Occupational Health Clinics for Ontario Workers

Centre de Santé des Travailleurs(ses) de l'Ontario

COVID – Ventilation within the Spectrum of Prevention Activities

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Occupational Hygienist

June 2, 2021

Anyone can be a source. Anyone can be a receiver.

RISK FACTORS

ENCLOSED SPACES:
Infectious particle concentrations can build up in enclosed spaces.

MANY PEOPLE:
More infected people can lead to high particle concentrations.

POOR VENTILATION:
Failure to replace and filter air can lead to high particle concentrations.

MANY MINUTES:
More time in a space can increase the chance of inhaling an infectious dose.

https://www.acgih.org/covid-19-fact-sheet-virus-in-air/

the **6** (or 7) **C's**:

Crowded places

Close contact

Continuous exposures

Coverings

Cold air temperature (high humidity?)

Closed space

Circulation (outdoor air supply)

https://www.nationalacademies.org/event/08-26-2020/airborne-transmission-of-sars-cov-2-a-virtual-workshop

Skagit Valley Chorale outbreak (March 10/20):

"61 attended rehearsal on March 10, amid concerns about COVID-19 transmission. Precautions were taken during rehearsal, including the use of hand sanitizer, no hugging or handshakes, and maintaining distance between singers."

"53 cases in total were subsequently identified including the index case, with 33 confirmed through positive COVID-19 tests and 20 unconfirmed but probable secondary cases based on symptoms and timing."

https://onlinelibrary.wiley.com/doi/10.1111/ina.12751

Amsterdams Gemengd Koor (March 8/20)

Practices:

- Feb 25
- Mar 3 (a few sick – stayed away)
- Mar 7 (15 absent, some will still attend concert)
- **Mar 8** concert (30 missing)

- 130 members attend
- 102 ill
- 1 death (+3 partners died)
- members of the string orchestra and soloists also infected
- very few of the 1000+ concert attenders were infected (still awaiting the results of the investigation)
- in the Netherlands at the time there had been a total of only 400 people with confirmed COVID

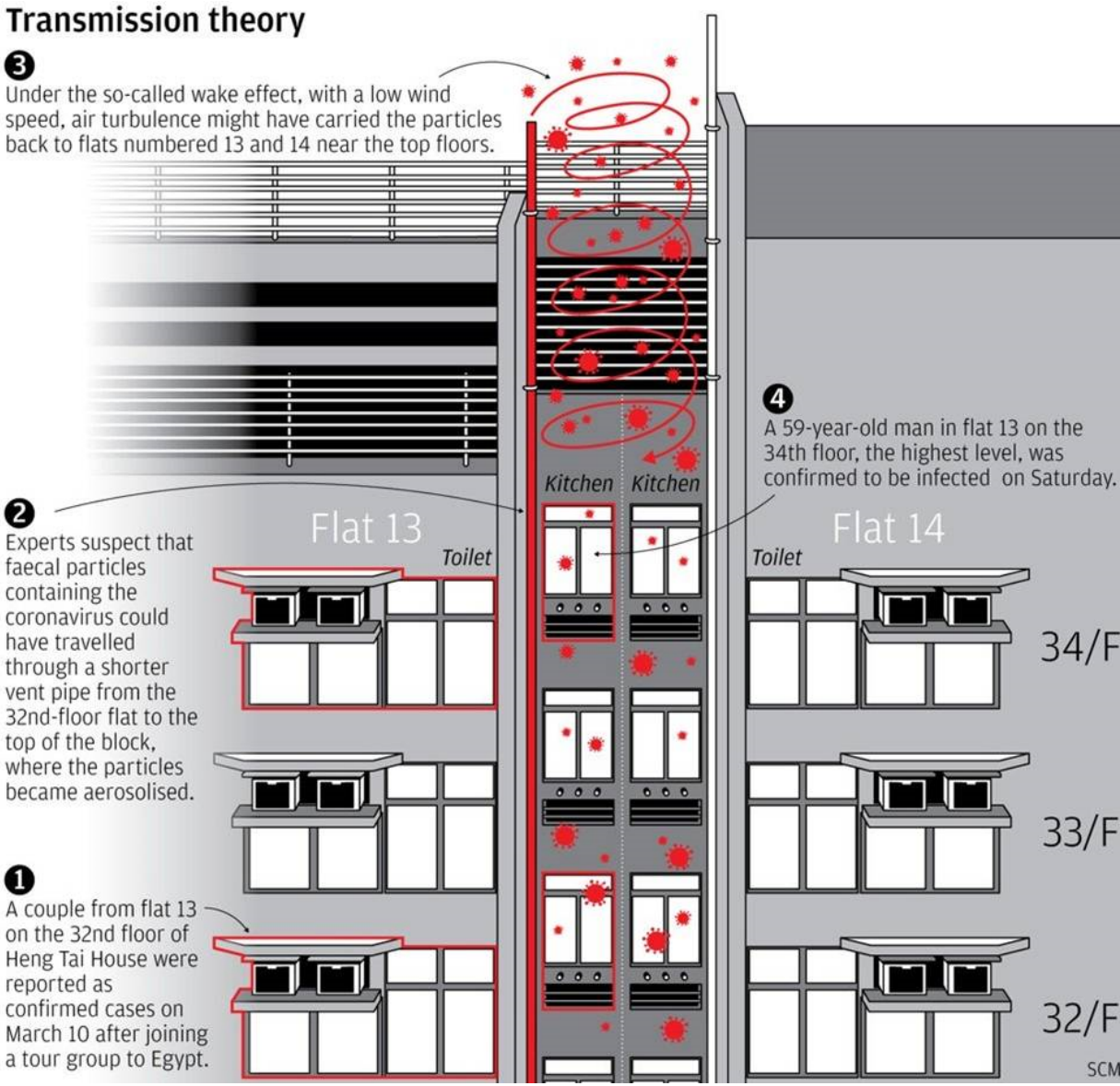
https://www.trouw.nl/nieuws/die-ene-passion-die-wel-doorging-met-rampzalige-gevolgen~b4ced33e/?referrer=https%3A%2F%2Fwww.google.com%2F

Hong Kong

(March 15, 2020)

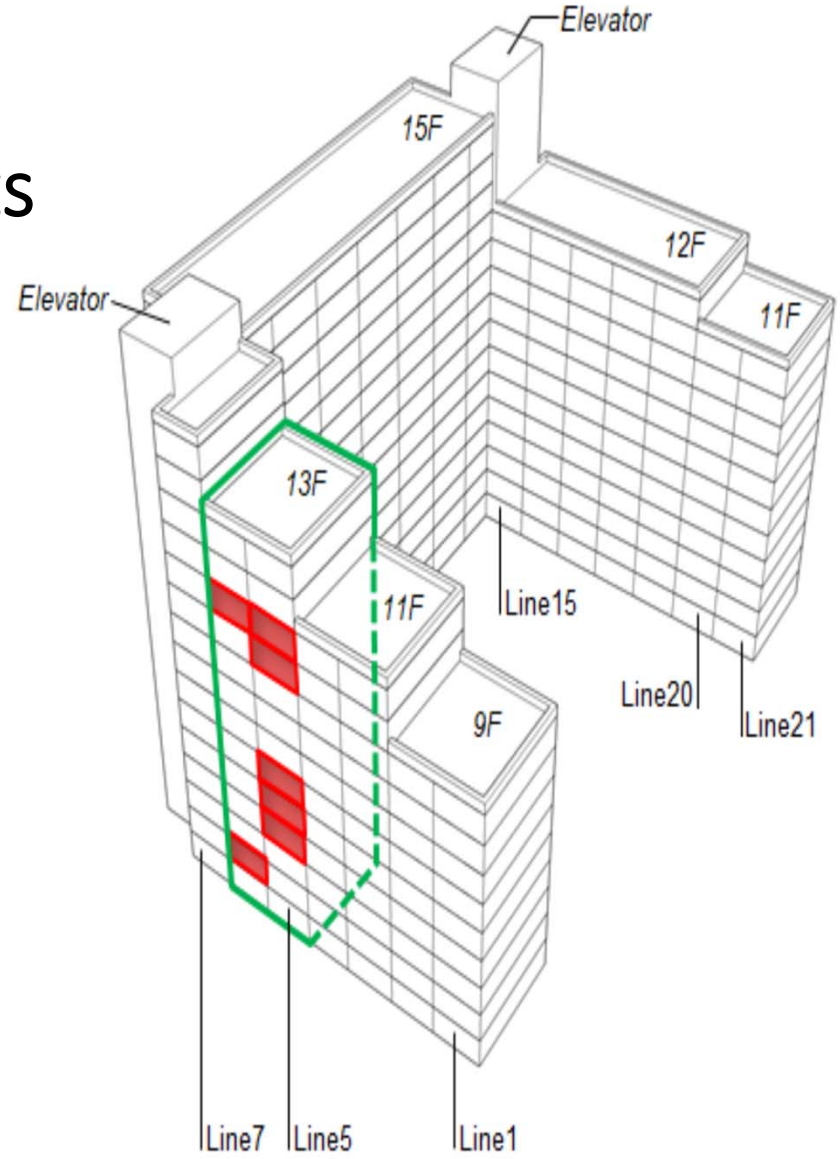
Coronavirus: eight more households evacuated from Hong Kong housing block after three earlier infections in building

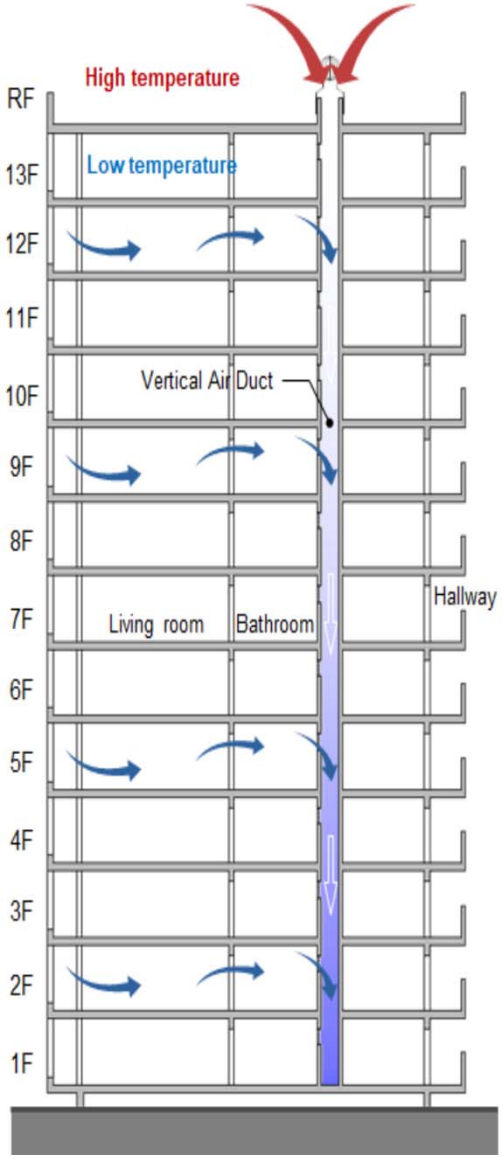
https://www.scmp.com/news/hong-kong/health-environment/article/3075275/coronavirus-eight-more-households-evacuated-hong



Transmission via bathroom air vents

(South Korea, August 2020)





Hwang et al. (2020) “Possible Aerosol Transmission of COVID-19 Associated with an Outbreak in an Apartment in Seoul, South Korea, 2020”

Particles emitted after flushing the toilet

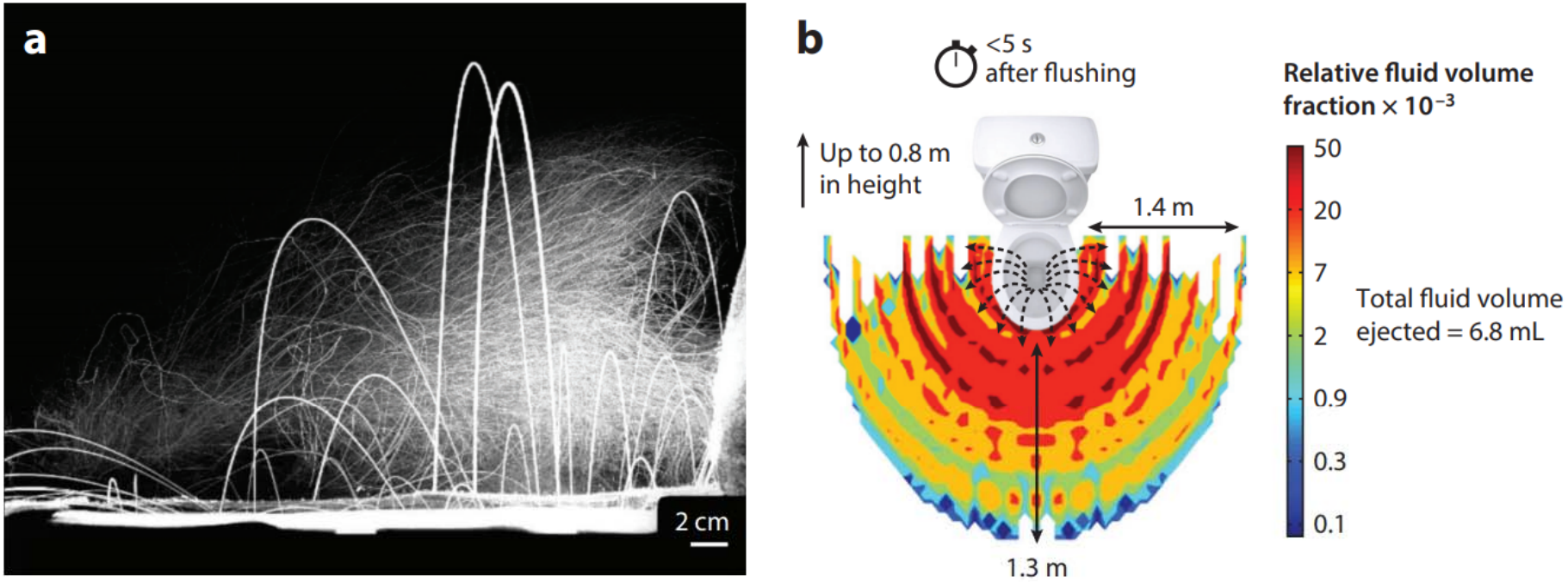


Figure 6

(*a*) High-speed imaging of droplet trajectories emitted from a high-pressure flush of a typical hospital toilet, showing ballistic trajectories for larger droplets and meandering droplet suspension for smaller ones (L. Bourouiba, original data). (*b*) Quantification and visual illustration of the projected relative surface and air contamination (up to 0.8 m above ground) from toilet flush emissions within 5 s after flushing (C. Lu & L. Bourouiba, original data).

Bourouiba (Oct 6 2020) "The Fluid Dynamics of Disease Transmission"

SARS1 outbreak

(Hong Kong 2003)

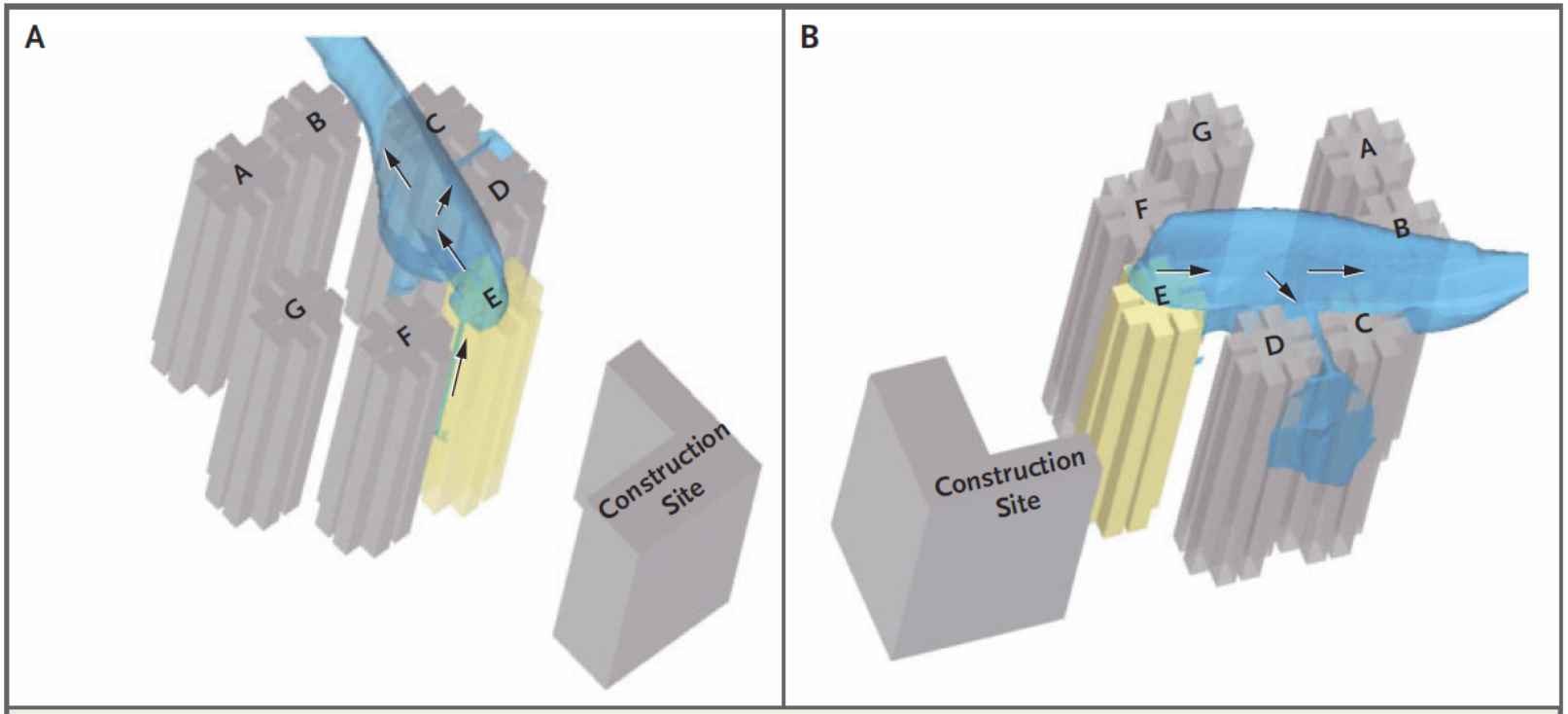
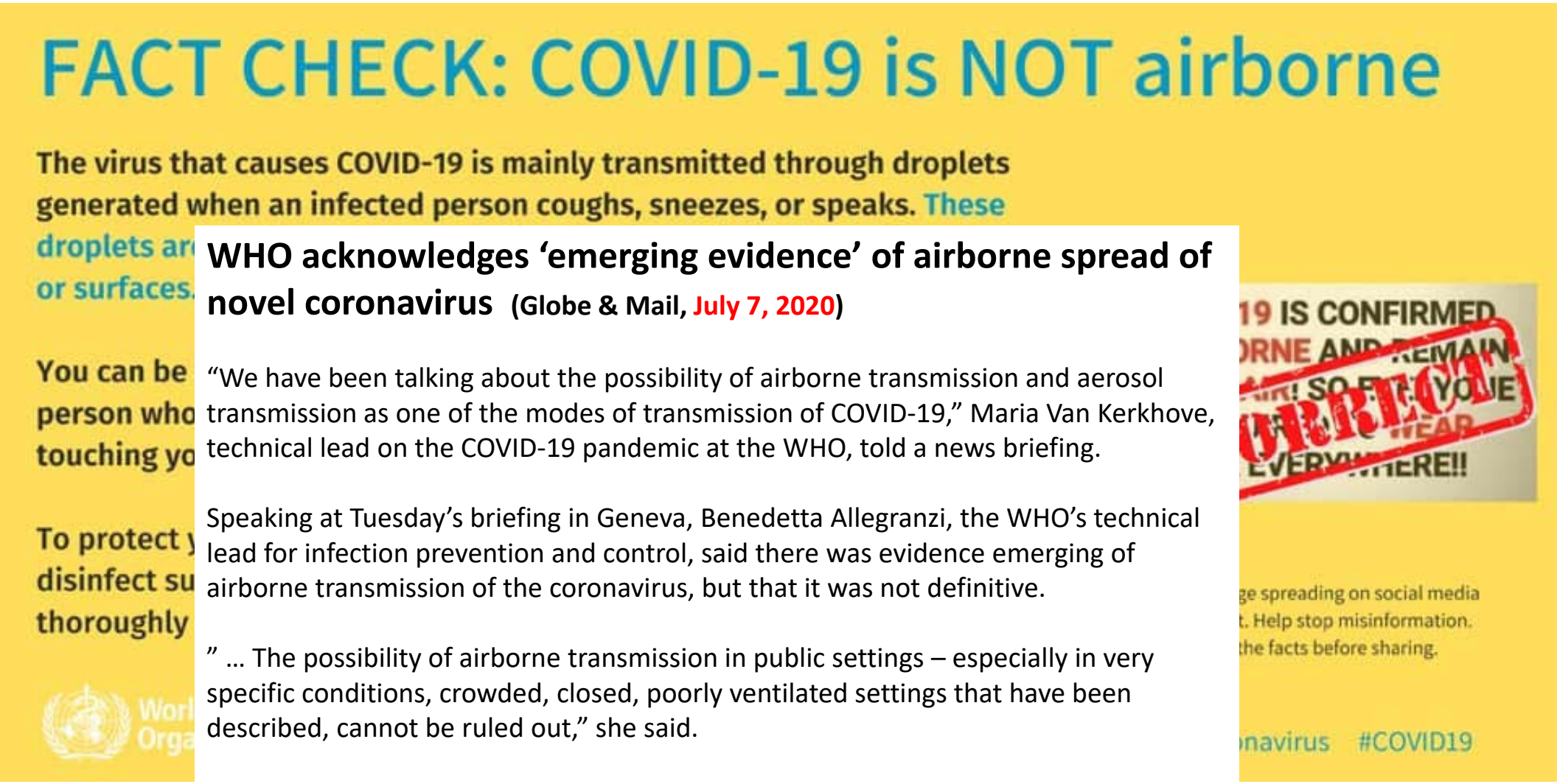


Figure 3. Model of the Movement of the Virus-Laden Plume.

According to our computational fluid-dynamics modeling, the buoyant plume (blue) rose from the air shaft between two housing units in building E (yellow) and was carried by a northeasterly wind toward the middle-level floors in buildings C and D. The L-shape structure (Panels A and B) was a nearby construction site that blocked the wind flowing toward lower-level floors in buildings E, C, and D. The wake flow of the construction site created a region of negative air pressure in the space between buildings E, C, and D (Panel B) that caused the plume to bend downward, toward buildings C and D.

Yu et al. (2004) "Evidence of Airborne Transmission of the Severe Acute Respiratory Syndrome Virus", *New England Journal of Medicine*, 350:1731-9



WHO acknowledges 'emerging evidence' of airborne spread of novel coronavirus (Globe & Mail, July 7, 2020)

"We have been talking about the possibility of airborne transmission and aerosol transmission as one of the modes of transmission of COVID-19," Maria Van Kerkhove, technical lead on the COVID-19 pandemic at the WHO, told a news briefing.

Speaking at Tuesday's briefing in Geneva, Benedetta Allegranzi, the WHO's technical lead for infection prevention and control, said there was evidence emerging of airborne transmission of the coronavirus, but that it was not definitive.

" … The possibility of airborne transmission in public settings – especially in very specific conditions, crowded, closed, poorly ventilated settings that have been described, cannot be ruled out," she said.

"However, the evidence needs to be gathered and interpreted, and we continue to support this."

PHAC: on modes of transmission

Originally: November 2020
Date modified: 2021-03-12

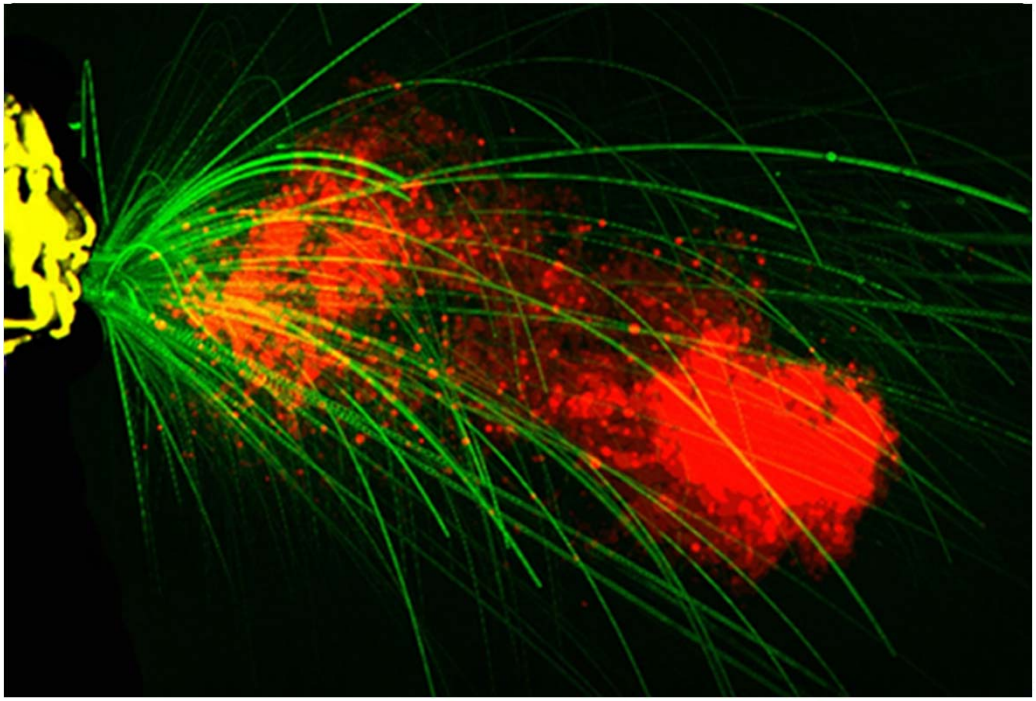
"SARS-CoV-2, the virus that causes COVID-19, spreads from an infected person to others through respiratory droplets and aerosols when an infected person coughs, sneezes, sings, shouts, or talks. The droplets vary in size, from large droplets that fall to the ground rapidly (within seconds or minutes) near the infected person, to smaller droplets, sometimes called aerosols, which linger in the air under some circumstances."

"Reports of outbreaks in settings with poor ventilation suggest that infectious aerosols were suspended in the air and that people inhaled the virus. These settings have included a choir practice, fitness classes, and restaurants. Transmission in these settings may have been facilitated by certain environmental conditions, such as re-circulated air."

"Maximize ventilation by ensuring that heating, ventilation and air conditioning (HVAC) systems are in good working order. Drawing as much fresh air as possible from outside will decrease the concentration of aerosols that may be suspended in the air, and reduce the chances of SARS-CoV-2 spread if those aerosols happen to contain the virus. If the weather permits, open a window. Reduce the noise level in public spaces, for example turn off or reduce the music volume, so people can speak quietly.."

https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/health-professionals/main-modes-transmission.html

This is what happens in "close contact"

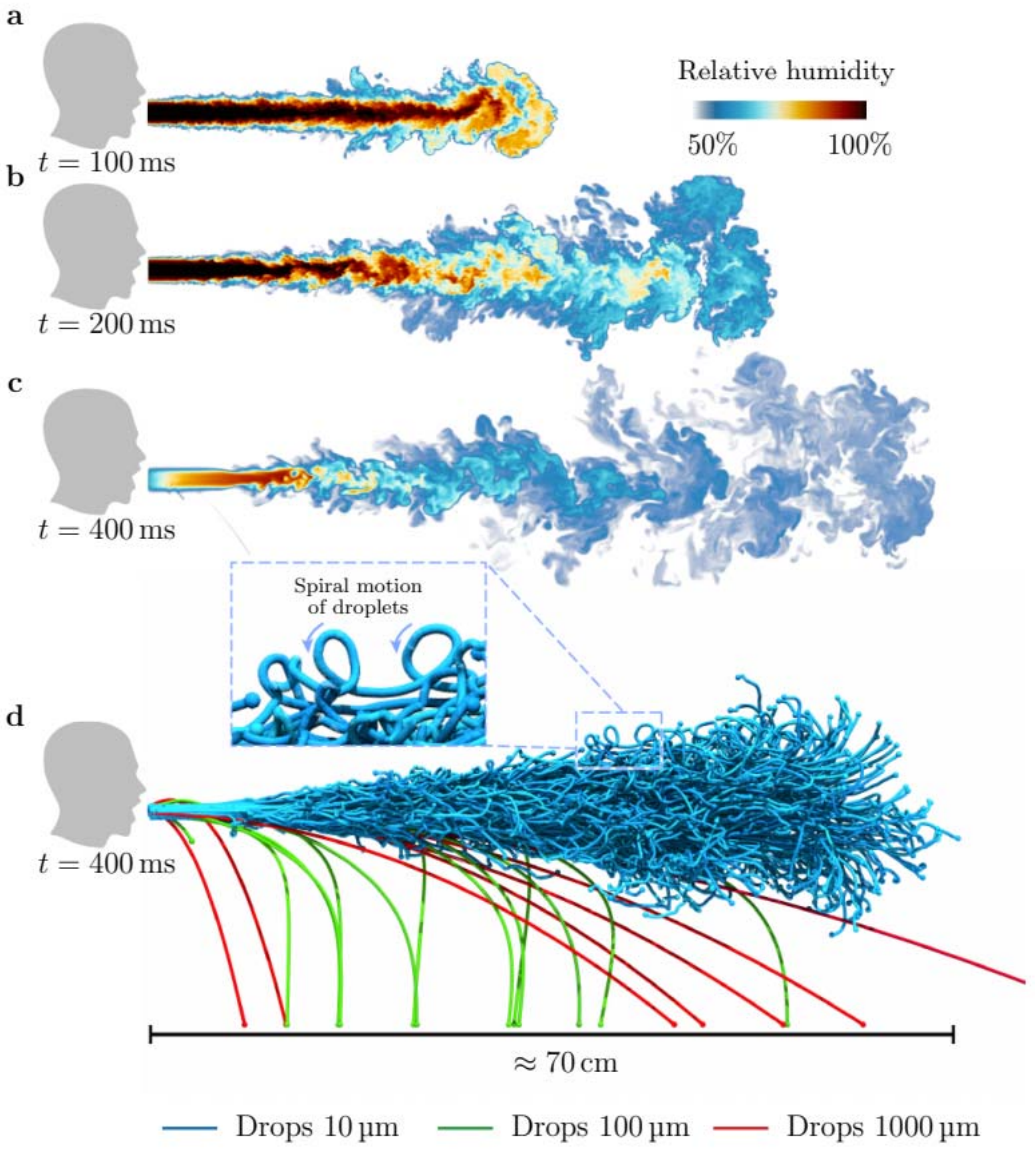


"plume" and "room" dispersion aerodynamics ("plume" independent of room air flow patterns) – stop it with a mask

Figure 1: Image reproduction showing the semi-ballistic largest drops, visible to the naked eye, and on the order of mm, which can overshoot the puff at its early stage of emission [14, 15]. The puff continues to propagate and entrain ambient air as it moves forward, carrying its payload of a continuum of drops [13], over distances up to 8 meters for violent exhalations such as sneezes [17].

https://www.sciencedirect.com/science/article/pii/S0301932220305498

Chong et al (Aug 4 2020) - Extended lifetime of respiratory droplets in a turbulent vapour puff and its implications on airborne disease transmission



What Is an Aerosol-Generating Procedure?

Klompas, Baker & Rhee; JAMA Surgery **156**:113-114 (Feb 2021)

"The answer lies in the evolving science of respiratory transmission. It has become clear that the traditional dichotomy between droplet vs aerosol-based transmission is overly simplistic. In practice, people routinely produce a profusion of respiratory particles in a range of sizes that include both droplets and aerosols as well as particles in between.[6] Respiratory particles of all sizes can carry virus and all are potentially capable of transmitting infection. The amount of respiratory particles one emits varies by activity. Quiet breathing generates a small but steady flow of aerosols. Loud speaking, heavy breathing, and coughing produce far more. Larger respiratory particles will rapidly fall to the ground within a narrow radius of the source patient. Smaller respiratory particles can remain suspended in the air but will diffuse and get diluted by the surrounding air leading to progressively lower concentrations of virus the further one is from the source patient."

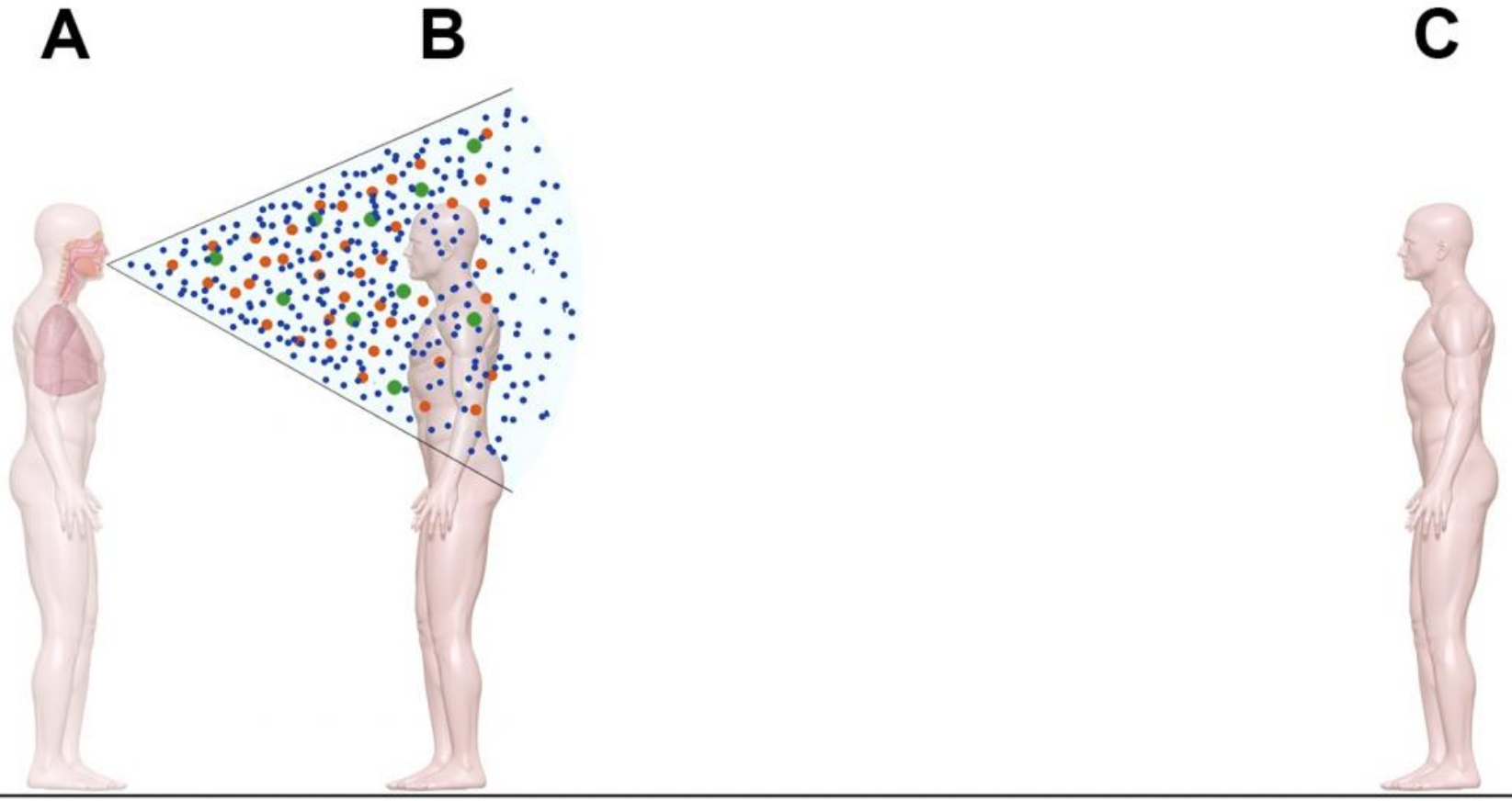
"Any time air is forced over moist respiratory mucosa, it will generate more virus-laden respiratory particles. This may explain the increased risk of infection associated with noninvasive positive pressure ventilation and cardiopulmonary resuscitation. However, by the same logic, coughing, spirometry, and heavy breathing should also be considered aerosol generating because these activities also increase the velocity and volume of air being forced over respiratory mucosa."

"As such, the term *aerosol-generating procedure* is a misnomer. It is not the procedure that increases risk but sustained proximity to the respiratory tract of a highly symptomatic patient."

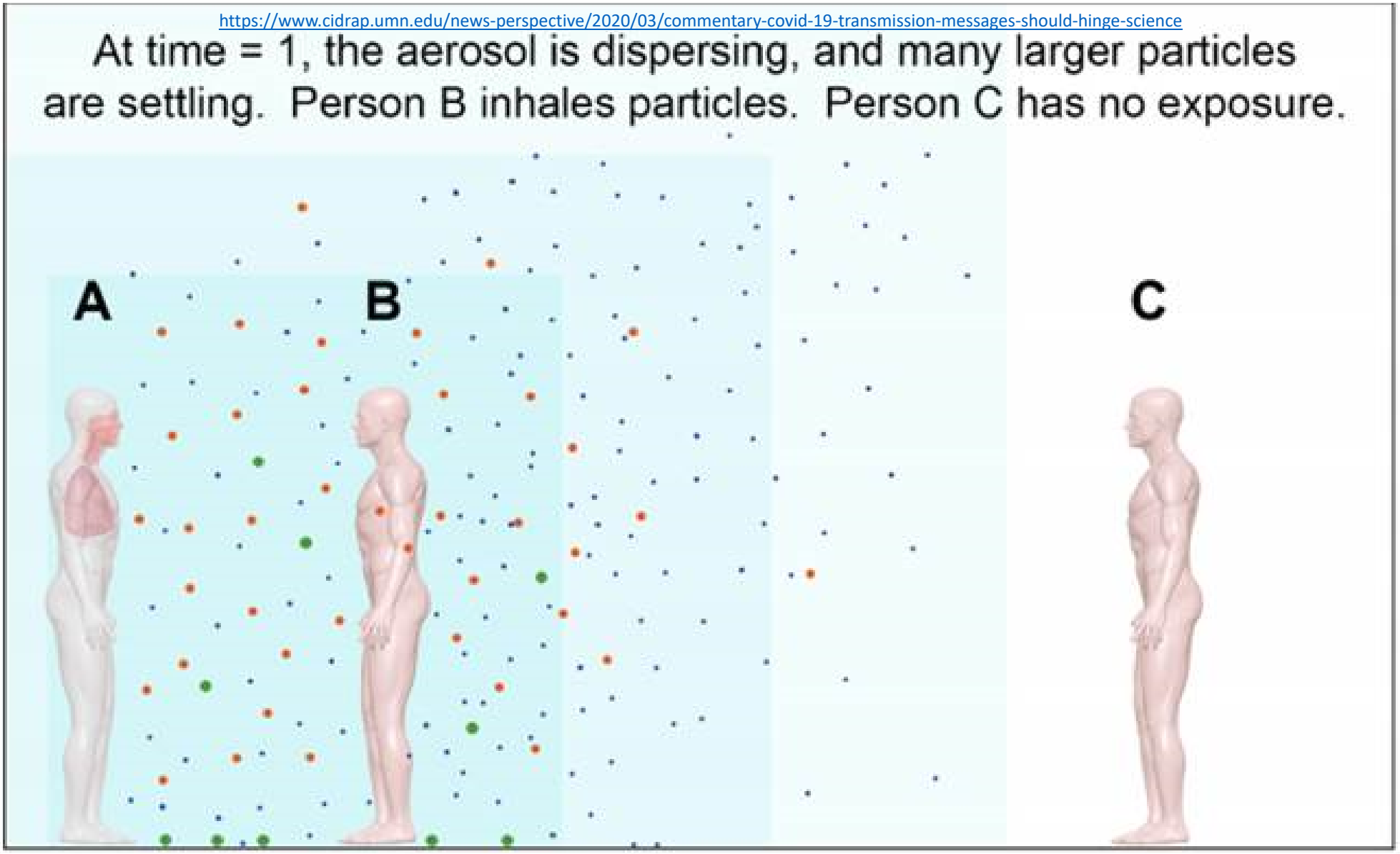
https://jamanetwork.com/journals/jamasurgery/fullarticle/2774161

https://www.cidrap.umn.edu/news-perspective/2020/03/commentary-covid-19-transmission-messages-should-hinge-science

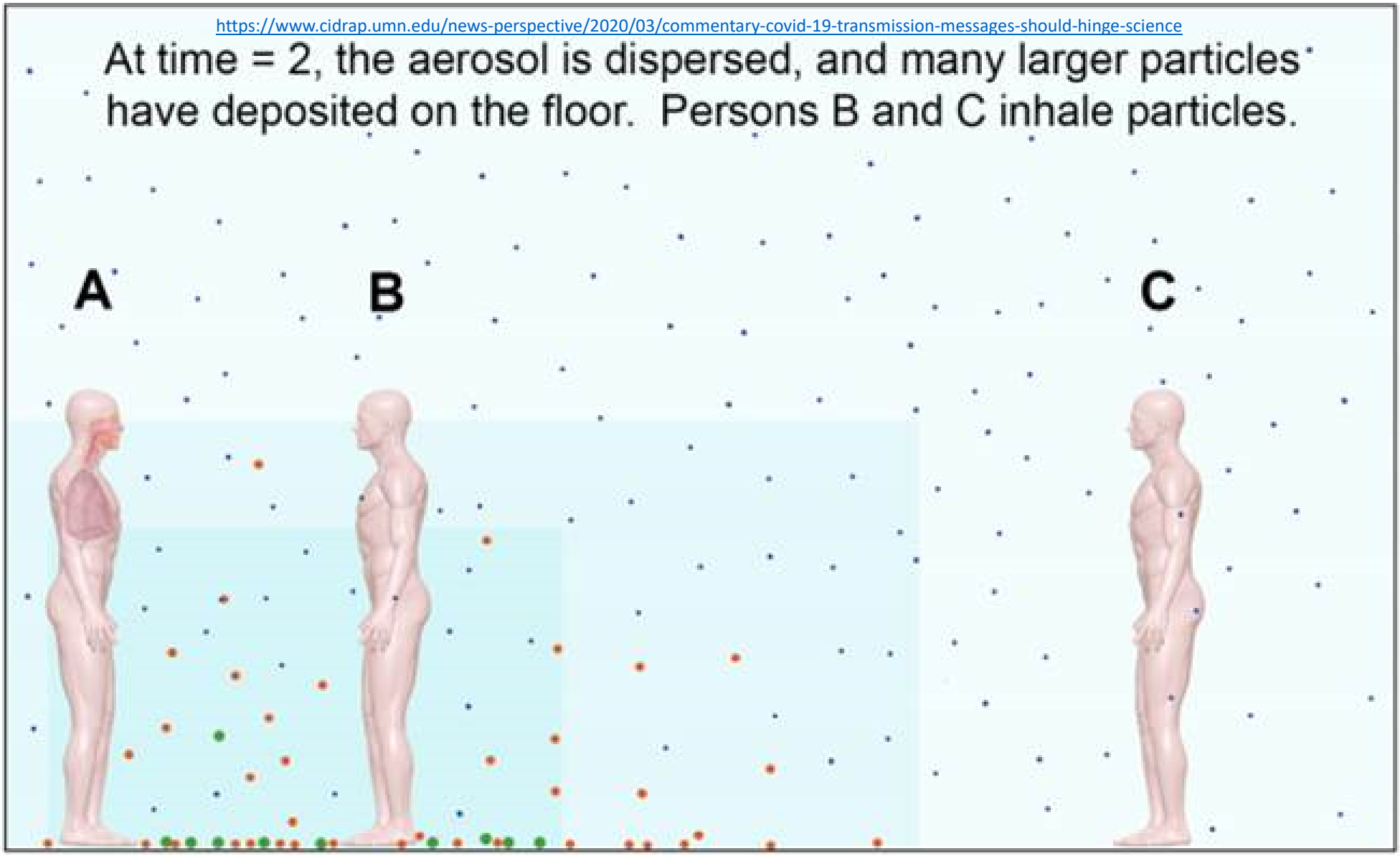
At time = 0, an aerosol is generated by person A.
Person B receives droplet spray and inhales particles.
Person C has no exposure.



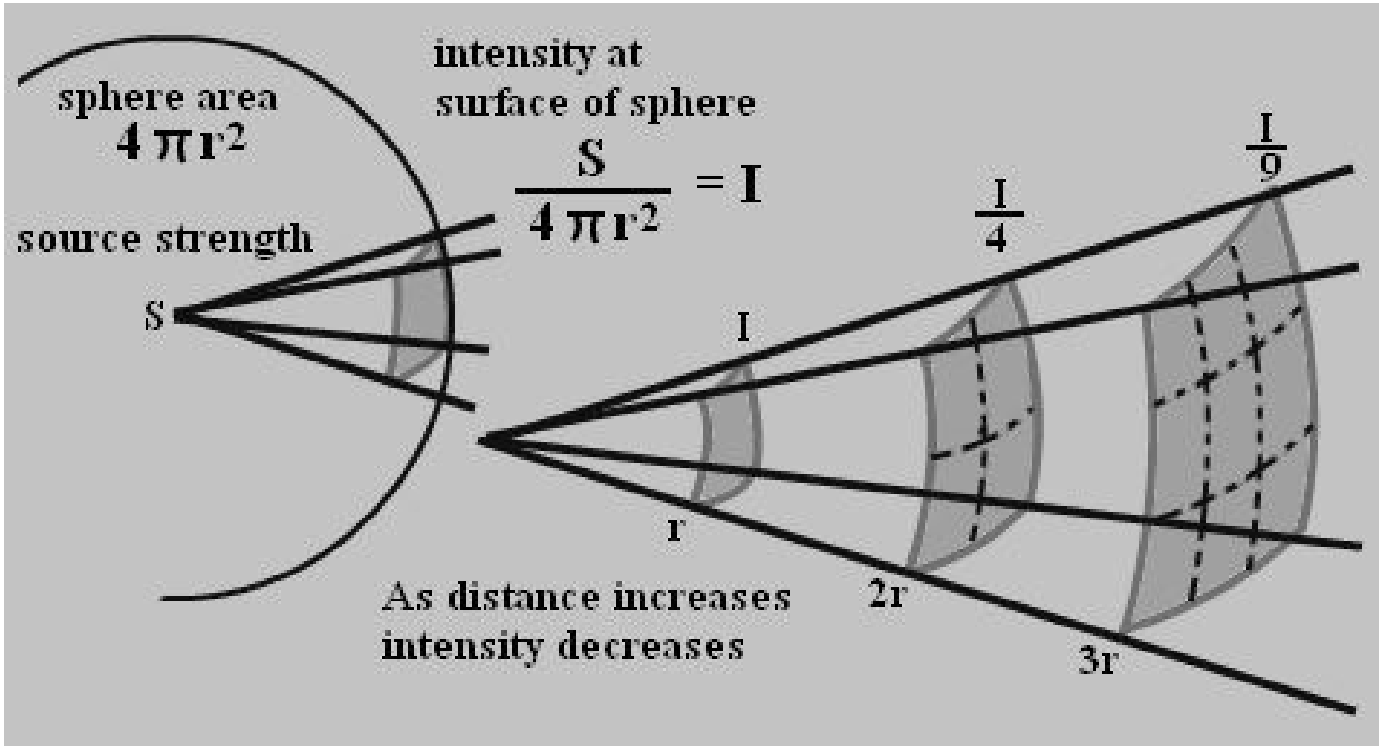
https://www.cidrap.umn.edu/news-perspective/2020/03/commentary-covid-19-transmission-messages-should-hinge-science



https://www.cidrap.umn.edu/news-perspective/2020/03/commentary-covid-19-transmission-messages-should-hinge-science



Why distance is important:



The 3 foot rule (6 foot? 2 meter?)?

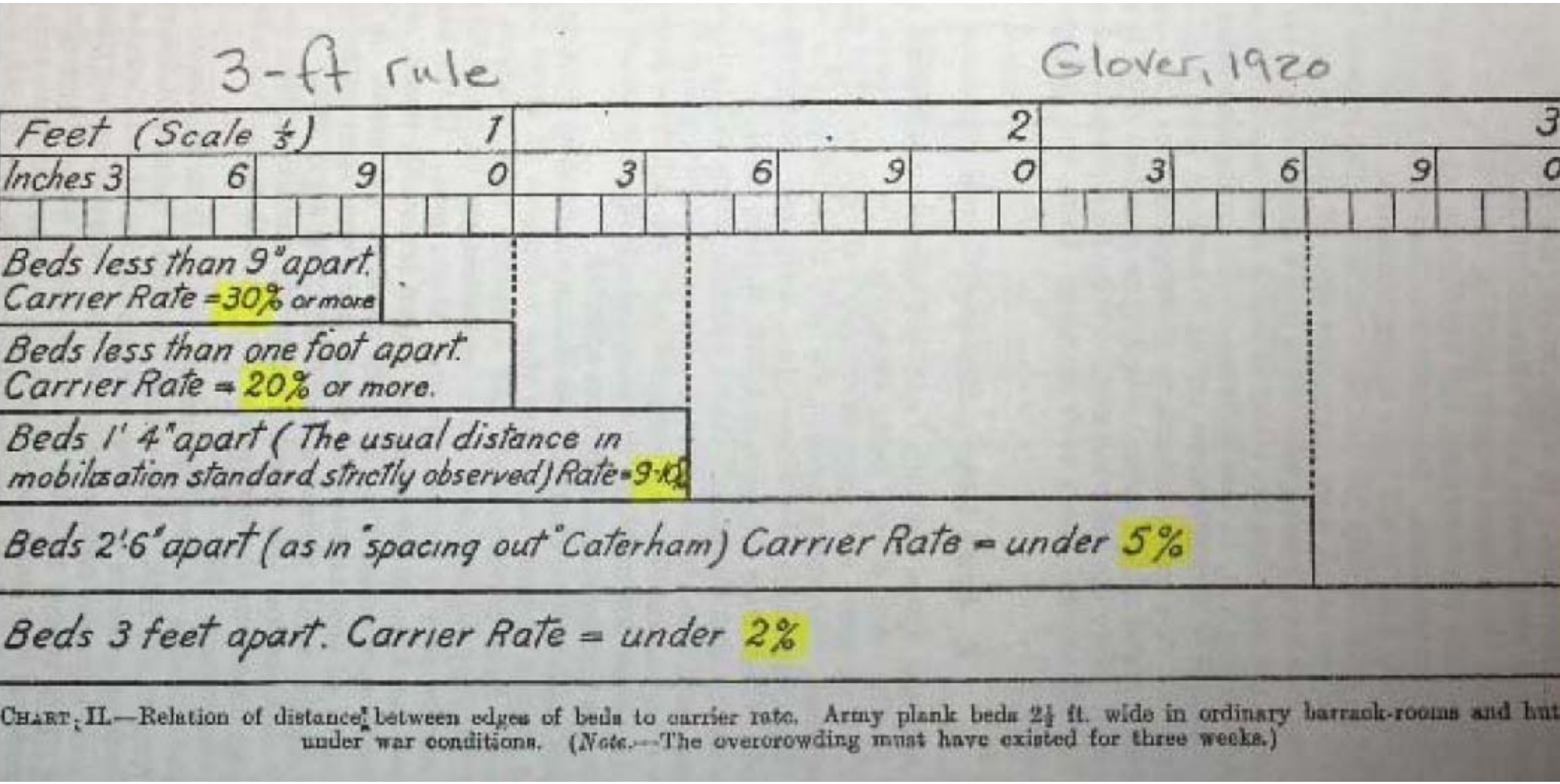
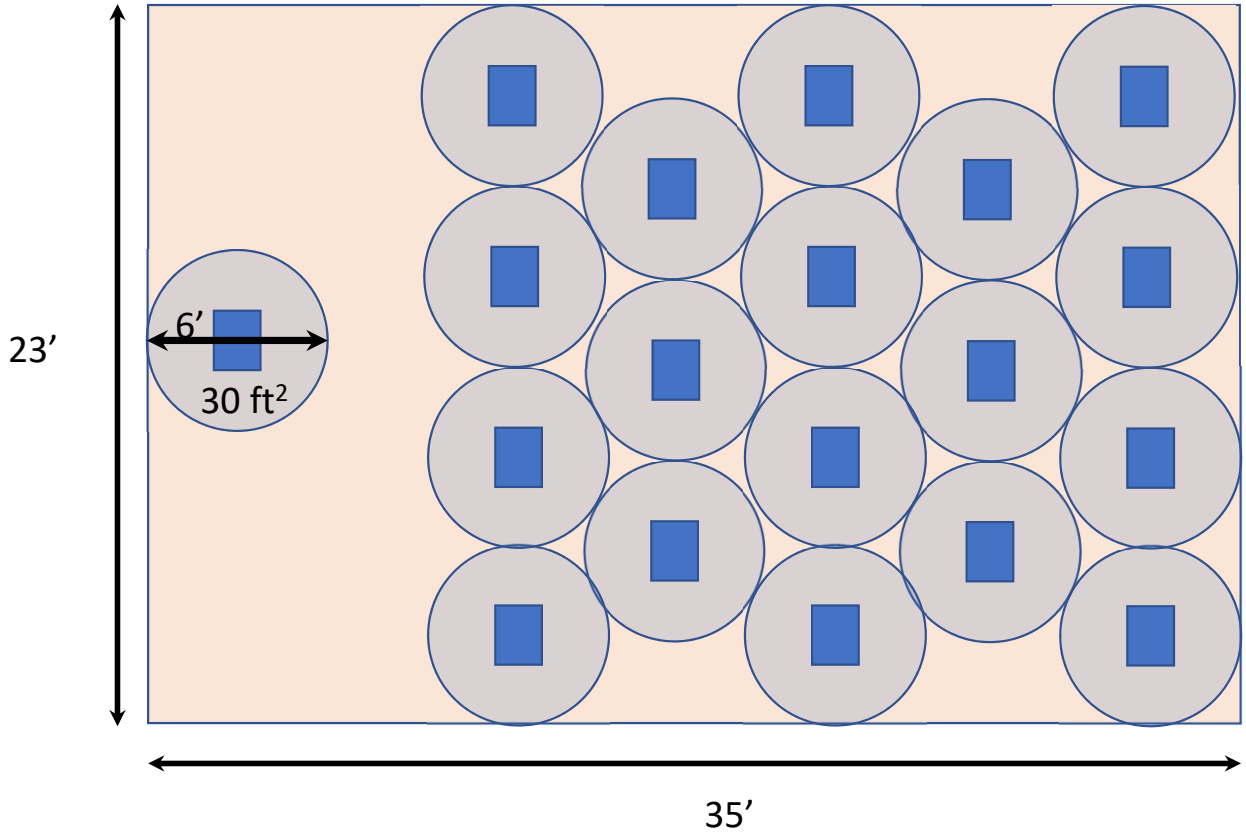


CHART II.—Relation of distance between edges of beds to carrier rate. Army plank beds 2½ ft. wide in ordinary barrack-rooms and hut under war conditions. (*Note.*—The overcrowding must have existed for three weeks.)

Keeping 6’ apart; maximum occupancy: 18 students – one teacher



total area:
805 ft²
assuming 9’ ceilings,
total volume:
7245 ft³
one air change per hour (ach) is equivalent to:
7245 ft³/hour, or;
121 cfm (or ft³/min)
or 6.36 cfm/person

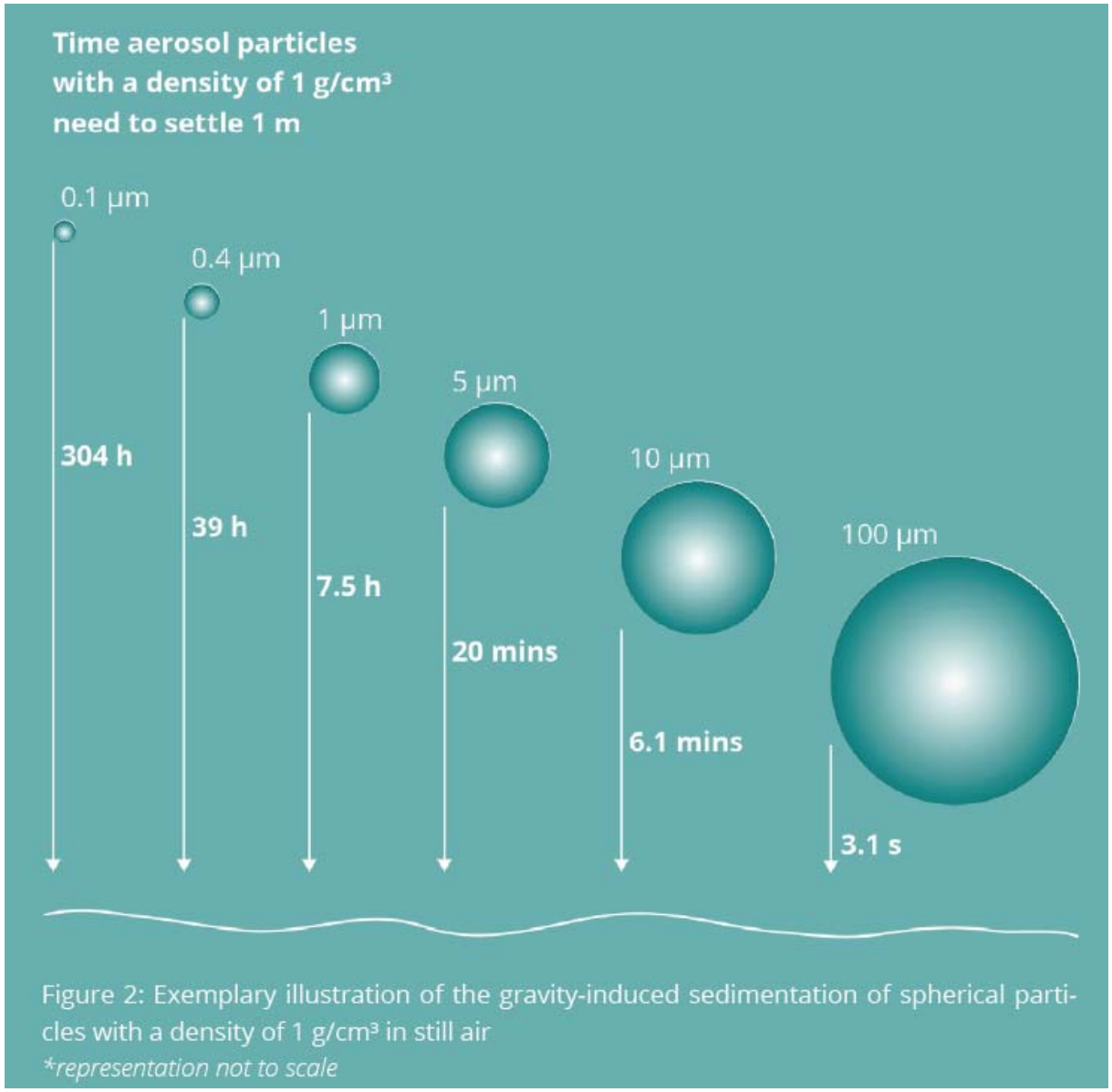
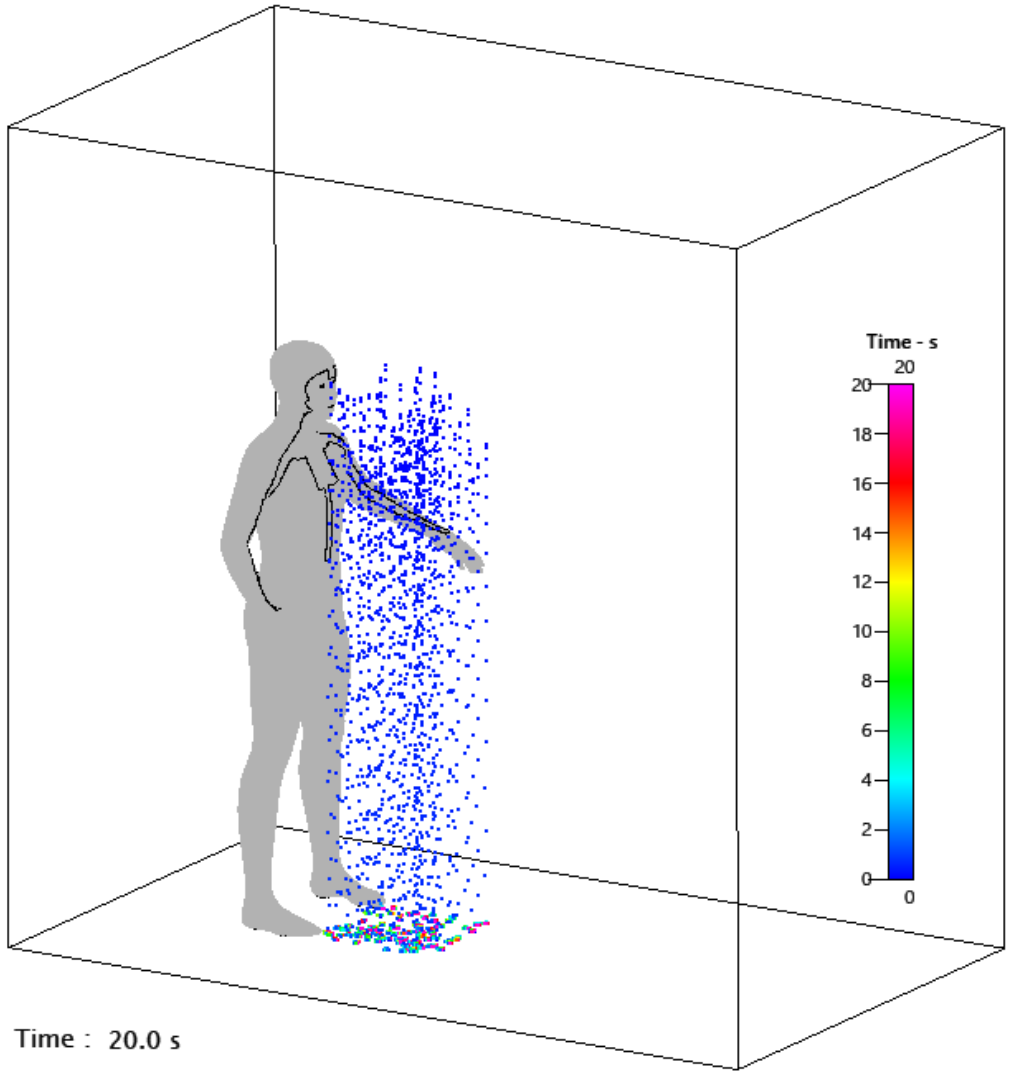


Figure 2: Exemplary illustration of the gravity-induced sedimentation of spherical particles with a density of 1 g/cm³ in still air
*representation not to scale

Settling times (in still air):

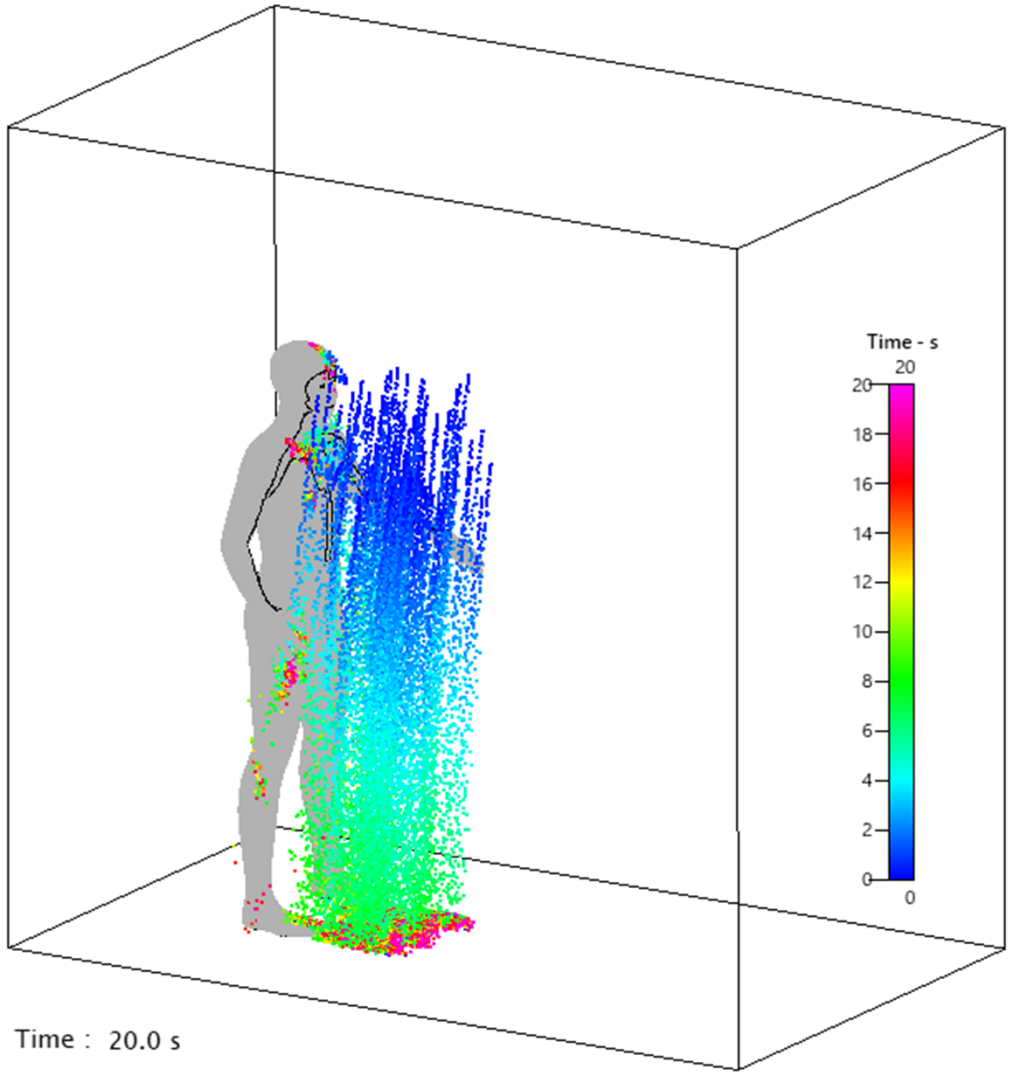
Position paper of the Gesellschaft für Aerosolforschung on understanding the role of aerosol particles in SARS-CoV-2 infection (Dec 17/20)

Particle trajectory: **320 µm** particle



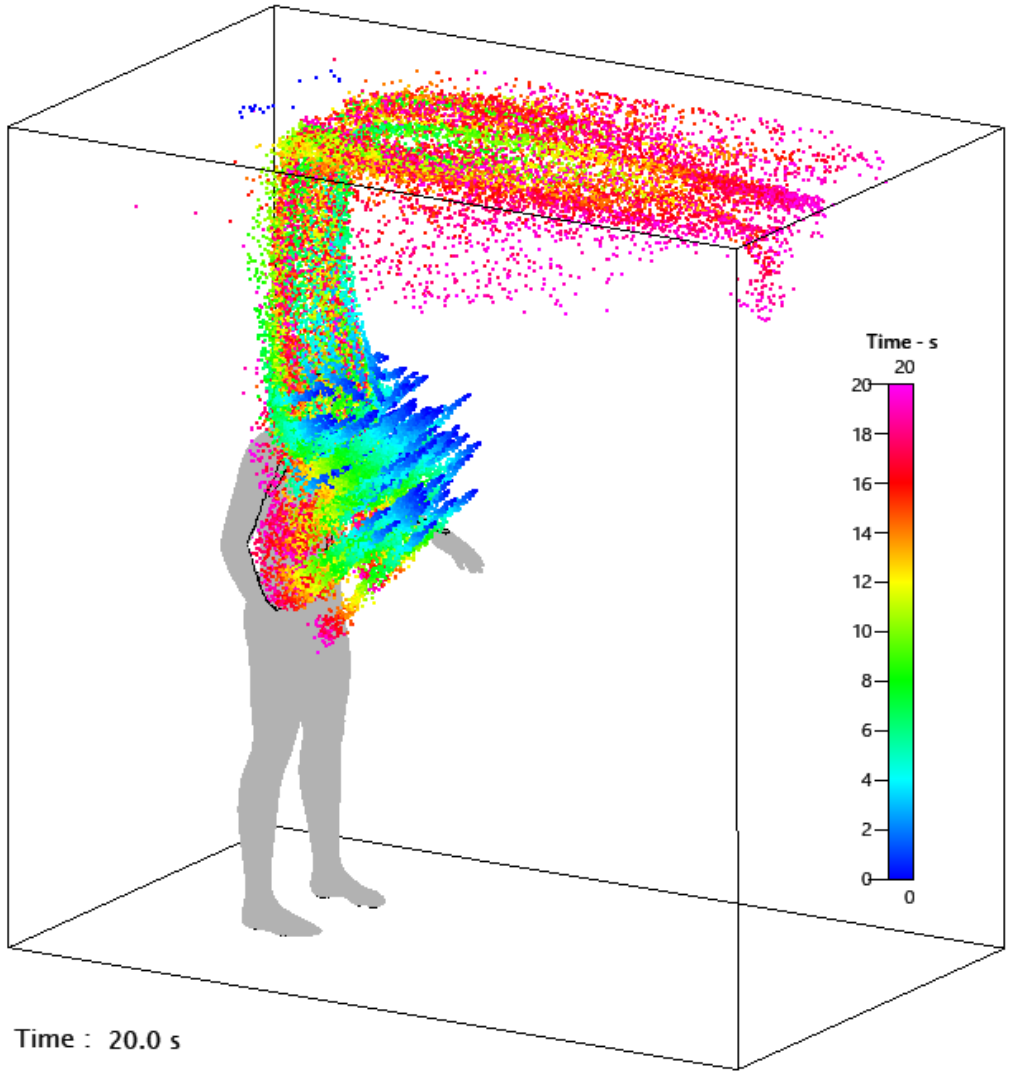
https://athenasys.co.jp/main/product/cfd-ace/spray/spray_on_virus_diffusion_en.html

Particle trajectory: **80 µm** particle



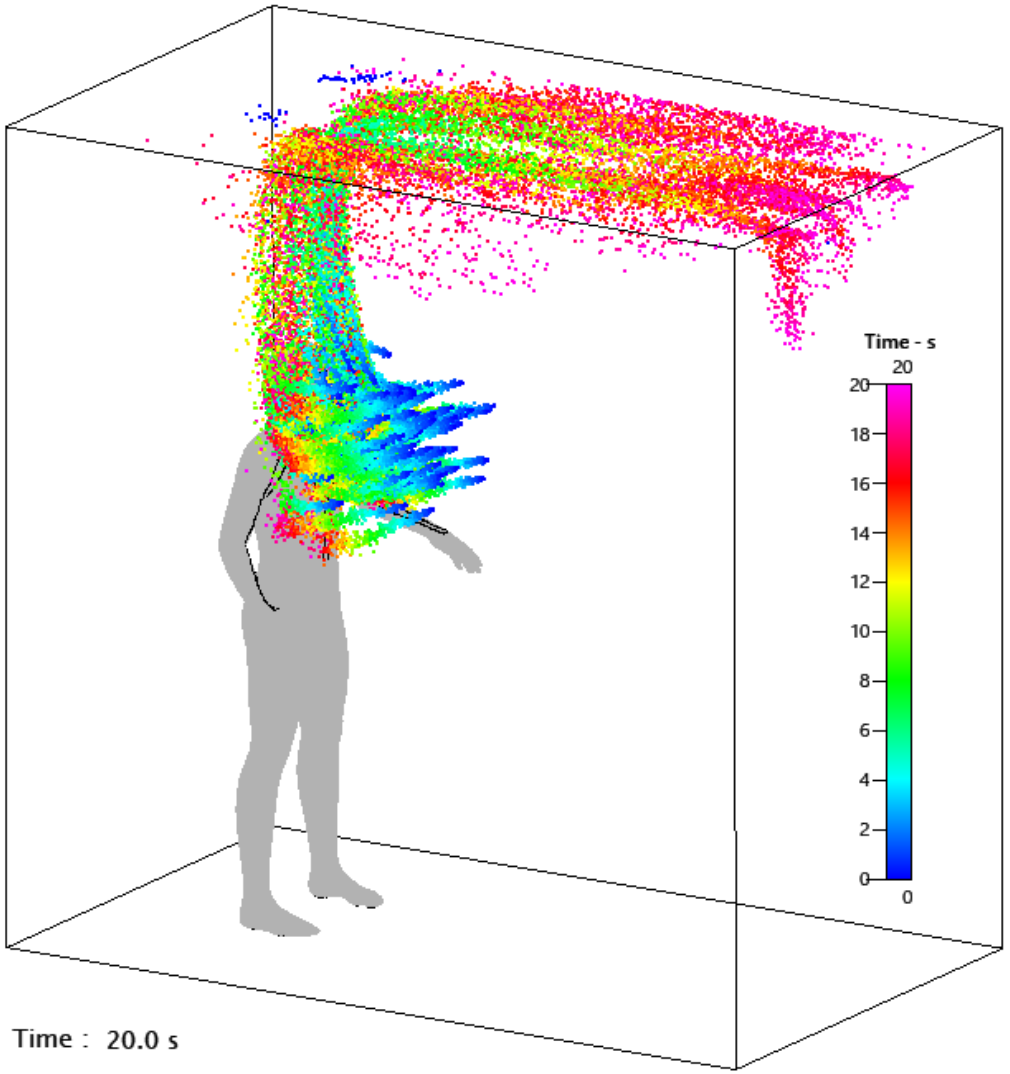
https://athenasys.co.jp/main/product/cfd-ace/spray/spray_on_virus_diffusion_en.html

Particle trajectory: **20 µm** particle



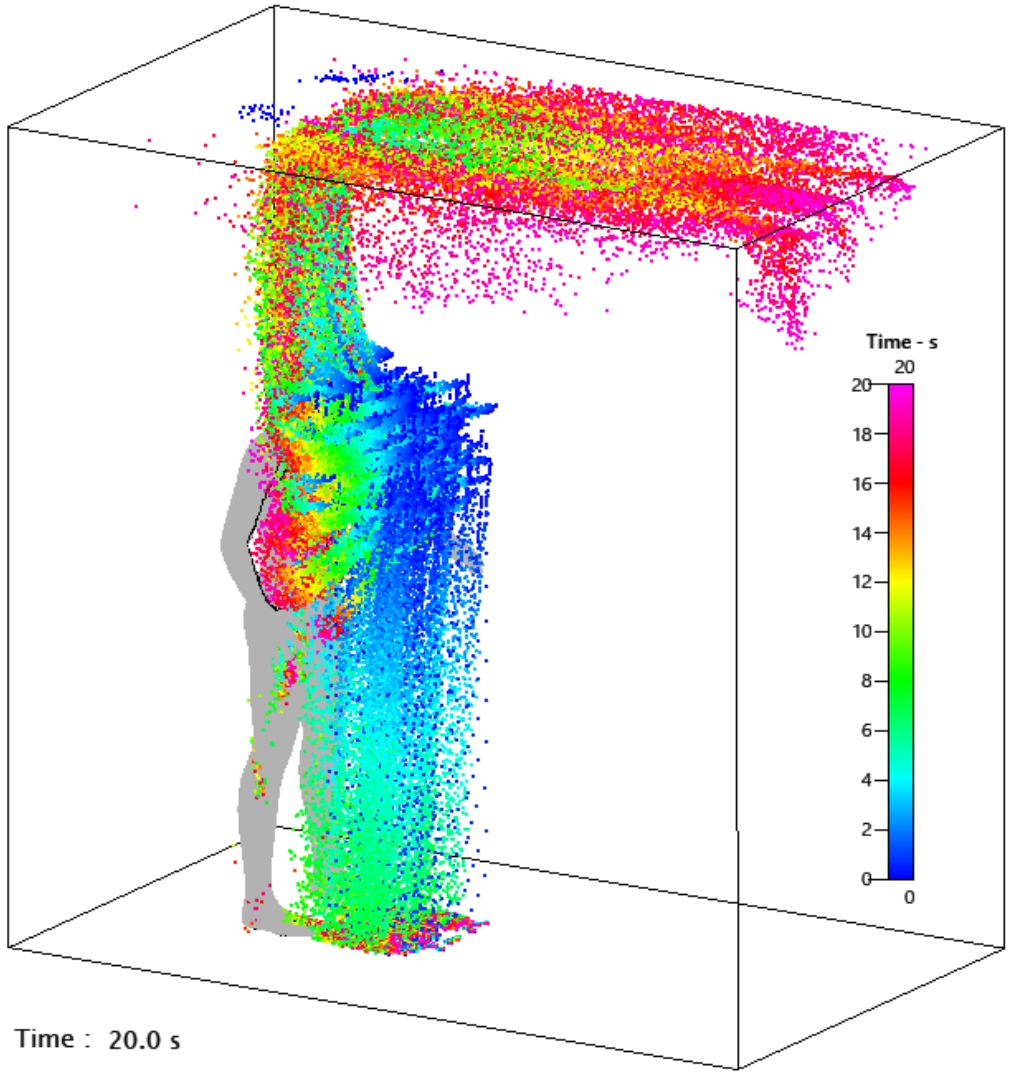
https://athenasys.co.jp/main/product/cfd-ace/spray/spray_on_virus_diffusion_en.html

Particle trajectory: **5 µm** particle



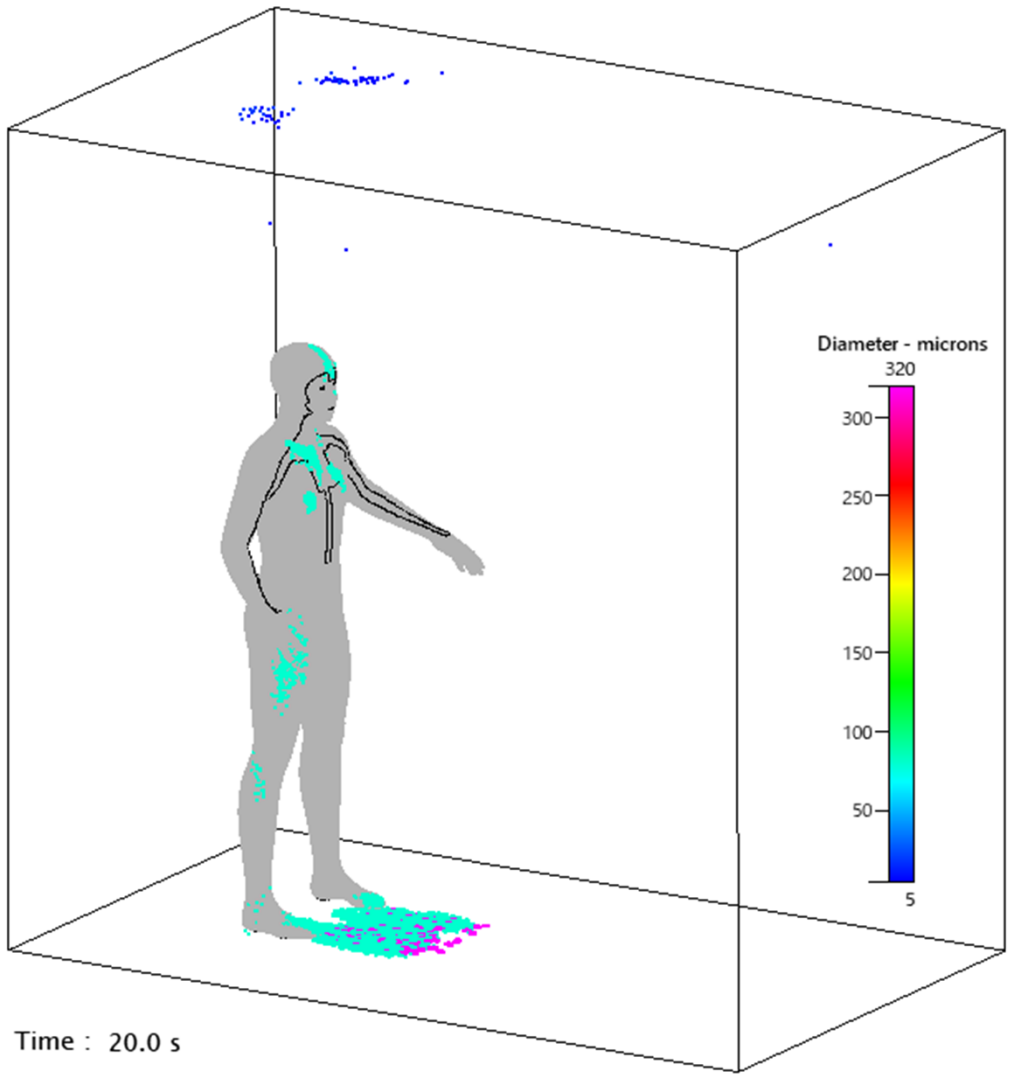
https://athenasys.co.jp/main/product/cfd-ace/spray/spray_on_virus_diffusion_en.html

Particle trajectory: all particle sizes



https://athenasys.co.jp/main/product/cfd-ace/spray/spray_on_virus_diffusion_en.html

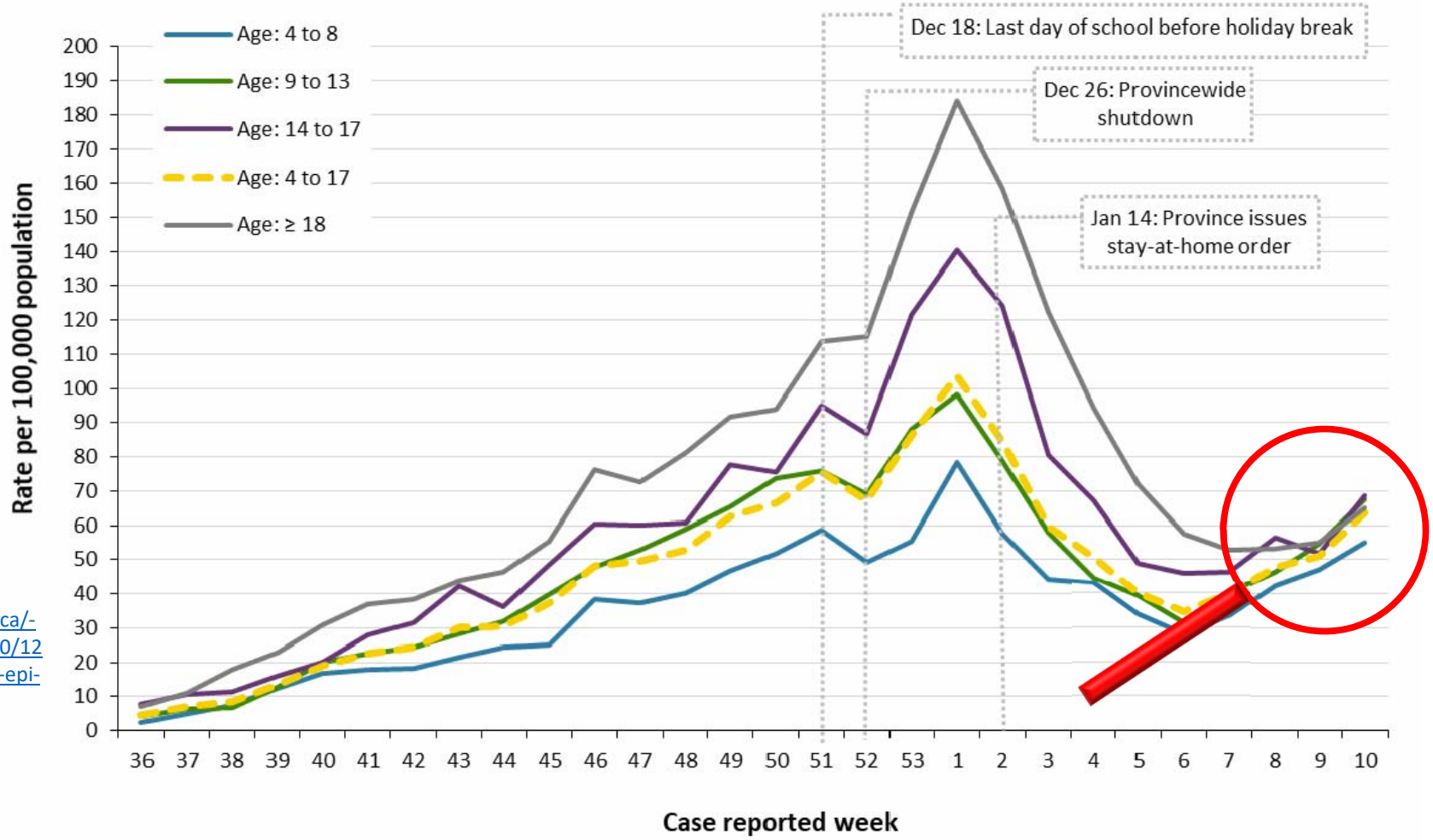
Particles adhering to floor, wall, and body



https://athenasys.co.jp/main/product/cfd-ace/spray/spray_on_virus_diffusion_en.html

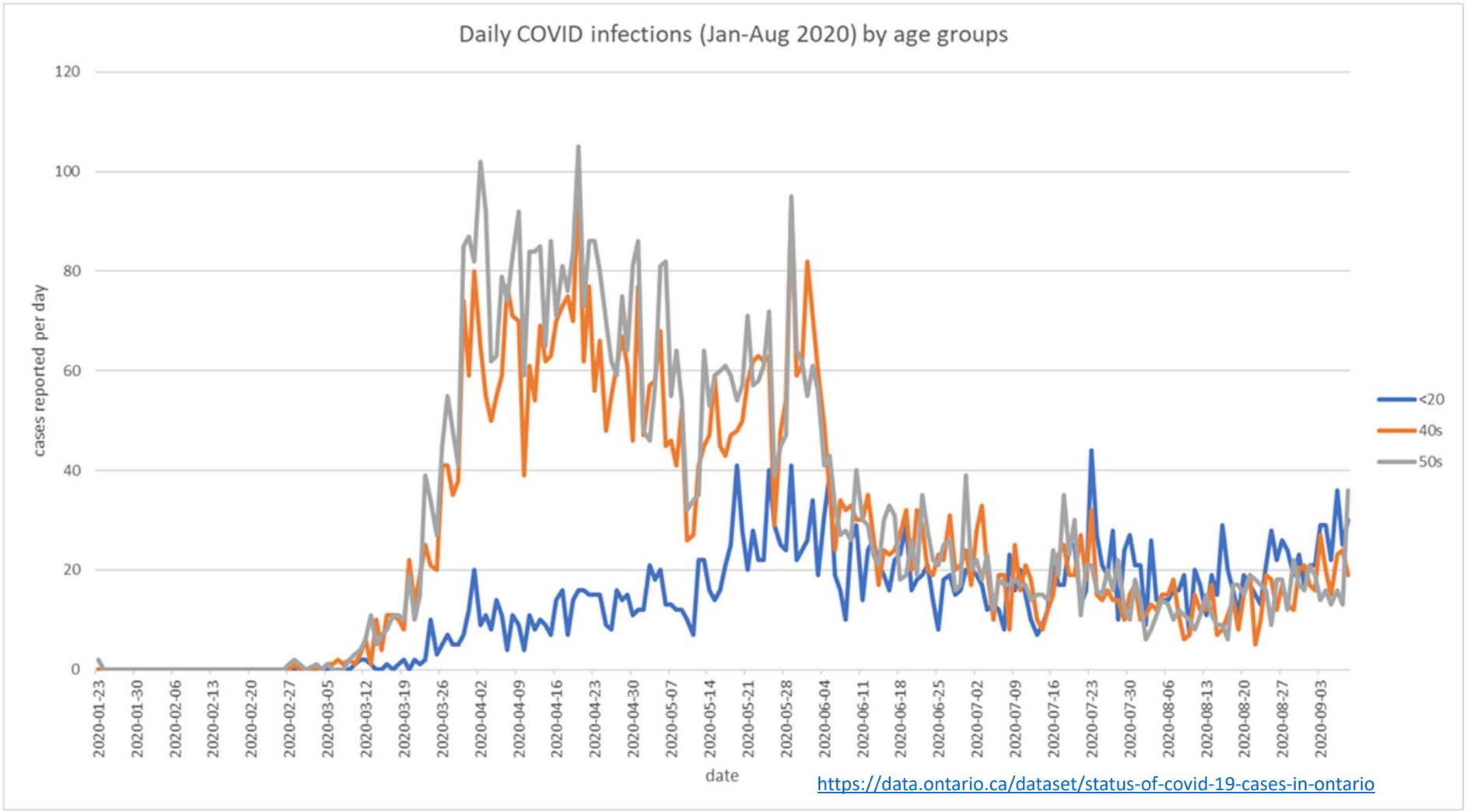
What’s the risk?

Figure 1. Rate of COVID-19 per 100,000 population among cases reported August 30, 2020 to March 13, 2021 by case reported week.



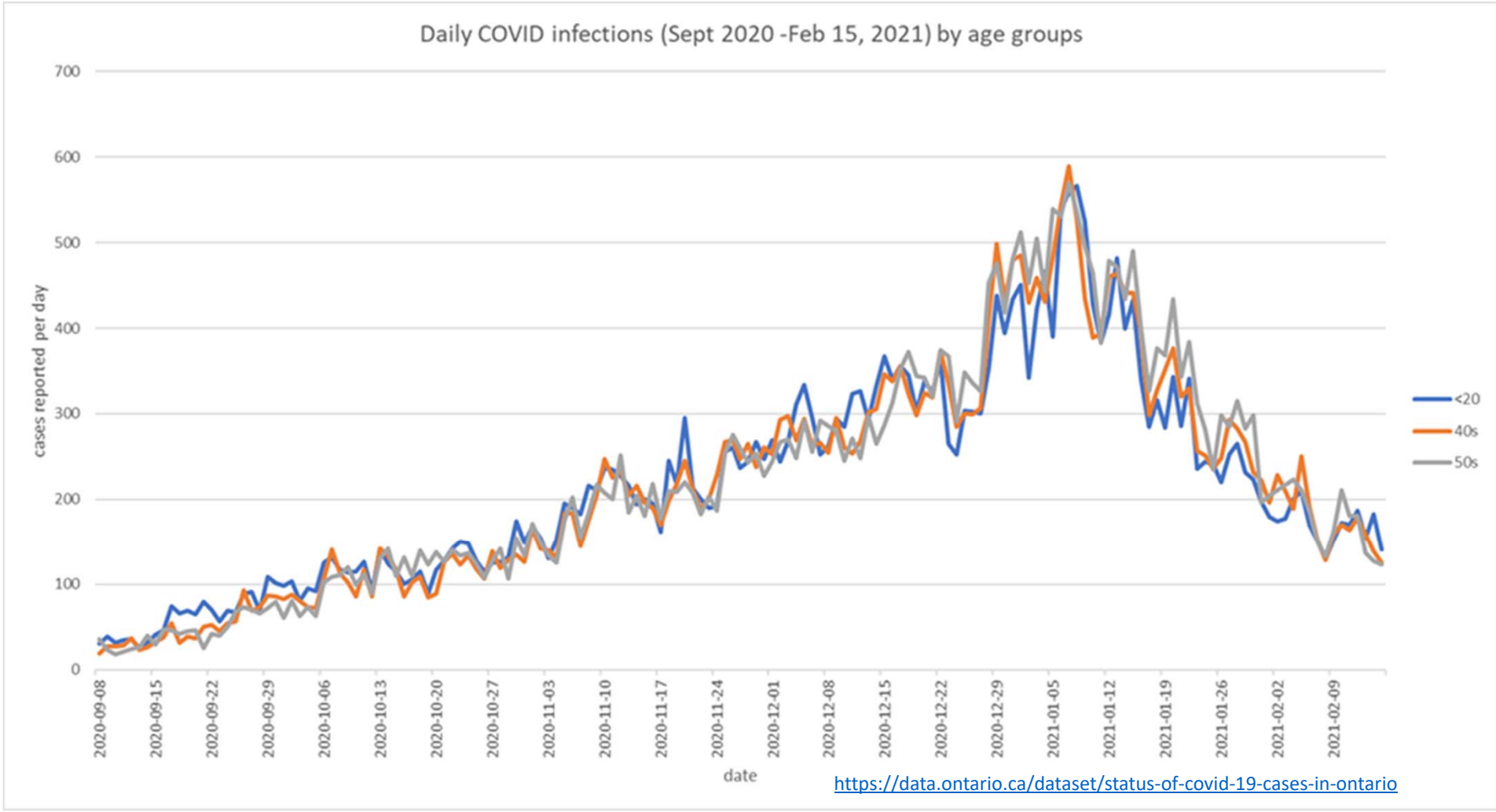
https://www.publichealthontario.ca/-/media/documents/ncov/epi/2020/12/covid-19-school-outbreaks-cases-epi-summary.pdf?la=en

Comparative COVID-19 Case Counts for Age Groups (1st Wave)



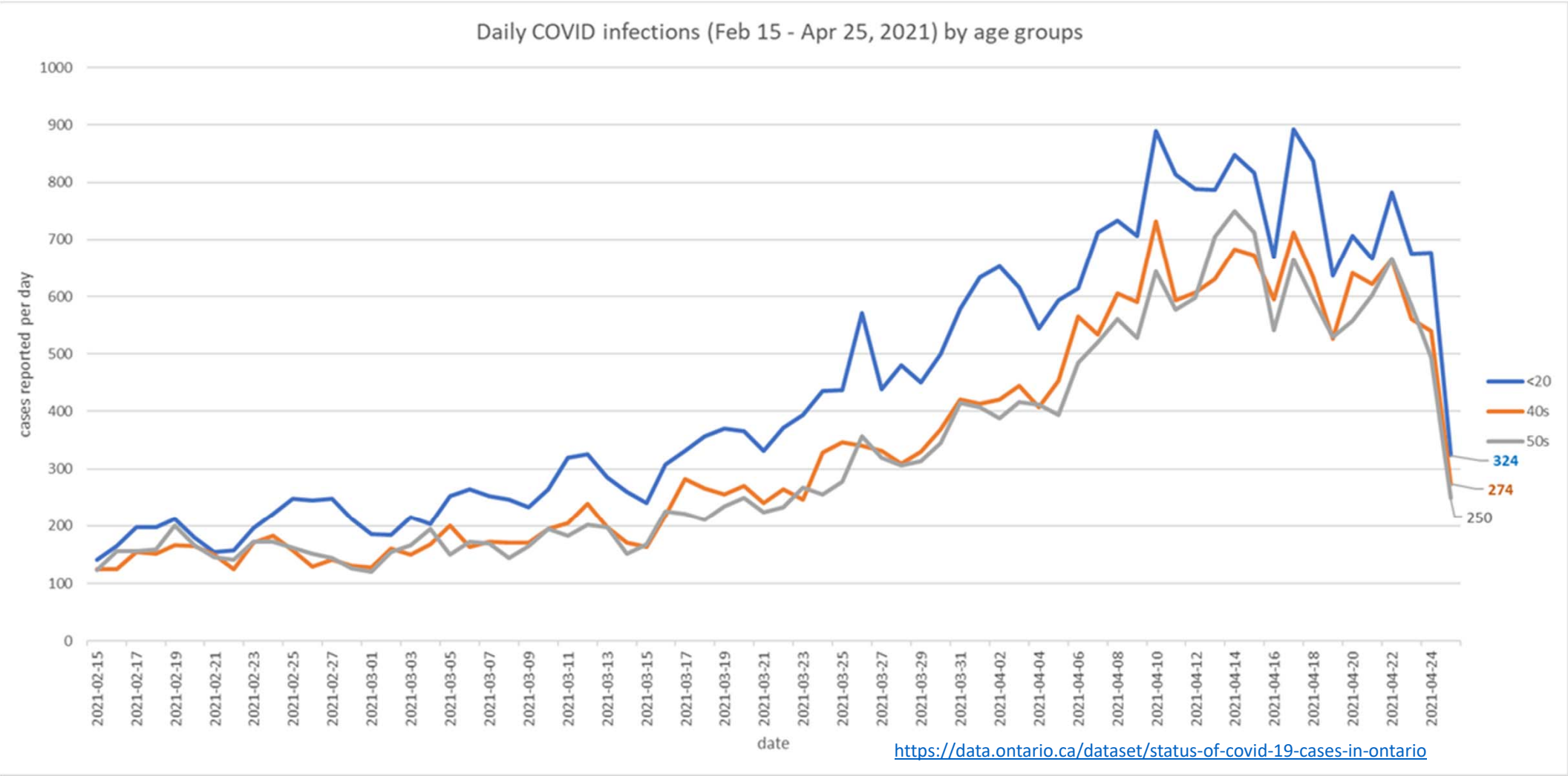
https://data.ontario.ca/dataset/status-of-covid-19-cases-in-ontario

Comparative COVID-19 Case Counts for Age Groups (2nd Wave)

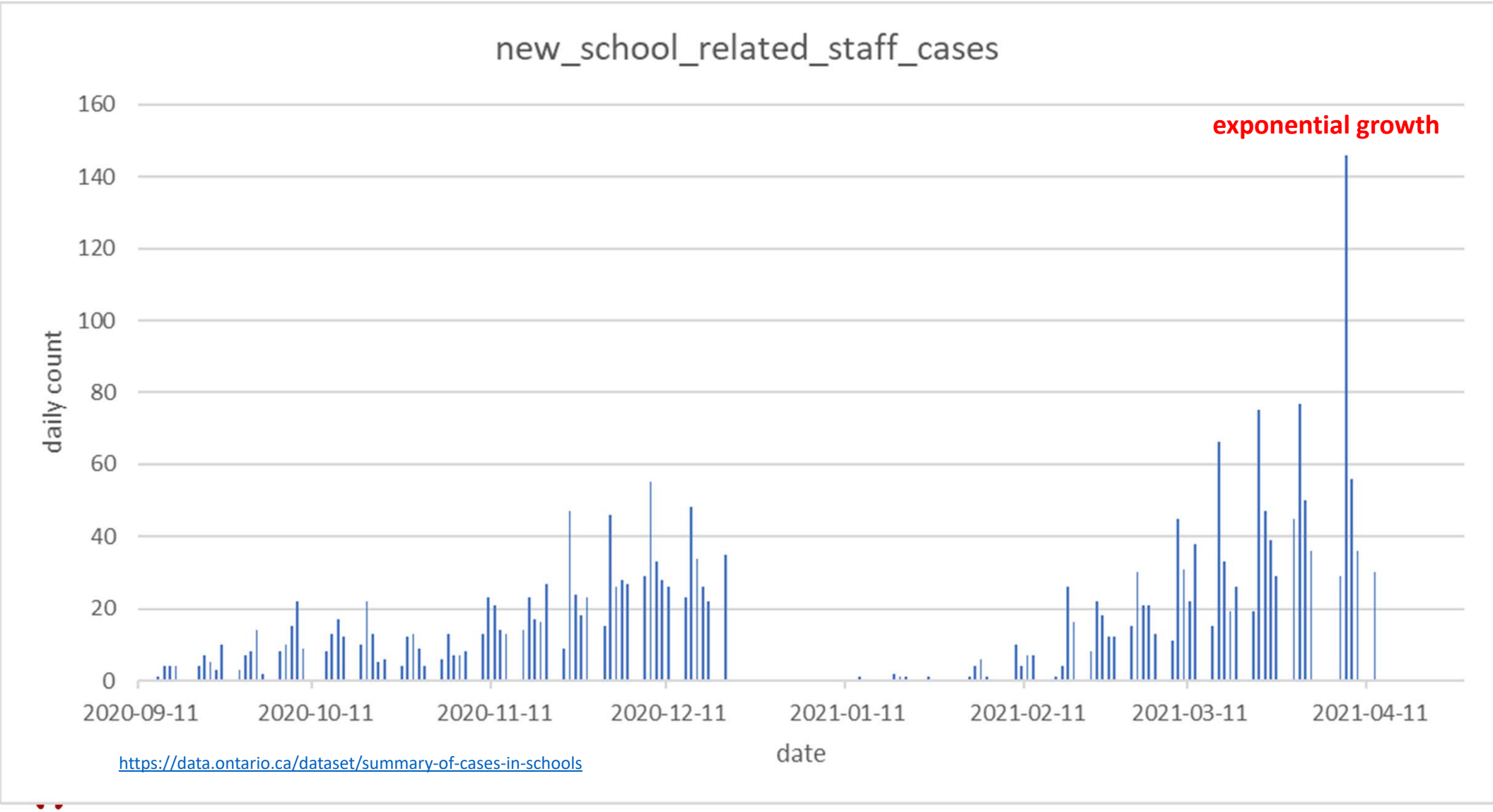


https://data.ontario.ca/dataset/status-of-covid-19-cases-in-ontario

Comparative COVID-19 Case Counts for Age Groups (3rd Wave)



https://data.ontario.ca/dataset/status-of-covid-19-cases-in-ontario



https://data.ontario.ca/dataset/summary-of-cases-in-schools

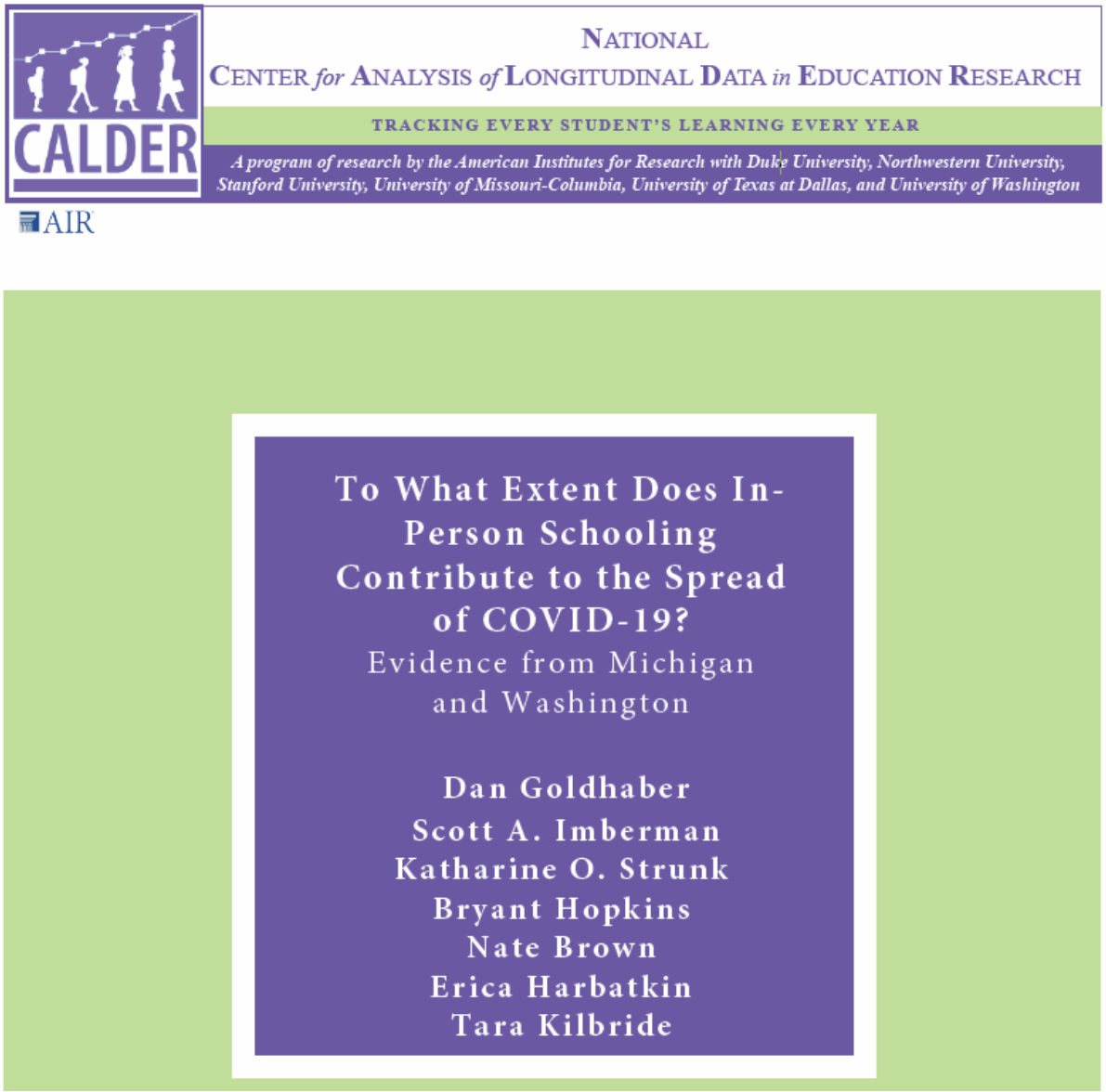
Dr. Osterholm Director of the Center for Infectious Disease Research andPolicy, or CIDRAP, at the University of Minnesota (July 22, 2020)

"To know whether my community is in that place where it can start again, I would say basically if you were at **5 cases or less per 100,000 population, if you had decreasing numbers of cases for the past 14 days, and if your hospitals have at least a 25% extra capacity to handle cases**, then I think you're talking about reopening, knowing that it's still going to be a challenge, but those are the numbers I would use, and I heard over and over again from school superintendents, I wish somebody would just give me a number, so at least I could go to a meeting, and have that, so I'm going to throw that out. 5 cases per 100,000 population or less per day, you have 14 days of decreasing numbers of new cases, and you have at least a quarter of your hospital beds available should there be a surge and you need to address it."

https://www.cidrap.umn.edu/sites/default/files/public/downloads/ep._17_transcript.pdf @ 0:51:00 (podcast)

- Ontario's red zone starts at 40 cases per week per 100,000 which would be 5.7 cases per day per 100,000.

A study by Goldhaber et al. used daily new cases rates and calculated different thresholds based on data from two states: **20 new daily cases per 100,000** people for Michigan and about **5 cases per 100,000** for Washington state



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Regional Risk Tool & Tips

Escalating Advice Based on Your Region's COVID-19 Infection Experience For

Communicating, Cleaning, Handwashing, Ventilating, Distancing, Screening, and Masking

This page provides a tool to determine your local infection risk and corresponding tips for COVID-19 prevention in non-healthcare workplaces.

- based on Public Health Ontario published** COVID-19 reported case counts
- graphs the 14-day rolling count divided by population for a rate per 10000 in each Public Health region
- regional infection risk levels are classified into 5 categories (coloured bands)
- escalating set of tips, based on risk, to protect your workplace from COVID-19
- plus daily summary **Regional Risk Table At A Glance**

https://www.ohcow.on.ca/regional-risk-tool-and-tips.html

Comparison of the two scales:

0.0-0.5/100,000	0.5-1.0/100,000	1.0-2.5/100,000	2.5-5/100,000	5+/100,000	← daily rates
Minimal risk low to absent community transmission **0-0.7** cases in the last 14 days per 10,000 people	**Controlled risk** some sporadic community activity **0.7-1.4** cases in the last 14 days per 10,000 people	**Some community risk** regular sporadic activity **1.4-3.5** cases in the last 14 days per 10,000 people	**Wider community risk** regular activity outbreaks **3.5-7** cases in the last 14 days per 10,000 people	**High risk** uncontrolled community outbreaks **7+** cases in the last 14 days per 10,000 people	
0.0-3.5/100,000	3.5-7.0/100,000	7.0-17.5/100,000	17.5-35/100,000	35+/100,000	← weekly rates
PREVENT (Standard Measures)	**PROTECT** (Strengthened Measures)	**RESTRICT** (Intermediate Measures)	**CONTROL** (Stringent Measures)		
Epidemiology • Weekly incidence rate is < 10 per 100,000	**Epidemiology** • Weekly incidence rate is 10 to 24.9 per 100,000	**Epidemiology** • Weekly incidence rate is 25 to 39.9 per 100,000	**Epidemiology** • Weekly incidence rate ≥ 40 per 100,000		

Osterholm's criteria: Less than 5 cases per 100,000 people/day

High risk uncontrolled community outbreaks

7+ cases in the last 14 days per 10,000 people

5+/100,000 ← daily rates

RESTRICT (Intermediate Measures)	CONTROL (Stringent Measures)
Epidemiology • Weekly incidence rate is 25 to 39.9 per 100,000	**Epidemiology** • Weekly incidence rate ≥ 40 per 100,000
3.6-5.7/100,000	5.7+/100,000 ← daily

https://www.ohcow.on.ca/regional-risk-tool-and-tips.html

(updated to June 2, 2021)

Rank	Region Public Health Unit (PHU)	Regional Infection Risk Level*	ON Framework Categories**
1	Porcupine Health Unit	High risk	CONTROL
2	Peel Public Health	High risk	CONTROL
3	Hamilton Public Health Services	High risk	CONTROL
4	Durham Region Health Department	High risk	CONTROL
5	Toronto Public Health	High risk	CONTROL
6	Haliburton, Kawartha, Pine Ridge District Health Unit	High risk	RESTRICT
7	York Region Public Health Services	High risk	RESTRICT
8	Middlesex-London Health Unit	High risk	RESTRICT
9	Brant County Health Unit	High risk	CONTROL
10	Region of Waterloo, Public Health	High risk	RESTRICT
11	Niagara Region Public Health Department	High risk	RESTRICT
12	Halton Region Health Department	High risk	RESTRICT
13	Windsor-Essex County Health Unit	High risk	RESTRICT
14	Wellington-Dufferin-Guelph Public Health	High risk	RESTRICT
15	Ottawa Public Health	High risk	RESTRICT
16	Simcoe Muskoka District Health Unit	Wider community risk	RESTRICT
17	Haldimand-Norfolk Health Unit	Wider community risk	PROTECT
18	Peterborough Public Health	Wider community risk	PROTECT

Notice no one is in these OHCOW blue or green categories

Minimal risk
low to absent community transmission

0-0.7 cases in the last 14 days per 10,000 people

0.5/day/100,000

Controlled risk
some sporadic community activity

0.7-1.4 cases in the last 14 days per 10,000 people

0.5-1.0/day/100,000

Rank	Region Public Health Unit (PHU)	Regional Infection Risk Level*	ON Framework Categories**
19	Huron Perth District Health Unit	Wider community risk	RESTRICT
20	Lambton Public Health	Wider community risk	PROTECT
21	Southwestern Public Health	Wider community risk	PROTECT
22	Thunder Bay District Health Unit	Wider community risk	RESTRICT
23	Eastern Ontario Health Unit	Some community risk	PROTECT
24	Renfrew County and District Health Unit	Some community risk	PROTECT
25	Hastings and Prince Edward Counties Health Unit	Some community risk	PREVENT
26	Northwestern Health Unit	Some community risk	PREVENT
27	Grey Bruce Health Unit	Some community risk	PREVENT
28	Sudbury & District Health Unit	Some community risk	PREVENT
29	North Bay Parry Sound District Health Unit	Some community risk	PREVENT
30	Leeds, Grenville and Lanark District Health Unit	Some community risk	PREVENT
31	Algoma Public Health Unit	Some community risk	PREVENT
32	Chatham-Kent Health Unit	Some community risk	PREVENT
33	Timiskaming Health Unit	Controlled risk	PREVENT
34	Kingston, Frontenac and Lennox & Addington Public Health	Controlled risk	PREVENT

https://www.ohcow.on.ca/regional-risk-tool-and-tips.html
(updated to June 2, 2021)

Criteria for re-opening:

- **Colin Furness**, Infection Control Epidemiologist and an Assistant Professor at the Faculty of Information at the University of Toronto (interviewed on CBC's Fresh Air radio program, May 29, 2021)
  - Range of built forms – some schools more risky than others
  - Regional risk – some areas of the province have low levels of COVID activity
  - Leave it to the PHUs and School Boards
  - Universal testing – test every student/staff
  - Worried about the B.1.617 variant (originally identified in India now in the UK – Ontario seems to be tracking UK experience) becoming dominant in Ontario by September

https://www.cbc.ca/listen/live-radio/1-193-fresh-air/clip/15846070-how-ontarios-re-opening-plans-compare-provinces
section regarding school opening beginning at 8:32

'Up to three quarters of the UK's new Covid cases are of B.1.617 strain'

UK Health Secretary Matt Hancock said almost half and possibly three-quarters of all new coronavirus cases in the country are of the B.1.617 variant

Topics

Coronavirus | UK govt | Health crisis

IANS | London

Last Updated at May 28, 2021 10:05 IST

https://www.business-standard.com/article/current-affairs/up-to-three-quarters-of-the-uk-s-new-covid-cases-are-of-b-1-617-strain-121052800245_1.html

What about vaccination?

Chung et al (May 28, 2021) **"Effectiveness of BNT162b2 and mRNA-1273 COVID-19 vaccines against symptomatic SARS-CoV-2 infection and severe COVID-19 outcomes in Ontario, Canada"**

> "aVE against symptomatic infection ≥14 days after receiving only 1 dose was 60% (95%CI, 57 to 64%), increasing from **48%** (95%CI, 41 to 54%) **at 14–20 days after the first dose** to **71%** (95%CI, 63 to 78%) **at 35–41 days**. aVE ≥7 days **after receiving 2 doses was 91%** (95%CI, 89 to 93%)."
>
> (*NOTE: only about 4% of vaccinated and unvaccinated positive cases were the B.1.1.7 variant)*

Lopez-Bernal et al (May 20, 2021) **"Effectiveness of COVID-19 vaccines against the B.1.617.2 variant"**

> "Given that vaccine effectiveness against symptomatic disease with **B.1.1.7 is estimated at approximately 60% after dose 1 and 85% after dose 2** (10, 27) these results would indicate effectiveness of **45% and 76% respectively for B.1.617.2**." (*NOTE: UK experience)*

Yassi et al (May 25, 2021) **"Infection control, occupational and public health measures including mRNA-based vaccination against SARS-CoV-2 infections to protect healthcare workers from variants of concern: a 14-month observational study using surveillance data"**

> "Our study shows **33.2%** (95% CI, 15.9 to 47.0%) vaccine effectiveness against PCR-confirmed infections **≥14 days after first dose**, and **77.6%** (95% CI, 62.9 to 86.5%) effectiveness **≥7 days after the second dose** when compared to unvaccinated HCWs, even with high rates of the B1.1.7 and P.1 variants."

Escalating Advice Based on Your Region's COVID-19 Infection Experience for:

Communicating,
Cleaning,
Handwashing,
Ventilating,
Distancing,
Screening, and
Masking

https://www.ohcow.on.ca/regional-risk-tool-and-tips.html

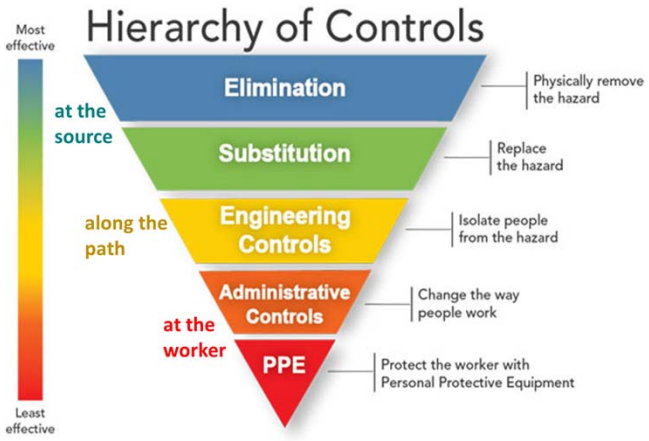
Ventilation within the full spectrum of controls:

1. **Removal and control of COVID-19 source(s)**
   - Hold off persons with COVID-19 or with COVID-19-related symptoms from staying with other people in closed indoor spaces.

2. **Engineering controls in mechanically ventilated (by HVAC systems) and naturally ventilated closed spaces**
   - Comply with best practice of maintenance and settings of HVAC systems in the context of COVID-19;
   - Ensure frequently opened windows in naturally ventilated closed spaces.

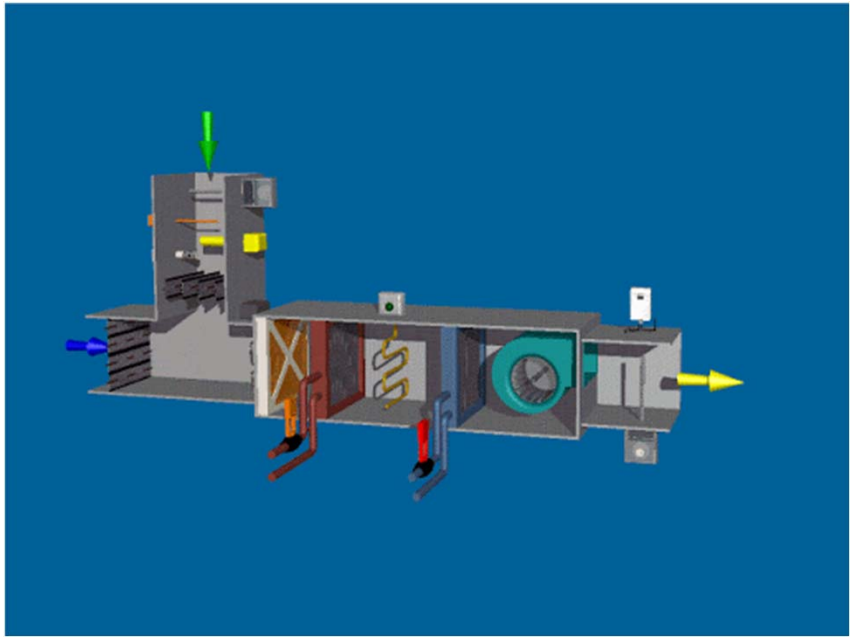
3. **Administrative controls**
   - Reduce occupancy of closed indoor spaces.

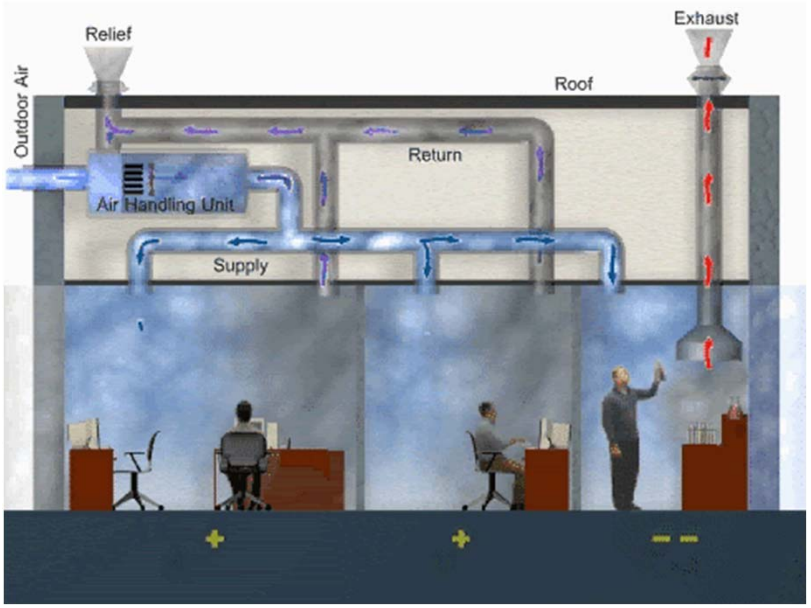
4. **Personal protective behaviour**
   - Keep physical distance;
   - Practise respiratory etiquette;
   - Wear a community face mask.



https://www.ecdc.europa.eu/en/publications-data/heating-ventilation-air-conditioning-systems-covid-19

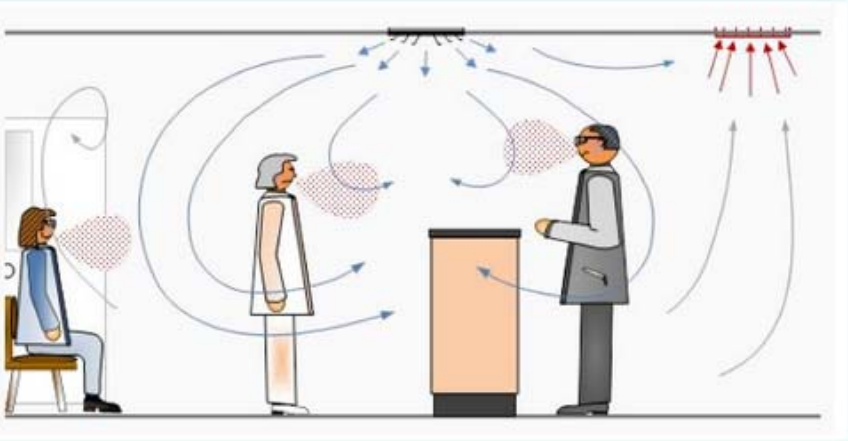
Heating Ventilating and Air Conditioning (HVAC) unit





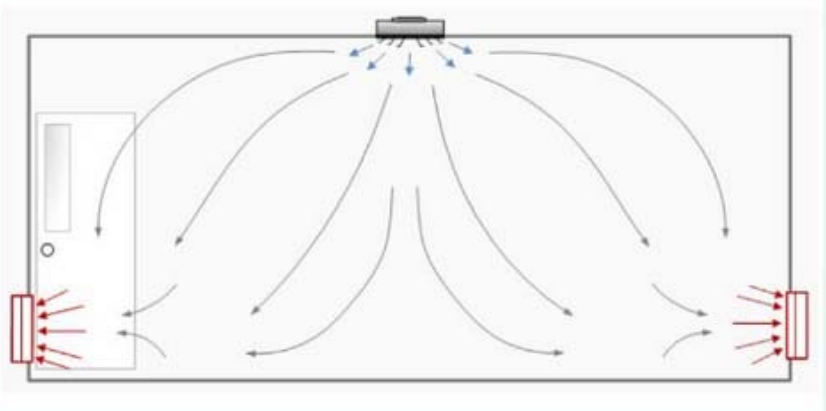

Supply
air blows into the room
Return
air leaves the room

What's the Exposure?



- Anyone can be a source of infectious particles.
- Particles follow air currents.
- Particle concentrations increase over time.
- Exposure may result from the transport of particles from an infectious person to an uninfected person.

Proper Supply and Exhaust can Significantly Reduce the Risk of Exposure



Consider optimizing the type and location of supply and exhaust to enhance airflow, mixing, dilution and removal of contaminants.

https://www.acgih.org/covid-19-fact-sheet-airflow-patterns-matter/

go look on the roof …

make sure you look inside

never know what you'll find …

2do list: go look inside your HVAC unit

Measuring air flow (the proper way):

thermal anemometer

balometer

use air flow measurements to calculate air exchange rate in air changes per hour (or **ach**)

ACH	time required for 99% removal	time required for 99.9% removal
2	2 hrs 18 min	3 hrs 27 min
4	1 hr 9 min	1 hr 44 min
6	46 min	1 hr 9 min
8	35 min	52 min
10	28 min	41 min
12	23 min	35 min
15	18 min	28 min
20	14 min	21 min
50	6 min	8 min

This table assumes perfect mixing in the room (this usually does not occur)

https://www.cdc.gov/infectioncontrol/guidelines/environmental/appendix/air.html

Air Exchange Rates (ACH):

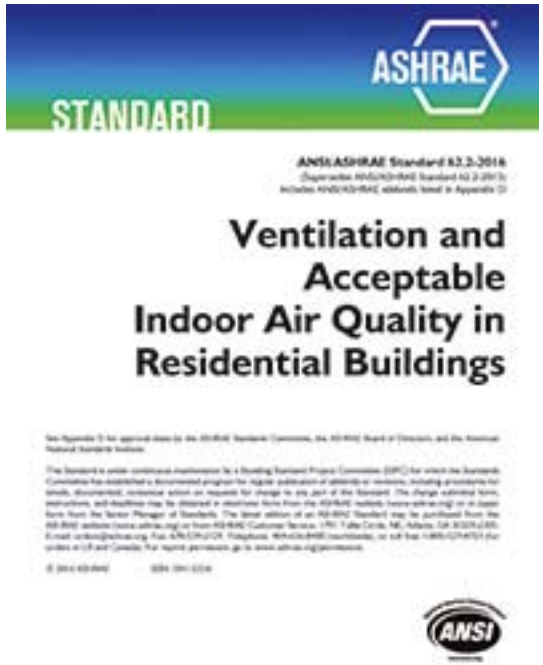
2do list: make fan setting is on "ON"

- Most HVAC systems designed to turnover the volume of the room about 5 to 6 time per hour (if the fan setting left on "ON" not "AUTO")
- Usually only 10-25% of the air being circulated by the HVAC unit is outdoor air
- Thus, if you have 5-6 air turnovers per hour, only 10-25% of that air is outdoor air ("fresh air"), so actually the rate is 0.5-1.5 outdoor air changes per hour.
- This all assumes you have "perfect mixing" i.e. the air circulates over the whole volume of the room leaving no "dead air" spaces
- Open windows and doors will give you more air exchanges and possibly more outdoor air supply
- If you go to 100% outdoor air supply you won't be able to manage the temperature and humidity in extreme weather (very hot or very cold)

https://schools.forhealth.org/wp-content/uploads/sites/19/2021/01/Harvard-Healthy-Buildings-program-How-to-assess-classroom-ventilation-10-30-2020-EN_R1.8.pdf

ASHRAE 62.1-2016:

- Sets out **design** and **operational** requirements
- two procedures for prescribing adequate air quality:
  - **ventilation rate** prescribes **minimum quantity** of outdoor air supply per occupant (e.g. 17 cfm/person in an office environment, 15 cfm/person in classroom (for ages 5-8); CO_2 as a marker of dilution rates)
  - **IAQ procedure** prescribes **minimum quality** of supply air (measure contaminants; CO_2 as a marker for bio-effluents)



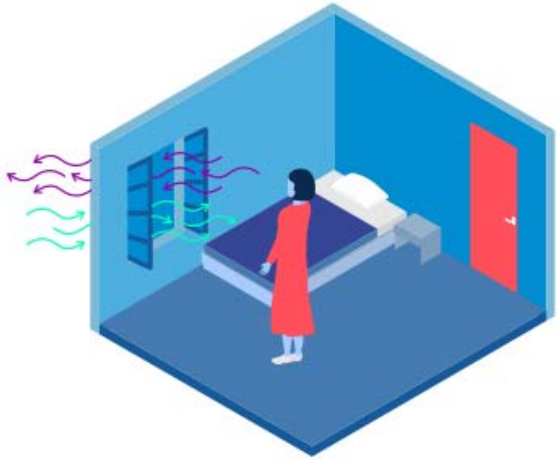
CO_2 as a surrogate measure for outdoor air supply:

- **ASHRAE 62.1-2019**
  - 17 cfm/person (equivalent to **900 ppm CO_2** if outside CO_2 is 400 ppm; 15 cfm/person equivalent to **1100 ppm CO_2** or CO_2 level no more than 700 ppm above background)
- **Ministry of Labour**

background (outside air)	400-500 ppm
no problem	500-600 ppm
possible problem	600-800 ppm
probable problem	800-1000 ppm
more outdoor air needed	1000+ ppm
TWAEV	5000 ppm

World Health Organization

Roadmap to improve and ensure good indoor ventilation in the context of COVID-19



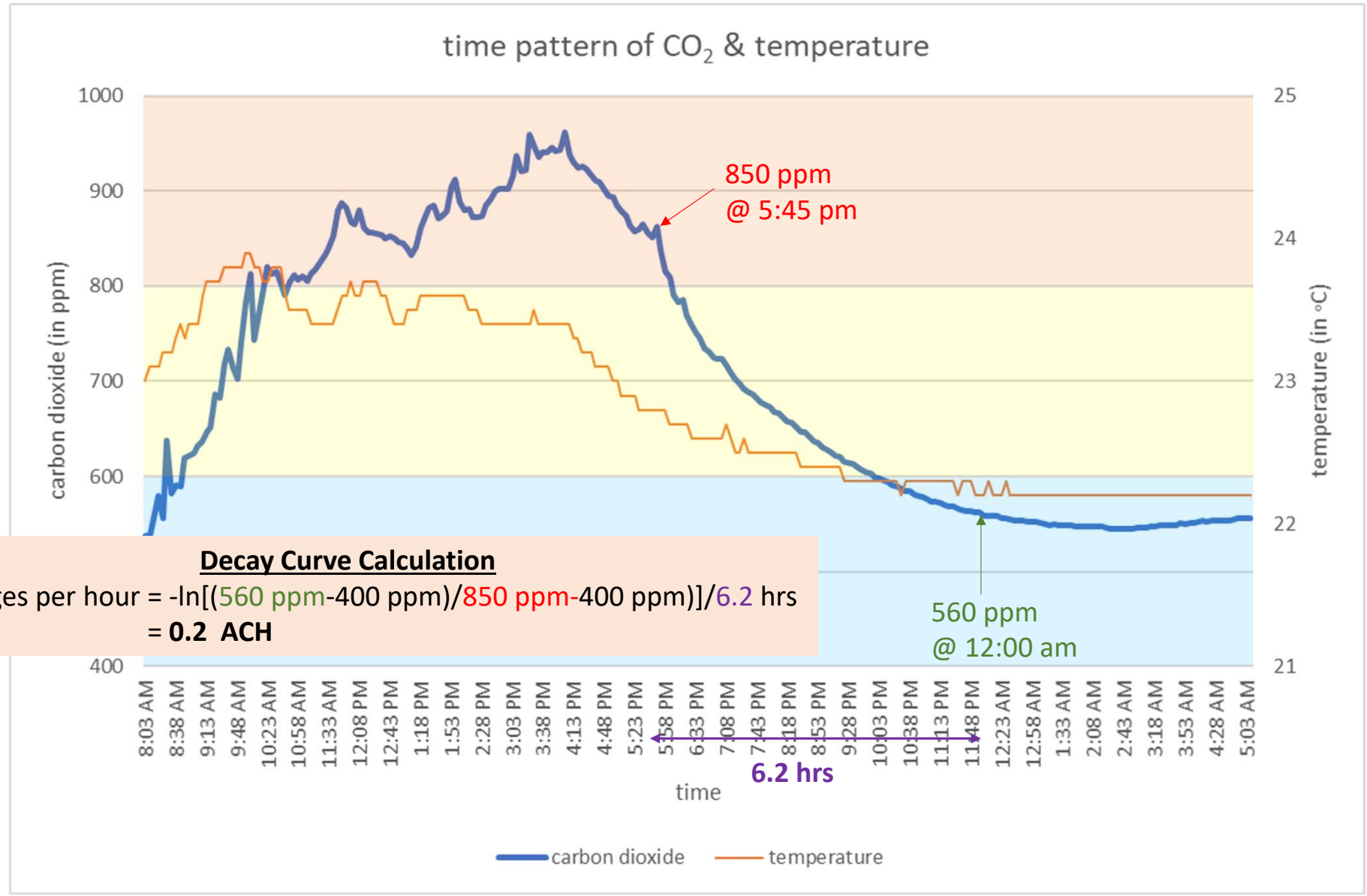
https://www.who.int/publications/i/item/9789240021280

10 L/s/person =
21 cfm/person
outdoor air
≈ **900 ppm** CO_2

6.2 Non-residential settings

natural ventilation

Minimum requirements	Steps – key questions	Strategies
Minimum recommended ventilation rate: •10 L/s/person (EN 16798-1) *(42, 43)*	Does the ventilation rate meet the minimum requirement? To estimate the ventilation rate consult point 2.	NO → Assess the opening location and opening surface considering potential new openings (add/modify window or door dimensions). Enable cross ventilation, if not yet present, instead of single-sided ventilation. Keep the doors open to allow air movement. (single side ventilation / cross ventilation) The use of a pedestal fan placed close to an open window could enable ventilation. Installation of air extractors or whirlybirds *(33)*; building works to improve stack effect of other natural ventilation strategies. If no other strategy can be adopted, consider using a stand-alone air cleaner with MERV 14 / ISO ePM1 70-80% filter *(44)*. The air cleaner should be positioned in the areas used by people and close to people. Air cleaner capacity should at least cover the gap between the minimum requirement and the measured ventilation rate – compare the device clean air delivery rate (CADR) (m^3/hr] with the room ventilation rate. Note: Consider that filtered recirculated air does not replace ventilation in any circumstance.
	YES ↓	
As a contaminant dilution strategy the indoor air should be changed as uniformly as possible	Is the air within the space well mixed?	NO → The use of fans and/or fan coil or split units for cooling and heating as well as ceiling fans increase the air mixing within the room or the space *(44)*. This strategy should be implemented only if the minimum ventilation rate has been met. (1) pedestal fan 2) ceiling fan 3) split
	YES ↓	
Occupancy and ventilation	Does the facility have periods of non-occupancy?	YES → Open the windows to allow proper ventilation before and after occupied times. Windows should be opened for approximately 15 minutes when entering the room (especially when the room was occupied by others beforehand) *(37)*.
	NO ↓	
Heating and air conditioning with recirculating units should be assessed, maintained and cleaned	Are air conditioning and heating performed by non-ducted (with indoor air recirculation) convectors such as split system or fan coil units?	YES → In collaboration with a HVAC professional, if the device is equipped with filters, consider replacing existing air filters with MERV 14 / ISO ePM1 70-80% or the highest compatible with the filter rack. Make sure the units can overcome the additional pressure drop of the new filters. Note: Consider that non-ducted recirculating units do not replace ventilation in any circumstance. Air-conditioning and heating units performed by split system and fan coil units should be periodically cleaned and maintained. Filters should also be periodically cleaned or changed. Note: Consider that non-ducted recirculating units do not replace ventilation in any circumstance.
	NO ↓ END	



Decay Curve Calculation

Air changes per hour = -ln[(560 ppm-400 ppm)/850 ppm-400 ppm)]/6.2 hrs

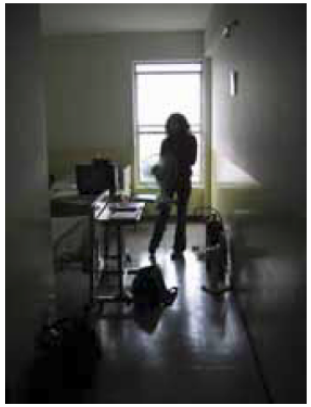
= **0.2 ACH**

What if there are no occupants (i.e., no sources of CO_2)?

CO_2 release

Very big rooms – lots of fire extinguishers

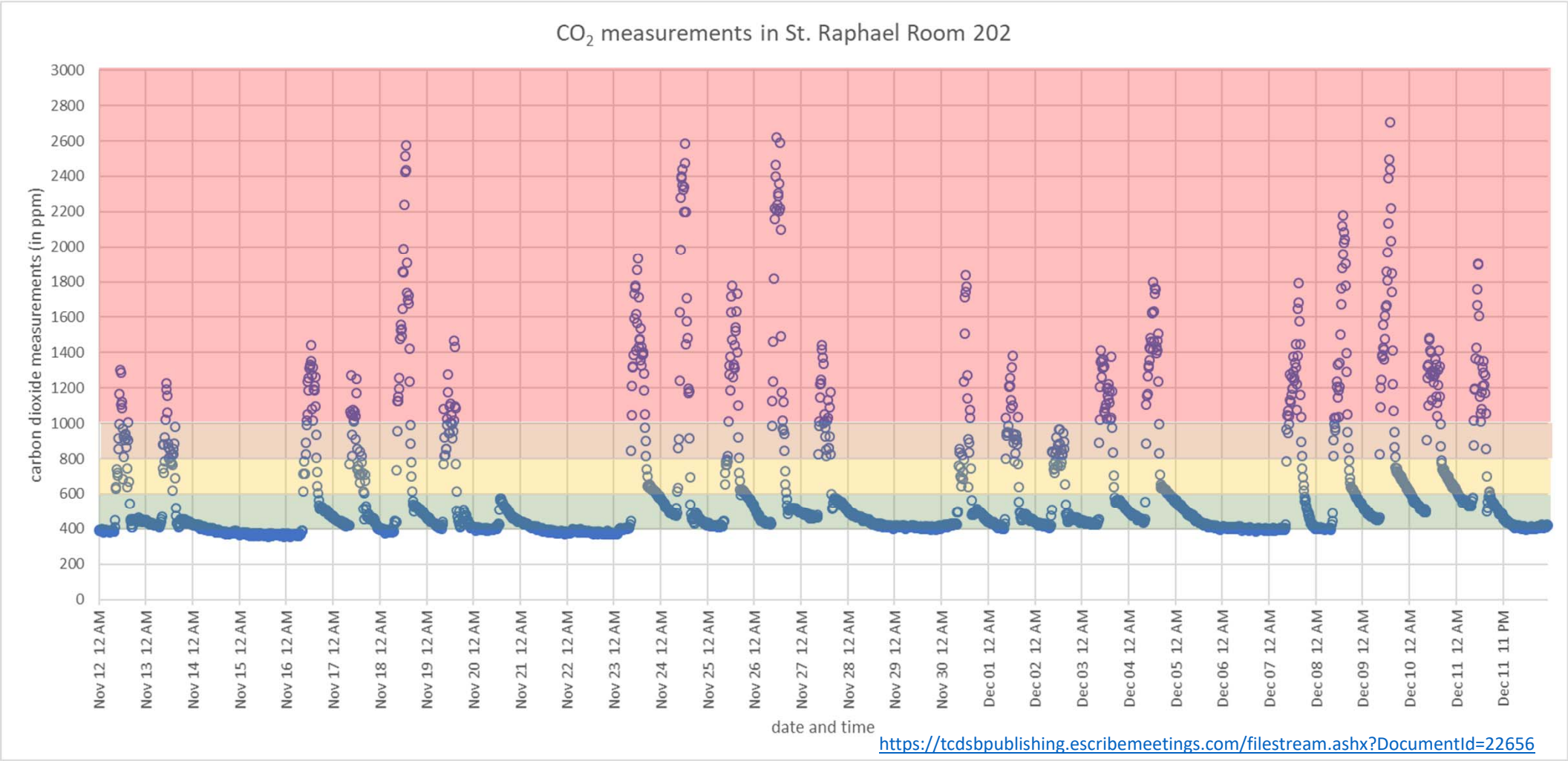
Mixing: Aiming for complete mixing



Escombe "Measuring Air Changes per Hour with Carbon Dioxide"

https://www.ghdonline.org/uploads/Measuring_Air_Changes.pdf

Classroom without forced air (“worst room”)

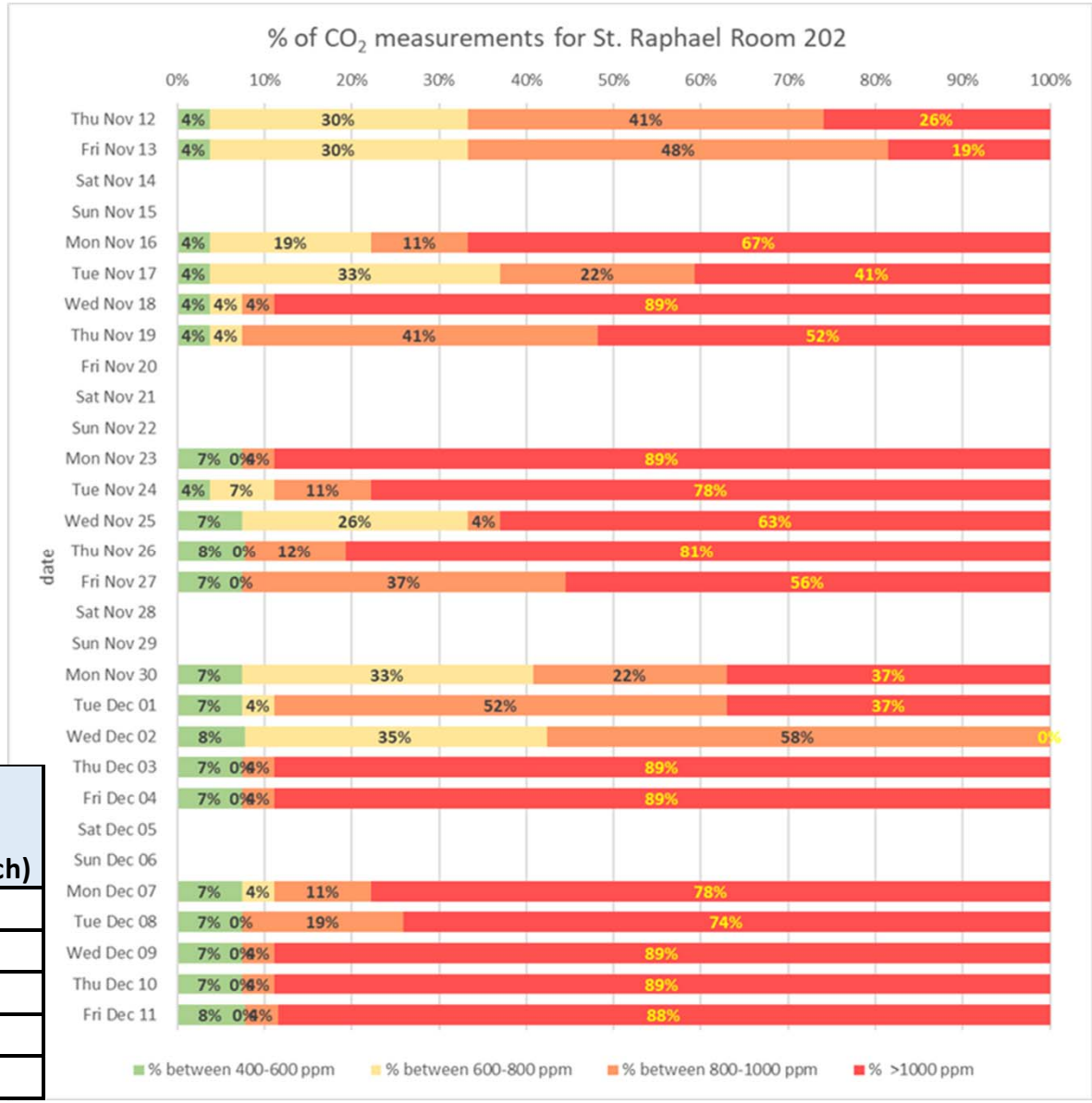


https://tcdsbpublishing.escribemeetings.com/filestream.ashx?DocumentId=22656

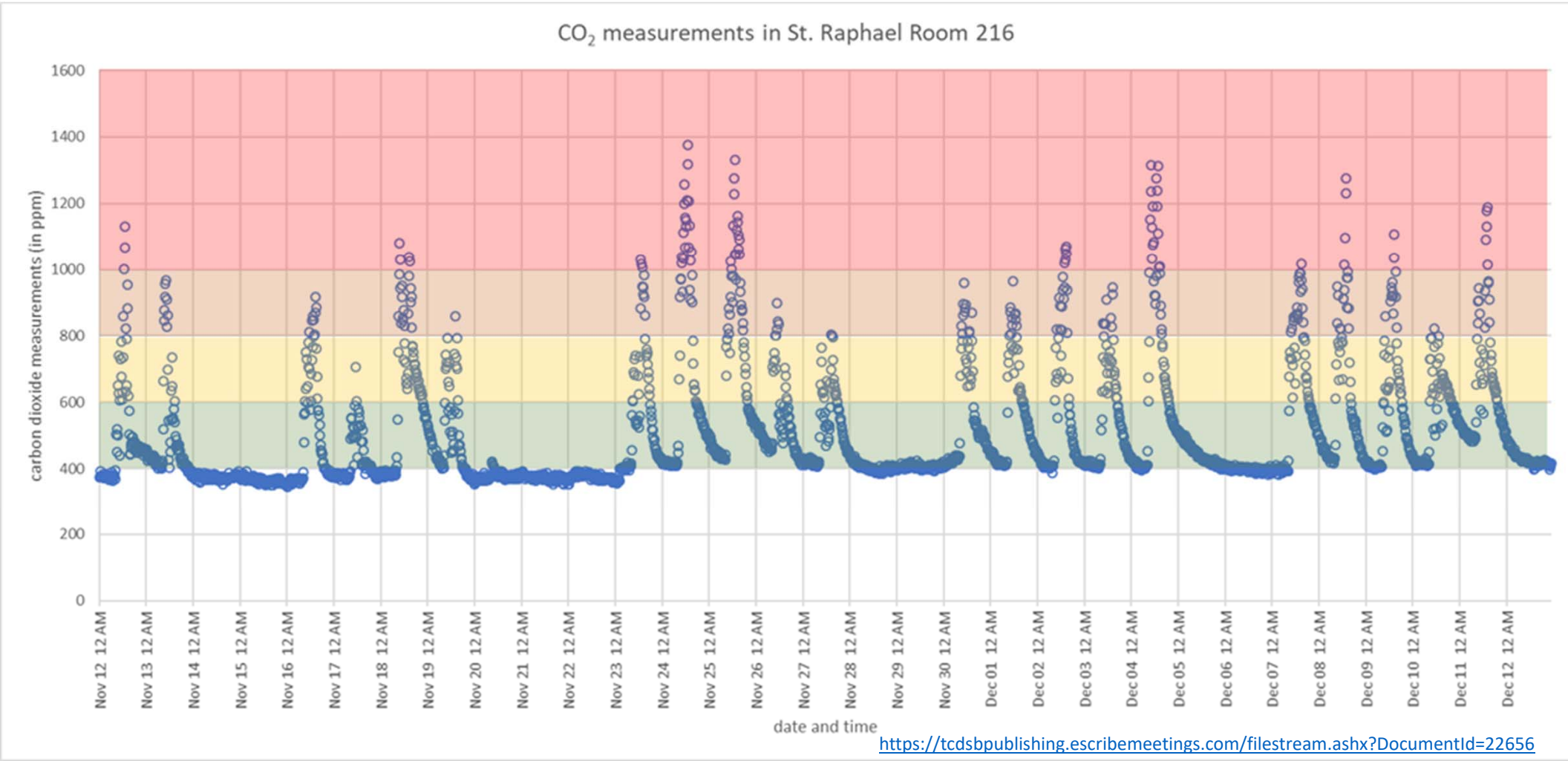
Proportion of the time in the CO_2 concentration bands

legend
% < 600 ppm CO_2
% 600-800 ppm CO_2
% 800-1000 ppm CO_2
% > 1000 ppm CO_2

Time period (≥1 hr decay)	**Average Air Exchange Rate (in ach)**	**Range (minimum – maximum, in ach)**
midnight to 8:00 am (n=20)	0.4	0.1 – 1.4
before lunch (n=5)	0.8	0.3 – 1.3
lunch (n=4)	0.8	0.5 – 1.4
immediately after 3:00 pm (n=25)	1.1	0.5 – 2.5
after 5:00 pm to midnight (n=31)	0.2	0.1 - 0.9



Classroom without forced air (“best room”)

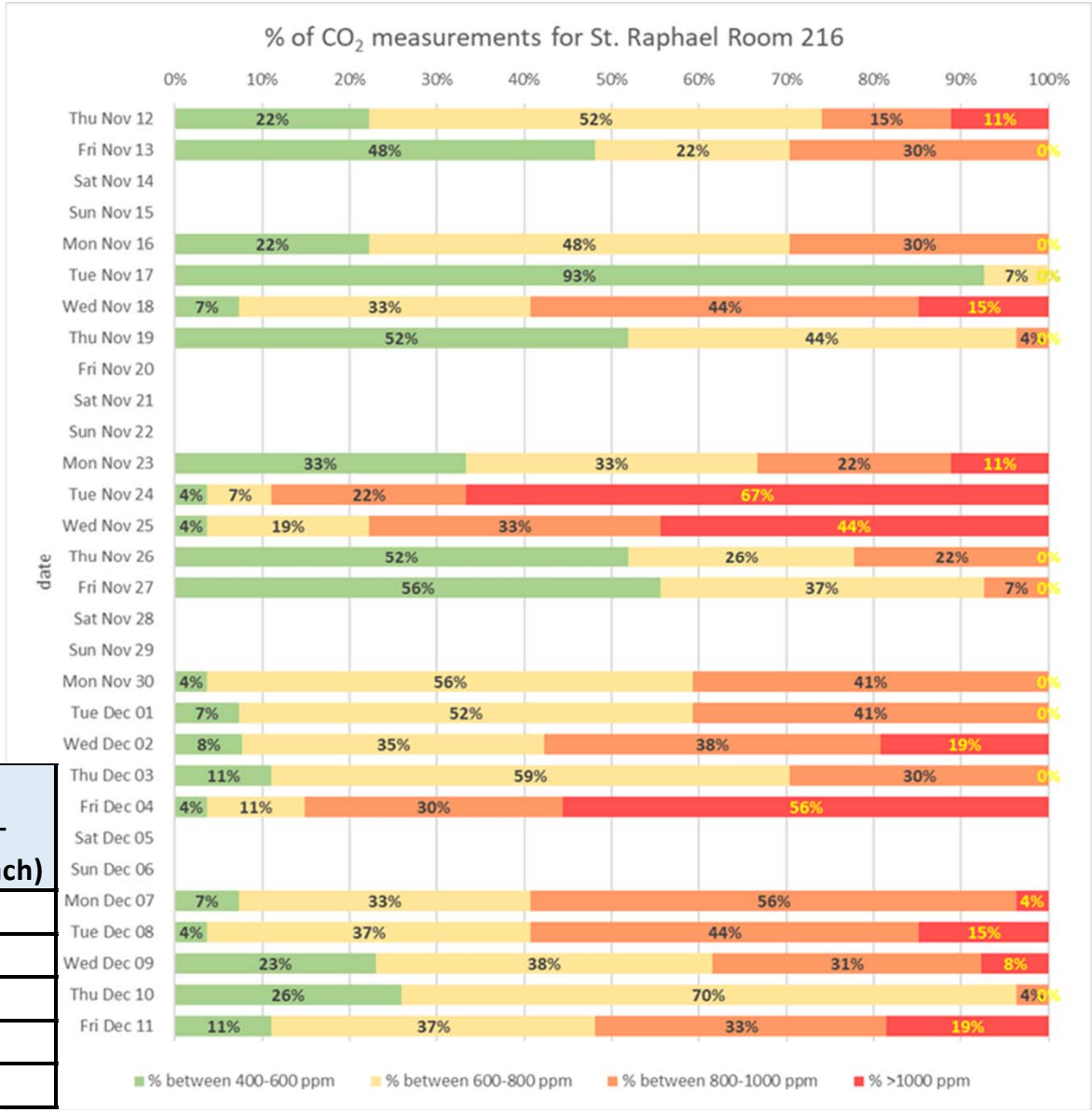


https://tcdsbpublishing.escribemeetings.com/filestream.ashx?DocumentId=22656

Proportion of the time in the CO_2 concentration bands

legend
% < 600 ppm CO_2
% 600-800 ppm CO_2
% 800-1000 ppm CO_2
% > 1000 ppm CO_2

Time period (≥1 hr decay)	**Average Air Exchange Rate (in ach)**	**Range (minimum – maximum, in ach)**
midnight to 8:00 am (n=10)	0.4	0.1 – 0.6
before lunch (n=2)	0.6	0.5 – 0.7
lunch (n=7)	0.9	0.5 – 1.5
immediately after 3:00 pm (n=13)	0.6	0.3 – 1.3
after 5:00 pm to midnight (n=36)	0.3	0.1 – 0.9



Remember:

0.2-1.1 ach →

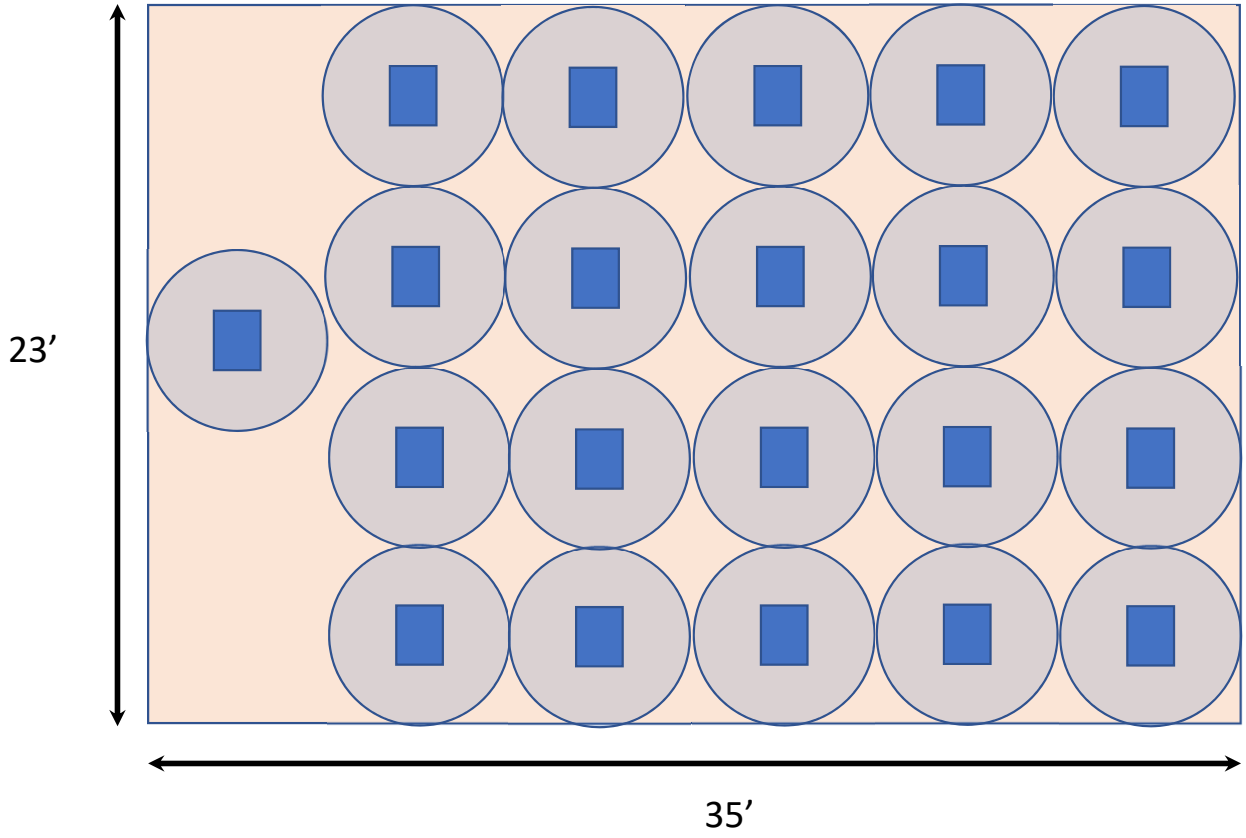
ACH	time required for 99% removal	time required for 99.9% removal
2	2 hrs 18 min	3 hrs 27 min
4	1 hr 9 min	1 hr 44 min
6	46 min	1 hr 9 min
8	35 min	52 min
10	28 min	41 min
12	23 min	35 min
15	18 min	28 min
20	14 min	21 min
50	6 min	8 min

This table assumes perfect mixing in the room

https://www.cdc.gov/infectioncontrol/guidelines/environmental/appendix/air.html

Time period (≥1 hr decay)	**Room 202 air exchange rates (in ach)**	**Room 216 air exchange rates (in ach)**
midnight to 8:00 am	0.4	0.4
before lunch	0.8	0.6
lunch	0.8	0.9
immediately after 3:00 pm	1.1	0.6
after 5:00 pm to midnight	0.2	0.3

Keeping 6’ apart; maximum occupancy: 20 students – one teacher

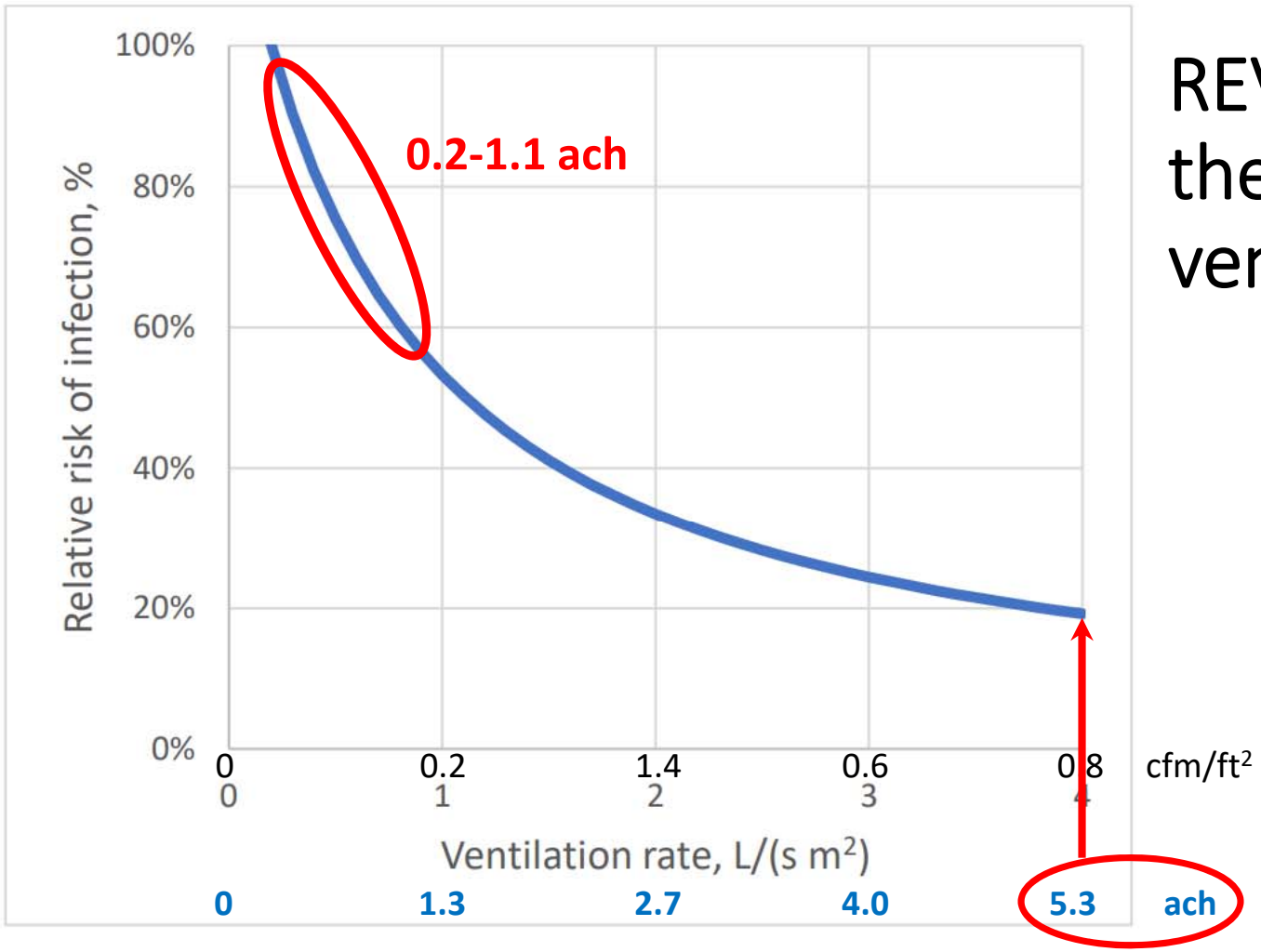


total area:
805 ft^2
assuming 9’ ceilings,
total volume:
7245 ft^3

ASHRAE 62.1 (pre-pandemic) requires:
15 cfm/person, or,
2.5 ach

WHO “Roadmap” requires:
21.2 cfm/person, or
3.7 ach

REHVA (EU):
5.3 ach (800 ppm CO_2), or, 30 cfm/person



REVHA calculation of the risk of infection by ventilation rate:

for a classroom of: 805 ft^2 x 0.8 cfm/ft^2 (i.e., 4L/(s m^2)) = 644 cfm; or **5.3 ach**

Figure 7. Relative risk in open plan office of 50 m2 where 2 L/s per person (0.2 L/s per m2) ventilation rate is considered as a reference level for a superspreading event with 100% relative risk.

https://www.rehva.eu/activities/covid-19-guidance/rehva-covid-19-guidance

Improved but still not meeting the target

PINCHIN

Phase II IAQ Data Summary St. Raphael
St. Raphael, 3 Gade Drive, North York, Ontario
Toronto Catholic District School Board

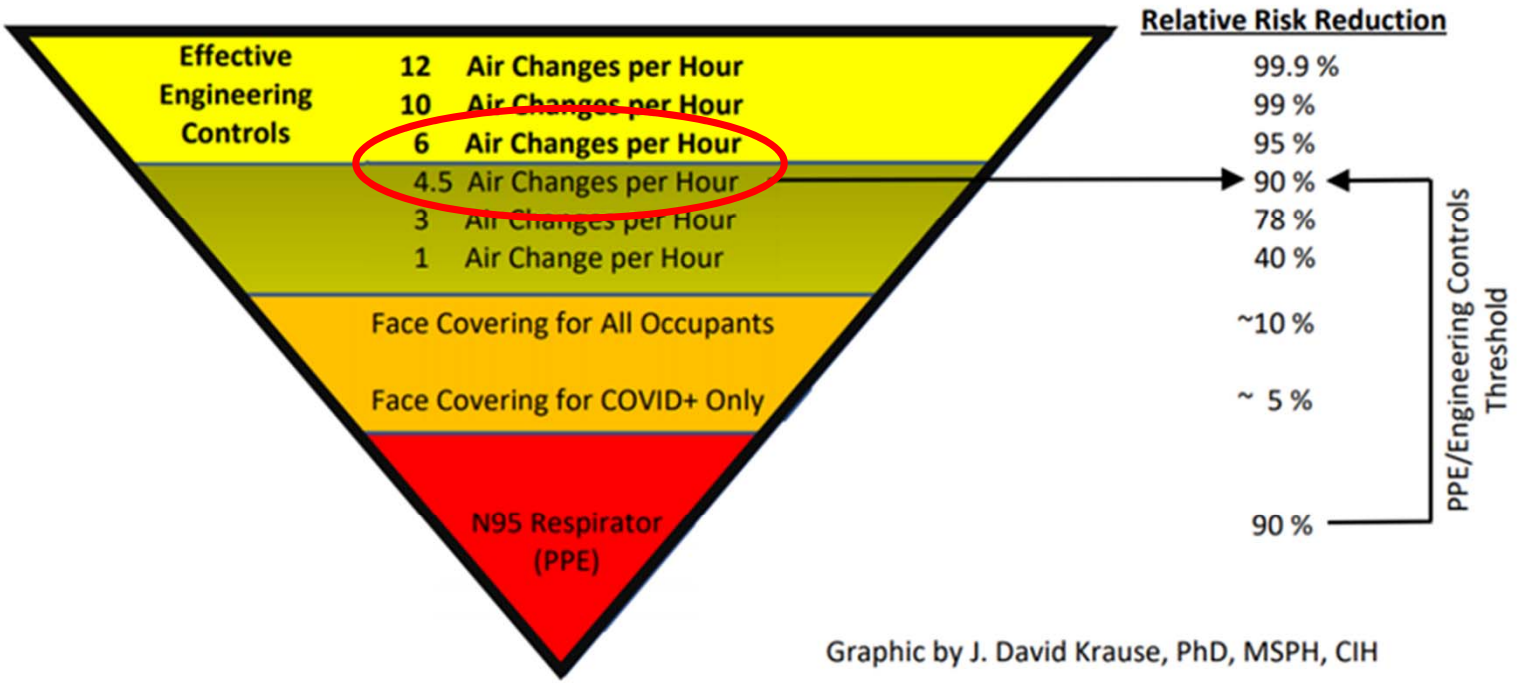
April 13, 2021
Pinchin File: 281161
FINAL

3.0 DISCUSSION

Changes to window operation and maintenance of the exhaust fans present in some of the classrooms have resulted in an improvement to ventilation rates in the subject rooms. Exceedances over 1200 ppm occurred in six of seven rooms during the Phase I testing period. Exceedances over 1200 ppm were identified only in Classroom 202 during the Phase II round of testing. In Classroom 202, measurements above 1200 ppm were reduced to 84 from the previous 270. Exceedances over 800 ppm still occurred in each room, but less than during the prior round. Exceedances over 800 ppm saw a 38% – 99% improvement.

It's like telling the police officer when he catches you going over the 80 km/hr speed limit that at least I wasn't going as fast I as was a few months ago!

AIHA Air Exchange Rate Recommendations:



https://aiha-assets.sfo2.digitaloceanspaces.com/AIHA/resources/Guidance-Documents/Reducing-the-Risk-of-COVID-19-using-Engineering-Controls-Guidance-Document.pdf

TARGET IS AT LEAST 5 TOTAL AIR CHANGES PER HOUR

Ideal (6 ACH)

Excellent (5-6 ACH)

Good (4-5 ACH)

Bare minimum (3-4)

Low (<3 ACH)

1. Measure the Classroom Dimensions
2. Perform Preliminary Audio and Visual Checks
3. Measure or Estimate Outdoor Air Ventilation Rate (using one of four methods)
4. Compare Results to Targets
5. If Needed, Consider Supplemental Air cleaning Strategies to Meet Targets

https://schools.forhealth.org/ventilation-guide/

Ventilation assessment criteria

criteria	air exchange rate (in ach)	equivalent CO_2 concentration
pre-pandemic ASHRAE 62.1	2.0-2.6 (15 cfm OA/person)	1100 ppm
pandemic ASHRAE 62.1 (Apr 2020)	as much OA as possible	<<1100 ppm
Harvard (Allen et al., Aug 2020)	**3-4 (min); 4-6 (preferred)**	**4-5 ach ≈ 800 ppm**
AIHA (Sept 2020)	6-12 (threshold 4.5)	4.5 ach ≈ 800 ppm
ACGIH (Aug 2020)	6-12	6 ach ≈ 700 ppm
REHVA (Nov 2020)	5	800 ppm
CDC (latest update: Mar 2021)	-	800 ppm
WHO (Roadmap, Mar 2021)	2.6-3.7 (21 cfm OA/person)	900 ppm

CO_2 generation rates are lower for children than for adults

		Age Range		Weight		Height		Surface Area		CO_2 Emission Rates		
Grade Level	Activity (MET)	Start (Year)	End (Year)	Boys (kg)	Girls (kg)	Boys (cm)	Girls (cm)	Boys (m2)	Girls (m2)	Boys (L/min)	Girls (L/min)	Average (L/min)
K	**1.4**	**5**	**6**	20.7	20.3	115.4	114.7	0.81	0.80	0.163	0.161	**0.162**
1.0	**1.4**	6	7	23.1	22.8	121.7	121.4	0.89	0.88	0.178	0.176	**0.177**
2.0	**1.4**	**7**	**8**	25.7	25.7	127.8	127.5	0.96	0.96	0.192	0.192	**0.192**
3.0	**1.4**	**8**	**9**	28.6	29.1	133.4	132.9	1.04	1.04	0.208	0.209	**0.208**
7.5	**1.4**	**12**	**14**	48.3	47.5	159.9	158.4	1.48	1.46	0.296	0.292	**0.294**
Adult	1.7	20	70	88.2	75.6	176.8	163.3	2.05	1.82	0.500	0.442	**0.471**

Location / Grade	Occupant Load	Approximate Room Size (ft^2)	ASHRAE 62.1 Outdoor Air Supply Rate (cfm OA)	ventilation rate (OA cfm/person)	air changes per hour (ach)	estimated CO_2 concentration (in ppm)
Room 202 – Grade 7/8	21	815	308	14.7	2.5	1103
Room 209 - Grade 2	16	760	251	15.7	2.2	860
Room 103 - Grade 1	14	760	231	16.5	2.0	790
Workroom 211	5	264	82	16.3	2.1	1093
Room 216 – Grade 3	15	815	248	16.5	2.0	871
Room 117 – Kindergarten	20	760	291	14.6	2.6	963
Admin Office Room 123	not provided	not provided	can't be calculated	n/a	n/a	n/a

REHVA recommendation to monitor CO_2 levels in schools:

(p.34) in REHVA COVID-19 guidance document: "**How to operate HVAC and other building service systems to prevent the spread of the coronavirus (SARS-CoV-2) disease (COVID-19) in workplaces**" (April 15, 2021)

Interpretation criteria:

<600 ppm CO_2

600-800 ppm CO_2

>800 ppm CO_2

https://www.rehva.eu/activities/covid-19-guidance/rehva-covid-19-guidance

Québec is putting CO_2 monitors in every classroom

TVA NOUVELLES | ACTUALITÉS | MA RÉGION | ARGENT | SPORTS | BUZZ | EN DIRECT

› ACTUALITÉS › POLITIQUE › QUÉBEC AURA À L'ŒIL LA QUALITÉ DE L...

Québec aura à l'œil la qualité de l'air dans toutes les classes

Geneviève Lajoie | Journal de Québec | **Publié le 27 mai 2021 à 06:04**

Le gouvernement Legault s'apprête à lancer un appel d'offres pour doter les 48 000 classes du Québec d'un lecteur de CO_2 informatisé, afin de surveiller la qualité de l'air et ainsi de limiter les risques de transmission de la COVID-19 dans les écoles.

https://www.journaldequebec.com/2021/05/27/quebec-aura-a-lil-la-qualite-de-lair-dans-toutes-les-classes

Centers for Disease Control and Prevention
MMWR
Morbidity and Mortality Weekly Report
https://www.cdc.gov/mmwr/volumes/70/wr/mm7021e1.htm
Early Release / Vol. 70
May 21, 2021

Mask Use and Ventilation Improvements to Reduce COVID-19 Incidence in Elementary Schools — Georgia, November 16–December 11, 2020

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https://www.cdc.gov/mmwr/volumes/70/wr/mm7021e1.htm

Summary

What is already known about this topic?

Kindergarten through grade 5 schools educate and address the students' physical, social, and emotional needs. Preventing SARS-CoV-2 transmission in schools is imperative for safe in-person learning.

What is added by this report?

COVID-19 incidence was 37% lower in schools that required teachers and staff members to use masks and 39% lower in schools that improved ventilation. Ventilation strategies associated with lower school incidence included dilution methods alone (35% lower incidence) or in combination with filtration methods (48% lower incidence).

What are the implications for public health practice?

Mask requirements for teachers and staff members and improved ventilation are important strategies in addition to vaccination of teachers and staff members that elementary schools could implement as part of a multicomponent approach to provide safer, in-person learning environments.

https://www.cdc.gov/mmwr/volumes/70/wr/mm7021e1.htm

What does this mean?

- **Masks** alone: 37% reduction in infections
- **Ventilation:** 39% reduction in infections
  - Dilution ventilation alone: 35% reduction
  - Dilution ventilation **& filtration**: **48% reduction**

So why are we policing masking but not ventilation?

Do you know how good your ventilation is?

French & English

Occupational Health Clinics for Ontario Workers Inc. | Centres de santé des travailleurs (ses) de l'Ontario Inc.

Ventilation checklist (COVID-19)

The following checklist can be used as a guide. Pertinent questions are suggested that can be used to assess the suitability of ventilation in the workspace/building that are to be occupied.

According to ASHRAE: "Statement on airborne transmission of SARS-CoV-2. "*Transmission of SARS-CoV-2 through the air is sufficiently likely that airborne exposure to the virus should be controlled. Changes to building operations, including the operation of heating, ventilating, and air-conditioning systems, can reduce airborne exposures*". Therefore, engineering or control via ventilation is critical and provides a higher order control.

Question	Y / N	Additional Guidance	Reference/Notes
1. Has the Hierarchy of Controls (HOC) been used to implement physical distancing, appropriate engineering, administrative, and personal protective equipment (PPE) options in that order (Refer to CDC worker protection tool 1) based on a risk assessment?			1
2. Check in with the person in charge of the day to day operation of the heating, ventilating and air conditioning (HVAC) system.		Ask about the status of the HVAC system. For example: Is it running properly? What service does it need? Are its parts clean? Does anything need to be done to make the system work more effectively? Are the Plans and Specifications available for review, just in case? Is there anything else to know?	9

OHCOW Ventilation Checklist:

26 questions, some with guidance and references

- connecting with the people who operate the system
- increase outdoor air supply
- measure air changes per hour (ACH)
- check integrity of complete system (clean if necessary)
- operate system 24/7
- ensure adequate washroom supply and exhaust ventilation
- use at least MERV 13 filters if possible
- consider the use of air cleaners
- keep relative humidity between 40-60%
- perform risk assessment

https://www.ohcow.on.ca/ventilation-checklist-2.html

Thermal comfort issues:

- Due to the heating/cooling load that 100% outdoor air may bring (ideal outdoor air temperature for air conditioning is 10°C (or 50°F in American)) occupants may experience some thermal discomfort
- Adjusting workplace clothing is a means of addressing this issue (lots of sweaters, blankets, even thin gloves) and space heaters
- Open windows and the use of barriers (e.g. Plexiglas dividers) may disrupt designed air flows (use soap bubble gun to see the air flow patterns)
- Relative humidity (e.g. 40-70%) will be very difficult to maintain in the Canadian winter – steam injection humidification systems are probably the best, if designed and maintain adequately

Portable air filters:

- Not to be used in place of supplying outdoor air (i.e., to reduce heating/cooling costs)
- Need to be sized properly taking into account the amount of noise that is tolerable (variable speed units)
- Need to be maintained (poorly maintained units will eventually put out more particles than they take in)
- Filters age and lose their electrical properties for particle collection

Things to watch out for when buying air purifiers

An excuse not to bring in more outdoor air ($)

	Low	Mid	High
Air Purifier	Levoit LV-H134	Blue Pure 121	Medify MA-112
Image			
CADR	312 cfm 460 ft^2	400 cfm 570 ft^2	560 cfm 800 ft^2
AHAM Verification	✖	✔	✖
Maximum Noise Level	54 decibels	56 decibels	70 decibels
Rated Power	45W	61W	95W
Pros & Cons	✓ 100% ozone-free ✓ 360-degree air intake ✗ Not AMAM approved	✓ Minimalist design ✓ Washable pre-filter ✗ No true HEPA filter	✓ Very high CADR ✓ Large filter surface ✗ No air quality monitor on V2.0
In-depth Review	-	Blueair Blue Pure 121 Review	Medify MA-112 Review
Customer Ratings	★★★★½	★★★★½	★★★★½
Prime Status	Prime	Prime	-
Current Price	$407.82	$439.99	Price not available

Clean Air Delivery Rate (CADR):
need roughly a CADR (dust) of **70 cfm per 100 ft^2 of floor space**

recommended background noise level: **30-40 dBA**

27 students

1 teacher

1 “scientist”

3 or 4 air purifiers!

CADR: 196 cfm (280 ft^2)

CO_2: 1000-2700 ppm

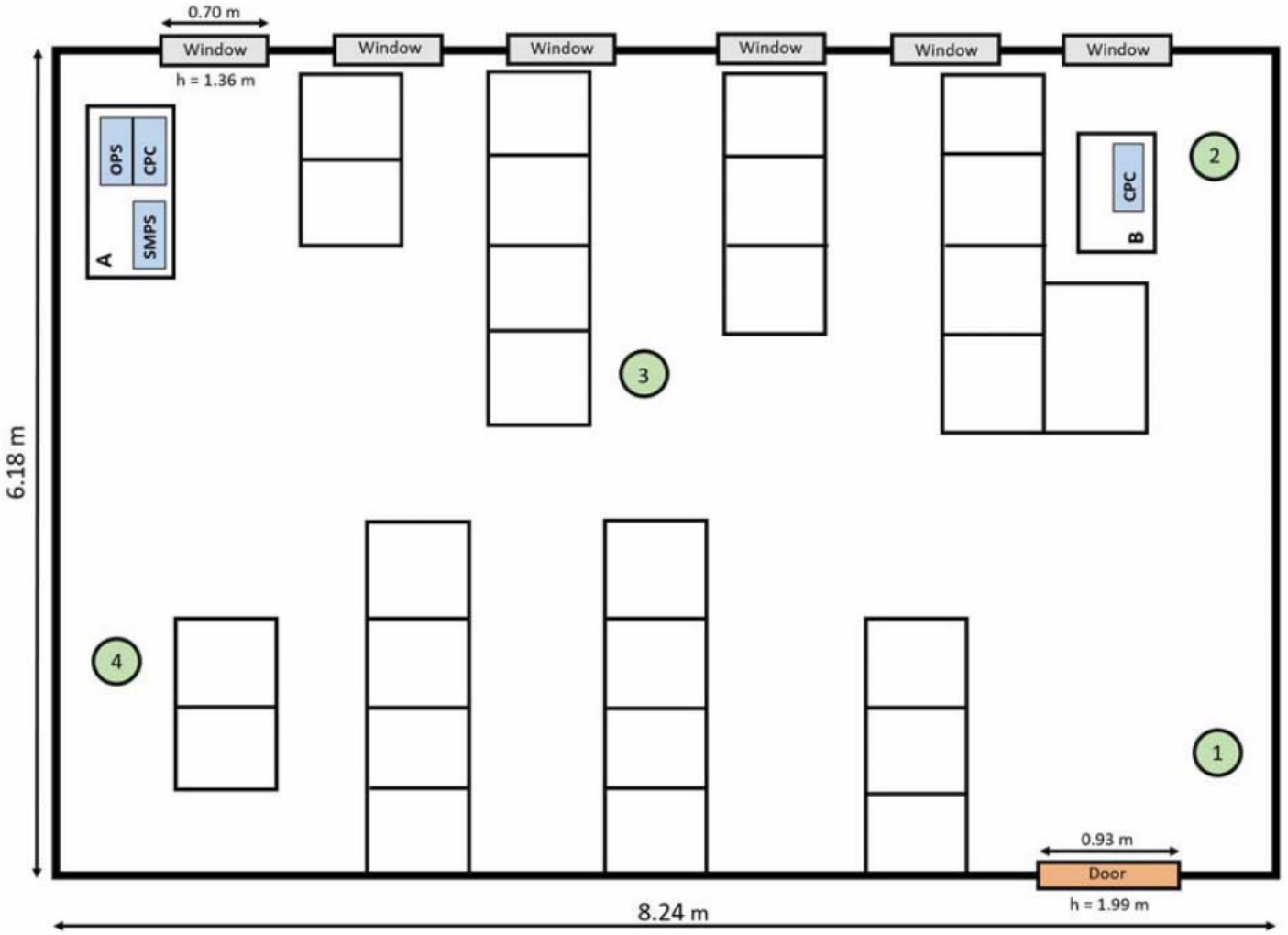
noise from fan settings:

setting2: 39 dB (143 ft^2)

setting3: 48 dB (197 ft^2)

“turbo”: 54 dB (280 ft^2)

room = 550 ft^2



recommended classroom background noise level: **30-40 dBA**

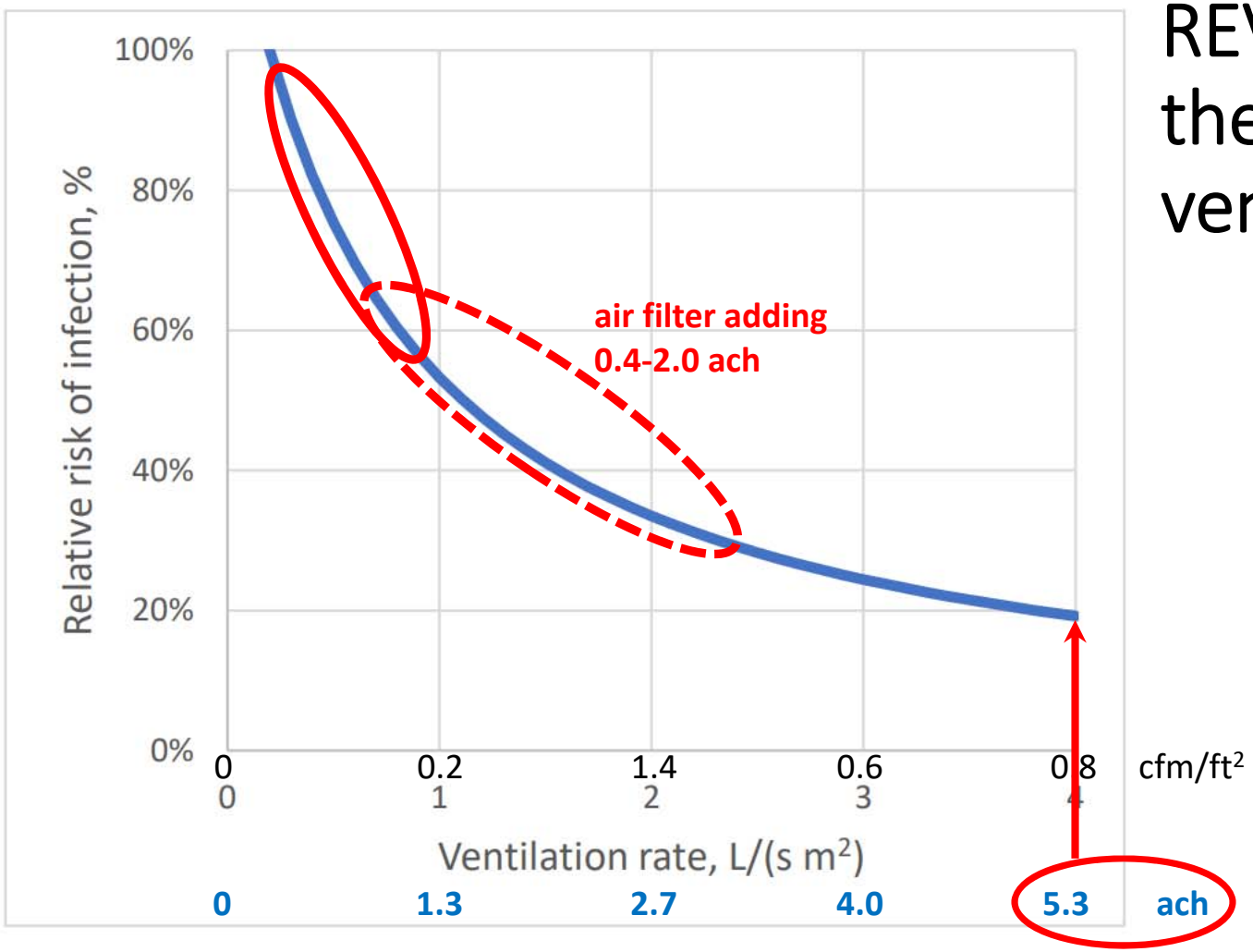
https://www.tandfonline.com/doi/full/10.1080/02786826.2021.1877257

Austin HealthMate HM400 Standard HEPA Air Purifier

(≈$800)

- refuses to provide **CADR** rating
- three speed control:
  - **400 cfm** on high setting,
  - 200 cfm on medium setting,
  - 75 cfm on low setting
- these flowrates are for when the filter isn't in the unit; with the filter installed: max **250 cfm** (or ≈**360 ft²**)
- sound levels:
  - **65 dB** at high speed, (≈ 360 ft²) ≈ 2.0 ach
  - 55 dB at medium speed, (≈ 180 ft²) ≈ 1.0 ach
  - <40 dB at low speed(≈ 70 ft²) ≈ 0.4 ach

recommended classroom background noise level: **30-40 dBA**

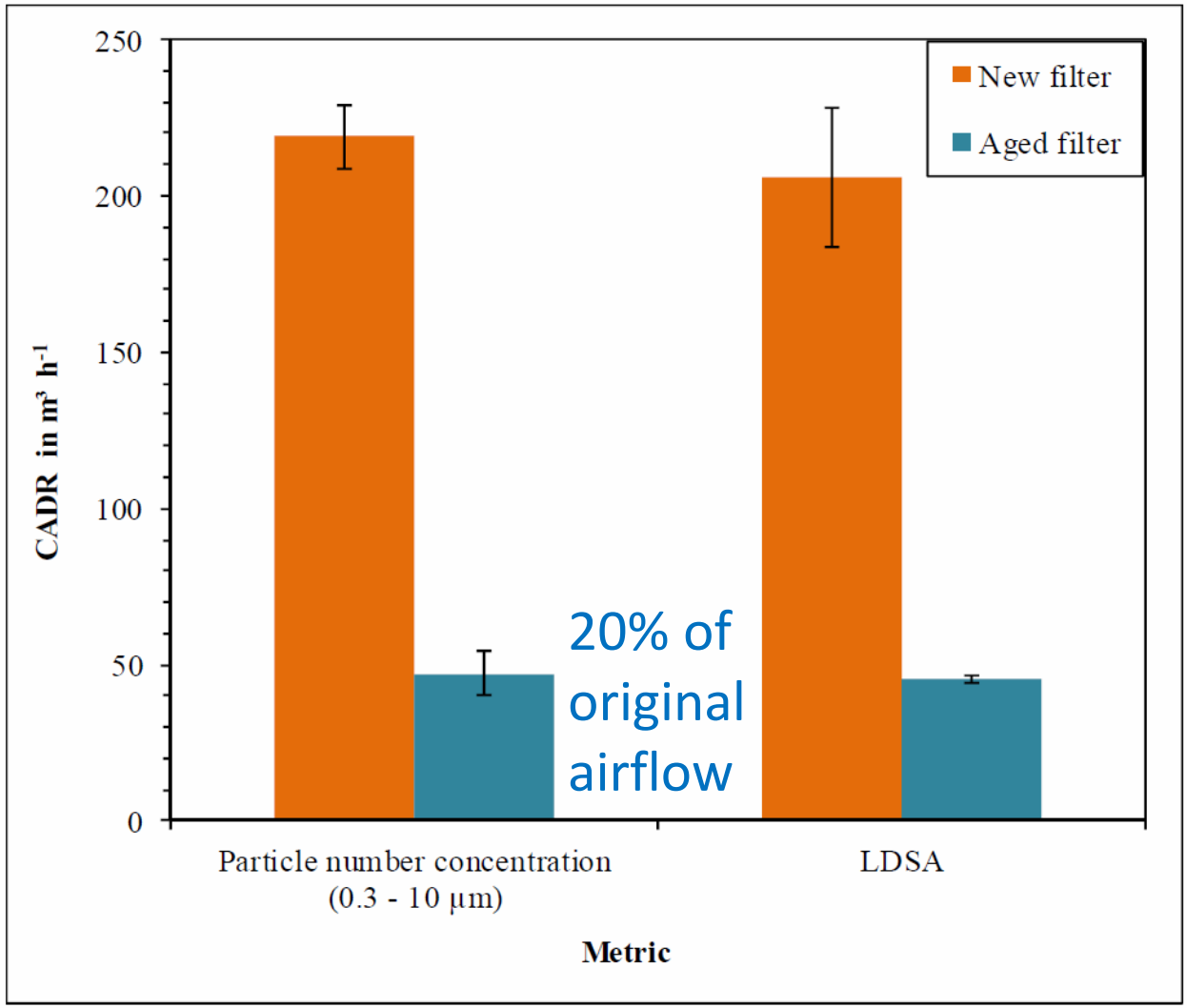


REVHA calculation of the risk of infection by ventilation rate:

for a classroom of: 805 ft^2 x 0.8 cfm/ft^2 (i.e., 4L/(s m^2)) = 644 cfm; or **5.3 ach**

Figure 7. Relative risk in open plan office of 50 m2 where 2 L/s per person (0.2 L/s per m2) ventilation rate is considered as a reference level for a superspreading event with 100% relative risk.

Aged filters



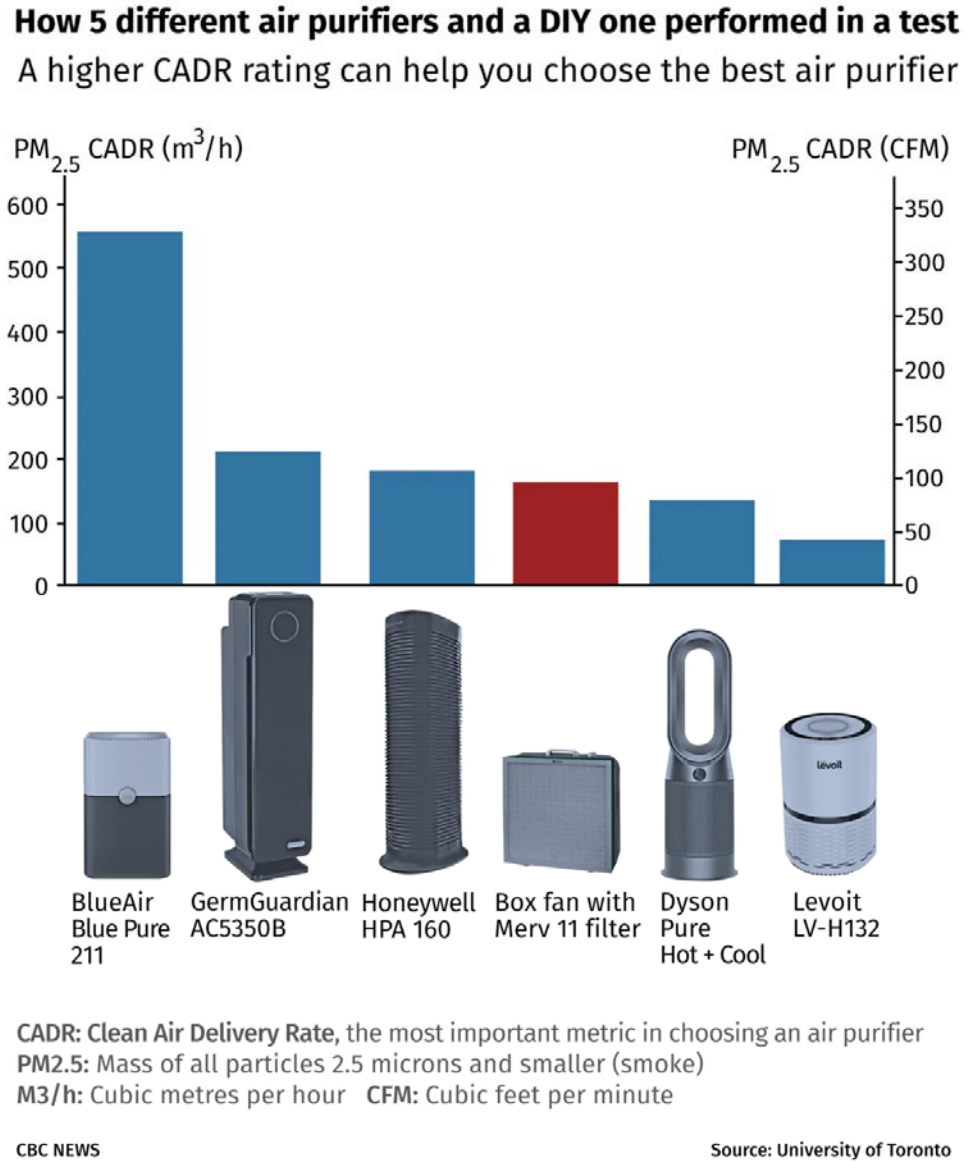
2do list: if you're getting into these units, make sure you do your homework (size & locate them properly) and take good care of them!

Fig. 3. Mean CADR (bars) with scatter (error bars) based on two different metrics for new and aged filters, n = 3, respectively.

https://aaqr.org/articles/aaqr-19-01-oa-0029.pdf

Make your own (DIY)

https://www.cbc.ca/news/business/portable-air-purifier-tests-marketplace-1.5900782



DIY air cleaner

https://www.texairfilters.com/a-variation-on-the-box-fan-with-merv-13-filter-air-cleaner/

https://www.texairfilters.com/how-to-improve-the-efficiency-of-the-box-fan-and-merv-13-filter-air-cleaner/

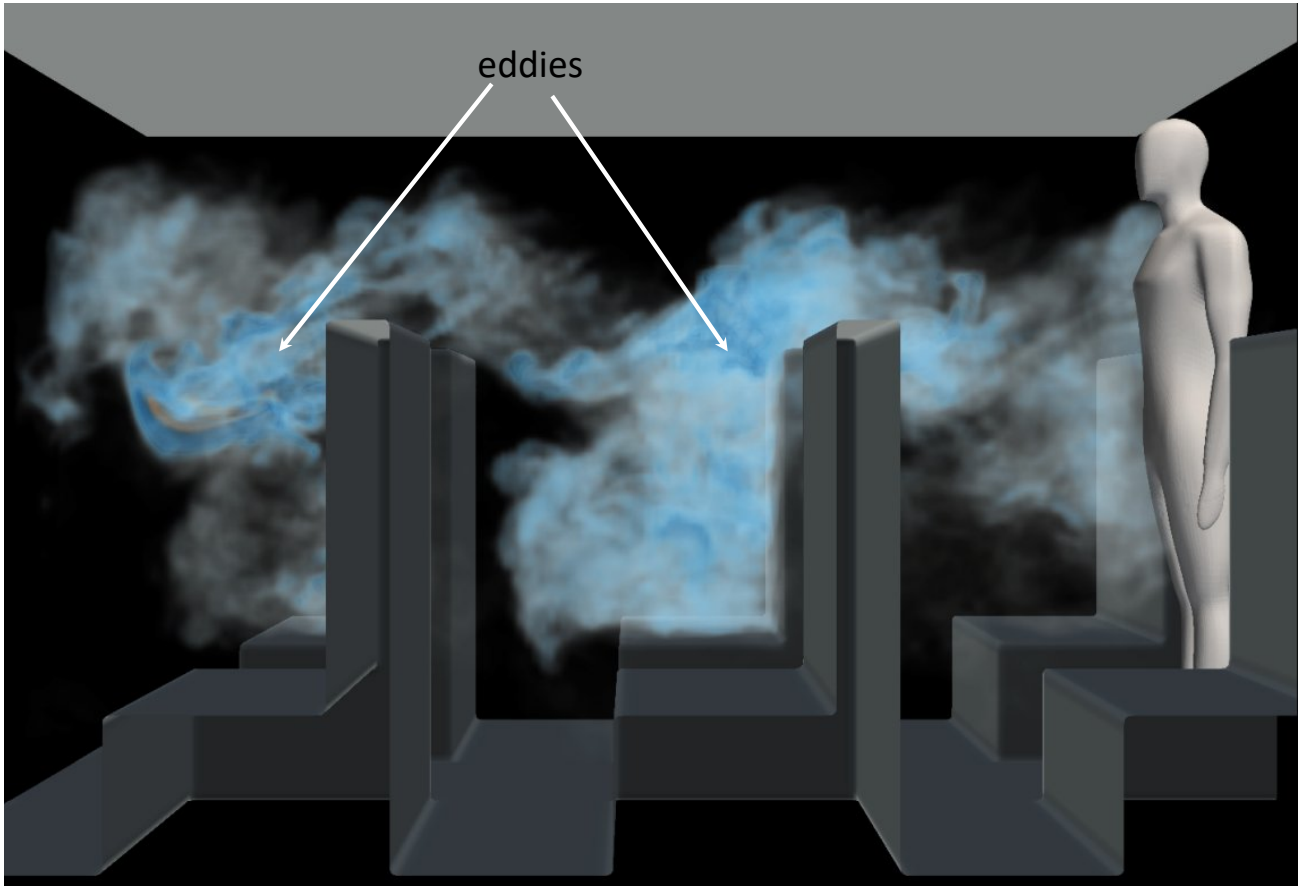
https://www.texairfilters.com/its-all-about-the-air-flow-through-the-filter/

five 20x20x2 MERV-11

What about plexiglass barriers?

Think of **cigarette smoke**:
– would a plexiglass barrier on a desk prevent you from smell the cigarette smoke if the person on the other side was smoking?

– actually interfere with designed air flow and trap emissions



https://twitter.com/VVuorinenAalto/status/1313841391999627265

Jeffrey Siegel (U of T) on UV systems & other technologies:

"A properly designed and maintained UV system, often in concert with filtration, humidity control, and airflow management, has been shown to reduce infections from other viruses. The details of the system are very important (e.g., design of fixtures, lamp type, lamp placement airflow amount and mixing, etc.). Simply adding UV to an existing system without consideration of these factors has not been demonstrated to have a benefit."

"Ionizers, ozone generators, plasma, and other air cleaning technologies; None of these technologies have been proven to reduce infection in real buildings, even if they have promise based on tests in a laboratory or idealized setting. Some of them have substantial concerns about secondary issues (such as ozone production)."

https://www.nafahq.org/covid-19-corona-virus-and-air-filtration-frequently-asked-questions-faqs/

What about the new variants?

- Increased transmissibility
- Investigations in Australia & New Zealand show transmission outside of “close contact” zone
- In the EU people are being asked to wear N95s in retail & mass transit

… makes the full spectrum of controls all the more important!

https://themunicheye.com/ffp2-masks-now-compulsory-on-public-transport-3913

With an N95 filtering facepiece respirator (FFR)...

...he has 1-10% inward leakage and outward leakage.

Workers need a fit-tested* respirator to prevent inhalation of infectious particles. Better respirators with higher protection factors should be used for high particle concentrations.

90-99%

With a surgical mask...

...he has 50% inward leakage and outward leakage

A surgical mask may be appropriate for patients to wear as source control. It does not provide adequate protection for workers from inhalable infectious particles.

50%

With a cloth face covering (Cloth FC)...

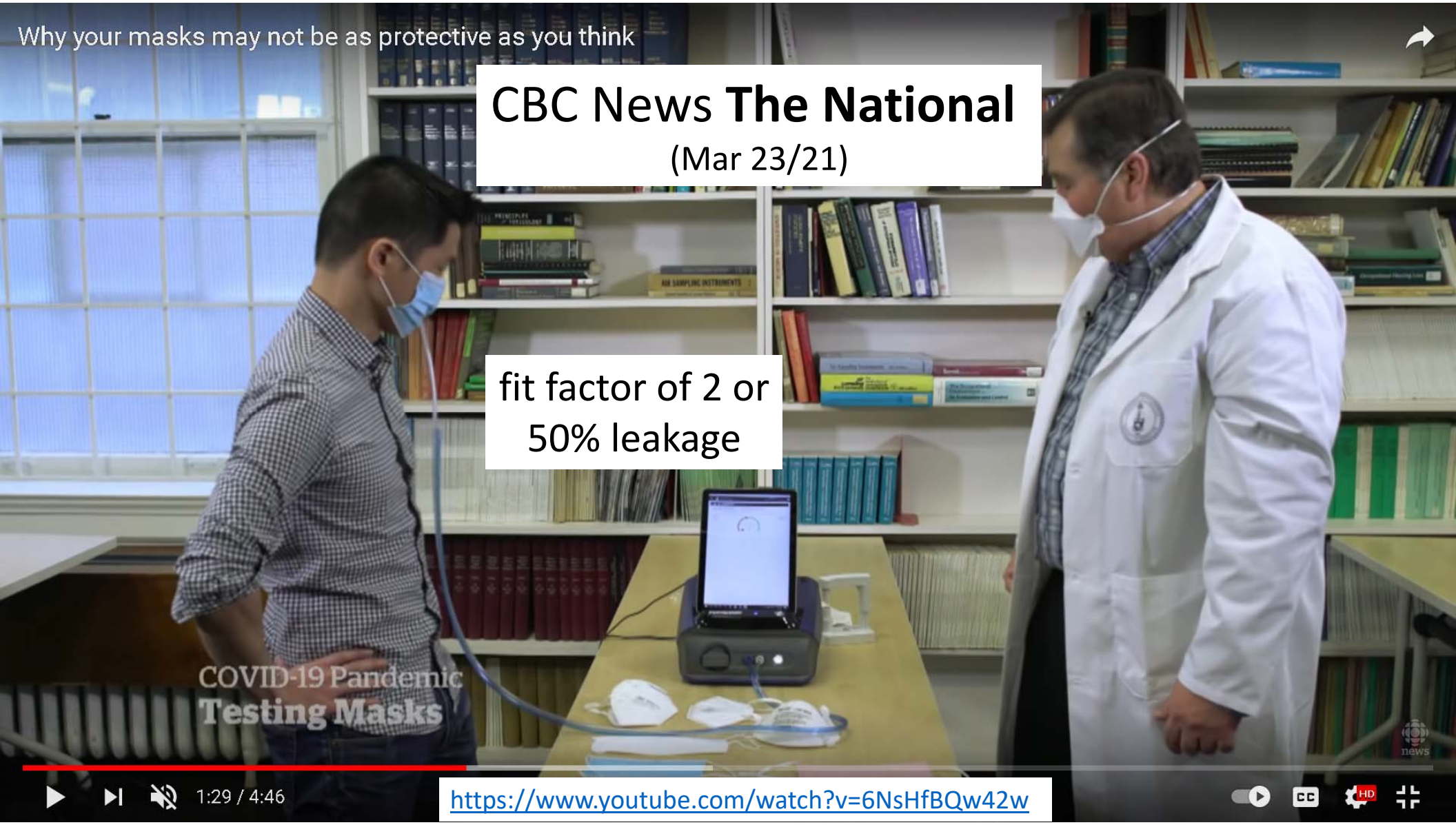
...he has 75% inward leakage and outward leakage.

A cloth face covering may be appropriate for the public to wear as source control, but they should limit proximity to others and time spent in an indoor space.

25%

https://www.acgih.org/covid-19-fact-sheet-worker-resp/

*N95 FFRs have an assigned protection factor of 10 (10% inward leakage) but must receive a fit factor of 100 (1% inward leakage) on an individual worker.


Why your masks may not be as protective as you think
CBC News **The National**
(Mar 23/21)
fit factor of 2 or
50% leakage
COVID-19 Pandemic
Testing Masks
1:29 / 4:46
https://www.youtube.com/watch?v=6NsHfBQw42w

… meanwhile in Ontario …

Masking Policy

« Go back to COVID-19 Information at UHN (/Covid19)

Why we're asking our patients, visitors and vendors to wear a mask

Updated Policy: Effective November 23, 2020

Everyone entering UHN must wear a medical mask. You will be given a mask by screening staff. If you are wearing a mask from home (including an N95 or K95 mask), screening staff will give you a medical mask to wear instead.

REHVA: Summary of practical measures for building services operation during an epidemic

1. Provide adequate ventilation of spaces with outdoor air
2. Switch ventilation on at nominal speed at least 2 hours before the building opening time and set it off or to lower speed 2 hours after the building usage time
3. Overrule demand-controlled ventilation settings to force the ventilation system to operate at nominal speed
4. Open windows regularly (even in mechanically ventilated buildings)
5. Keep toilet ventilation in operation at nominal speed in similar fashion to the main ventilation system
6. Avoid opening windows in toilets to maintain negative pressure and the right direction of mechanical ventilation air flows
7. Instruct building occupants to flush toilets with closed lid
8. Switch air handling units with recirculation to 100% outdoor air

https://www.rehva.eu/activities/covid-19-guidance/rehva-covid-19-guidance

REHVA: Summary of practical measures for building services operation during an epidemic

9. Inspect heat recovery equipment to be sure that leakages are under control
10. Ensure adequate outdoor air ventilation in rooms with fan coils or split units
11. Do not change heating, cooling and possible humidification setpoints
12. Carry out scheduled duct cleaning as normal (additional cleaning is not required)
13. Replace central outdoor air and extract air filters as normal, according to the maintenance schedule
14. Regular filter replacement and maintenance works shall be performed with common protective measures including respiratory protection
15. Introduce an IAQ (CO_2) sensor network that allows occupants and facility managers to monitor that ventilation is operating adequately

https://www.rehva.eu/activities/covid-19-guidance/rehva-covid-19-guidance

additional 2do list:

1. Make sure the fan setting on the thermostat is on “ON” and not on “AUTO”
2. Measure the air exchange rate (measure air flows directly or use CO_2 decay curves from data logging air quality monitoring machine in order to estimate ach)
3. Have a look inside your HVAC unit (do you want to breath the air that passes through this unit?)
4. Check to see if the filters fit snuggly (i.e., no way for the air to circumvent the filters)
5. If you’re going use portable air filters, make sure you do your homework (size & locate them properly) and take good care of them!
6. If you have natural ventilation (i.e., no forced air) use open windows and doors to get more air into the room and use fans to boost the airflow through these openings
   - Consider installing a forced air ventilation system this summer!

Occupational Health Clinics for Ontario Workers

Centre de Santé des Travailleurs(ses) de l'Ontario

Institute for Work & Health

Research Excellence Advancing Employee Health

Pandemic Experience by Healthcare, Education and other Workers Survey Results

John Oudyk, Peter Smith & Leonor Cedillo

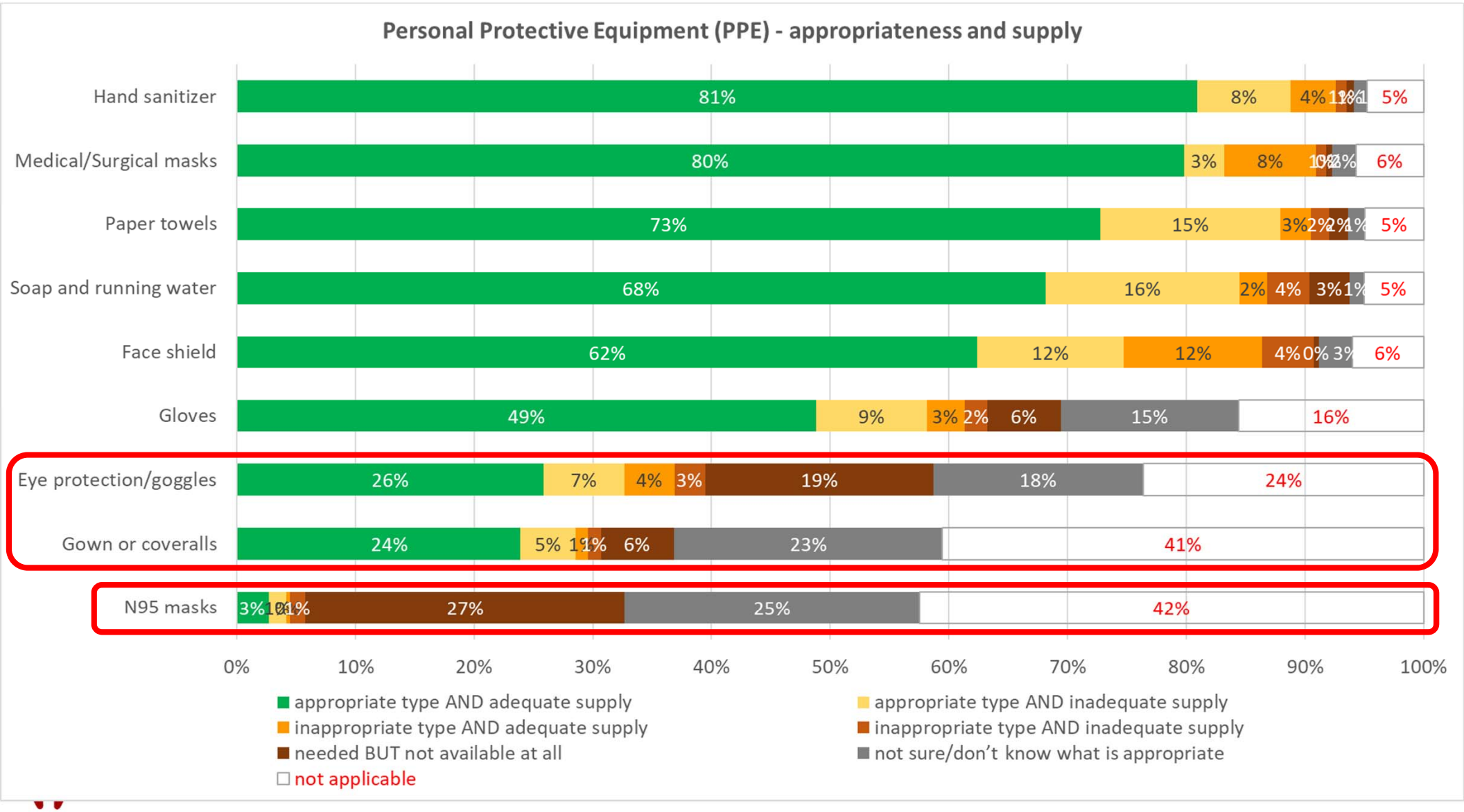
& the COVID-19 ad-hoc Survey Group

April 30, 2021

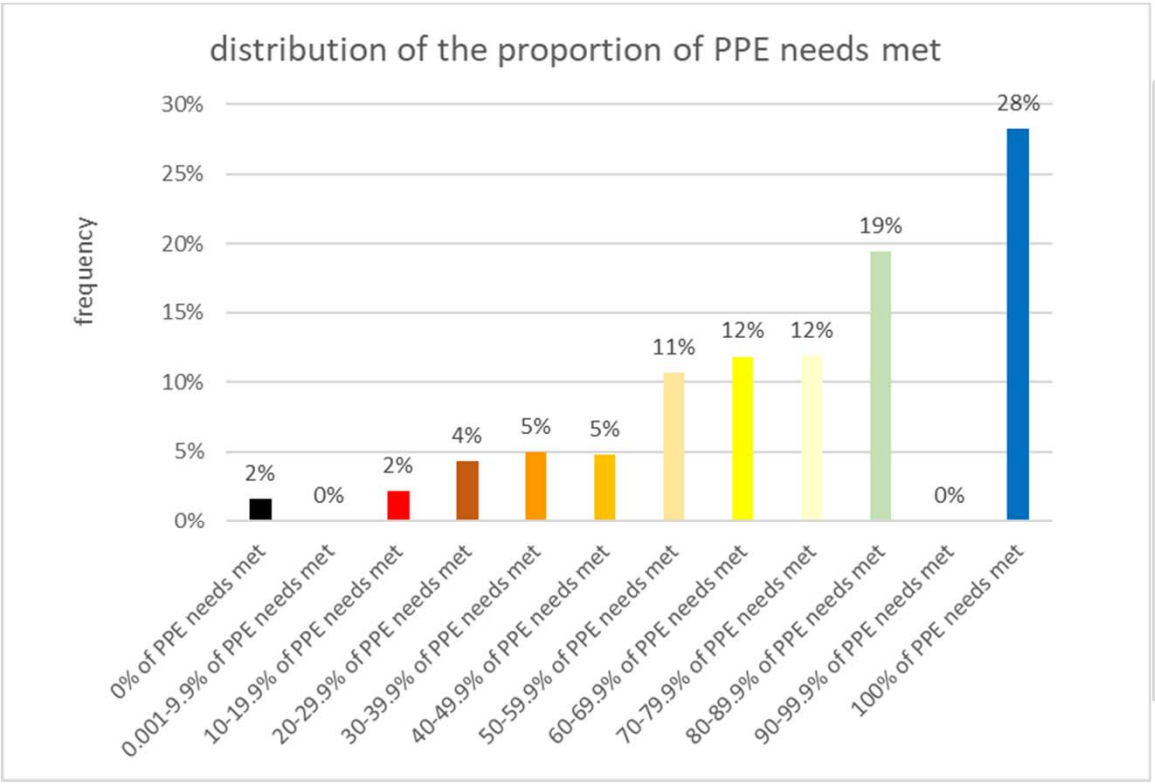
Personal protective equipment (PPE) supply and adequacy

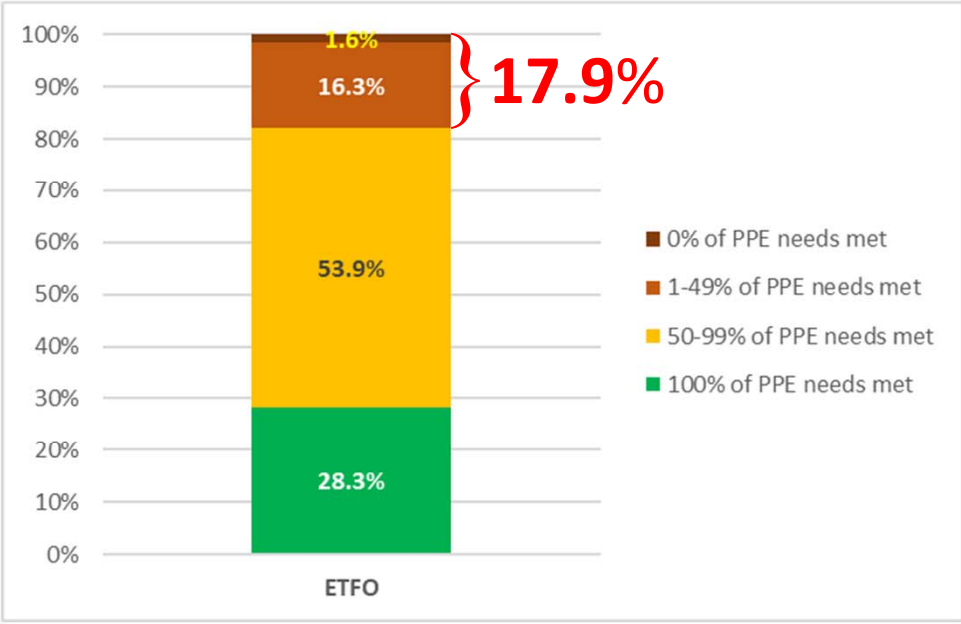
Appropriate type and adequate supply	Appropriate type but inadequate supply	Inappropriate type, but adequate supply	Inappropriate type and inadequate supply	Needed, but not available	Not sure/don't know what is appropriate	Not applicable
Type of PPE is needed					**Type of PPE is not needed**	
Needs Met	**Needs not Met**	**Needs not Met**	**Needs not Met**	**Needs not Met**	**Not Applicable**	

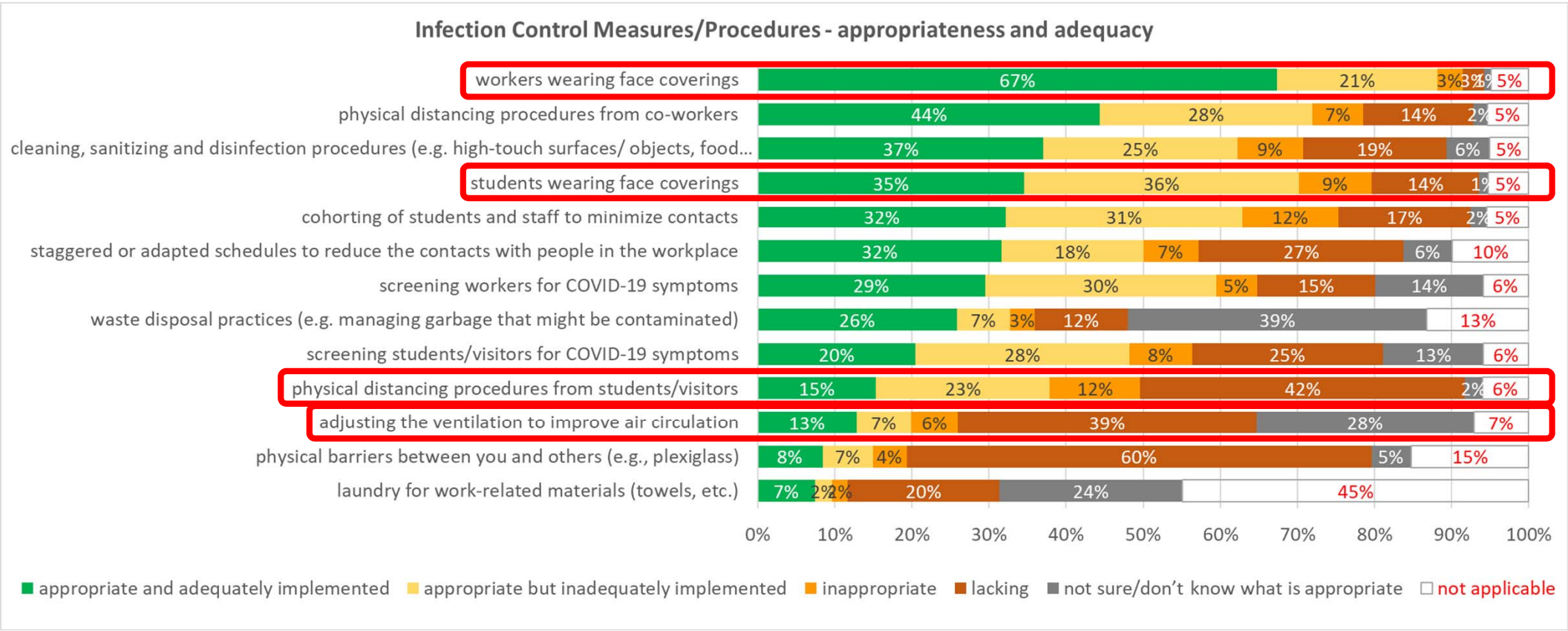
(1) hand sanitizer; (2) surgical or medical masks; (3) paper towels; (4) soap & running water; (5) face shield; (6) Gloves; (7) Eye protection/goggles; (8) gown or coveralls; (9) N95 masks;


Personal Protective Equipment (PPE) - appropriateness and supply
Hand sanitizer
81%
8%
4%
5%
Medical/Surgical masks
80%
3%
8%
6%
Paper towels
73%
15%
5%
Soap and running water
68%
16%
5%
Face shield
62%
12%
12%
6%
Gloves
49%
9%
16%
Eye protection/goggles
26%
7%
4%
3%
19%
18%
24%
Gown or coveralls
24%
5%
6%
23%
41%
N95 masks
27%
25%
42%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
appropriate type AND adequate supply
appropriate type AND inadequate supply
inappropriate type AND adequate supply
inappropriate type AND inadequate supply
needed BUT not available at all
not sure/don't know what is appropriate
not applicable

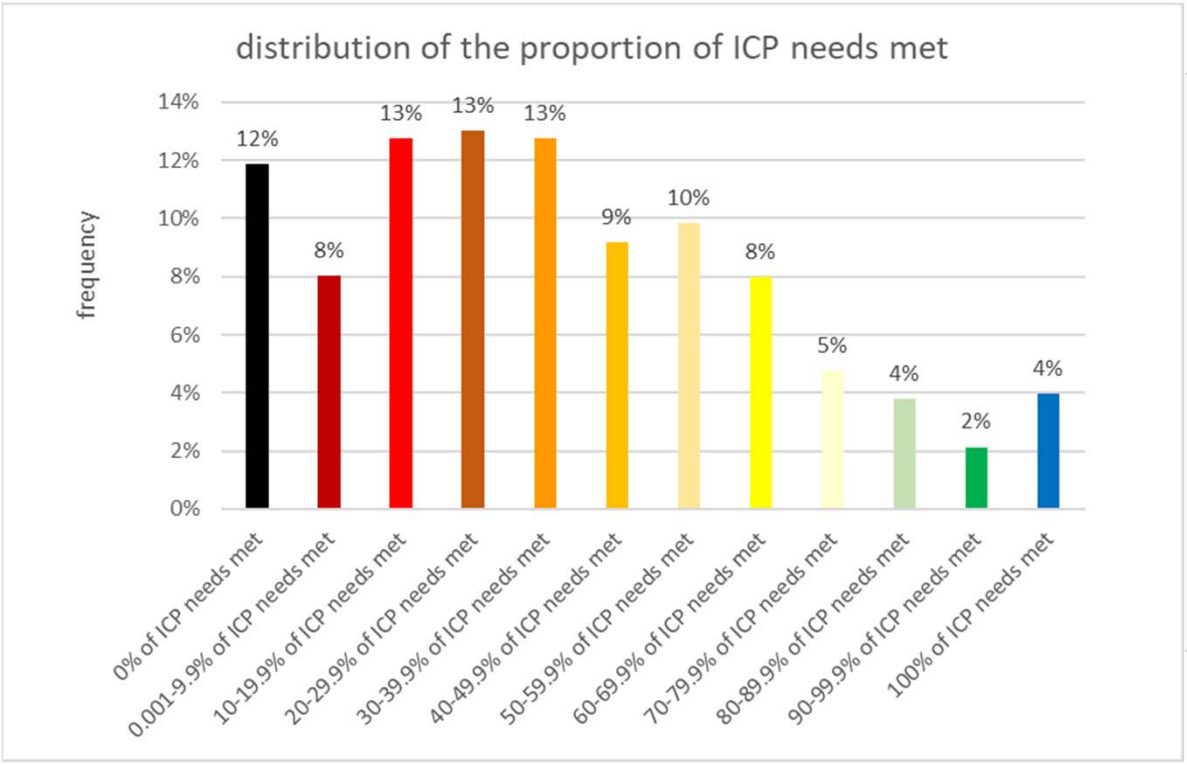
Perceived adequacy of PPE among in-person (n = 4,001)

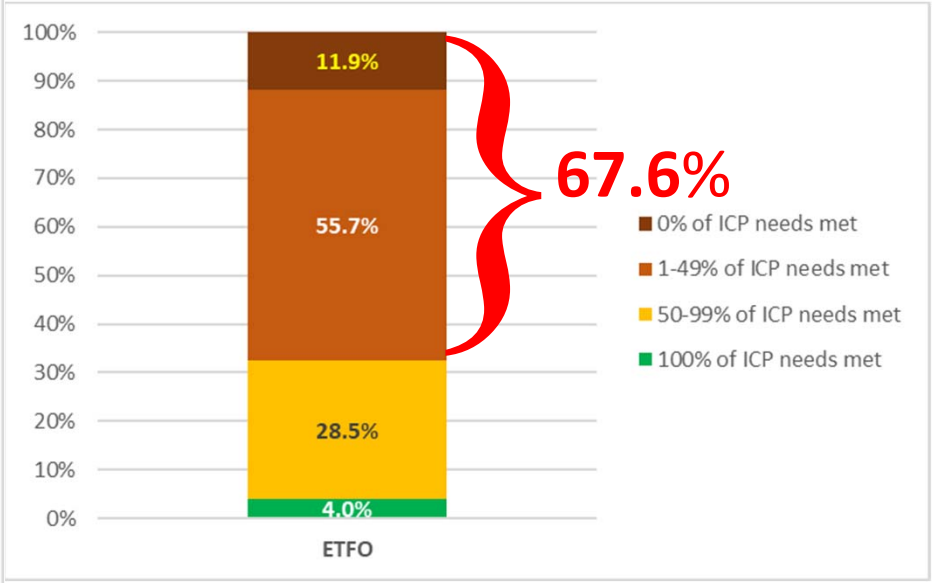




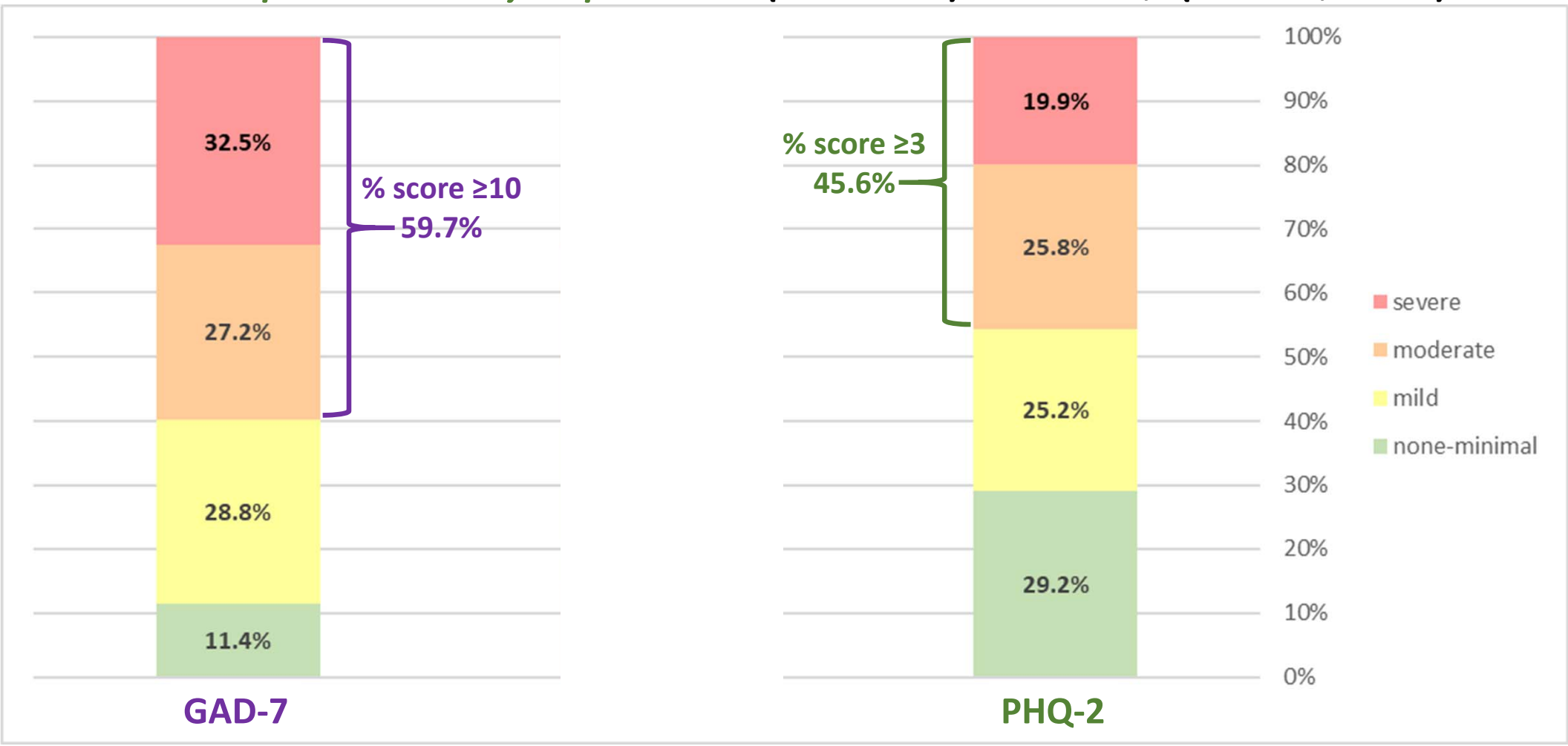

Infection Control Measures/Procedures - appropriateness and adequacy
workers wearing face coverings
67%
21%
3%
3%
5%
physical distancing procedures from co-workers
44%
28%
7%
14%
2%
5%
cleaning, sanitizing and disinfection procedures (e.g. high-touch surfaces/ objects, food...
37%
25%
9%
19%
6%
5%
students wearing face coverings
35%
36%
9%
14%
1%
5%
cohorting of students and staff to minimize contacts
32%
31%
12%
17%
2%
5%
staggered or adapted schedules to reduce the contacts with people in the workplace
32%
18%
7%
27%
6%
10%
screening workers for COVID-19 symptoms
29%
30%
5%
15%
14%
6%
waste disposal practices (e.g. managing garbage that might be contaminated)
26%
7%
3%
12%
39%
13%
screening students/visitors for COVID-19 symptoms
20%
28%
8%
25%
13%
6%
physical distancing procedures from students/visitors
15%
23%
12%
42%
2%
6%
adjusting the ventilation to improve air circulation
13%
7%
6%
39%
28%
7%
physical barriers between you and others (e.g., plexiglass)
8%
7%
4%
60%
5%
15%
laundry for work-related materials (towels, etc.)
7%
2%
2%
20%
24%
45%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
appropriate and adequately implemented
appropriate but inadequately implemented
inappropriate
lacking
not sure/don't know what is appropriate
not applicable

Perceived adequacy of ICP among in-person (n = 4,035)

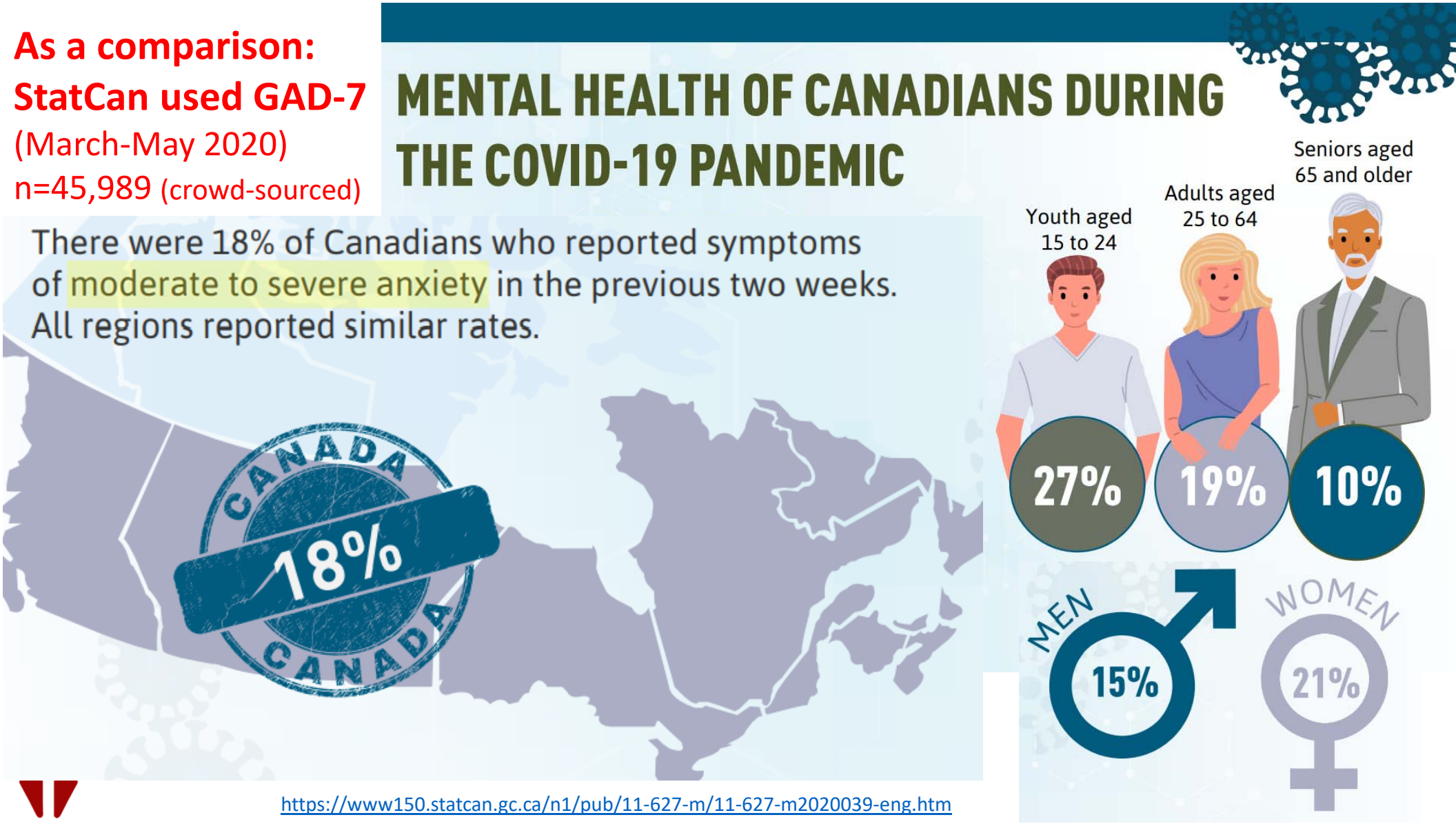




Distribution of *anxiety symptoms* (GAD-7) & *depressive symptoms* (PHQ-2) scores; (n = 5,314)

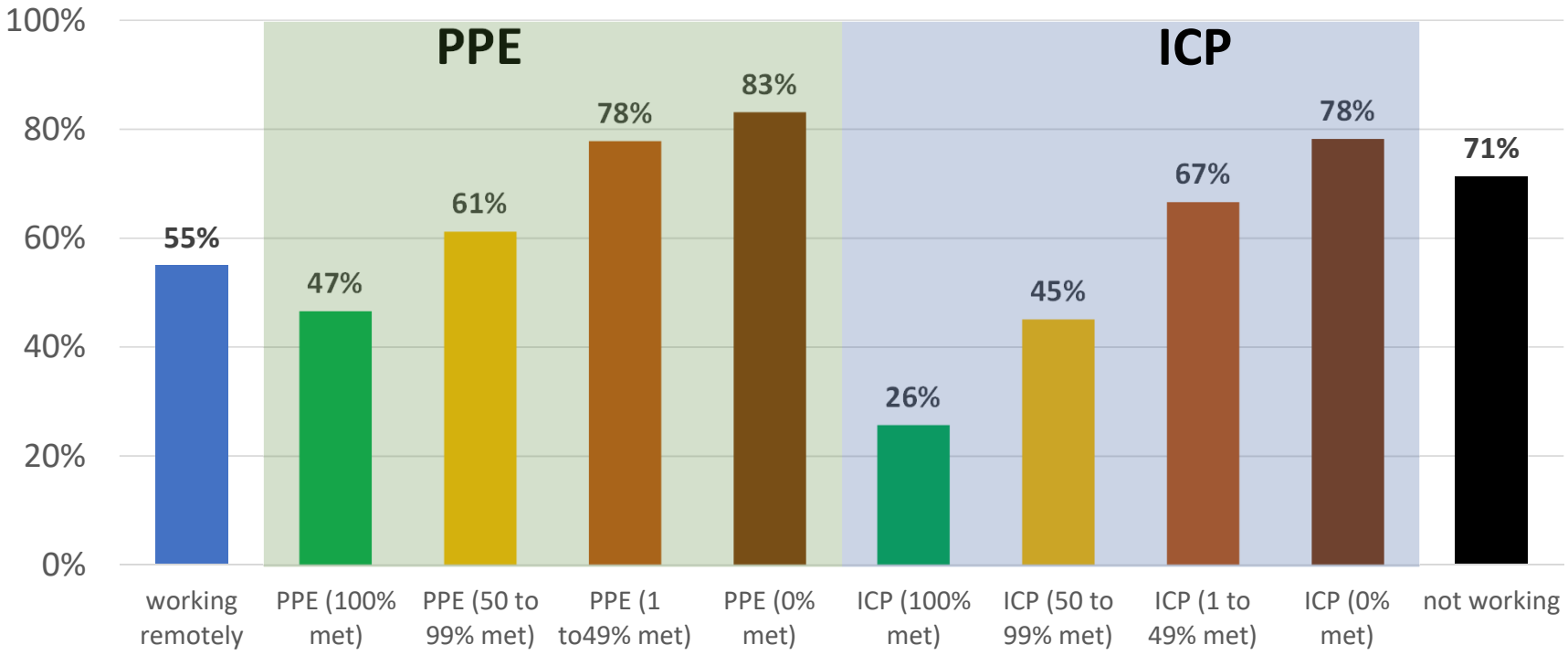


As a comparison:
StatCan used GAD-7
(March-May 2020)
n=45,989 (crowd-sourced)



https://www150.statcan.gc.ca/n1/pub/11-627-m/11-627-m2020039-eng.htm

Unadjusted proportion of sample with anxiety (GAD-7) scores 10 and over by PPE needs met, ICP needs met



https://journals.sagepub.com/doi/full/10.1177/0706743720961729

Canadian Psychiatric Association
Association des psychiatres du Canada

Original Research

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The Association between the Perceived Adequacy of Workplace Infection Control Procedures and Personal Protective Equipment with Mental Health Symptoms: A Cross-sectional Survey of Canadian Health-care Workers during the COVID-19 Pandemic

L'association entre le caractère adéquat perçu des procédures de contrôle des infections au travail et de l'équipement de protection personnel pour les symptômes de santé mentale. Un sondage transversal des travailleurs de la santé canadiens durant la pandémie COVID-19

Peter M. Smith, PhD[1,2,3], John Oudyk, MSc[4], Guy Potter, PhD[5], and Cameron Mustard, ScD[1,2]

Annals of Work Exposures and Health, 2020, 1–11
doi: 10.1093/annweh/wxaa119
Original Article

Original Article https://academic.oup.com/annweh/advance-article/doi/10.1093/annweh/wxaa119/6032759

Labour Market Attachment, Workplace Infection Control Procedures and Mental Health: A Cross-Sectional Survey of Canadian Non-healthcare Workers during the COVID-19 Pandemic

Peter M. Smith[1,2,3*], John Oudyk[4,5], Guy Potter[6], Cameron Mustard[1,2] on Behalf of Members of the Ad Hoc Pandemic Survey Group

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Thanks for your time and attention!