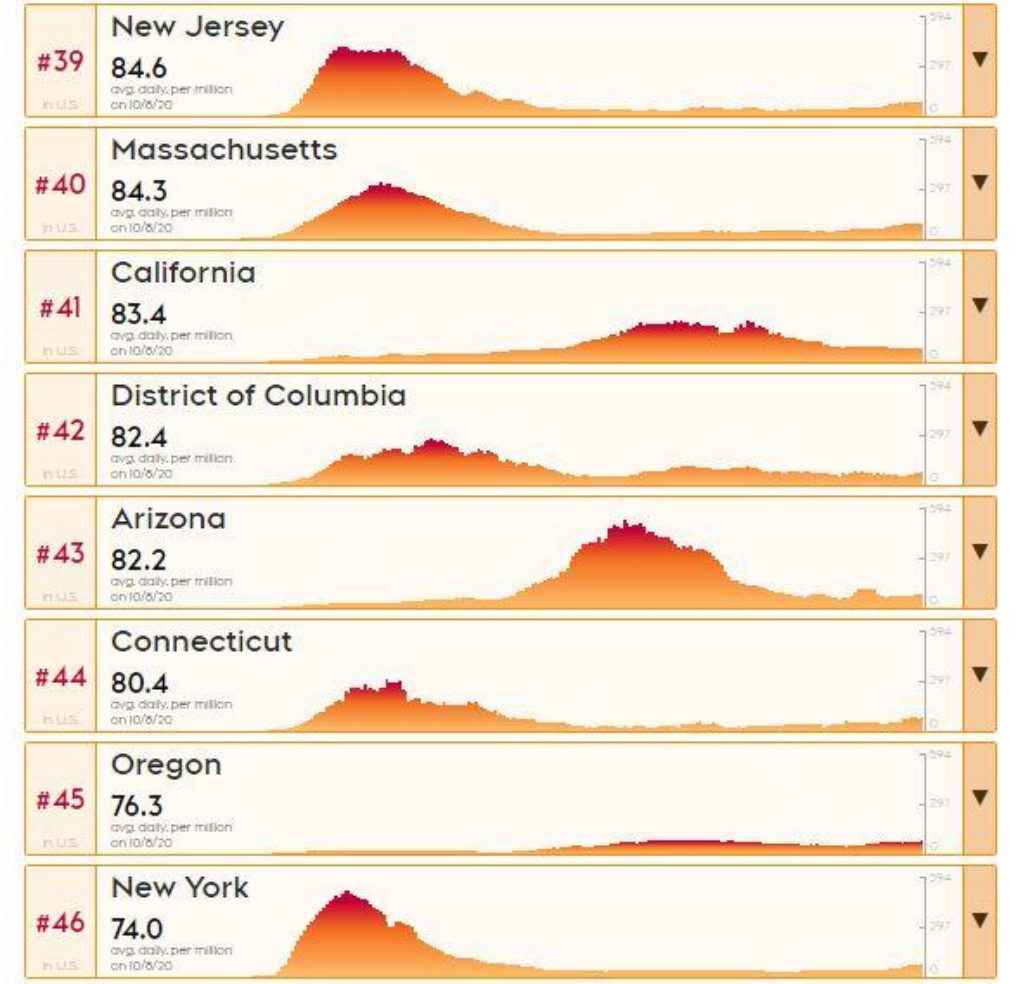


[a7]

- **In Canada, Quebec had the highest 7-day case rate: 131**

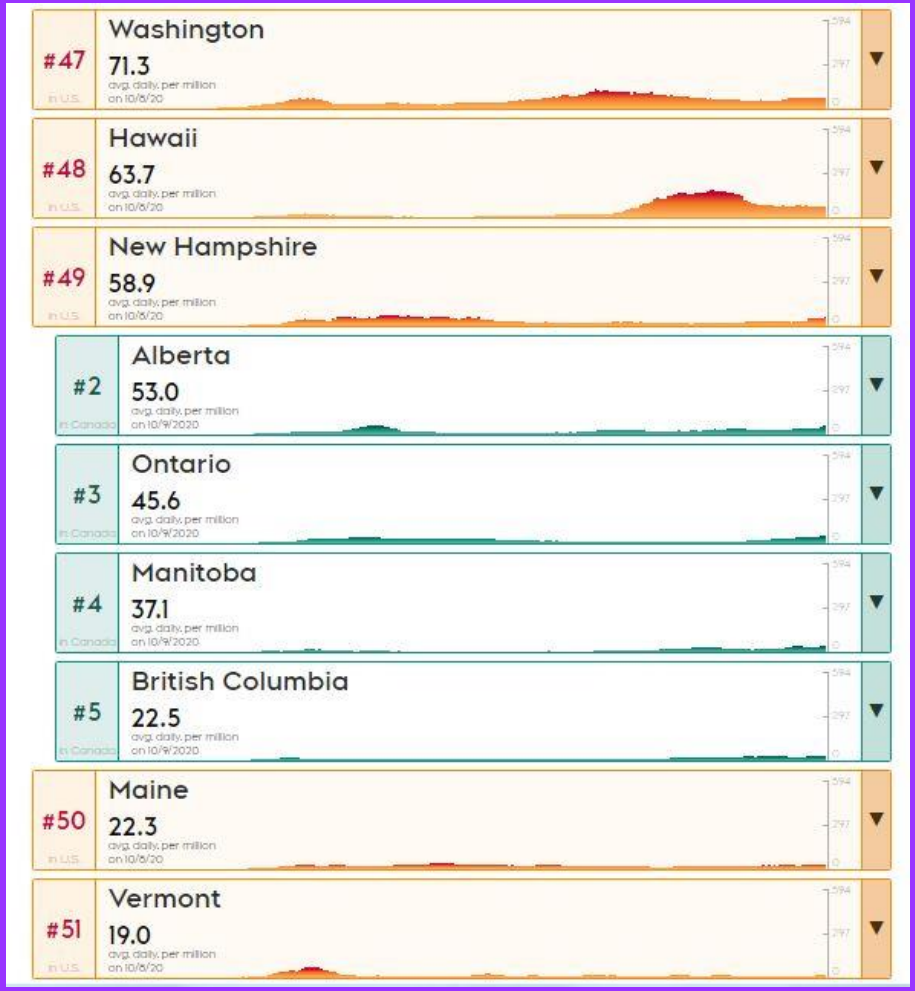

#31
Virginia
112.7
avg. daily, per million
on 10/6/20
#32
Florida
112.2
avg. daily, per million
on 10/6/20
#33
Ohio
109.4
avg. daily, per million
on 10/6/20
#34
Georgia
108.3
avg. daily, per million
on 10/6/20
#35
Michigan
107.0
avg. daily, per million
on 10/6/20
#36
West Virginia
104.2
avg. daily, per million
on 10/6/20
#37
Maryland
92.5
avg. daily, per million
on 10/6/20
#38
Pennsylvania
88.2
avg. daily, per million
on 10/6/20

[a7]



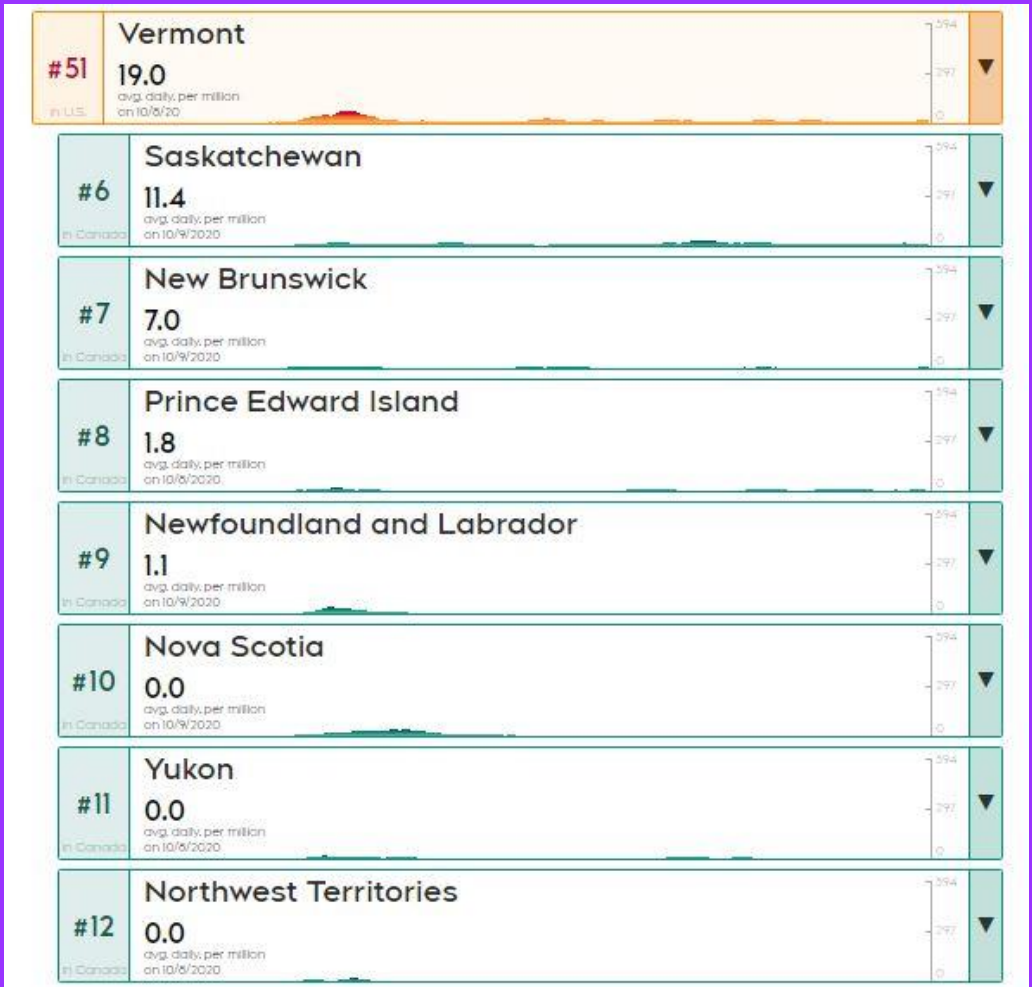
[a7]

- **By January 2021, Arizona had become the leader (~1,350) with Rhode Island (~1,300) second.**



[a7]

- **Alberta (53) & Ontario (46) were behind, with Manitoba (37) & BC (23) further back**



[a7]

- **Saskatchewan (11) & New Brunswick (7) were low & remaining provinces & territories were near 0**

Annex B: Masks

- Some places (e.g., China) accepted mask-wearing readily
- Others (e.g., Sweden) saw no need to wear masks, sometimes even within hospitals
- Others (e.g., USA) had people split into pro- and anti-mask camps

[b1]

Contrasting attitudes

[b2]

- **Contagion measures in 1918-19 were based on infection with a bacterium Dr R Pfeiffer isolated from influenza victims' lungs in the 1892 pandemic** [b3]
- **Masks were, even then, known to filter out bacteria**
  - **Bacteria are 1 to 2 orders of magnitude larger than viruses** [b4]
- **Influenzavirus was found in 1933, but we seem stuck in our thinking** [b5]

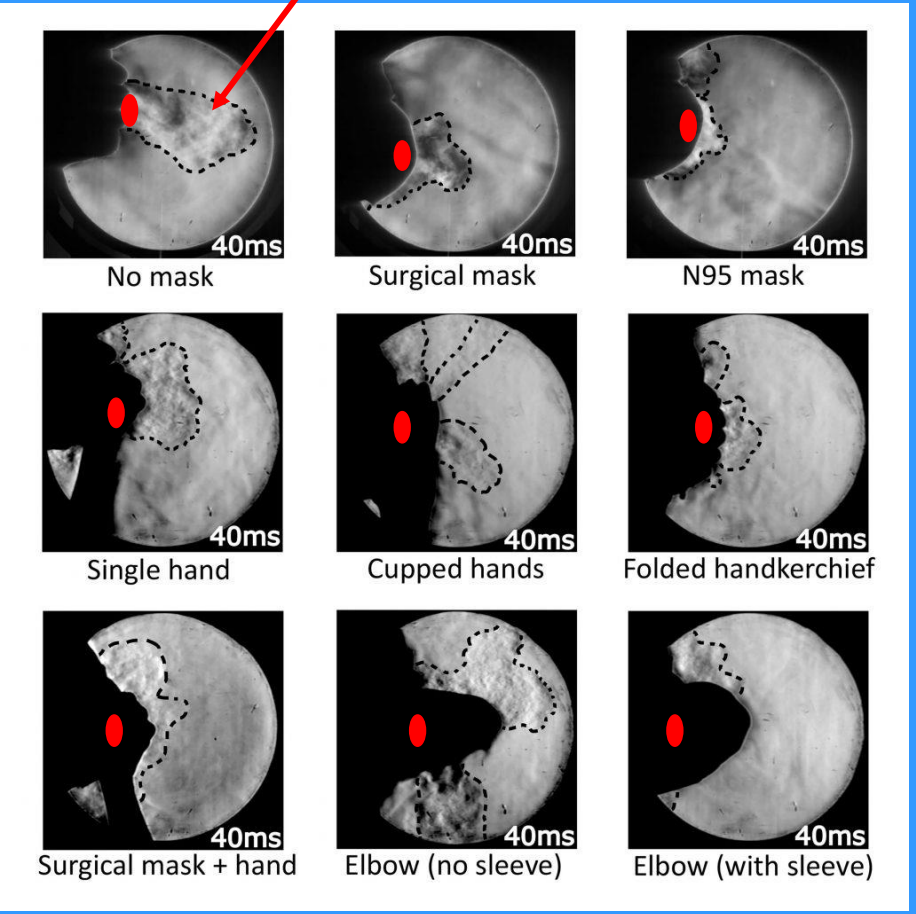
- **Evidence on the effectiveness of masks is based mostly on pathogens other than SARS2**
- **Evidence is limited & mixed** [b6, b7]
  - **A November 2020 meta-analysis of 17 studies found no association between face mask intervention & respiratory infections**
  - **Adjusting for age, sex, & vaccination suggested protective effect**
  - **A subgroup meta-analysis of 14 studies in adults with (unadjusted) risk ratios found a decrease in respiratory infections & another of 4 studies with a combined face masks & hand hygiene**
  - **A meta-regression adjusting the effect estimates for non-compliance in the controls supported mask use** [b8]
- **Even with masking & other preventive measures, people are still getting infected with SARS2**

Masks are controversial & evidence of their effectiveness is mixed. [b9googledoc]

- **Early advice was that the public did not need to wear masks, but healthcare workers should do so**
- **Masks did not prevent all healthcare workers from getting ill**
  - **~20% of deaths in Canada have been among healthcare workers** [b10]
- **Production of N95s was expanded, but supply remained limited** [b11]

- **Advice changed to include the public wearing masks**
- **Evidence seems to indicate N95 masks and surgical masks are similar in effectiveness** [b12]
- **Society has split into mask-believers & personal rights advocates**

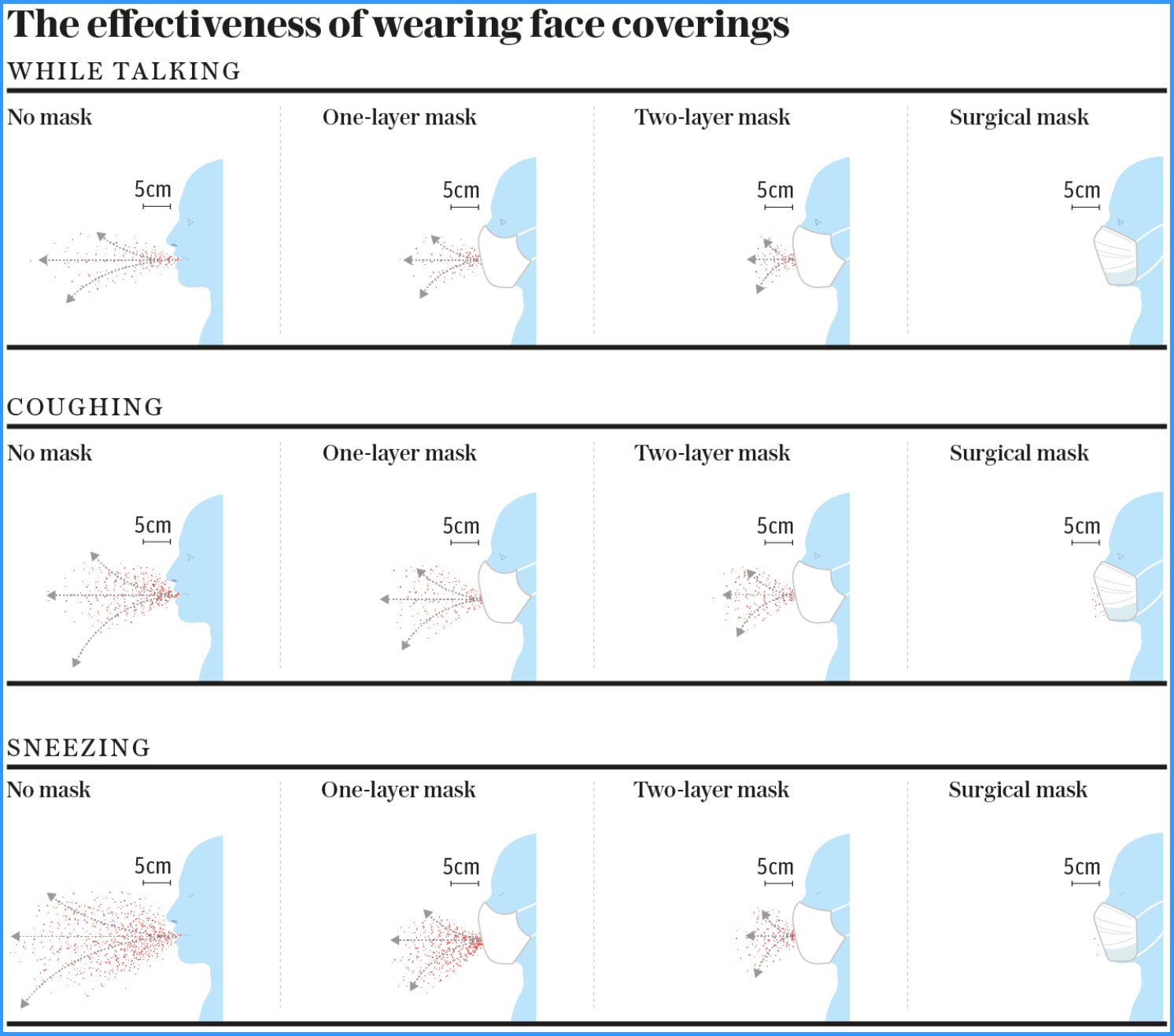
The breath cloud at 40 milliseconds



[b13]

The cloud of breath emitted by coughs (circle = mouth location)

The effectiveness of wearing face coverings



[b14]

Without physical distancing, wearing a mask may not prevent infection. [b15]

- Researchers tested how 5 types of mask impacted the spread of droplets that carry SARS2 when we cough or sneeze
- Masks reduced the number of droplets that were spread, but at < 2 m, enough droplets to cause illness still made it through several
- Not wearing a mask properly worsens its effectiveness [b16]

Wearing a mask might lead faster to becoming immune.

- Wearing a mask can trap virions
- The mask can be a fomite, leading to repeated transfer of small numbers virions into the body
- The body may be able to cope with small doses and eventually mount an effective immune response [b17immune]

A collaborative did a wide-ranging review & found…

- **The physics is known: if a porous obstacle is put in the path of air that contains aerosols, some of the aerosols will end up in the obstacle**
- **Effectiveness of a mask varies: fit & material determine filteration of aerosols**
  - **A properly-fitted N95 respirator filters out at least 95% of aerosols of all sizes for the wearer**
  - **Surgical masks are an excellent option, as they offer protection in the range of 70-80%**
  - **Cloth masks with pockets that can hold filters should be especially effective** [b18]

Masks transfer of responsibility to the individual.

- In health & safety, reducing identified hazards involves a cascade
  - Alternative methods designed by institutions
  - Engineering controls installed by institutions
  - Personal protective equipment worn by workers
- Opinion: masks will reduce droplet transmission but will be insufficient to prevent infection given prolonged exposure to aerosol clouds containing SARS2

Annex C: Responses to select questions and comments

- Vitamin C (ascorbic acid): Yes, vitamin C is partly converted to oxalate, which enters the urine and can precipitate to form oxalate-based kidney stones. This is problematic in men, but women. Dietary sources of vitamin C are usually insufficient to cause stones, which have been found only to form when supplementation is above 1,000 mg (1 g) per day. As a result of this, until the pandemic is over, I will reduce my own intake from 2 g to 1 g.
- [relevant to slides 6, 59, 60, 70]
  - See https://pubmed.ncbi.nlm.nih.gov/26463139/

- Vitamin D: Yes, vitamin D can have side effects if taken in excess. Dietary sources and sun exposure are usually insufficient to cause undesired health effects. [I would not generation of vitamin D from exposure can provide very high levels of vitamin D in the blood.] High levels of vitamin D can cause high calcium in the blood, which leads to nausea, vomiting, weakness, and frequent urination. It can also lead to calcium-based kidney stones. As the calcium source is the bones, it can lead to weakened bones and pain in the bones. The problematic dose levels appears to be in excess even of the high doses being used to treat COVID19 (50,000 IU per day). I am going to maintain my current dose of 3,000 IU.
- [relevant to slides 6, 60, 70]
  - See https://www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/expert-answers/vitamin-d-toxicity/faq-20058108

- Air Decontamination with Ultraviolet Light: UV-C (but not UV-A or UV-B, which are not sufficiently energetic) is useful in air ducts for inactivating viruses and killing other pathogens. It can also be used to decontaminate materiel and surfaces.
- [relevant to slides 6, 49]

  - See https://www.canada.ca/en/health-canada/services/drugs-health-products/covid19-industry/medical-devices/ultraviolet-decontamination-notice.html
  - and https://www.fda.gov/medical-devices/coronavirus-covid-19-and-medical-devices/uv-lights-and-lamps-ultraviolet-c-radiation-disinfection-and-coronavirus

- Minimum wage rates around the world: While there are no data for many countries, there are international comparisons of minimum wage (nominal and purchasing-power-parity). One shows the ten **highest** countries by PPP are:
  - Argentina
  - New Zealand
  - Luxembourg
  - Australia
  - Germany
  - San Marino
  - United Kingdom
  - Taiwan
  - Turkey
  - Netherlands

  The ten **lowest** countries are:
  - Mauritania
  - Georgia
  - Liberia
  - Bangladesh
  - Tanzania
  - Kyrgyzstan
  - Democratic Republic of Congo
  - Guinea-Bissau
  - Solomon Islands
  - The Gambia
- **Canada** is 13th, USA 22nd.
- Perhaps some enterprising economist or social scientist will plot minimum wages against SARS2 death rates and infections rates, but that is a task for another day.
  - See https://en.wikipedia.org/wiki/List_of_countries_by_minimum_wage

Citations

Example of a website containing a wealth of information that is regularly updated: Centre for Evidence-Based Medicine https://www.cebm.net/

Another website containing a wealth of information, this one Canadian https://www.cmaj.ca/covid-19

Citations for *The Societal Responses and Effects*

- [1] SARS-CoV-2 coronavirus particles (orange) on a cell (blue). Credit: NIAID/NIH/SPL https://www.nature.com/articles/d41586-020-01989-z?utm_source=Nature+Briefing&utm_campaign=beb9f70649-briefing-dy-20200827&utm_medium=email&utm_term=0_c9dfd39373-beb9f70649-45004781
- [2] What you might wish to do to protect yourself https://youtu.be/vN30emwcNS4
- [3] Gowned nurse https://www.ft.com/coronavirusfree
- [4] Outbreaks among teams in the National Football League https://www.sportsnet.ca/nfl/article/virus-toll-32-nfl-teams-hit-covid-19/
- [5] NFL player with no fans in the stands https://sports.yahoo.com/how-would-nfl-games-change-if-there-are-no-fans-players-offer-their-perspective-and-guesses-130032539.html
- [6] Case and death numbers globally and in various countries https://www.worldometers.info/geography/how-many-countries-are-there-in-the-world/

- [7] Outbreak at an Antarctic base
  https://en.wikipedia.org/wiki/COVID-19_pandemic_in_Antarctica
- [8] Ships with SARS2 outbreaks
  https://en.wikipedia.org/wiki/COVID-19_pandemic_on_cruise_ships
- [9] Military ships with SARS2 outbreaks
  https://en.wikipedia.org/wiki/COVID-19_pandemic_on_naval_ships
- [10] World case map
  https://www.covid19map.world/
- [11] Epidemiologic models
  https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2465549/
- [12] Waves of infection (1918-19 H1N1 influenza in USA)
  https://www.cdc.gov/flu/pandemic-resources/1918-commemoration/three-waves.htm
- [13] Caring for chronically ill and frail patients in the pandemic
  https://www.theguardian.pe.ca/news/canada/canadian-forces-members-report-cases-of-alleged-abuse-in-long-term-care-facilities-453992/

- [14] Young adults get serious illness
  https://www.nytimes.com/2020/12/16/opinion/covid-deaths-young-adults.html
- [15] World population
  https://www.worldometers.info/world-population/
- [16] Total humans who have ever lived
  https://www.prb.org/howmanypeoplehaveeverlivedonearth/
- [17] Births and deaths
  https://ourworldindata.org/births-and-deaths
- [18] Population growth
  https://ourworldindata.org/world-population-growth
- [19] Anthropocene
  http://quaternary.stratigraphy.org/working-groups/anthropocene/
- [20] Countries and territories
  https://www.worldometers.info/geography/how-many-countries-are-there-in-the-world/
- [21] GDP
  https://data.worldbank.org/indicator/NY.GDP.MKTP.CD

- [22] Human population in cities https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html
- [23] Population in cities https://ourworldindata.org/urbanization#number-of-people-living-in-urban-areas
- [24] Human use of net primary production https://www.researchgate.net/publication/237018054_Global_Human_Appropriation_of_Net_Primary_Production_Doubled_in_the_20th_Century
- [25] Human use of net primary production https://www.pnas.org/content/110/25/10324
- [26] Forest loss to human activity https://www.nature.com/articles/nature14967
- [27] Greenhouse gas emissions in 2019 https://www.iea.org/articles/global-co2-emissions-in-2019
- [28] Emissions in 2019 https://www.globalcarbonproject.org/

- [29] Emissions per day https://www.nature.com/articles/s41558-020-0797-x#Tab1
- [30] Emissions including land use change https://www.theworldcounts.com/challenges/climate-change/global-warming/global-co2-emissions/story
- [31] A clearcut in British Columbia's remaining old growth forest https://www.change.org/p/bc-ndp-stop-logging-in-bcs-old-growth-rainforests
- [32] Cultural diversity https://www.girltalkhq.com/wp-content/uploads/2014/04/Screen-Shot-2014-04-10-at-9.53.38-AM.png
- [33] Horsemen of the Apocalypse (war, famine, disease, death) https://revth.files.wordpress.com/2018/01/4-h-men.jpg
- [34] Pandemic plans https://www.washingtonpost.com/health/2019/10/24/none-these-countries-us-included-is-fully-prepared-pandemic-report-says/
- [35] Public Health Agency of Canada https://www.canada.ca/en/public-health/corporate/mandate/about-agency/history.html

- [36] Crowded hospital https://www.cbc.ca/news/canada/london/ontario-hospitals-efficiency-healthcare-reform-1.5406753
- [37] Global Health Security Index https://en.wikipedia.org/wiki/Global_Health_Security_Index
- [38] European SARS2 response co-ordination centre https://www.politico.eu/article/eu-aims-better-control-coronavirus-responses/
- [39] Grave diggers in Indonesia https://www.yahoo.com/news/indonesian-gravediggers-under-strain-covid-072927159.html
- [40] USA has poor data on the pandemic https://www.nature.com/articles/d41586-020-02478-z
- [41] Nurses calling for volunteers who think SARS2 is a hoax https://twitter.com/TheeAdamRich/status/1340399773971464193/photo/1
- [42] Droplet transmission https://www.who.int/news-room/commentaries/detail/modes-of-transmission-of-virus-causing-covid-19-implications-for-ipc-precaution-recommendations

- [43] Fomites in transmission https://www.bbc.com/future/article/20200317-covid-19-how-long-does-the-coronavirus-last-on-surfaces
- [44] Dispersal of droplets from coughing (U of New South Wales, Australia) https://www.youtube.com/watch?app=desktop&v=DNeYfUTA11s
- [45] Miasmas https://www.medicinenet.com/miasma/definition.htm
- [46] Denial of airborne transmission https://www.wired.com/story/they-say-coronavirus-isnt-airborne-but-its-definitely-borne-by-air/
- [47] The contaminated cloud behind a walking person https://www.medicinenet.com/script/main/art.asp?articlekey=250041
- [48] Pfeiffer's bacillus https://www.aai.org/AAISite/media/About/History/Articles/AAI_History_007-(1).pdf
- [49] 1918 influenza advice https://www.history.com/news/1918-pandemic-public-health-campaigns

- [50] People on a street in New York, NY, USA, in 1918 https://www.nytimes.com/2020/08/03/us/mask-protests-1918.html
- [51Thai] WHO poster from Thailand containing public health advice https://twitter.com/WHOThailand/status/1297398662339809291/photo/1
- [52] Testing available at the end of January https://cmajnews.com/2020/06/12/coronavirus-1095847/
- [53] Closures https://toronto.ctvnews.ca/ontario-orders-all-non-essential-businesses-to-shut-down-1.4864492
- [54] Cancellation of certain hospital services https://www.thestar.com/news/canada/2020/04/02/doctors-brace-for-backlog-as-elective-surgeries-postponed-amid-coronavirus-crisis.html
- [55] School children infected in Israel https://www.jpost.com/israel-news/thousands-of-ultra-orthodox-school-children-return-to-school-amid-covid-19-646160

- [56] People asked to remain 2 m apart https://www.blogto.com/city/2020/04/toronto-introduces-new-rule-requiring-2m-distance-between-people-parks-and-public-squares/
- [57] Restaurants closed by public health order https://ny.eater.com/2020/8/12/21336334/nyc-closings-lookback-coronavirus-pandemic-2020
- [58] Cleaning a school https://www.reminetwork.com/articles/cleaning-schools-covid-19/
- [59] Social bubbles https://www.bbc.com/news/world-52424709
- [60] Self-isolation advised for people with symptoms https://news.ontario.ca/en/statement/56348/enhanced-measures-to-protect-ontarians-from-covid-19
- [61] Vietnamese hospital outbreak https://wwwnc.cdc.gov/eid/article/27/1/20-2656_article
- [62] Potential for RNA vaccines https://www.cell.com/trends/biochemical-sciences/fulltext/S0968-0004(20)30295-4

- [63] Construction workers with PPE https://www.fieldwire.com/blog/covid-19-construction-sick-worker-response/
- [64] False positives and negatives for PCR testing https://www.bmj.com/content/369/bmj.m1808
- [65] False test results https://www.health.harvard.edu/blog/which-test-is-best-for-covid-19-2020081020734
- [66] Rapid tests https://www.thelancet.com/journals/eclinm/article/PIIS2589-5370(20)30421-1/fulltext
- [67] False positive in antigen tests https://www.cdc.gov/coronavirus/2019-ncov/lab/resources/antigen-tests-guidelines.html
- [68] False positive in antigen tests https://www.albertahealthservices.ca/assets/info/ppih/if-ppih-covid-19-sag-performance-and-feasibility-of-rapid-covid-19-tests-rapid-review.pdf
- [69] Predictive value https://www.fda.gov/medical-devices/letters-health-care-providers/potential-false-positive-results-antigen-tests-rapid-detection-sars-cov-2-letter-clinical-laboratory

- [70] Antibody test accuracy https://www.cochrane.org/CD013652/INFECTN_what-diagnostic-accuracy-antibody-tests-detection-infection-covid-19-virus
- [71] Asymptomatic carriers ~40% https://www.acpjournals.org/doi/10.7326/M20-3012
- [72] Asymptomatic carriers up to 80% https://www.cnbc.com/2020/10/08/more-than-80percent-of-people-with-coronavirus-had-no-symptoms-uk-study.html
- [73] Test results https://www.cdc.gov/coronavirus/2019-ncov/downloads/Factsheet-for-Healthcare-Providers-2019-nCoV.pdf
- [74] False positive effects https://www.thelancet.com/pdfs/journals/lanres/PIIS2213-2600(20)30453-7.pdf
- [75] Airborne transmission https://www.cnet.com/health/coronavirus-is-airborne-what-that-means-for-you/
- [76] N95 masks recommended https://jamanetwork.com/journals/jamainternalmedicine/fullarticle/2769441

- [77] Decontamination of masks using steam https://mbio.asm.org/content/11/3/e00997-20
- [78] Face shields with masks for healthcare https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/health-professionals/technical-brief-masking-face-shields-full-duration-shifts-acute-healthcare-settings.html
- [79] Innovation is taking PPE to new heights https://www.forbes.com/sites/davidhochman/2020/08/28/forget-n95-masks-these-space-helmets-are-the-latest-pandemic-fashion-accessory/?sh=52e397171ab5
- [80] Face shield on a mother in India https://www.hindustantimes.com/science/covid-19-scientists-develop-low-cost-method-to-test-mask-effectiveness-against-viral-droplets/story-efXPWyGrys3dMQX9oY2FXJ.html
- [81] Anti-mask movement https://www.fairobserver.com/region/north_america/barbara-molas-canada-anti-mask-movement-covid-19-restrictions-conspiracies-news-18888/

- [82] Key to Preventing Covid-19 Indoors: Ventilation https://www.wsj.com/articles/key-to-preventing-covid-19-indoors-ventilation-11598953607
- [83] Excess deaths (by age) from influenza in 1918 https://moshemilevsky.com/insurance-lessons-from-the-spanish-flu/
- [84] Unprecedented response https://anthrosource.onlinelibrary.wiley.com/doi/10.1111/maq.12599
- [85] New Zealand had less mortality than normal because of lockdown https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(20)32647-7/fulltext
- [86] Excess deaths from SARS2 https://www.ft.com/content/a2901ce8-5eb7-4633-b89c-cbdf5b386938
- [87] Collecting a sample from the nose https://health.ucdavis.edu/coronavirus/coronavirus-testing.html
- [88] Reclassification of deaths in UK https://www.youtube.com/watch?v=KXSd9i9a5kU
- [89] ICD-10 codes for COVID19 https://www.who.int/classifications/icd/COVID-19-coding-icd10.pdf

- [90] Dying with COVID19 or from COVID19 https://www.bmj.com/content/370/bmj.m2859
- [91] Excess deaths during the pandemic https://jamanetwork.com/journals/jama/fullarticle/2771761
- [92] SARS2 strains https://www.frontiersin.org/articles/10.3389/fmicb.2020.01800/full
- [93] Interferon concentrations in blood https://science.sciencemag.org/content/369/6504/718
- [94] Mutations that reduce interferon raise likelihood of severe COVID19 https://pubmed.ncbi.nlm.nih.gov/32972995/
- [95] Hyperthermia enhances interferon-γ synthesis and alters lymphocyte population https://www.liebertpub.com/doi/10.1089/jir.1988.8.143
- [96] COVID19 hospital care protocol https://www.evms.edu/media/evms_public/departments/internal_medicine/EVMS_Critical_Care_COVID-19_Protocol.pdf

- [97] COVID19 home care protocol https://www.shrineoftheblackmadonna1.org/latest-news/covid-19-protocol-for-home-care/
- [98] SARS2 epidemiology, clinical features, and treatments https://www.uptodate.com/contents/coronavirus-disease-2019-covid-19-critical-care-and-airway-management-issues
- [99] Management of long-covid patients https://www.bmj.com/content/370/bmj.m3026
- [100] Monoclonal antibodies https://amp.cnn.com/cnn/2020/12/16/health/monoclonal-antibodies-coronavirus-access/index.html
- [101] Crowded ICU in Delhi, India https://ca.finance.yahoo.com/news/spike-covid-cases-delhi-leads-072058817.html
- [102] Bodies are being stored in sea-tainers https://www.independent.co.uk/news/world/europe/germany-italy-covid-victims-containers-b1776074.html

- [103] Deaths by age group in USA https://www.statista.com/statistics/1191568/reported-deaths-from-covid-by-age-us/
- [104] US population by age group https://www.livepopulation.com/country/united-states.html
- [105] Long-term care resident https://www.halifaxtoday.ca/local-news/overcrowded-understaffed-long-term-care-homes-contribute-to-bedsores-advocate-1720288
- [106] Antibodies last 4 to 8 months https://www.medrxiv.org/content/10.1101/2020.12.10.20246751v1
- [107] Use of convalescent plasma https://www.bmj.com/content/371/bmj.m4072
- [108] Harmful effects of chloroquine, hydroxychloroquine, and azithromycin https://www.cmaj.ca/content/192/17/E450
- [109] Repurposed medications have disappointed https://www.who.int/emergencies/diseases/novel-coronavirus-2019/interactive-timeline?gclid=Cj0KCQiA88X_BRDUARIsACVMYD8VO9ceF_oq_XF5mpN3N6BrMOtZDbqfGOAPROcwdok2kYcLEWTMHm4aAi3mEALw_wcB#!

- [110] Prone positioning of SARS2 patients
  https://www.cmaj.ca/content/192/47/E1532
- [111] Hospital at home
  https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7523688/
- [112] Repurposing hospital wards for COVID19 patients
  https://www.sciencedirect.com/science/article/pii/S2352771420301002
- [113] Nightingale hospital in UK
  https://www.bbc.com/news/uk-england-london-55503536
- [114] Isolation centres (11 federally designated locations and two lodging spaces across Canada in Toronto, Montreal, Winnipeg, Vancouver, Kelowna, Calgary, Regina, Whitehorse, Fredericton, Halifax and St. John's)
  https://www.toronto.com/news-story/10232720-what-you-need-to-know-about-covid-19-isolation-sites-and-the-conspiracy-theories/
- [115] Sputnik V vaccine
  https://sputnikvaccine.com/
- [116] Sputnik V vaccine
  https://en.wikipedia.org/wiki/Gam-COVID-Vac

- [117] The various vaccines being developed to combat SARS2 https://en.wikipedia.org/wiki/COVID-19_vaccine#Vaccines
- [118] Various types of vaccine https://www.moneytalkgo.com/video/the-race-for-a-covid-19-vaccine/
- [119] Mutations in SARS2 https://elifesciences.org/digests/61312/how-sars-cov-2-could-evolve-to-evade-antibodies
- [120] Dr Anthony Fauci discussing vaccines https://youtu.be/f85IELosoTo
- [121] The mathematics of herd immunity https://ccdd.hsph.harvard.edu/2020/12/17/covid-19-vaccines-and-herd-immunity/
- [122] Role of vitamin C https://www.covid19treatmentguidelines.nih.gov/adjunctive-therapy/vitamin-c/
- [123] Role of vitamin D https://pubmed.ncbi.nlm.nih.gov/23857223/
- [124] Role of zinc in immune function https://nutrition.bmj.com/content/3/1/111

- [125] Population-adjusted case curves for Canadian provinces https://wernerantweiler.ca/feature/covid11.pdf
- [126] Nonpharmaceutical interventions to control SARS2 https://science.sciencemag.org/content/early/2020/12/15/science.abd9338.full
- [127] Drop in Canada's Gross Domestic Product https://www.spglobal.com/ratings/en/research/articles/200629-economic-research-canada-s-economy-faces-a-patchy-recovery-11552803
- [128] The fall in the TSX composite index of stocks https://www.cbc.ca/news/business/markets-monday-1.5498872
- [129] Women in Canada are now working much less https://www.cbc.ca/news/canada/toronto/women-employment-canada-covid-19-1.5652788
- [130] Effects of the pandemic on the Canadian economy https://www150.statcan.gc.ca/n1/pub/45-28-0001/2020001/article/00088-eng.htm
- [131] Job loss in Canada in the spring of 2020 https://www.cbc.ca/news/business/canada-jobs-march-covid-19-1.5527359

- [132] Hospitalizations in USA by The COVID Tracking Project https://twitter.com/COVID19Tracking/status/1346249816695742465/photo/1
- [133foodbank] Line-up of vehicles waiting to visit a food bank in Texas, USA https://www.cbsnews.com/news/thousands-line-up-in-dallas-texas-to-receive-food-ahead-of-thanksgiving-food-bank-donation/
- [134] Correlation of income inequality with cases and deaths https://link.springer.com/article/10.1007/s11606-020-05971-3
- [135] Continental populations https://en.wikipedia.org/wiki/List_of_continents_by_population
- [136] Effects of the pandemic on minorities in Canada https://www150.statcan.gc.ca/n1/pub/45-28-0001/2020001/article/00079-eng.htm https://www.economist.com/graphic-detail/2020/07/31/solar-power-output-in-delhi-has-surged-during-the-lockdown
- [137] Remains of toilet paper supply https://www.cnbc.com/2020/04/01/kimberly-clark-executive-on-when-will-toilet-paper-be-back-in-stock.html

- [138] The proposal to build a Canadian Shield https://drive.google.com/file/d/1wEeiAffT-TDtipteGx0bYQtVYQEy-ME1/view
- [139] As many as 400 M in India have been driven into poverty https://www.telegraph.co.uk/global-health/science-and-disease/first-coronavirus-now-starvation-hunger-stalks-millions-indians/
- [140] Deaths among various ethnic groups in UK https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/articles/updatingethniccontrastsindeathsinvolvingthecoronaviruscovid19englandandwales/deathsoccurring2marchto28july2020
- [141] Improved solar panel output with reduced air pollution https://www.economist.com/graphic-detail/2020/07/31/solar-power-output-in-delhi-has-surged-during-the-lockdown
- [142] Improved air quality in New Delhi https://www.cnn.com/2020/04/22/world/air-pollution-reduction-cities-coronavirus-intl-hnk/index.html
- [143] Greenhouse gas emissions in 2020 https://www.unenvironment.org/emissions-gap-report-2020

- [144] Carbon dioxide at Mauna Loa, Hawaii, USA https://www.esrl.noaa.gov/gmd/ccgg/trends/
- [145] World population growth slowed https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7217266/
- [146] Birth rate around the world are likely to fall for a short period https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7758229/
- [147] Food supplies were disrupted https://www.worldbank.org/en/topic/agriculture/brief/food-security-and-covid-19
- [148] Food shortage looms https://www.bloomberg.com/news/newsletters/2020-10-23/supply-chains-latest-the-world-faces-a-food-shortage-catastrophe
- [149] Wood prices have risen https://www.cbc.ca/news/business/lumber-prices-yearender-1.5853476
- [150] Government measures to support people and businesses in the pandemic http://www.oecd.org/tax/tax-policy-reforms-26173433.htm
- [151] The costs of pandemics https://twitter.com/DrTomFrieden/status/1296174527408480256

- [152] Estimate of world GDP in 1913 (as a proxy for 1918-20) https://thereaderwiki.com/en/Empire
- [153] 1918-19 H1N1 influenza and World War I deaths and economic effects https://www.nber.org/system/files/working_papers/w26866/w26866.pdf
- [154] The economic effects of SARS2 https://www.pnas.org/content/117/36/22035
- [155] SARS2 RNA reverse-transcribed and integrated into the human genome https://www.biorxiv.org/content/10.1101/2020.12.12.422516v1
- [156] Use of the pandemic to impose authoritarian regimes https://thetyee.ca/Analysis/2020/08/25/Fighting-Virus-Fight-For-Rights
- [157lumin] Dr Mark Lipsitch discusses the pandemic https://medium.com/luminate/what-this-epidemiologist-wants-americans-to-know-about-covid-19-right-now-9e051a849ddc
- [158buzz] A dozen lessons learned https://www.buzzfeednews.com/amphtml/zahrahirji/13-coronavirus-facts-2020

Citations for Annex A: *Infection Curves*

- [a1] Case and death numbers globally and in various countries https://www.worldometers.info/geography/how-many-countries-are-there-in-the-world/
- [a211] New variant of SARS2 in UK https://www.bmj.com/content/371/bmj.m4857
- [a312variant] Importance of the new variant unknown https://www.sciencemag.org/news/2020/12/mutant-coronavirus-united-kingdom-sets-alarms-its-importance-remains-unclear?s=09
- [a4WHOv] Description of variants, responses, risks, and PH advice https://www.who.int/csr/don/31-december-2020-sars-cov2-variants/en/
- [a54] Case and death numbers globally and in various countries https://www.worldometers.info/geography/how-many-countries-are-there-in-the-world/
- [a613] South Africa's high infection rate https://www.bbc.com/news/world-africa-55333126
- [a7118prov] SARS2 7-d case per million in Canadian provinces and US states https://www.ctvnews.ca/health/coronavirus/covid-19-in-the-u-s-how-do-canada-s-provinces-rank-against-american-states-1.5051033

Citations for Annex B: *Masks*

- [b145] Mask wearers https://currently.att.yahoo.com/att/coronavirus-burn-sars-stay-045419475.html
- [b246] Anti-mask demonstration https://www.thepeterboroughexaminer.com/news/peterborough-region/2020/08/01/dozens-protest-against-mandatory-masks-in-peterborough.html
- [b347] Pfeiffer's bacillus https://www.aai.org/AAISite/media/About/History/Articles/AAI_History_007-(1).pdf
- [b448] Bacteria compared to viruses https://www.diffen.com/difference/Bacteria_vs_Virus
- [b549] Influenzavirus discoveries https://www.virology.ws/2008/12/23/discovery-of-viruses/
- [b6enemy] Why we should not forego masks https://www.eurosurveillance.org/content/10.2807/1560-7917.ES.2020.25.49.2001998
- [b7b] Comprehensive SARS2 examination including transmission and masking https://link.springer.com/article/10.1007/s12210-020-00938-2
- [b850] Review of mask RCTs https://www.medrxiv.org/content/10.1101/2020.07.31.20166116v2

- [b9googledoc] Collaborative expert review of transmission and masking https://docs.google.com/document/d/1fB5pysccOHvxphpTmCG_TGdytavMmc1cUumn8m0pwzo/edit
- [b1075] Deaths among healthcare workers https://www.cihi.ca/en/covid-19-cases-and-deaths-among-health-care-workers-in-canada
- [b1176] N95 masks supplies https://www.tpsgc-pwgsc.gc.ca/comm/aic-scr/provisions-supplies-eng.html
- [b1277] Mask effectiveness https://www.cmaj.ca/content/192/28/E805
- [b1378] Effectiveness of masks https://publishing.aip.org/publications/latest-content/effectiveness-of-cloth-masks-depends-on-type-of-covering/
- [b14] The effectiveness of wearing face coverings https://www.reboothealth.co.uk/blog/face-masks-herd-immunity
- [b15[distance] Masks are not sufficient https://www.sciencedaily.com/releases/2020/12/201222132057.htm

- [b16] Effectiveness of masks: material and fit https://www.nature.com/articles/d41586-020-02801-8
- [b17immune] Face masks could be giving people immunity https://www.telegraph.co.uk/global-health/science-and-disease/face-masks-could-giving-people-covid-19-immunity-researchers/?s=09
- [b18] How much protection face masks offer https://www.mayoclinic.org/diseases-conditions/coronavirus/in-depth/coronavirus-mask/art-20485449