

# Improving Ventilation Cleaning the air at work

## Ventilation is not just for Covid but for Healthy Working Life

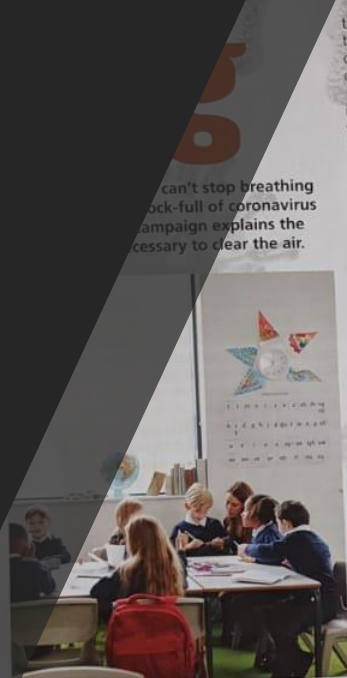
- Covid has exposed but not caused poor ventilation at work
- Harm of dirty air - we work and live in toxic soup of chemicals + inhale most of them via the air
- Benefits of better ventilation + cleaner air = better health, less sickness
- What is ventilation – air flow, CO2 can act as proxy measurement
- Employers' legal duties and minimum standards on general ventilation, competence etc
- Holding employers to account, questions to ask, challenging, monitoring, standards to demand
- What we want – clean air that won't make us ill, the best health-based standards:

It is our right to breathe clean air at work

@hazardscampaign [info@hazardscampaign.org.uk](mailto:info@hazardscampaign.org.uk)

[hilda@gmhzards.org.uk](mailto:hilda@gmhzards.org.uk)

**HAZARDS  
CAMPAIGN**



the air for seconds to hours, often after the infected person has left. They fall out of the air, are deposited on surfaces and can be recirculated by air currents.

Virus concentrations can build up in indoor areas that are poorly ventilated, where workers breathe shared air for hours at a time.

Aerosols persist longer in colder, drier air, an added occupational risk in jobs like food processing (page B).

Face masks can help, but good ventilation is critical to reducing the viral load in the air. Lower loads reduce the risk of infection and the severity of infection.

Effective ventilation removes stale air and brings in cooler, drier air containing more oxygen, less carbon dioxide (CO<sub>2</sub>) and water vapour and fewer microbes.

The concentration of carbon dioxide in indoor air is a useful indication of how well the ventilation is functioning.

Carbon dioxide increases from 0.04 per cent to 4 per cent in exhaled breath. Outside air contains 300-400 parts per million (ppm) carbon dioxide near ground level.

Indoor air at 600 to 800 ppm carbon dioxide indicates a relatively well-ventilated room. Over 1,500 ppm means very poor ventilation and action is needed. A minimum of six air changes per hour is recommended.

There is no one silver bullet that is 100 per cent effective to prevent infection from coronavirus in near- and far-field aerosols. But a combination of good ventilation, 2 metre minimum distancing and PPE all contribute to overall protection.

### UK rules on ventilation

An infectious person may exhale 100,000 to 10 million virus particles an hour, so effective ventilation is essential to infection prevention. UK guidance was slow to recognise this.

It was as recently as 26 November 2020 when the UK business department BEIS issued updated workplace guidance, with an 'objective' recommending "ventilation to mitigate the transmission risk of Covid-19."

The BEIS guide notes: "Good ventilation can be different for areas depending on how many people are in there, how the space is being used, and the particular layout of the area. Therefore you will need to consider the particular ventilation requirements in the area you are considering."

"Ventilation and air conditioning during

the coronavirus (Covid-19) pandemic', an HSE guide published in December 2020, notes: "Good ventilation, together with social distancing, keeping your workplace clean and frequent hand-washing, can help reduce the risk of spreading coronavirus."

The Workplace (Health, Safety and Welfare) Regulations lays down the legal ventilation requirements at work. The regulations note: "Effective and suitable provision shall be made to ensure that every enclosed workplace is ventilated by a sufficient quantity of fresh or purified air."

"The fresh-air supply rate should not normally fall below 5 to 8 litres per second, per occupant. When establishing a fresh-air supply rate, consider the following factors: the floor area per person; the processes and equipment involved; whether the work is strenuous." HSE references technical guidance from the building services professional body, CIBSE.

An October 2020 CIBSE update recommends a minimum of 10 litres per second per person of outside air in offices and avoiding recirculating air. That's your benchmark.

### Assessing the risks

Ventilation systems can be as simple as opening windows and doors to complex centralised Heating Air Conditioning Ventilation systems (HACV).

Find out the type of ventilation system in your workplace, how well it is performing in removing stale shared air and bringing in fresh air.

The employer should provide safety reps with information about the workplace ventilation system – is it providing the recommended air flow, is it maintained properly, are the correct filters in use and replaced and maintained frequently?

Ask for monitoring and maintenance data, including CO<sub>2</sub> levels.

Workplace risk assessment must consider all the factors affecting the risk of inhaling near- and far-field aerosols. Key factors to consider are:

- **Location:** Outdoors less risk, indoor workplaces higher risk, increasing with factors below.
- **Occupancy:** Halving occupancy is equivalent to doubling the ventilation rate. Remember, though, that aerosols can linger for minutes or hours, so previous occupancy levels may create lingering risk.
- **Infection levels:** Research suggests that around half of coronavirus transmission could be from people with no symptoms (asymptomatic).
- **Proximity:** 2 metres physical distancing is a rough minimum distance to avoid inhaling high concentrations of near-field aerosols or being sprayed with droplets.

### REDUCING THE RISKS

Follow the hierarchy of prevention. In order of priority, utilise:



Visible particles  
of dust, droplets

Over 100 microns  
cannot be inhaled

## The elephant of air pollution in workplace room

A toxic soup of substances from the air outside, the building itself, from the work activity, and from the people in the room (bioeffluents). Gases, fumes, particles, biological agents. Very poor ventilation, high CO2 and pollutant levels.

Carcinogens, Mutagens, Reprotoxins, Endocrine Disrupting Chemicals (EDCs), Allergens/Asthmagens, Irritants, Sensitisers, Volatile Organic Compounds, Vehicle fumes, Respiratory aerosols, Cleaning chemicals, Pesticides, Solvents, Personal Care products, Biological agents - viruses bacteria, fungal spores, pollen, animal dander.

Particles – micro and nanoparticles of plastic, carbon, metals etc

Invisible particles + aerosols  
+ gases

100 microns and below can  
be inhaled into body – nose,  
mouth throat

Below 10 microns gets into  
the lung

Below 2.5 microns gets  
deep into lung alveoli air  
sacs and can be absorbed  
into blood system and taken  
all round body to all cells  
and organs

WHO: no safe level of PM2.5

Size matters: A micron,  $\mu\text{m}$  = 1 thousandth of millimetre, 1 millionth of metre.

<https://economictimes.indiatimes.com/magazines/panache/air-pollution-may-increase-covid-severity-even-in-fully-vaccinated-patients-says-study/articleshow/94580720.cms>

# We live and Work in a Toxic Soup:

- Polluted air contains MERCs- Mutagens, Endocrine Disrupting Chemicals, Reproductive toxins + Carcinogens in ppm, ppb+ pptillion,+PM 2.5 microns and below. No cell or organ unaffected
- Not all ill-health effects of chemicals are known; synergistic, additive and cumulative effects – Multiple exposures at home, in environment and at work, so need Precautionary Principle
- Use LAW+ organise collective action: SRSC Regs, HASAW Act, COSHH Regs. Management Regs to tackle HSE Work Exposure Limits, WELs, where set, are not health based, neither are ventilation levels
- TUC approach – safest level of CHEMICAL EXPOSURE IS ZERO No Toxic Substance/Hazard = No RISK
- INEQUALITY -We don't all breathe the same air – lower paid you are, more likely to live in polluted area, travel to + work in more polluted air+ your children to go to school in most polluted areas than higher paid richer people
- Polluted air causes or makes other conditions worse eg asthma, COPD, Covid:  
<https://economictimes.indiatimes.com/magazines/panache/air-pollution-may-increase-covid-severity-even-in-fully-vaccinated-patients-says-study/articleshow/94580720.cms>
- SEX/GENDER ISSUES – research + WELS set for men, hormonal, reproductive issues, double and triple exposures, exposure of mother affects foetus and developing eggs; of father affects sperm
- [Documentary | Unbreathable: The Fight for Healthy Air https://www.unbreathable.org/](https://www.unbreathable.org/)
- Toxic Use Reduction, TUR, approach based on hazard class not risk assessment. **We need to get toxic substances out of our workplaces, out of products we make, out of our air, water, soil and food, out of our homes, our bodies and our lives.** [Toxic Chemicals - Risk prevention through use reduction – YouTube https://www.youtube.com/watch?v=5jWY6PGiNb0](https://www.youtube.com/watch?v=5jWY6PGiNb0)
- Link workplace H+S with wider environmental air pollution movement, reducing traffic, wood, fossil fuel burning, Climate Change+ Plastic Pollution see Trade Union Clean Air Network Air Pollution All in a Day's Work? <https://drive.google.com/file/d/1nUlfHf7TN658qgoInL9mqDMhm03rOmev/view?usp=sharing>

# Ventilation – what is it and what is it good for?

- **Air flow** – from outside into building. NATURAL Ventilation - via windows/ doors trickle vents/ brick /grills. MECHANICAL HVAC–via Heating Ventilation Air Conditioning systems by fans, ducts, vents, filters
- **Ventilation cleans the air** –by diluting, dispersing and removing stale air containing pollutants and higher level of carbon dioxide,CO<sub>2</sub>, warm and humid – replacing with cleaner, cooler, drier air, less pollutants and CO<sub>2</sub> and more Oxygen – only true if outdoor air is clean not polluted
- **Outdoor air becomes indoor air**, with all the traffic and other pollutants it contains unless filtered in mechanical Heating Ventilation+ Air Conditioning Systems – HVAC
- **Indoor air = \*outdoor air + its pollutants PLUS** any other harmful chemical/substance that arise from: **\*the work activity itself \* the buildings \* fixtures and fittings \* the people inside** - viruses, bacteria in their exhaled air, skin cells plus pathogens, + Volatile Organic Compounds, VOCs, from personal care product, Particulate Matter, PM, eg micro plastics from clothing
- **Harmful substances get into our bodies by Ingestion/eating, skin absorption and inhalation - Inhalation is biggest exposure route:**

Anything in air 100micron diameter+below can be inhaled, PM 2.5 microns gets deep in lungs.

Spend 90% of time indoors + indoor air can be 2-5 x more polluted than outdoor air

We drink few litres of water but breathe about 11,000 litres of air a day, cannot choose when and where to breathe

**So reducing pollutants/improving air quality at work protects our health**

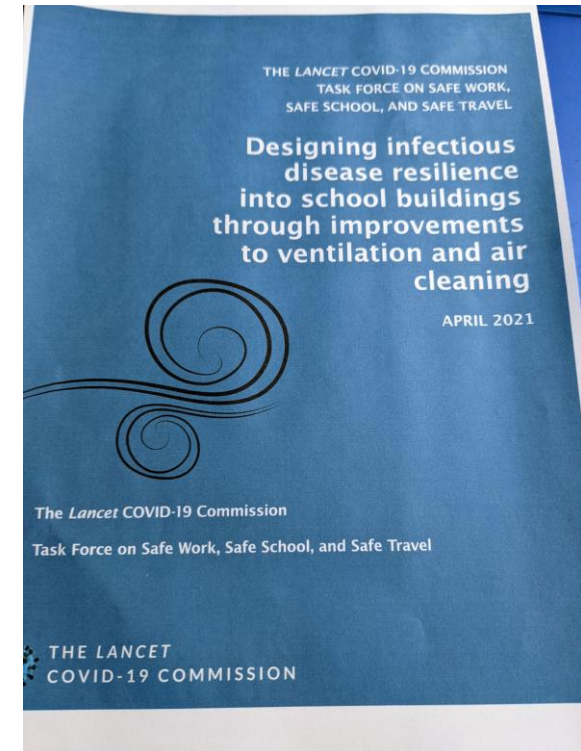
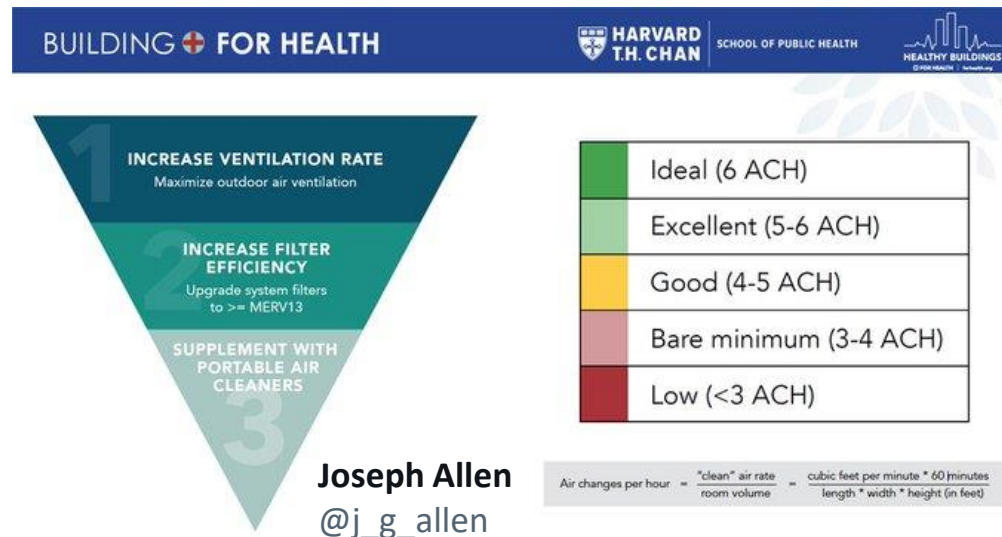
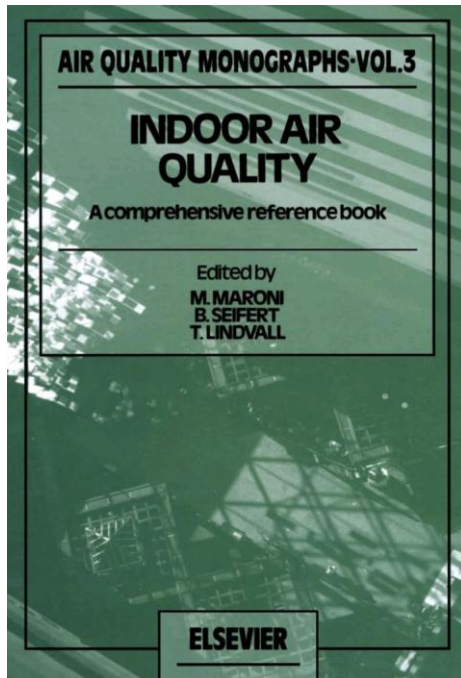
# Ventilation standards generally + to reduce risk of inhaling Covid

- **Ventilation** measured in litres per person per second, l/p/s, or cubic metres/m<sup>3</sup> per person per hour (l/p/s x 3.6 = m<sup>3</sup> per person per hour) + also in room Air Changes per Hour, ACH.
- **HSE 'Workplace (Health, safety and welfare) at work' Regulations covers general ventilation (LEV covered in COSHH)** <https://www.hse.gov.uk/pubns/books/l24.htm> *'Regulation 6 Ventilation: (1) Effective and suitable provision shall be made to ensure that every enclosed workplace is ventilated by a sufficient quantity of fresh or purified air.'*  
**Guidance - minimum 5-8 l/p/s fresh or purified air but CIBSE** (Chartered Institute of Building Services Engineers) **rec. for COVID in classrooms/offices is min of 10 l/p/s minimum or 36 m<sup>3</sup> per person per hour**
- **WHO Recommends 6 ACH**, some experts say 9 or 10 ACH. **More for strenuous work**
- 1 Air Change per Hour takes 3 hours to remove 95% pollutant but 6 ACH only takes ½ hour/all air in room replaced every 10 minutes
- **More ventilation/air flow the better** to remove stale air/Covid/pollutants = lower risk of inhalation but thermal comfort important too so use filtration as well as ventilation
- **Fewer people = more fresh air per person**, half number of people in room = 2x as much ventilation per person; bigger room= more air per person.
- **CO2 level is a rough proxy for ventilation: 600-800ppm = well ventilated room**

Despite Building and other regulations, standards from CIBSE, REHAVA, ASHRAE etc we have had Sick Building Syndrome, workers, safety reps and union complaints/struggles of ill health associated with poor workplace ventilation over decades, little support from engineers or the HSE.

Ventilation standards - Not related to the health of workers. More recent work trying to focus on health and buildings

"Because of the usual division of responsibility and authority in organizations occupying buildings, the relationship between these costs (*to workers health*) is not often considered." "It was pointed out that, in any building, the cost of losses in productivity due to absenteeism and restricted activity far exceeds the total cost of operating and maintaining the heating, cooling and ventilation systems." circa 1995 Indoor Air Quality



**Better ventilation must be for life not just for Covid**

Dr Richard Corsi US IAQ specialist : 'I do not believe aiming for 4 or 6 ACH in schools or other indoor spaces is sufficiently aspirational & have written about how a combo of increased outdoor air supply and use of #CorsiRosenthalBoxes can get us close to 10 equivalent ACH in classrooms'

# Lots of new research on healthier buildings to reduce Covid, infections and improve health

The *Lancet* COVID-19 Commission Task Force  
on Safe Work, Safe School, and Safe Travel

## The First Four Healthy Building Strategies Every Building Should Pursue to Reduce Risk from COVID-19

JULY 2022

1. Commission or Recommission Building HACV systems to take account of infectious diseases
2. Maximise outdoor air intake 10 litres per person per second and 6 Air Changes per hour minimum
3. Upgrade Air Filters to Minimum Efficiency Reporting Value, MERV 13
4. Supplement with Portable Air Cleaners where needed

# Better ventilation and cleaner air is proven to have many beneficial cognitive and overall health benefits

Table 1. Additional benefits of higher ventilation and improved air quality in schools beyond airborne infectious disease transmission.

Impact of Ventilation	Context	Findings	Reference
↑ Test scores	Ventilation renovations were completed to improve IAQ in all school buildings within a single Texas school district.	Math and reading test scores significantly improved, with an increased probability of passing by 2% and 3%, respectively.	42
↑ Cognitive function	CO <sub>2</sub> concentrations were measured as a proxy for ventilation rates in classrooms.	Cognitive testing of students shows a 5% decrease in 'power of attention' in poorly ventilated classrooms. Researchers equate this to the effect of a student skipping breakfast.	38
↑ Math, reading, and science scores	Classroom ventilation rates were measured in 140 fifth grade US classrooms.	Mean mathematics scores increased by up to 0.5% per each liter per second per person increase in ventilation rate, with similar effects on reading and science scores.	43
↓ Asthma symptoms	Exposure factors were measured in 100 primary and secondary school classrooms with and without new ventilation systems.	Pupils who attended schools with new ventilation systems reported fewer asthmatic symptoms.	44
↓ Respiratory symptoms	Over 4,000 sixth graders from 297 schools participated in a survey of indoor environmental quality in schools.	Lower ventilation rates, moisture, and dampness were all independently associated with a higher incidence of respiratory symptoms. Inadequate ventilation was also associated with more missed school days.	45
↓ Missed school days	Increased ventilation rates and child sick days were studied for 635 children attending 20 day-care centers in Denmark.	A 12% decrease in sick days was found per hour increase in the air exchange rates.	46
↓ Child absenteeism	CO <sub>2</sub> as a proxy for ventilation was studied in 60 naturally ventilated primary school classrooms in Scotland.	For each 100 ppm increase in time average CO <sub>2</sub> concentration, student attendance decreased by about 0.4 days per year.	47
↓ Missed school days	CO <sub>2</sub> concentration was measured continuously over two years in 162 US primary school classrooms with a mixture of mechanical and natural ventilation.	For each 1 L/s (2.2 cfm) per occupant increase in ventilation rate, illness absence decreased 1.6%.	26
↓ Illness absence			

Other research on air quality:

- At 1400ppm of CO<sub>2</sub>, basic decision making is 25% worse and complex strategic thinking 50% worse
- High CO<sub>2</sub> and PM in air = lower mood, depression?
- Student cognitive performance falls by up to 13% when carbon dioxide concentrations rise from 600 to 1000ppm, and by 24% at 1800ppm. "<https://www.chemistryworld.com/features/can-we-clean-covid-from-the-air-around-us/4016017.article>
- "On average, a 400-ppm increase in CO<sub>2</sub> was associated with a 21% decrease in a typical participant's cognitive scores across all domains"

[Associations of Cognitive Function Scores with Carbon Dioxide, Ventilation, and Volatile Organic Compound Exposures in Office Workers: A Controlled Exposure Study of Green and Conventional Office Environments - PMC \(nih.gov\)](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4892924/) <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4892924/>  
<https://tinyurl.com/rtfep9mj> <https://iopscience.iop.org/article/10.1088/1748-9326/ac1bd8>  
<https://www.vox.com/2020/1/8/21051869/indoor-air-pollution-student-achievement>  
<https://tinyurl.com/s9n8dw2y>

**National Engineering Policy Centre: 'Infection resilient environments: time for a major upgrade' June 2022** <https://tinyurl.com/mt99kaz3>

*'Even without a pandemic, seasonal respiratory diseases cost the UK about £8bn a year in disruption+ sick days...another severe pandemic within next 60 years, societal cost could be as high as £23bn a year.'*

<https://tinyurl.com/bd5sm7sy>

**Let's Clear the Air: White House Office of Science + Technology Policy Discussion on COVID and Clean Indoor Air – YouTube**

<https://www.youtube.com/watch?v=QBSQumZ4PsY>

Oct 2022 White House Summit on Indoor Air Quality:

<https://www.youtube.com/watch?v=1BeEfDLJSA&feature=youtu.be>

**LANCET: 'Designing infectious disease resilience into school buildings through improvements to ventilation and air cleaning' APRIL 2021**

<https://tinyurl.com/bddb5dw> - Poor air in school contributes to 6 weeks lost learning a year





**Figure 14: Health effects from indoor air pollution in childhood.**

	<b>Birth and infancy</b> <ul style="list-style-type: none"><li>• Respiratory problems – wheeze, rhinitis, atopic asthma, respiratory infections</li><li>• Low birthweight and pre-term birth</li></ul>
	<b>Pre-school</b> <ul style="list-style-type: none"><li>• Respiratory problems – wheeze, allergies, asthma, risk of respiratory diseases and pneumonia</li><li>• Eczema and atopic dermatitis</li><li>• Greater hyperactivity, impulsivity and inattention</li></ul>
	<b>School age</b> <ul style="list-style-type: none"><li>• Respiratory problems – wheeze, rhinitis, asthma, throat irritation, nasal congestion, dry cough</li><li>• Eczema, dermatitis, conjunctivitis, skin and eye irritation</li><li>• Reduced cognitive performance, difficulty sleeping</li></ul>

Source: Royal College of Paediatrics and Child Health

# Safety Reps Ventilation Checklist for COVID

1. Do risk assessments consider ventilation requirements+ system provision+ consult safety reps ?
2. What is the ventilation system ? Is it effective and maintained? Has employer upgraded air filters to MERV 13 or higher (“MERV” = “minimum efficiency reporting value”).
3. Is amount of outdoor air that comes into buildings, either through the HVAC system or open windows being maximised? Checked with CO<sub>2</sub> monitors ?
4. Is the air flow at least 10 litres per person per sec with minimum of 6 Air Changes an Hour ?
5. Is the **ventilation system set for 100% outdoor air to prevent recirculation**, turned on 2 hours before occupation and automatic CO<sub>2</sub> sensor switched off or set to 400ppm?
6. If there is no HVAC, does natural ventilation create unhealthy/ uncomfortable work environment (temperature, noise, pollution) or pose risk of spreading infection?
7. Are areas with inadequate ventilation taken out of use or alternative methods to reduce risk used (e.g. reducing occupancy, use of upper air UVC disinfection, portable HEPA filtration units)?
8. Are rooms subject to no occupancy to allow contaminants to dissipate? PURGING
9. Are rooms cleaned regularly to reduce recirculation of any virus deposited on surfaces, adsorbed on dust?
10. Is the relative humidity too low and the air dry – optimum is 40-70%

# **Summary of practical measures for building services operation**

## **PCS union used this checklist effectively during early stages of Covid**

From REHVA: Federation of European Heating, Ventilation and Air Conditioning Associations <https://www.rehva.eu/activities/covid-19-guidance>

1. Secure ventilation of spaces with outdoor air
2. Switch ventilation to nominal speed at least 2 hours before the building usage time and switch to lower speed 2 hours after the building usage time
3. At nights+ weekends, do not switch ventilation off, but keep systems running at lower speed
4. Ensure regular airing with windows (even in mechanically ventilated buildings)
5. Keep toilet ventilation 24/7 in operation
6. Avoid open windows in toilets to assure the right direction of ventilation
7. Instruct building occupants to flush toilets with closed lid
8. Switch air handling units with recirculation to 100% outdoor air
9. Inspect heat recovery equipment to be sure that leakages are under control
10. Switch fan coils either off or operate so that fans are continuously on
11. Do not change heating, cooling and possible humidification setpoints
12. Do not plan duct cleaning for this period
13. Replace central outdoor air+extract air filters as usually, according to maintenance schedule
14. Regular filter replacement and maintenance works shall be performed with common protective measures including respiratory protection

<https://www.hazards.org/gallery/dustup.htm>

## How does dust hurt you?

### Chronic Obstructive Pulmonary Disease (COPD)

Also called Chronic Obstructive Airways Disease (COAD), a blanket term for 'obstructive' lung conditions like bronchitis and emphysema, where the airways are narrowed. HSE has estimated 15-20 per cent could be work-related.

### Asthma

Another obstructive lung disease, caused by exposure to irritants or allergens ('sensitisers') at work. Studies are typically showing between 15 and 20 per cent of all cases are work-related.

### Extrinsic allergic alveolitis (EAA)

An allergic condition which affects workers exposed to biological dusts, causing conditions including farmers' lung and pigeon fanciers' lung.

### Fibrosing alveolitis

Also known as pulmonary fibrosis, can be caused by some occupational dust exposures, for example work with cobalt or 'hard metals' in cutting tools. Related conditions, for example 'flock workers' lung' and 'popcorn lung' (Hazards 104), have been discovered recently.



### Pneumoconiosis

A group of 'restrictive' lung diseases like silicosis, talcosis and asbestosis, where dust exposure causes debilitating lung scarring.

### Cancers

Tumours, particularly of the lung and nose, are related to substances commonly encountered at work including asbestos, silica, chrome VI, nickel, cadmium and wood dust. These account for thousands of work-related deaths each year.

### Heart disease

Dust-affected lungs put extra strain on the heart, which can lead to right-sided heart failure. Some occupational exposures, like hard metal dust, can cause potentially fatal conditions like cardiomyopathy.

### Other problems

Exposure levels half the level allowable for most workplace dusts overwhelm the body's first line of defence, the 'mucociliary clearance' that filters out dust in the upper respiratory tract. This can leave the worker more vulnerable to infections and more susceptible to occupational lung disease. Lots of other dust-related conditions occur, some specific to particular exposures; beryllium is linked to sarcoidosis, chrome dust to chrome ulcers.

## Size matters

**DUST:** Never just a 'nuisance' depends on substance/size of particulate matter (PM)

**Inhalable Dust** = 100 microns ( $\mu\text{m}$ ) & less

>10 microns (PM10) filtered out by nose/throat

**Thoracic dust** = 10microns & below, gets to lungs

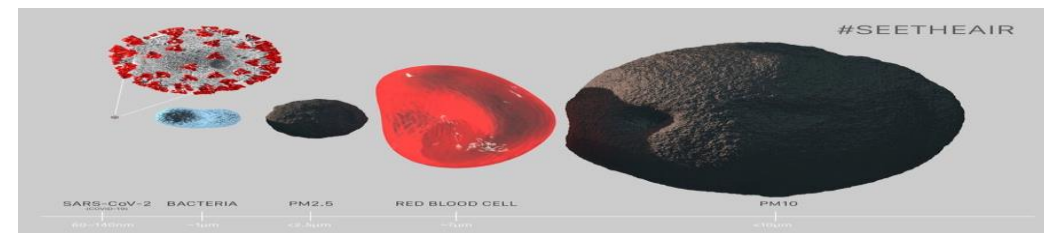
**Respirable dust** = 5 microns (PM5) and below, gets deep into lungs

**WHO say:** PM2.5 microns & less absorbed into blood crosses blood brain barrier – **NO SAFE LEVEL**

0.3 microns are absorbed through skin

**HSE WELs- Work Environment Limits** about 500 in mg/cubic metre, not safe levels

A micron,  $\mu\text{m}$  = 1 thousandth of millimetre, 1 millionth of metre. PM2.5 = particle matter with diameter of 2.5 microns + below. Nanometre = 1 billionth of a metre smaller than a virus, size of DNA strand . Nanoparticles of carbon/any material far more hazardous than normal carbon dust



# Hazardous Substances in air @Work

- **Any harmful fumes, aerosols, dust/particles, microbes in air that can be inhaled, ingested or absorbed through skin**
- **Particulate Matter <100 microns can be inhaled**, smaller the more harmful so PM10 gets into upper respiratory tract, PM2.5 micron diameter & smaller are inhaled deep into lungs, absorbed into blood stream, across placenta into foetus, across blood brain barrier; PM0.3 & nanoparticles absorbed direct through skin. No safe exposure limit for PM2.5s
- **Elements** eg lead and arsenic; **Minerals** eg **asbestos and silica**;
- **Compounds + mixtures** eg pesticides + solvents, cleaning agents, fragrances, personal care – VOC pollution effect almost= to traffic pollution?
- **Biological agents** – viruses e.g. Covid, flu, colds, bacteria, fungal spores from moulds
- **Diesel exhaust emissions/all vehicle emissions**: Nitrogen oxides, NO<sub>2</sub>, Carbon Dioxide, CO<sub>2</sub>, Carbon Monoxide, CO, Hydrocarbons e.g. Poly aromatic hydrocarbons, PAHs, Particles/soot – many substances are **MERCs**
- **'New hazards'** such as micro/nano plastic particles fibres e.g. from clothes + carpets, floor surfaces; MDF Furniture off-gassing VOCs – formaldehyde-, upholstery/carpets/clothing flame retardants, stain protectors – PFAs 'forever chemicals'- antimicrobial dust, chemicals in IT products etc

# Indoor and outdoor air pollution increases risk of:

- **Heart+ circulatory disease** – stroke, heart attack, damage to blood vessels and heart
- **Lung disease Respiratory illnesses** – asthma, COPD, irritation, upper respiratory tract + lung infections, reduced lung development in children,
- **Brain + neurological damage** – reducing IQ and cognitive powers in adults and in developing foetus, dementia, depression and anxiety
- **Other organ/system damage** e.g. IBS now linked to microplastics in air
- **Cancer** – of lungs and other organs inc. breasts;
- **Reproductive harm** – miscarriage, premature birth, low birth weight, developmental damage to foetus, chromosome effects that reduces life expectancy, reduction in fertility for men and women
- **Immune system disorders** inc. obesity and diabetes, increase in auto immune illnesses
- **No cell or organ that cannot be affected by pollution in air** once it is inhaled +absorbed via lungs in to blood and carried around body. **sperm, eggs, and foetus most vulnerable**

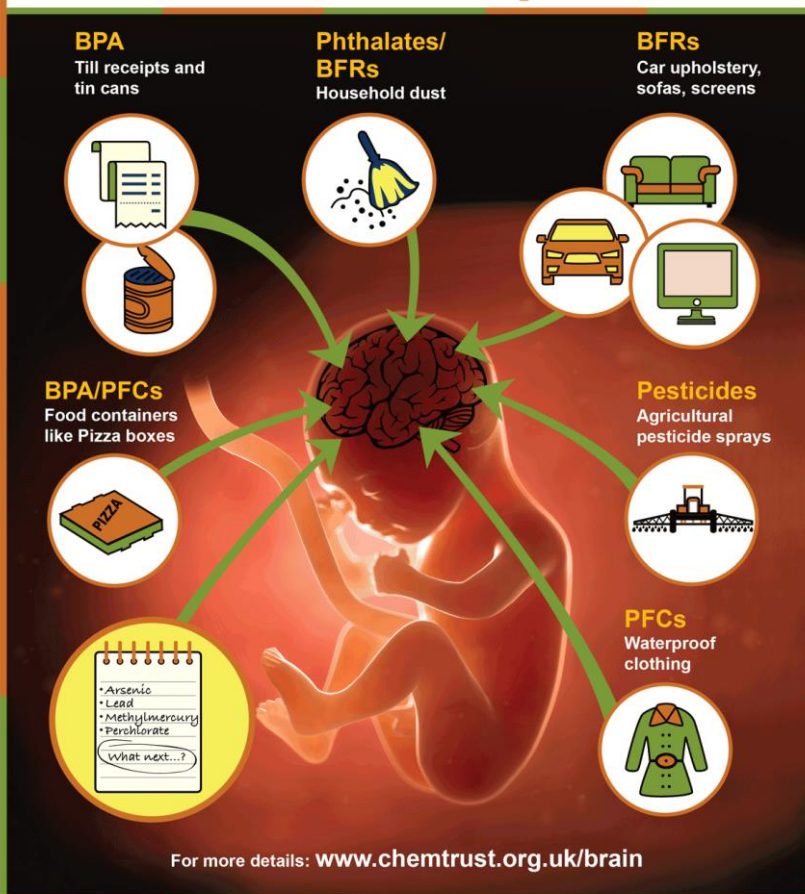
<https://economictimes.indiatimes.com/magazines/panache/air-pollution-may-increase-covid-severity-even-in-fully-vaccinated-patients-says-study/articleshow/94580720.cms>

# Hazardous Substances in the air @Work

- **Asbestos-fabric of buildings built/renovated <year 2000- demolition, renovation, tradesman, teachers, school children, health care workers-** mesothelioma, lung cancer, asbestosis, pleural thickening
- **Allergens – fungi, microbes, animal/plant matter, isocyanates** cause asthma, respiratory irritation and sensitivity
- **Cleaning chemicals & personal care products, fragrances** cause skin, eye and respiratory irritation, asthma, hormone disrupting disorders and cancers
- **MERCS: Mutagens, Endocrine Disrupting Chemicals, Reproductive Hazards, Carcinogens**
- **Endocrine disrupting chemicals (EDCs) Ubiquitous and harmful in parts per trillion** found in plastics, pesticides, cleaning products, canning, automotive work, food & many other products cause endocrine system problems- diabetes, obesity, reproductive system cancers, developmental disorders, male and female fertility problems, cognitive impairment and brain damage to foetus
- **Dust generally including office dust –** lung cancer, COPD, asthma, heart disease, strokes, allergies, immune system
- **Organic Solvents** cause skin, eye, respiratory and neurological illnesses
- **Chemicals coming into work** in containers with MSDS, warning signs,
- **Arising from the work activity: Diesel fumes, silica from stone cutting, wood dust, cleaning and other chemicals, drugs**

Endocrine Disrupting Chemicals - EDCs – in vehicles fumes,  
indoor air, plastics etc. Active at low levels -  
1 teaspoon in Olympic Swimming pool, Parts Per Trillion ppt

## Chemical threat to brain development



Bis Phenol A- BPA

Dioxins

Atrazine

Phthalates

Perchlorate

Fire Retardants

Lead

Arsenic

Mercury

Perfluorinated chemicals

Organophosphate pesticides

Glycol Ethers

[www.chemtrust.org.uk/brain](http://www.chemtrust.org.uk/brain)

*Babies born  
pre polluted and  
this is linked to  
development of  
range of illnesses  
later in life*



# Adverse health outcomes of air pollution

## Fetus

- Fetal growth restriction 
- Stillbirth
- Preterm birth 
- Miscarriage
- Congenital birth defects e.g. cleft lip/palate 

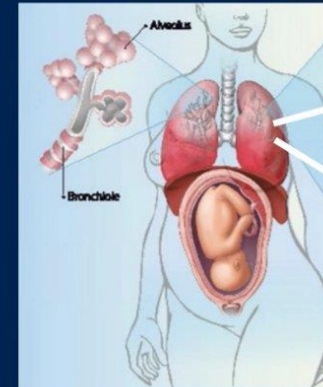
## Mother

- 
  - Pre-eclampsia
  - Infertility
  - Gestational Diabetes
- 

## Child

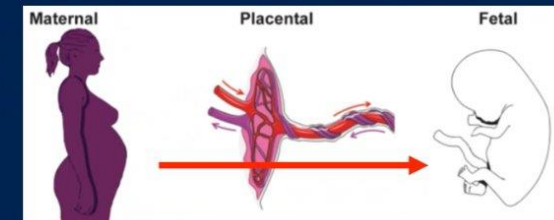
- Child asthma
- Childhood cognitive dysfunction
- Childhood cancers
- Child cardiovascular disease

Air pollution-induced disease is rooted in dysfunctional fetal development



Amount of air breathed in/out with each breath & oxygen consumption ↑ 35%

Blood volume ↑ 40%



Rapid fetal cell division = critical window of exposure to pollutants

# Covid Transmission is via the air

## Sars CoV2 Virus causes multi-system illness, death, Long Covid

Hands. Face. Space Won't cut it!

Covid is in the air:

Ventilate

Filter/clean air

Source Control masks

Worker PPE

Multiple layered

Control measures

TUC webinar:

<http://www.hazardscampaign.org.uk/blog/managing-ventilation-as-a-covid-safety-measure-webinar-recording-and-resources>

[#COVIDisAirborne](https://www.covidisairborne.org/)

<https://www.covidisairborne.org/>

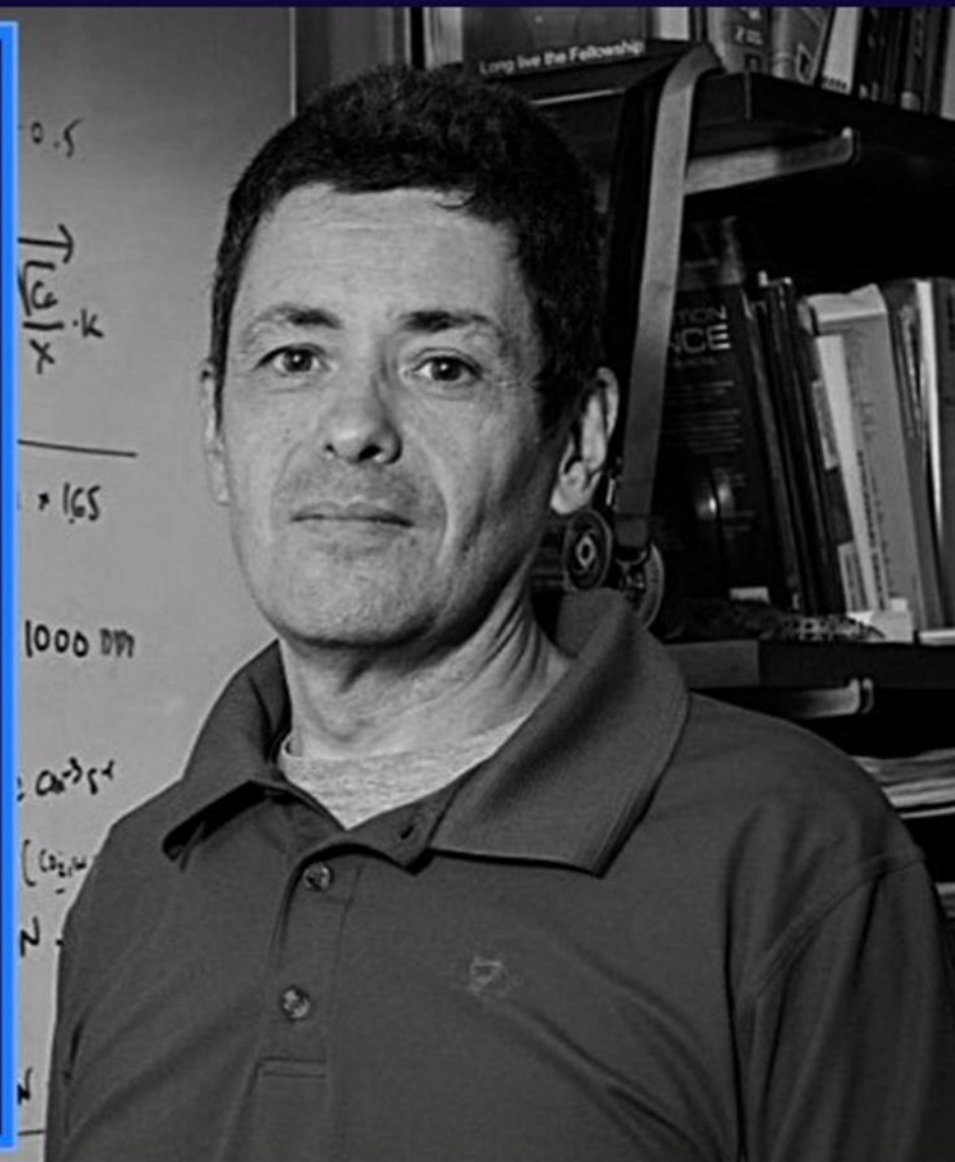


# Covid isn't over. Ignoring it, dropping all preventions does not allow us to live with it but sickens, disables and kills us

Droplets and surfaces are very convenient for people in power - all of the responsibility is on the individual.

On the other hand, if you admit it is airborne, institutions, governments and companies have to do something.

- Jose-Luis Jimenez -



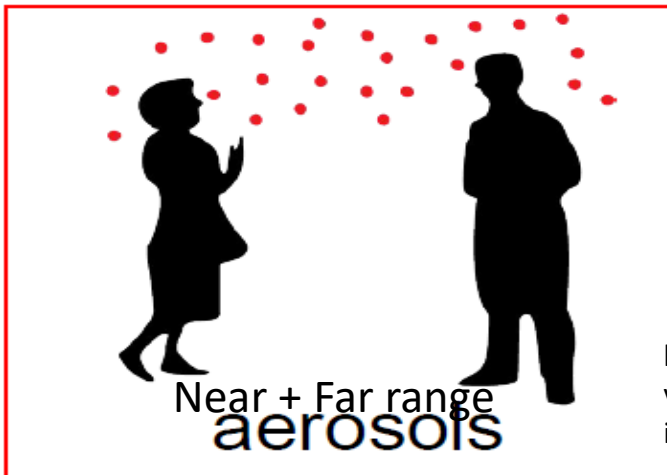
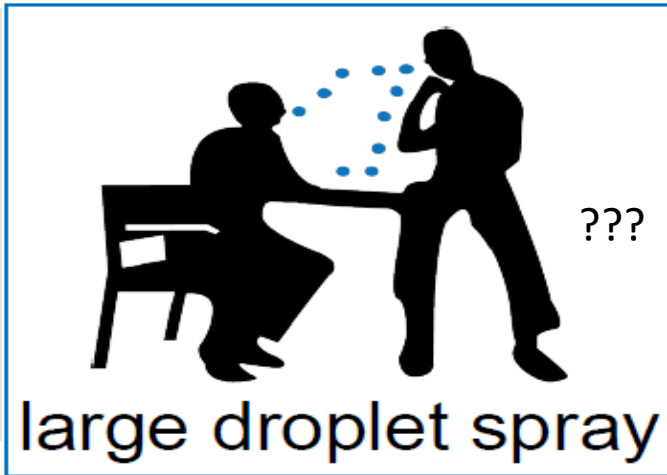
# COVID-19

Don't breathe it in <https://www.youtube.com/watch?v=kX9t8jQ9-fM&feature=youtu.be> Japanese video: <https://youtu.be/jKF1gLldxDw>

# Transmission Routes

Aerosol transmission proven via observation, case studies, sentinel cases, cluster outbreaks + experimental studies. WHO now accept it. UK Govt SAGE accepts, HSE Guidance too. IPC doesn't accept, only AGP require rPPE

[Ten scientific reasons in support of airborne transmission of SARS-CoV-2 - The Lancet](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(21)00869-2)  
[https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(21\)00869-2](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(21)00869-2)



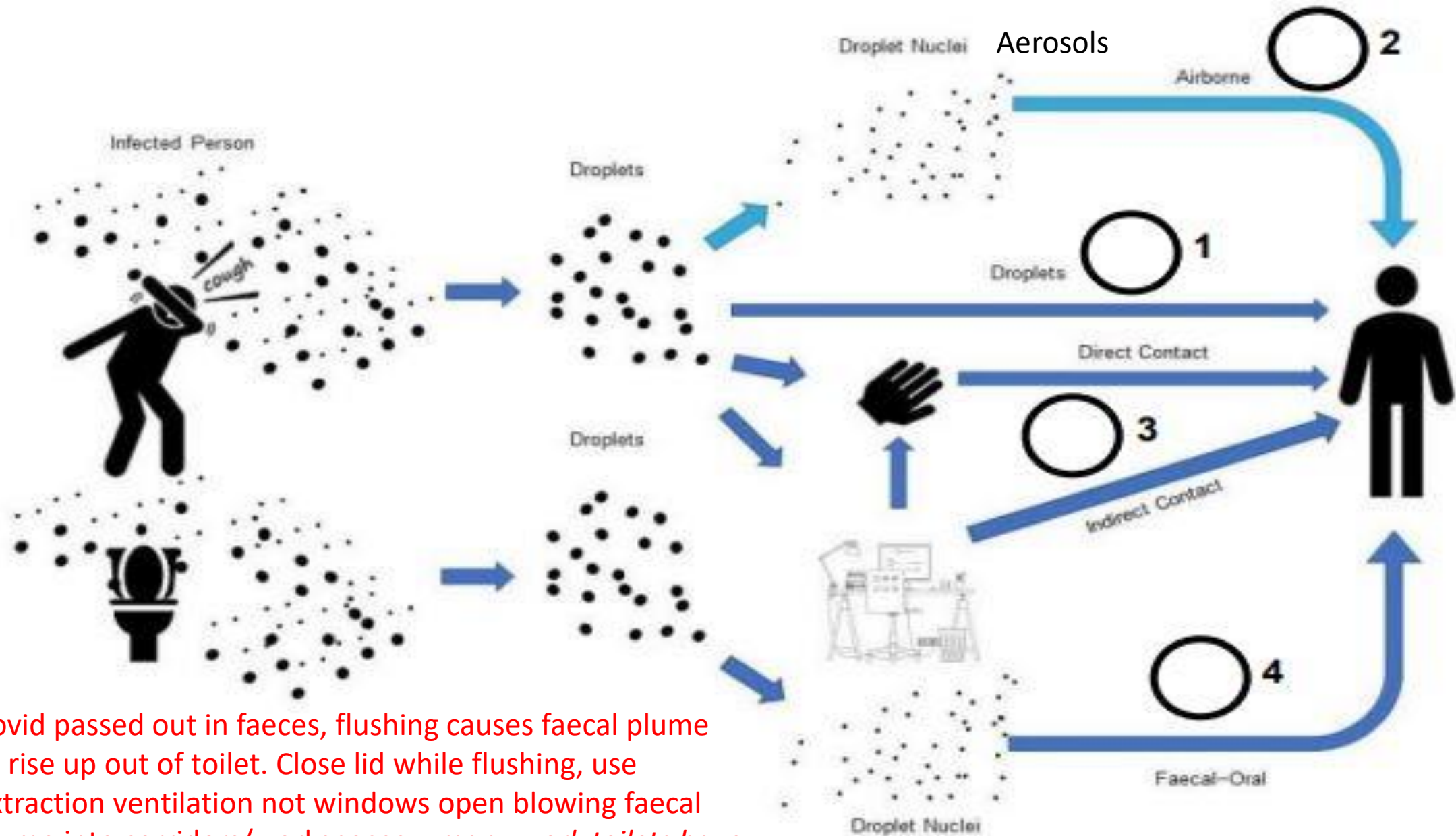
<https://english.elpais.com/society/2020-10-28/a-room-a-bar-and-a-class-how-the-coronavirus-is-spread-through-the-air.html>  
[https://english.elpais.com/usa/2021-03-29/how-to-avoid-coronavirus-infection-in-indoor-spaces-dont-breathe-other-peoples-air.html?ssm=TW\\_CC](https://english.elpais.com/usa/2021-03-29/how-to-avoid-coronavirus-infection-in-indoor-spaces-dont-breathe-other-peoples-air.html?ssm=TW_CC)

<https://www.nature.com/articles/d41586-021-00810-9>

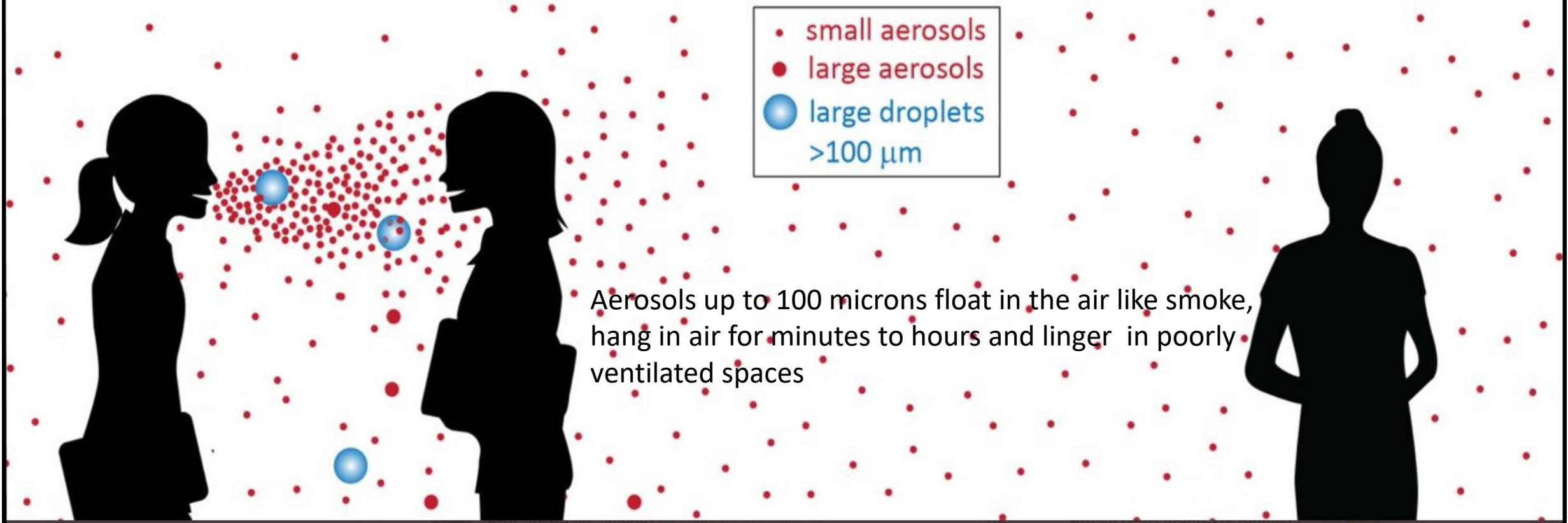
Kate Cole Occupational Hygienist Australia  
<https://twitter.com/YouAreLobbyLud/status/1351455732680466442>

<https://elpais.com/especiales/coronavirus-covid-19/how-to-avoid-the-infection-in-indoor-spaces/>

Brilliant engineers, aerosol, Air Quality scientists: Prof. Jose-Luis Jimenez @jjcolorado Shelly Miller, PhD @ShellyMBoulder Kimberly Prather, PhD @kprather88 Linsey Marr @linseymarr Dr. Richard Corsi @CorsiAQ Jim Rosenthal @JimRosenthal4 Joseph Allen @j\_g\_allen Lisa M Brosseau @brosseau\_lisa Raina McIntyre Global Biosecurity @Globalbiosec Prof Cath Noakes #Ventilate @CathNoakes David Elfstrom



Covid passed out in faeces, flushing causes faecal plume to rise up out of toilet. Close lid while flushing, use extraction ventilation not windows open blowing faecal plume into corridors/workspaces – *many work toilets have no lids?*



### Near field airborne spread

### Far field airborne spread

*'The most common way COVID-19 is transmitted from one person to another is through tiny airborne particles of the virus hanging in indoor air for minutes or hours after an infected person has been there. While there are various strategies for avoiding breathing that air – from remote work to masking – we can and should talk more about how to make indoor environments safer by filtering or cleaning air.'* Dr. Alondra Nelson, head of the White House Office of Science and Technology Policy+ Deputy Assistant to President

**Even with good ventilation and air filtration, still need to wear good masks- preferably FFP2/3 everywhere indoors in shared air whether close or distanced**

High concentration of small aerosols near the person breathing out .

**Need mask/rPPE up close**

**Droplet-borne route**  
Transmitted by  
Medium or large  
droplets

1 micron = 1 millionth metre

Particles up to 100 micron aerosols travel in air like smoke, hang there for mins to hours, linger and build up in poorly ventilated spaces: **Need mask/rPPE far away**

**Short-range airborne route**  
Transmitted by aerosols

**Need mask/rPPE everywhere in room**

**Long-range airborne route**  
Transmitted by aerosols

Airborne aerosols count for 90% of Covid transmission

<https://workinmind.org/2021/07/07/dr-joseph-allen-our-buildings-have-the-power-to-combat-covid-19/>



**fomite route**

Beware the 'Theatre of hygiene' with use of strong harmful disinfectants. More cleaning the air than surfaces! But hand washing good. Each contact with contaminated surface has <1 in 10,000 risk of causing Covid infection

<https://www.ncbi.nlm.nih.gov/books/NBK570437/>

<https://www.health.com/condition/infectious-diseases/coronavirus/hygiene-theater-cdc-cleaning-guideline>

Ballistic trajectory of large droplets

KEEP YOUR DISTANCE No magic distance but big droplets >100 microns fall out over about 2-3 metre. DROPLETS DROP!

1m = 10x more risk than 2metres



1 micron,  $\mu\text{m}$  = 1 thousandth of millimetre, 1 millionth of metre.  
PM10 = particulate matter with diameter of 10 microns.

Size Matters:

100 microns ( $\mu\text{m}$ ) & less = Inhalable particles/aerosols

Over 10 microns filtered out by nose/throat

Thoracic particles 10 microns & below, get to lungs

Respirable dust = 5 microns and below, gets deep into lungs

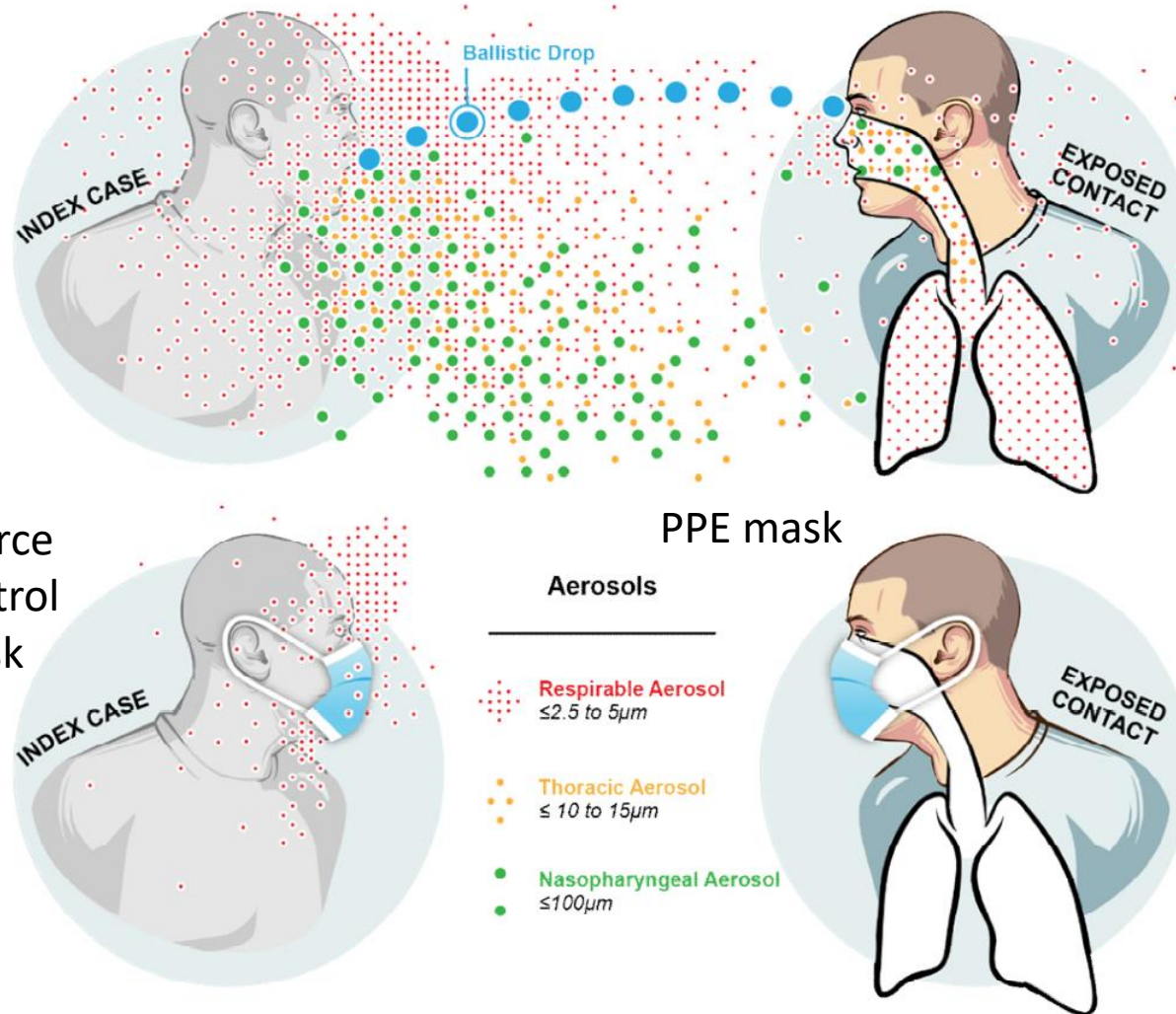
**Smaller particles are inhaled more deeply into lungs and cause most severe infections. The more particles inhaled- viral load- the more severe the illness. So any reduction in smaller particles in air, reduces viral load and can reduce risk of infection and the severity of illness**

Modelling shows very small amount of virus needed to become infected. Without masks and ventilation, physical distancing rapidly becomes inadequate

indoors <https://www.biorxiv.org/content/10.1101/2021.04.27.441510v1>

<https://www.pnas.org/content/pnas/118/17/e2018995118.full.pdf> The

[Astounding Physics of N95 Masks - YouTube](https://www.pnas.org/content/pnas/118/17/e2018995118.full.pdf) <https://tinyurl.com/r9s3t6z5>



Source control mask

PPE mask

Aerosols

Respirable Aerosol  
 $\leq 2.5 \text{ to } 5 \mu\text{m}$

Thoracic Aerosol  
 $\leq 10 \text{ to } 15 \mu\text{m}$

Nasopharyngeal Aerosol  
 $\leq 100 \mu\text{m}$

Figure 1: Representative behaviour of different sizes of respiratory particles and the influence of face coverings (reproduced with permission from (Milton, 2020))



# Role of ventilation + use of CO2 Monitors

- Ventilation in workplaces very poor before Covid which only exposed it
- Don't need to be expert to Question + challenge employers + demand better ventilation for general health, even more to prevent Covid
- People breathing in indoor space take Oxygen out + add Carbon Dioxide to air which can build up in poor ventilation
- Poor ventilation= increased CO2 + PM 2.5 + other pollutants which damage health and increase sickness absence.
- CO2 level in air can be measured as a proxy for ventilation- higher it is , worse the ventilation
- Ventilation/air flow dilutes and disperses and removes CO2 and pollutants including Covid virus, and brings in fresh air, more O2, less CO2- **but outdoor air may be polluted, so not fresh.**
- Ventilation reduces the amount of exhaled air potentially containing Covid in the air and so reduces risk of Covid infection by inhalation

# CO2 Monitors make ventilation visible. More CO2 = higher level of other people's exhaled breath and potentially more aerosols containing Covid

Use Non-dispersive infrared NDIR CO2 monitors with downloadable data

Aranet 4 = good

CO2 rough proxy measure of ventilation:

Expert rec/Hazards Campaign Limits:

External air CO2 = 400-420 ppm

Indoor air 600-800ppm = well ventilated room, HSE agrees but wont enforce

> 800ppm = concern, start to act

>1000ppm= great concern, take action

>1,500 = room not to be used

Govt Guidance doesn't reflect risk + action levels too high

Reading taken on Crossrail train, Manchester to Bournemouth.



## CO2 LIMIT AS AN INDIRECT INDICATOR OF THE RISK OF INFECTION

The risk of infection (aerosols) is proportional to the CO2 concentration:

- It is calculated as the **difference** between the CO2 found **indoors** and **outdoors** ( $\Delta\text{CO}_2$ ).
- If  $\Delta\text{CO}_2 > 0$ , risk already exists.

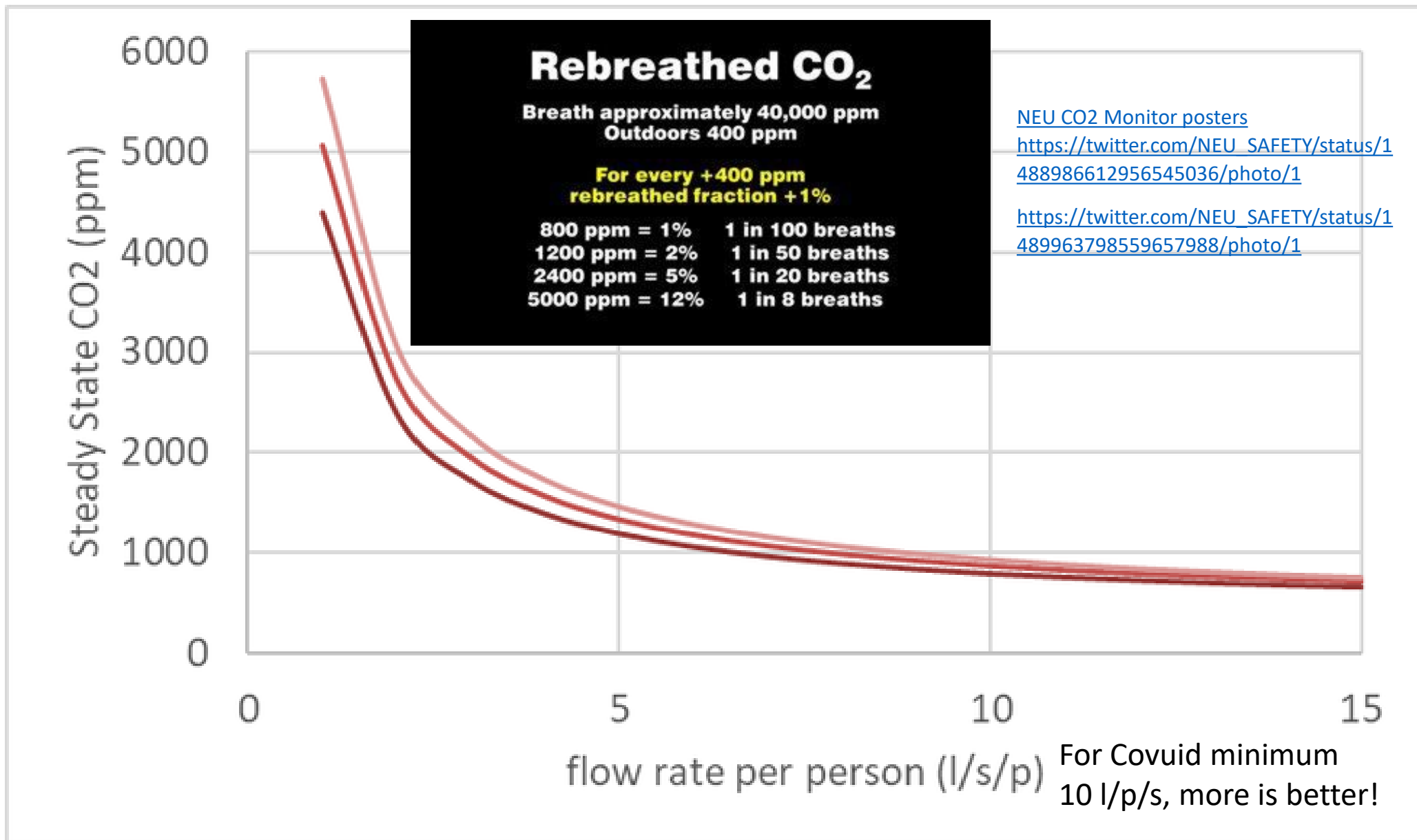
Prof. Jose-Luis Jimenez  
@jjcolorado

CO2 LEVEL (CO2,air ≈ 420 ppm)	$\Delta\text{CO}_2$ indoors-outdoors	% rebreathed air	If a HEPA filter is operating	
≥ 1000 ppm	600 ppm	1,47%	limit	WHO limit
≥ 900 ppm	500 ppm	1,21%	warning	RITE limit (IDA 2)
≥ 800 ppm	400 ppm	0,96%	acceptable	-
≥ 700 ppm	300 ppm	0,71%	suitable	-
< 700 ppm	300 ppm	0,71%	suitable	Harvard/IDAEA-CSIC-LIFTEC Guides
< 550 ppm	150 ppm	0,33%	suitable	Corridors and common areas

@MA\_Campano

Every 400ppm over outdoor level is equivalent to 1% rebreathed air - other people's exhaled air that may contain Covid particles

# Ventilation in litres per person per sec vs CO2 level



# Clean Air Policy – UK v WHO

- UK environmental limits for Nitrogen Oxide (NO<sub>2</sub>) and Particulate Matter (PM<sub>2.5</sub>) are not in line with WHO guidelines
- Graham Petersen took PM<sub>2.5</sub> readings on the way to RMT conf in Doncaster, on tube and train and on the tube were very high:
- 500 microg/m<sup>3</sup> + (over 100 times the WHO standard)
- At one point in Stockwell it hit over 1,100 (over 200 xWHO std)
- Very important for Tube workers and users
- UK Workplace limits are set by HSE in EH 40 and differ from Env limits
- We should argue for the best stds for all

Pollutant	Averaging time	UK Standards	WHO guidelines
PM <sub>2.5</sub> microg/m <sup>3</sup>	Annual	25	5
PM <sub>2.5</sub> microg/m <sup>3</sup>	24 hour		15
PM <sub>10</sub> microg/m <sup>3</sup>	Annual	40	15
PM <sub>10</sub> microg/m <sup>3</sup>	24 hour	50 (max 35x pa)	45
NO <sub>2</sub> microg/m <sup>3</sup>	Annual	40	10
NO <sub>2</sub> microg/m <sup>3</sup>	24 hour	200 (max 18x pa)	25
Microgrammes = millionthsof gram			

# NO2/VOC and Particulate Matter PM 10 and PM 2.5 monitors



**SAMHE** Project - Schools Air Quality Monitoring for Health and Education. Involving 6 educational institutions and the Dfe with EPSRC funding . Offers free air monitors for schools who get involved: <https://www.sei.org/projects-and-tools/projects/samhe/> <https://samhe.org.uk/resources/air-pollution> links to Global Action Plan UK and international schools projects

**Smart Air sell a Quingping monitor**

<https://smartairfilters.com/en/product/qp-pro-air-quality-monitor-qingping/>

Measures Temp, Rel humidity, PM 10 and 2.5 and CO2, the Pro version measures Total Volatile Organic Compounds too.

**What is the outdoor air pollution like in your area/school/workplace** <https://addresspollution.org/> 97% of UK addresses breach at least one WHO guideline of air pollution – NO2, PM 10 +PM2.5 <https://tinyurl.com/2p9f7hha>

**TUCAN** <https://greenerjobsalliance.co.uk/air-pollution/>

**TUCAN** <https://greenerjobsalliance.co.uk/air-pollution/> TUCAN have a PM and NO2 monitor and provide advice for workers

**AIR FORCE | Air pollution should not be all in a day's work - Hazards magazine**

<https://www.hazards.org/workandhealth/airforce.htm>

**Ventilation – removes stale exhaled air+ pollutants and replaces with fresher/outdoor air –**

**Beware external air pollution Good Ventilation can achieve dilution, dispersal, removal of Covivirus but not 100%**

**Ventilation is good for long range aerosols but not so effective for short range aerosols**

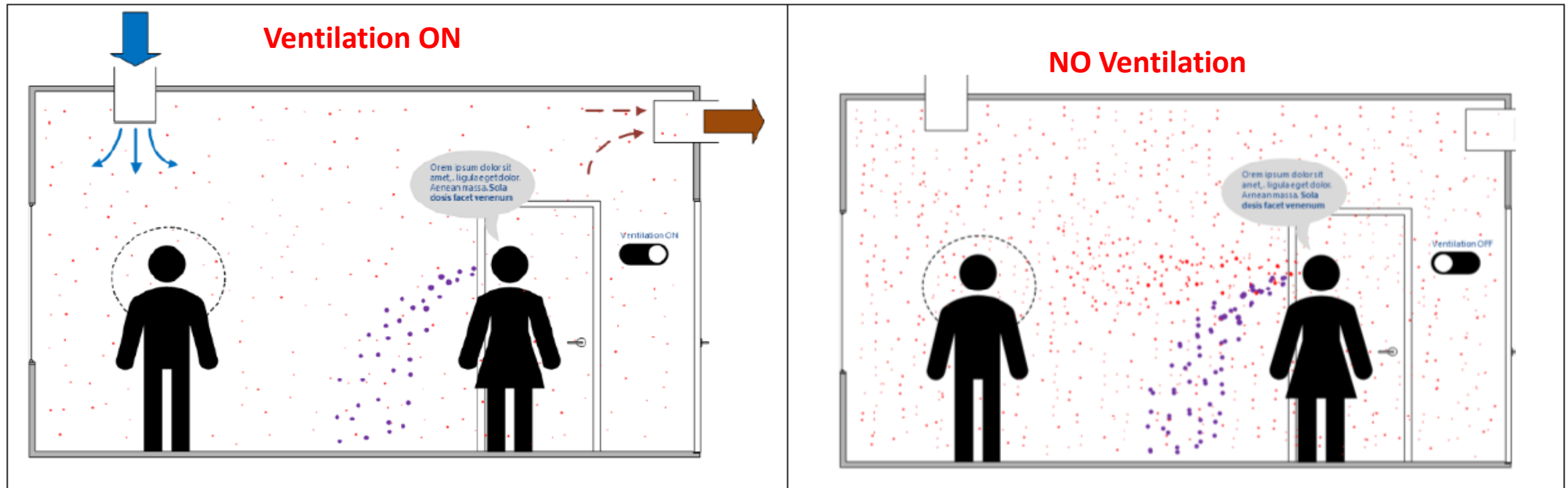


Figure 2. Illustration of how an infected person (speaking woman on the right) leads to aerosol exposure (red spikes) in the breathing zone of another person (man on the left in this case). Large droplet exhalation is marked with purple spikes. When the room is ventilated with mixing ventilation system, the amount of virus-laden particles in the breathing zone is much lower than when the ventilation system is off. Left figure: ventilation system on, right figure: ventilation system off.

**Recent Italian Study of schools: 2.4 Air Changes per Hour led to Covid infections reduced by 40%;**

**4 ACH = 66.8% reduction; and**

**6 ACH = 82.5% reduction in infection – equivalent to 10-14 litres air per person per sec**

# Quick hack to improve natural ventilation



- The fan reduced the CO<sub>2</sub> concentration in the room about 3x faster compared to having the window open with no fan.
- Using the fan as an "extractor" only dropped room temp by 1° C.
- When the fan was pointed inwards as a "fresh air" fan, the room temp dropped by 3 - 4° C.

# Poor Ventilation can be supplemented by Filtration + Ultra Violet C irradiation -but be aware of risks of radiation + chemicals + as much ventilation as possible is needed. Clean the air: Do it all strategy!

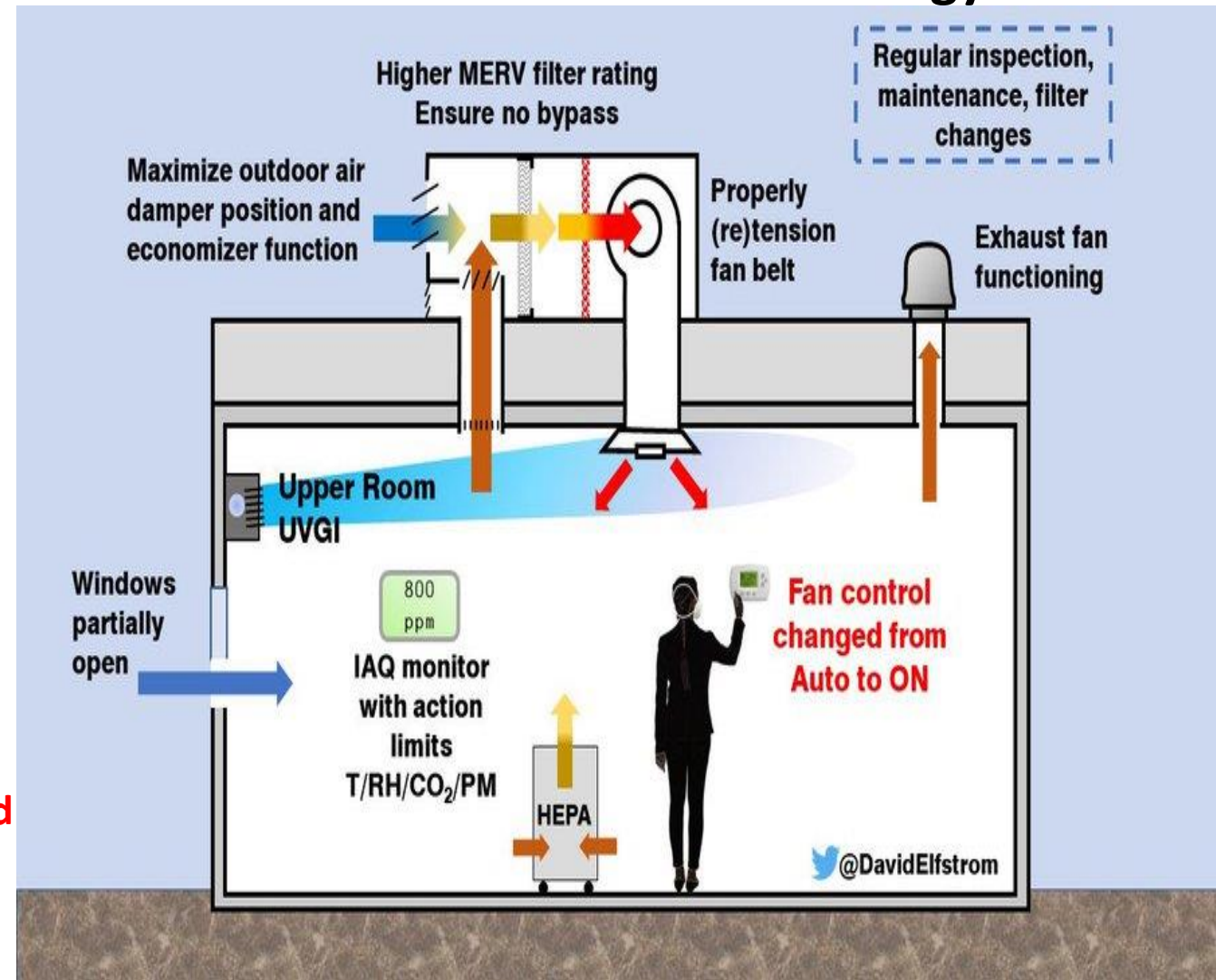
✓HEPA - High Efficiency Particle Air Filtration removes very small aerosols containing covid +other particles.  
HEPA Portable air cleaning units in room, at suitable capacity- Clean Air Delivery Rate, CADR – for room size, number of people, activity – is safe, just plug in, adds no chemicals, just removes virus/particles

✓UVC light radiation of air at ventilation system intake or in Upper room above 2.5/3m can be equivalent to 20+ ACH- needs professional installation

<https://www.researchsquare.com/article/rs-908156/v1>

## AVOID

- ×UVC at lower levels ,may be harmful to eyes + skin.
- ×Ozone- respiratory irritant at v low levels, suspected carcinogen, need levels immediately hazardous to health to clean room <https://tinyurl.com/y4xh5vy8>
- ×'Purifiers using plasma, ionisers, ozonators' etc can add harmful chemicals to the air + maybe ineffective + many systems on sale are not regulated or tested

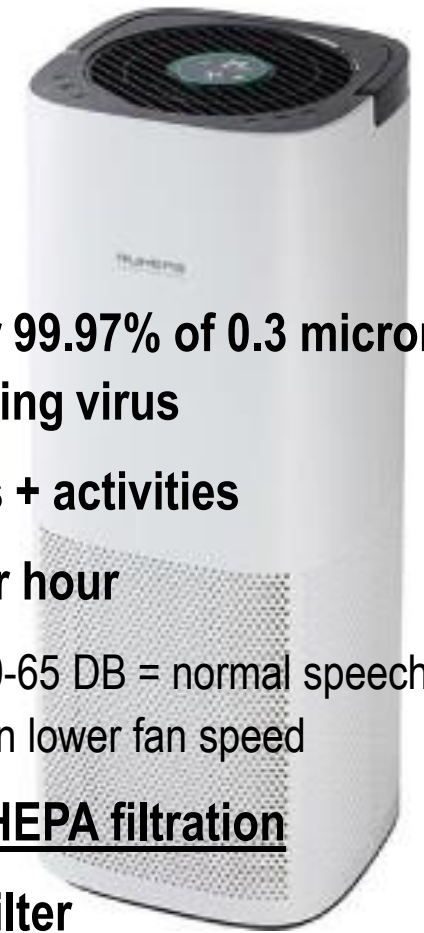


See SAGE Advice <https://tinyurl.com/4jrzbtr> CIBSE: Air cleaning technologies <https://tinyurl.com/yu85z6s4>

Dr Linsey Marr Does electronic air cleaning work ? <https://tinyurl.com/43d3f624>



# Portable HEPA Air Filtration



We don't recommend specific manufacturers, set out criteria to meet:

- Have inner HEPA or true HEPA filter not 'HEPA like'. HEPA guaranteed to catch over 99.97% of 0.3 microns, but filters out down to 0.1 microns (millionths of a metre) i.e all the aerosols containing virus
- Have sufficient Clean Air Delivery Rate, CADR, for room size , number of occupants + activities
- **VERY SIMPLIFIED** calculation: Desired No. ACH x Volume of room = CADR in m<sup>3</sup> per hour
- **Low Noise level – as quiet as possible** this will be listed in decibels dB(A) Guide- 50-65 DB = normal speech; 40 dB = quiet library 30 dB = whisper nearby; 20 dB = whisper at 5 metres. May need two, quieter on lower fan speed
- **Not have Ultra Violet light, plasma, ionisation or any other devices/chemicals, only HEPA filtration**
- **Additional outer filters are good as trap larger particles, protecting the inner HEPA filter**
- **Check cost of replacement filters, how often need changing and how to do safely.**

List of studies on HEPA efficiency for Covid: <https://medium.com/@carlvank/luchtreiniging-air-purification-hepa-5dd2c728ef8f>

SAGE Advice <https://tinyurl.com/4jrxbtr> CIBSE: Air cleaning technologies <https://tinyurl.com/yu85z6s4> Portable HEPA Air Cleaner Guide  
Clean Air Crew <https://cleanaircrew.org/air-cleaners/> Good UK HEPA filter list: <https://www.fullplasticscientist.co.uk/air-purifier-comparison> Clean Air Stars: <https://cleanairstars.com/filters/>

# Clean Air Delivery Rates, CADR, ROUGH Calculations

**Recommended 6 room Air Changes per Hour – ACH- minimum and 10 litres per person per second or 36 m<sup>3</sup> per person/hour minimum**

1. Chose CADR of HEPA filter to give equivalent of 3-5 room Air Changes per Hour (on top of existing ventilation assumed to be 1-3 ACH but should be known) Multiply the volume of classroom (width x length x height = volume in m<sup>3</sup>) by ACH needed to give m<sup>3</sup>/hr. This will give the clean air delivery rate you are after.

Example: Volume of room 150 m<sup>3</sup> x 5 ACH = 750 m<sup>3</sup>/hr. Source 2 HEPA units that can deliver 375 m<sup>3</sup>/hr good. Or 3 at 250 m<sup>3</sup>/hr. Go for a bit higher rather than lower to account for inefficiency and less noise, keep well under 50 dB noise level

Another option:

2. You can also size CADR on air flow per person and CO<sub>2</sub> level.

**If room CO<sub>2</sub> settles around 1,500ppm** you have approximately 5 litres per person per sec (l/p/s) of fresh air flow. To keep room well ventilated, reduce chance of inhaling others exhaled air and keep CO<sub>2</sub> level below 800ppm you need 10 litres per person per second or 36 m<sup>3</sup> per person/hour \*\*.

So can size HEPA filter CADR to add equivalent of another 5 litres per person per second. Take number of people, multiply by extra l/s/p you want and then multiply by 3.6 to convert to m<sup>3</sup> per person per hour. Now you have CADR needed in m<sup>3</sup>/hr

**Example for classroom with 1,500ppm CO<sub>2</sub> with of 32 people :**

**32 x 5 x 3.6 = CADR of 576 m<sup>3</sup> per hour. Maybe buy two of 300 m<sup>3</sup> CADR.**

*Room may not reach steady state of 1,500 ppm CO<sub>2</sub> may just rise and rise due to inadequate ventilation and we need to stop using such rooms. If forced to use room temporarily then HEPA filtration with higher CADR would be urgently needed. Rooms regularly +constantly over 1,500ppm should not be used unless reduced number of occupants /time can make the ventilation rate suitable*

\*\* 10 l/p/s or 36 m<sup>3</sup> per hour was pre Delta and Omicron recommendation for classroom/office ventilation, many experts now think air flow of 15l/p/s is more appropriate given higher number of covid containing aerosols released and therefore great risk of inhalation.

.Dr Richard Corsi: 'I do not believe aiming for 4 or 6 ACH in schools or other indoor spaces is sufficiently aspirational & have written about how a combo of increased outdoor air supply and use of #CorsiRosenthalBoxes can get us close to 10 equivalent ACH in classrooms'

[Choosing your classroom purifier \(airbon.co.uk\)](https://www.airbon.co.uk) <https://www.airbon.co.uk/post/classroom-air-purifier> based on Harvard University of Colorado tool

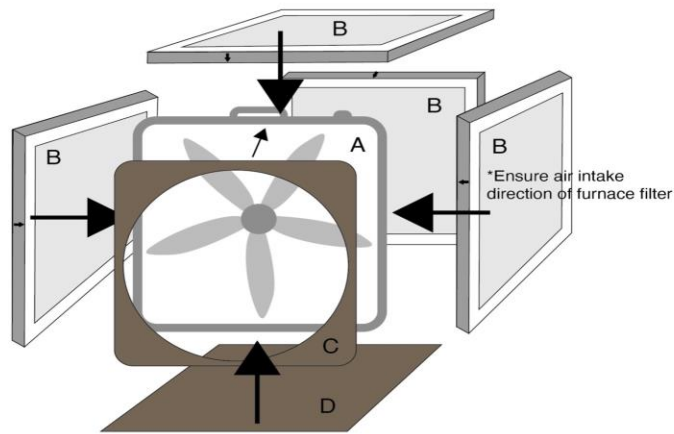
HEPA Filters - Clean Air Stars : <https://cleanairstars.com/hepafilters/> Good UK HEPA filter list: <https://www.fullplasticscientist.co.uk/air-purifier-comparison>

# DIY Filtration – Corsi Rosenthal Box- cCheaper than commercial filtration units

## Use MERV 13 ( Minimum Efficiency Reporting Value) filters not HEPA but more air flow

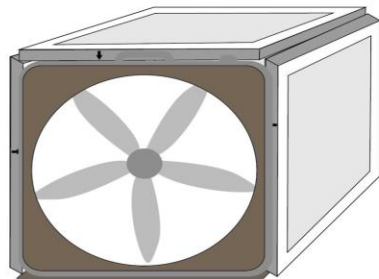
### Corsi-Rosenthal Box

illustrated by @ughberta



#### Materials:

- (A) 1x 20"x20" box fan
- (B) 4x 20"x20"x1" furnace filters
- MERV 13\*/Filtrete FPR 1900
- (\*can use MERV 11 if not available)
- (C) 1 fan shroud made of fan box
- (D) 1 fan bottom made of fan box
- lots of duct tape to seal everything super well



References:  
 Twitter: @corsiAQ, @jimrosenthal4, @kprather88  
<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/>

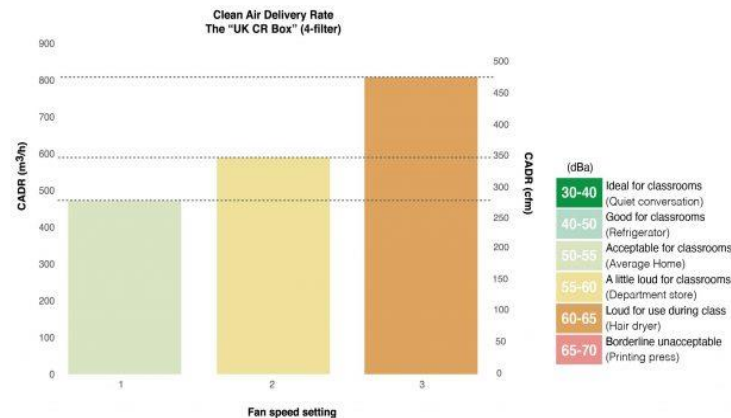
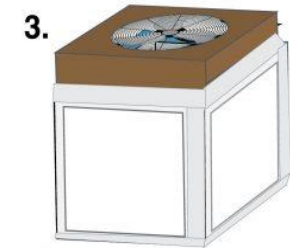
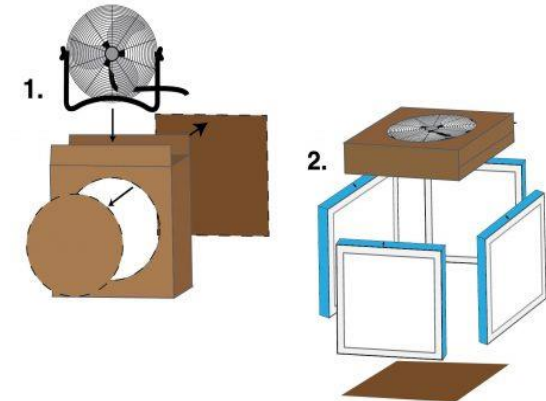
### The "UK CR Box" DIY Air Purifier (4-filter design)

#### Parts list:

- 4x 20"x20"x1" MERV 13 filter (Filterbuy filters used)
- 18" Metal "cage" fan
- Fan box, other cardboard
- Duct tape

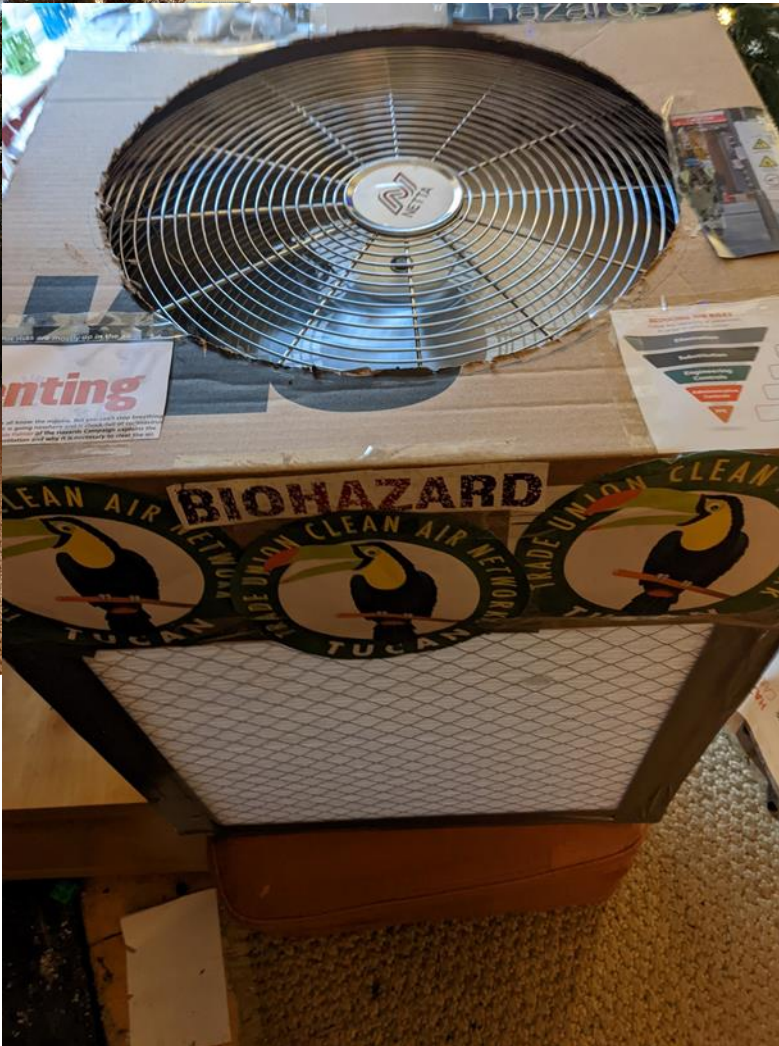
#### Mount options: Floor/table

Development notes:  
 Development status: V1.0 (un-certified prototype)  
 Future development: Reduce noise., anti-tamper protection, build to CE spec  
 Flow and sound tests performed by: @JBCLiftec  
 Flow test: ISO 5801 calibrated flow test  
 Sound test: Type 2 SP meter  
 Info card by: Amanda Hu (@ughberta)



[DIY box fan air filters – Corsi-Rosenthal box - Clean Air Crew: https://cleanaircrew.org/box-fan-filters/](https://cleanaircrew.org/box-fan-filters/) [Corsi-Rosenthal Cube – Encycl https://encycla.com/Corsi-Rosenthal\\_Cube](https://encycla.com/Corsi-Rosenthal_Cube), <https://www.parentsunited.net/the-diy-air-filter-movement-comes-to-the-uk/>  
<https://safeedforall.files.wordpress.com/2021/11/build-a-hepa-filter-stem-activity-kw-v8.pdf>  
[World Health Network https://www.worldhealthnetwork.global/projects](https://www.worldhealthnetwork.global/projects)

# My UK version of Corsi- Rosenthal Box



Using advice from **Stefan Stojanovic** @PlasticFull and Clean Air Crew: <https://cleanaircrew.org/box-fan-filters/>

In November 2021

I used the following components:

- Netta 18 inch 5 blade floor gym fan
- 4x Filtrete H13 filters 20 inches x 20 inches x 1 inch thick pleated
- Gaffer tape + Cardboard
- Cost £125 at the time.
- It took about 30 mins – mostly stuck on gaffer tape!

CADR of these CR boxes is huge compared to commercial devices: Characterizing performance of a DIY air filter medRxiv

<https://www.medrxiv.org/content/10.1101/2022.01.09.22268972v1>

We spread the information via training sessions, with trade unions and via TUCAN project, demonstrations and use at meetings/conferneces

For scale Rowun is 12yrs old and 5 foot 6"

# Dr. Rhys Thomas + Aled Dafis @rhythomas @Aledafis Cerdigion Schools Corsi Rosenthal Thomas Boxes

Improvements by Dr Rhys Thomas = Corsi-Rosenthal-Thomas Box!

- [Doctor Rhys Thomas MBBS MD FRCA @rhythomas](#) very clear instructions. <https://twitter.com/rhythomas/status/1479557715894620167?s=20> and
- Professional video showing how to make a CRT Filter in 10 min and £140. Thanks to Mr Aled Davies and Ysgol BroPedr Lampeter and Ceredigion Local & Education Authority <https://t.co/UJaYIERWNS>
- **Stefan Stojanovic (@PlasticFull)**
- <https://t.co/yEC6Mayap4>
- Build Video <https://www.youtube.com/watch?v=l4uCRuO-Ayo>
- Filter source [danthoma80@icloud.com](mailto:danthoma80@icloud.com)
- Filtration rate (CADR) estimator spreadsheet <https://t.co/JNAImrzDoD> <https://t.co/5jTQHttVim> ([https://twitter.com/PlasticFull/status/1509989794838978565?t=wCEaD\\_kUc3gl9uK87SjvGw&s=03](https://twitter.com/PlasticFull/status/1509989794838978565?t=wCEaD_kUc3gl9uK87SjvGw&s=03))



Can 10× cheaper, lower-efficiency particulate air filters and box fans complement High-Efficiency Particulate Air (HEPA) purifiers to help control the COVID-19 pandemic? YES! [https://drive.google.com/file/d/1Uaccu\\_md9usL\\_8CLQhQaJ38on38w8J8v/view?usp=sharing](https://drive.google.com/file/d/1Uaccu_md9usL_8CLQhQaJ38on38w8J8v/view?usp=sharing)

# Growing DIY filter grassroots movement: @BarnetNEU Corsi-Rosenthal Box made by Jess Dunn



Stefan Stojanovic (@PlasticFull Air Cleaner 2 has arrived. Open source design template based on the #CorsiRosenthalBox Now available at Github

<https://t.co/vecfzFYUJw> <https://t.co/G9CntjXFtu>  
(<https://twitter.com/PlasticFull/status/1504928806599024642?t=KA1yHsrnsFINV6U3bd-g&s=03>)

Airbon (@AirbonPurifier)

'We built a DIY purifier in the UK for under £80 that removed all PM2.5 in less than 15 minutes (22sqm room) using the amazing #corsirosenthalbox concept.' @CorsiAQ @DavidElfstrom et al @jimrosenthal



<https://t.co/AgioqSboqE> #airpurifier #DIYpurifier #AirPollution

<https://t.co/tygli8c1B3>

(<https://twitter.com/AirbonPurifier/status/1438107686915215360?t=wRoHa8ntZPva9z-hi62zeQ&s=03>)

Can 10× cheaper, lower-efficiency particulate air filters and box fans complement High-Efficiency Particulate Air (HEPA) purifiers to help control the COVID-19 pandemic? YES! [https://drive.google.com/file/d/1Uaccu\\_md9usL\\_8CLQhQaJ38on38w8J8v/view?usp=sharing](https://drive.google.com/file/d/1Uaccu_md9usL_8CLQhQaJ38on38w8J8v/view?usp=sharing)

Latest UK version of Corsi-Rosenthal Box developed and tested by Stefan Stojanovic @plasticfull other engineers and Michelle Wong @mishwoz produced the build instructions <https://drive.google.com/file/d/1WPrJBBD9ultDzv0jl0uP3OXIWR5Y7ghQ/view>




## A #CleanAir STEM PROJECT



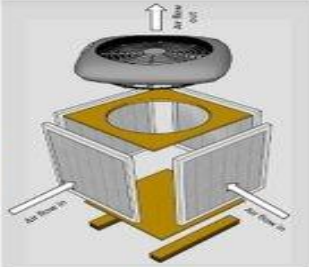
### HOW TO BUILD A UK DIY Air Cleaning Device #CorsiRosenthalBox

**VIDEO INSTRUCTIONS By Children Underway .... Stay tuned**

@cleanairclassm



## The 'CRBox' Arrangement



**Top: Fan**


**Box Lid:** Cardboard 'shroud' with Circular cut out

**Box Sides:** Filter panels  
Note filter flow direction (see panel edge)

**Box Bottom:** Cardboard

**Box Legs:** Cardboard

**The Completed CR Box**



**A CR Box With Protective Enclosure (optional)**



## Resources For the Air Cleaner





- Fan:** Vent Axia Box Fan 14 inch
- Filter Panels:** 4 x 3M Filtrete MPR1900 - 20 x 25 x 1 inches
- Box Lid, Bottom & Legs:** Corrugated Cardboard, Re use the packaging
- Tape:** Gaffa/Duct Tape
- Tools:** Cutting blade & board, ruler, pencil, paper, butterfly pin, screwdriver

## Step 1: Preparation- box lid & bottom

**Box Bottom:**  
Cut 1 sheet 21inch x 21inch square

**Box Lid 'Shroud':**  
Cut 2 sheets (for rigidity) of corrugated cardboard 21" x 21" square

Insert butterfly pin & paper to mark out 20cm radius

Dot points on the board  
Circs every 1cm apart  
To mark the circle

Draw the diagonals to find the centre

Cut out a rough circle following the dots

Use duct tape to seal 2 sheets complete at the circular cut out  
Tape at corners




## Resources For Protective Enclosure




- Perforated Board:** 4 x Ikea 'Skadis' Peg Boards 76cm x 56cm (re use corrugated strips for box legs)
- PVC coated wire:** Garden wire Or Kitchen Freezer bag ties

## Step 2: Preparation- box legs

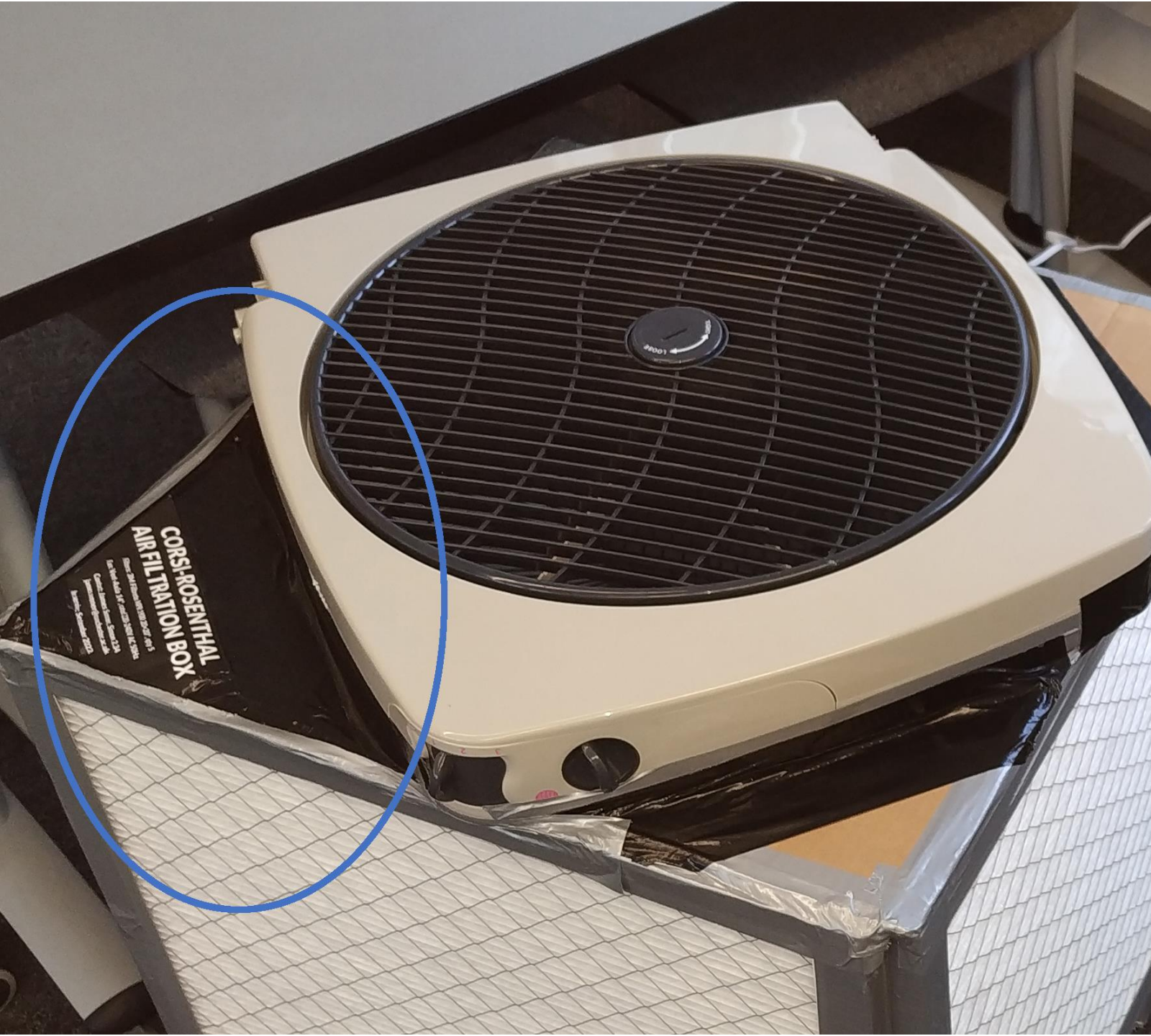
**Box legs:**  
Reuse 5 sheets corrugated cardboard from Ikea peg board packaging

Cut corrugated sheets into strips 10cm x 53cm (21") length

Form stacked layers at height approximately 10cm

Duct tape all around at ends and middle to form 2 number box legs





# Particles Captured

Filtrete™  
MPR 1900  
MERV 13

				
Lint	Household Dust	Dust Mite Debris	Mold Spores	Pollen
				
Pet Dander	Smoke	Smog Particles	Cough/Sneeze Debris	Bacteria
				
Viruses	Candle Soot	PM 2.5		



# Somerset County Cllr Oliver Patrick crowd funding, making, promoting UK Corsi-Rosenthal Boxes in Somerset schools @Cllr Oliver



Claire the air cleaner on promotional travels in Somerset

Corsi Rosenthal Box design and use revolution is spreading throughout UK and world. Keep in touch on twitter via **Richard Corsi, PhD, PE (Texas)**

**@CorsiAQ Jim Rosenthal @JimRosenthal4**

**@plasticfull Michelle Wong @mishwoz**

**AlexCRBOXes Everywhere @CRBoxKits**

**@hazardscampaign**

Different designs all the time

For example **@plasticfull MechaFlowManiac/Air-Cleaner-2**: Based on the Corsi Rosenthal box filter concept. Accepts MERV or EPA filters. Multiple material options. For batch or mass manufacture globally using, box, cage or commercial plate fan types.

<https://github.com/MechaFlowManiac/Air-Cleaner-2>;

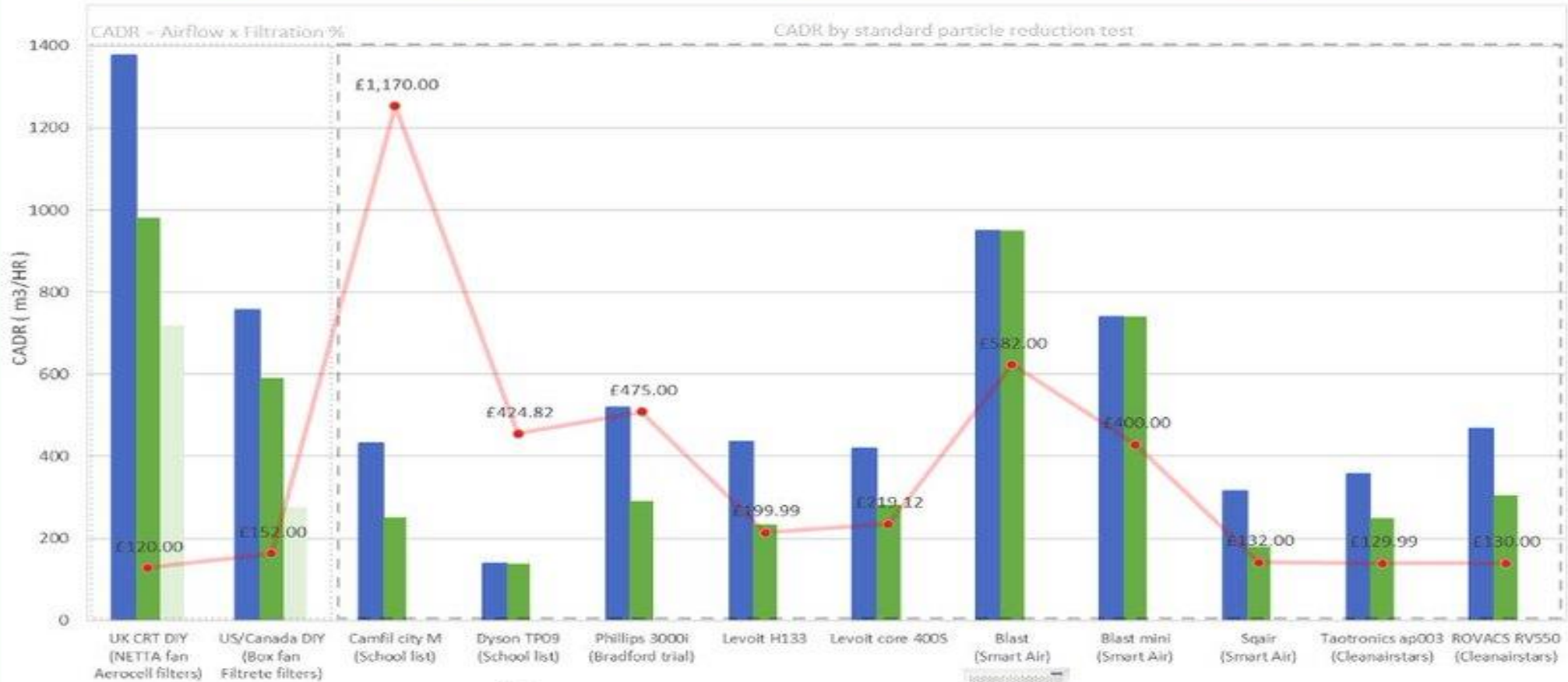
Follow **@plasticfull**



# CADR and Purchase cost

\*FERA = Filtration Efficiency for Respiratory Aerosols  
<http://tinyurl.com/CADRtests>

■ MAX FERA\* CADR   ■ FERA\* CADR below 50 dB / dBA   ■ DIY AHAM Smoke CADR below 50 dB / dBA   ● Initial Cost



## CADR / Cost below 50 dB

\*FERA = Filtration Efficiency for Respiratory Aerosols  
<http://tinyurl.com/CADRtests>

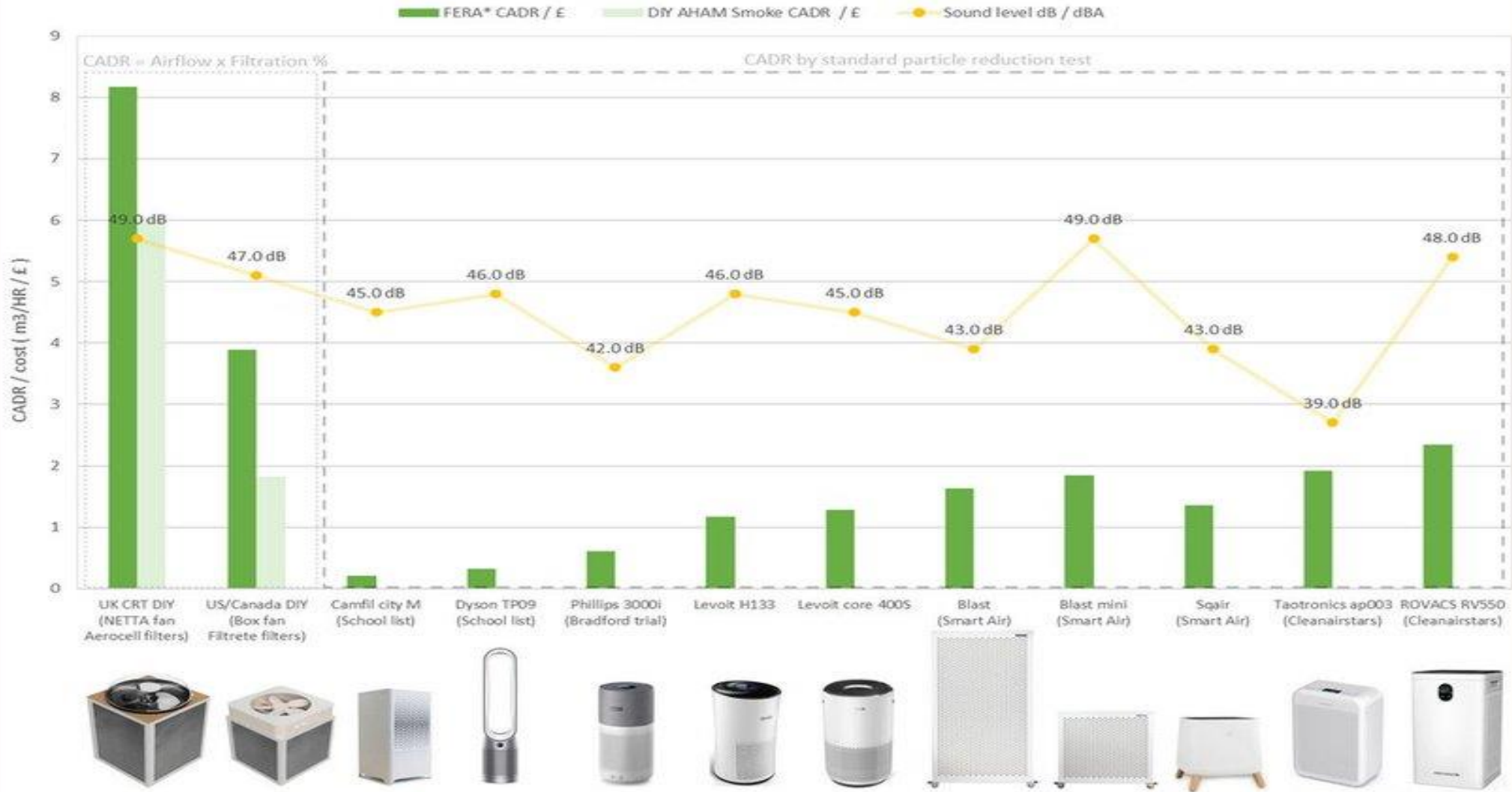


Chart version 2: 26/05/2022

# Clean Air Delivery Rate per £

# Taking Action at work: Educate, Agitate and Organise

AI is not OK  
Don't let the machines win

Deep breath  
Instructed to breathe poison

Deadline  
Stop 3 million work deaths

JANUARY-MARCH 2022 | THE WORKERS' HEALTH AND SAFETY MAGAZINE | NUMBER 157

## hazards

CLOSE GATE  
PROVE IT'S LOCKED



### NO-ONE IS COMING TO SAVE YOU

Since the Conservatives came to power, the number of workers harmed by their jobs each year has increased by 30 per cent, but convictions for work safety crimes have fallen by 75 per cent. Fines are in freefall. Preventive Health and Safety Executive (HSE) inspections are down by over two-thirds. No other government has ever cared less.

Today more than ever, your union may be the only protection you've got.

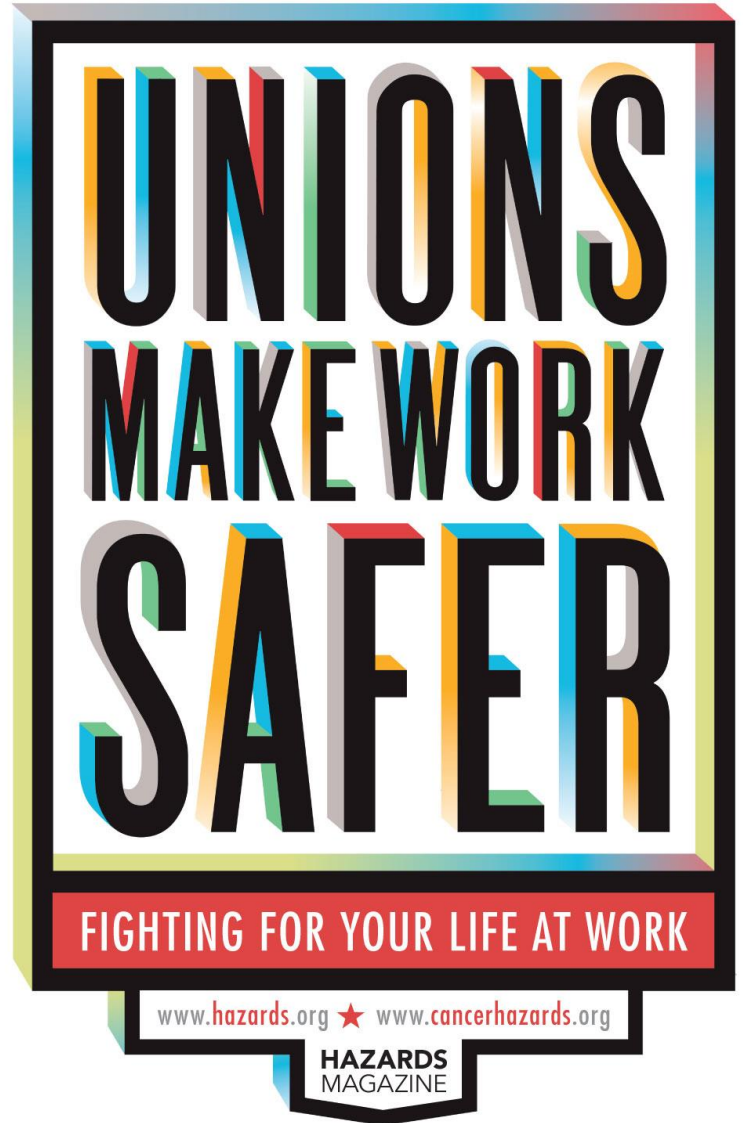
BACKPAGE POSTER A JOB TO DIE FOR? INTERNATIONAL WORKERS' MEMORIAL DAY



ORGANISED WORKPLACES  
ARE SAFER WORKPLACES

UNIONS  
MAKE WORK  
SAFER

HEALTHY WORK - IT'S WHAT WE BARGAINED FOR - WWW.HAZARDS.ORG/ORGANISE



# UNIONS MAKE WORK SAFER

FIGHTING FOR YOUR LIFE AT WORK

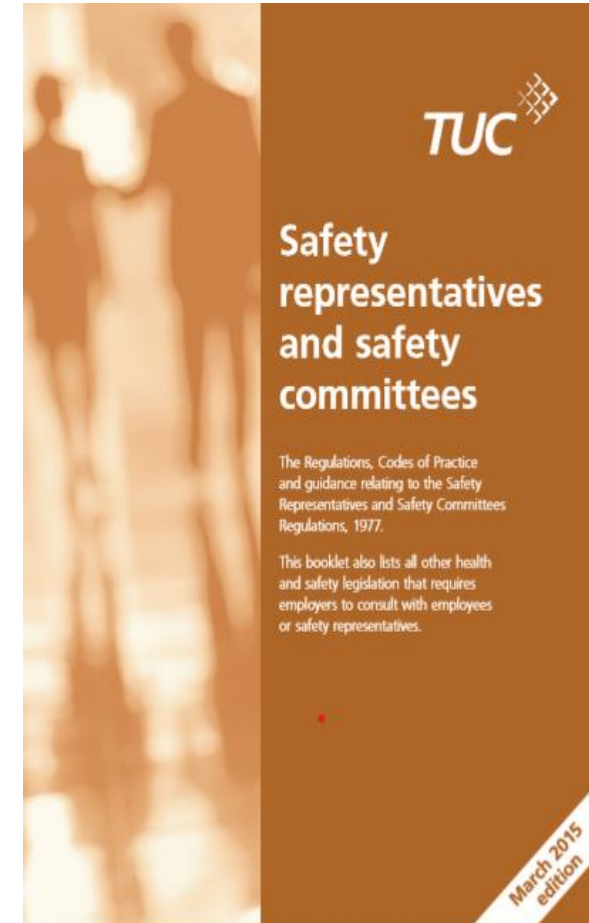
[www.hazards.org](http://www.hazards.org) ★ [www.cancerhazards.org](http://www.cancerhazards.org)

HAZARDS  
MAGAZINE

# Health and Safety Reps rights and Employers' duties towards them

- **Investigate** potential and actual hazards, complaints and accidents
- **Inspect** the workplace, and all relevant H&S documents
- **Represent** their members' H&S concerns to the employer
- Be provided with **information** from the employer and enforcement officers
- Be **consulted** by the employer about issues relating to health and safety in the workplace in good time – **risk assessments, safe systems of work**
- Call for establishment of, and right to attend meetings of **health and safety committees**

<https://www.tuc.org.uk/sites/default/files/BrownBook2015.pdf>



# Use law: SRSC, HASAWA, Management H&S @ Work Regs & Environmental Law/Standards as appropriate


- Health and Safety At Work Act: **S2 General duties of employers to their employees.**
- (1)It shall be the duty of every employer to ensure, so far as is reasonably practicable, the health, safety and welfare at work of all his employees.
- And S3 general duties of those not employed
- Management of Health and Safety at Work Regulations - Risk Ass., safe systems of work and hierarchy of control – fitting work to worker
- **Control of Substances Hazardous to Health Regulations, COSHH**
- Control of Asbestos at Work Regulations, CAWR
- Control of Lead at Work
- Workplace health, safety and welfare Regulations
- **Environmental standards – air pollution limits**

# The Control of Substances Hazardous to Health (COSHH) Regulations

- **The Control of Substances Hazardous to Health (COSHH) Regulations** employers must risk assess all substances and prevent exposure of workers to substances that harm their health at work. There are also specific Regulations covering exposure to Asbestos and Lead.
- **If substances are harmful to health then employers must use the COSHH Control Hierarchy:**
- **Identify** all substances used at, or arising in the course of, work— dust, fumes, gases, combustion & by-products
- **All workplaces** - get your employer to carry out air monitoring – what’s in the air, how much and what size particles?
- **Assess** their risks, and if they are hazardous to health - in short or long term e.g. carcinogenic, irritant, corrosive, asthmagenic, mutagenic, reproductive toxins, **then employers must:**
- **Eliminate or substitute** with safer substances. Think creatively
- Toxic use Reduction <http://www.subsport.eu/> - **If this is not possible, then**
- **Use engineering & other controls** to prevent exposure of all workers— isolate, enclose, local exhaust ventilation - and
- **Only as a last resort** use Personal Protective Equipment

# Trade Union Clean Air Network (TUCAN) 2018/19

TUCAN <https://greenerjobsalliance.co.uk/air-pollution/>



**Guidance  
on Air Pollution  
for Union Reps**

**For more information contact:**  
Hazards Campaign: [janet@gmhazards.org.uk](mailto:janet@gmhazards.org.uk)  
Greener Jobs Alliance: [gjacomsgmail.com](mailto:gjacoms@gmail.com)

Published by TUCAN (June, 2019)

## Greener Jobs Alliance

### **Air Pollution - a Public Health Emergency**

From 27 May 2017, a new online course **Air Pollution – a Public Health Emergency** will be available on the Greener Jobs Alliance website. Air pollution is responsible for 40,000 deaths in the UK each year and the World Health Organisation has called it a global health emergency. This course looks in detail at the issue and explores what can be done about it.

It is made up of 3 modules:

1. The Causes and Health Impacts of Air Pollution
2. The Law and Government Policy
3. Trade Union Responses and Campaigns

**FREE  
ONLINE  
COURSE**

This freely available, online course is aimed at trade unionists and anyone wishing to improve their knowledge of the air pollution crisis.

You can access the course at: [www.greenerjobsalliance.co.uk](http://www.greenerjobsalliance.co.uk)



# Trade Union Clean Air Network Charter



1. Introduce a new Clean Air Act that enshrines the right to breathe clean air.
2. Update Health and Safety law
3. Ensure effective enforcement
4. Involve the workforce
5. Protect jobs
6. Rapidly expand clean and inexpensive public transport systems alongside investment in active transport to increase levels of cycling and walking



# TUCAN Guidance on Air Pollution for Union Reps

<http://www.greenerjobsalliance.co.uk/wp-content/uploads/2019/06/TUCAN-Guidance-for-TU-Reps.pdf>



## Action at work

Find out the current state of play by discussing workplace air pollution with members and other reps. You may want to use the checklist below to help you get an overall picture. Obtain access to current policies or procedures. You may need to contact a member of management to provide some of the information. To start with focus on those areas, workers or jobs that may be at particular risk.

You may find useful information by contacting local organisations. This could include the local authority who should have an air quality action plan that may provide information on monitoring stations near to work locations. Community and campaign groups may also have access to useful information and resources.

## Air pollution checklist for union reps

Topic	Yes / No	Comments
1. <b>Pollution hotspots</b> – Are there any specific areas where you feel there may be a risk from air pollution?		
2. <b>Groups of workers</b> – Are there particular types of jobs that are at risk from air pollution, or vulnerable workers who may have pre-existing conditions that put them at risk?		
3. <b>Policy</b> – Is work-related air pollution referenced in the health and safety policy and / or any other policy document?		
4. <b>Indoor exposure levels</b> – Have measurements been taken of pollution levels inside the building?		
5. <b>Outdoor exposure levels</b> – Have measurements been taken of pollution levels outside the building?		
6. <b>Changes to work activities / infrastructure</b> - Does your employer carry out environmental impact assessments on air pollution related to future plans? i.e. any changes to sites, buildings, work processes, anything that could impact the environment physically.		
7. <b>Hazard identification</b> – Have hazards associated with air pollutants been identified?		
8. <b>Control of Substances Hazardous to Health (COSHH) Risk assessment</b> – Has a risk assessment been undertaken for hazards where there is a risk to workers and / or others		
9. <b>Consultation</b> – Has there been a discussion about air pollution at the health and safety committee or any other joint management / union forum?		

10. <b>Employer information</b> – Has the employer provided any information to staff about risks of air pollution in specific locations or travel routes, or jobs and groups of workers?		
11. <b>Trade Union information</b> – Has your union developed any policy or guidance on work-related air pollution?		
12. <b>Branch lead</b> - Is there anyone in the branch who is co-ordinating union work on air pollution?		
13. <b>Membership awareness</b> – Has any information been provided by the union on air pollution risks?		
14. <b>Links with external organisations</b> – Have any links been made with campaign groups to get support for information, monitoring, local authority measurements and related policies?		
15. <b>Obtaining data on pollution levels</b> – Are you interested in testing pollution levels in your workplace and / or receiving information on monitoring sites near your location?		
16. <b>TUCAN</b> - Are you interested in working towards the aims of the TUCAN charter by running or becoming involved in an event to promote it?		

## Air Pollution sources of information

**TUCAN** – Clean Air Charter <http://www.greenerjobsalliance.co.uk/wp-content/uploads/2019/04/GJA-TU-Clean-Air-CharterEMAIL.pdf>

**Greener Jobs Alliance** - Air pollution online training modules. Free of charge and no registration required <http://www.greenerjobsalliance.co.uk/courses/>

Bi-monthly newsletter with regular air quality updates

**Hazards** - Hazards Magazine Diesel special: [www.hazards.org/](http://www.hazards.org/)

Fuming: <http://www.hazards.org/chemicals/fuming.htm>

Diesel out Prevention Factsheet: <http://www.hazards.org/chemicals/diediesel.htm> and

Die diesel die poster: <http://www.hazards.org/images/h144nedposterlarge.jpg>

**Hazards** 144, October-December 2018. Hazards Infographic Cancers and their work

causes <http://www.hazards.org/images/h145targetcancerslarge.gif>

**TUC** - Diesel Exhaust in the workplace Guide <https://www.tuc.org.uk/sites/default/files/DieselExhaustWorkplace1.pdf>

**Individual union resources** – Check your union web site

**Hazards Campaign** – [www.hazardscampaign.org.uk](http://www.hazardscampaign.org.uk)

**Friends of the Earth** <https://friendsoftheearth.uk/clean-air>

**UN Air pollution and climate change resources** <https://www.unenvironment.org/news-and-stories/story/air-pollution-and-climate-change-two-sides-same-coin>

**Client Earth** <https://www.clientearth.org/air-pollution/>

**British Lung Foundation** <https://www.blf.org.uk/support-for-you/air-pollution>

**British Safety Council** <https://www.britsafe.org/campaigns-policy/time-to-breathe-air-pollution-campaign/>

**Kings College London Air Quality Network** <https://www.londonair.org.uk/LondonAir/Default.aspx>

**Global Action Plan** <https://www.globalactionplan.org.uk/clean-air/about-clean-air>

Risk assessing

Reducing risk of Covid-19 and infectious diseases

- <https://gmhazards.org.uk/wp-content/uploads/2022/08/Final-Reducing-risk-of-Covid-19-at-Trade-Union-meetings-and-Conferences.pdf>

# Risk Management – Employers' legal duty

- Risk management is a step-by-step process for controlling health and safety risks caused by hazards in the workplace.
- You can do it yourself or appoint a [competent person](#) to help you.
- [Identify hazards](#)
- [Assess the risks](#)
- [Control the risks](#) – using the Hierarchy of control
- [Record your findings](#)
- [Review the controls](#)
- <https://www.hse.gov.uk/simple-health-safety/risk/steps-needed-to-manage-risk.htm#article>

## Covid Risk Assessment factors assessments:

**Location** Outdoors far less risk, indoor workplaces higher risk, increasing with factors below. Far <1% cases caught outdoors?

**Occupancy** Halving occupancy equivalent to doubling ventilation rate. Remember aerosols can linger for minutes or hours, so previous occupancy levels may create lingering risk.

**Infection levels 1 in 30 currently** Research shows about half to 2/3 of coronavirus transmission from people with no symptoms (asymptomatic); local rate, new variants eg Omicron more infectious than original virus

**Proximity** 2 metres is a rough minimum distance to avoid inhaling high concentrations of near-field aerosols or being sprayed with droplets but no defence against long range aerosols.

**Duration** The longer spent in a space with poor ventilation, the higher the risk.

**Activity** Aerosols exhaled when breathing + talking. Loud talking, singing, aerobic activity= more virus-loaded aerosols

**Environment** Cooler/darker/drier conditions help aerosol spread+persistence; higher temp/humidity shorten virus survival time

**Air flow** The lower the air flow the higher the risk. Doubling the ventilation rate per person can halve the infection risk.

**Masks** [Face masks](#) use can [reduce the amount of virus in the air](#) by 50% + particularly effective if they are used 'properly' and by all occupants of the room

## % LIKELIHOOD OF BECOMING INFECTED IN DIFFERENT SITUATIONS

Updated for Omicron at rate of 1 in 100 infected

Type and level of group activity	Low occupancy			High occupancy		
	Outdoor and well ventilated	Indoor and well ventilated	Poorly ventilated	Outdoor and well ventilated	Indoor and well ventilated	Poorly ventilated
Wear face coverings, contact for short time						
Silent	0.001%	0.042%	0.25%	0.002%	0.15%	0.87%
Speaking	0.002%	0.21%	1.2%	0.009%	0.73%	4.3%
Shouting, singing	0.015%	1.2%	7.2%	0.052%	4.3%	23%
Heavy exercise	0.035%	2.9%	16%	0.12%	9.7%	46%
Wear face coverings, contact for prolonged time						
Silent	0.005%	0.42%	2.5%	0.017%	1.4%	8.4%
Speaking	0.025%	2.1%	12%	0.087%	7.0%	35%
Shouting, singing	0.15%	12%	53%	0.52%	35%	93%
Heavy exercise	0.35%	25%	83%	1.2%	64%	>99%
No face coverings, contact for short time						
Silent	0.001%	0.12%	0.71%	0.005%	0.42%	2.5%
Speaking	0.007%	0.59%	3.5%	0.025%	2.1%	12%
Shouting, singing	0.043%	3.5%	19%	0.15%	12%	53%
Heavy exercise	0.10%	8.0%	39%	0.35%	25%	83%
No face coverings, contact for prolonged time						
Silent	0.014%	1.2%	6.9%	0.050%	4.1%	22%
Speaking	0.071%	5.8%	30%	0.25%	19%	71%
Shouting, singing	0.43%	30%	88%	1.5%	71%	>99%
Heavy exercise	0.99%	57%	>99%	3.4%	95%	>99%

<https://theconversation.com/heres-where-and-how-you-are-most-likely-to-catch-covid-new-study-174473>

<https://pubs.acs.org/doi/pdf/10.1021/acs.est.1c06531>

# Visualising expert estimates of covid-19 transmission

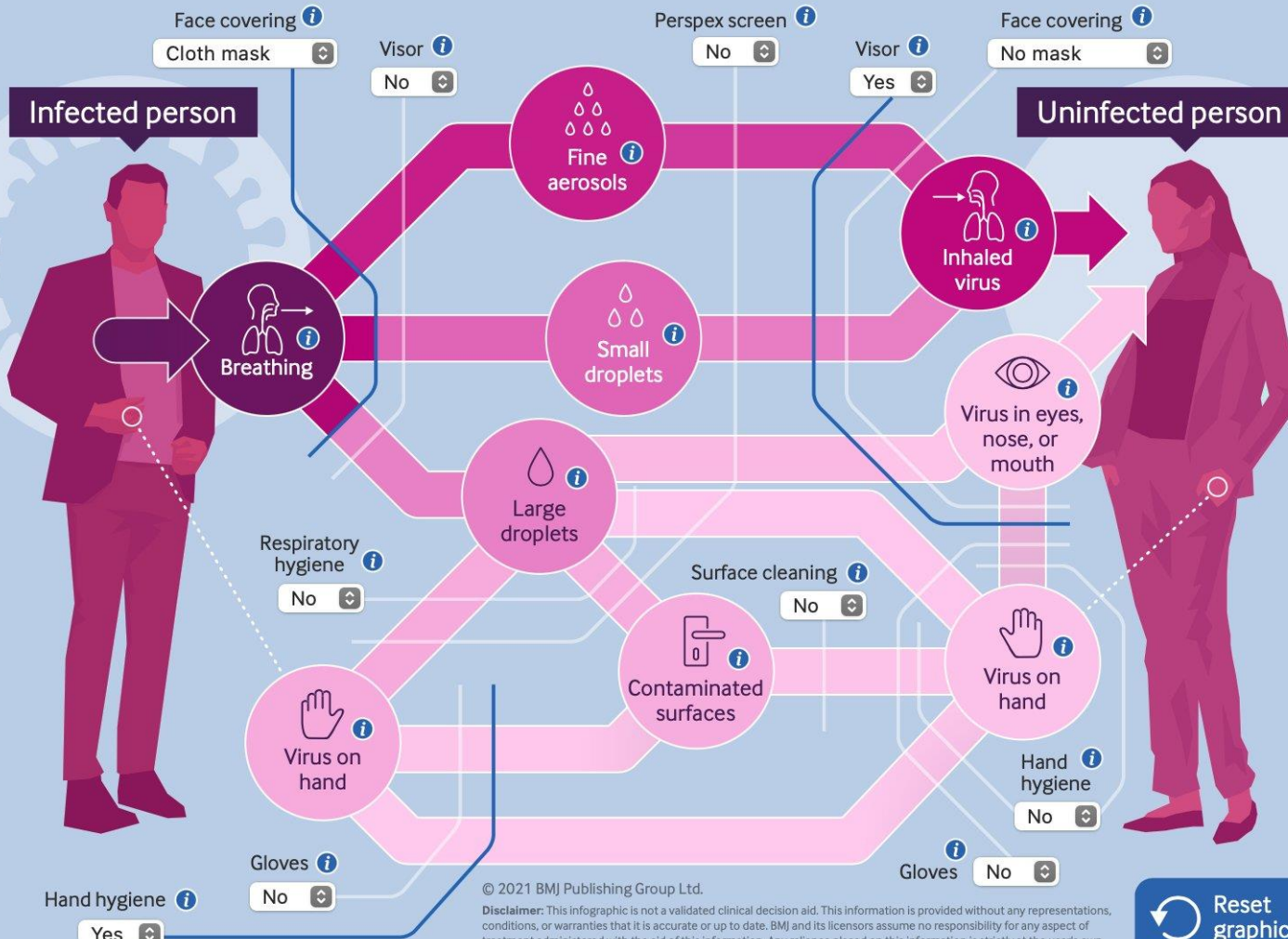
## What might be the best ways of protecting ourselves from covid-19?

This graphic simulates two people meeting, and what they can do to reduce the risk of catching covid-19. The colours show how much infectious virus is likely to be passed on, based on the best estimates of 26 international experts.



**Adjust scenario**

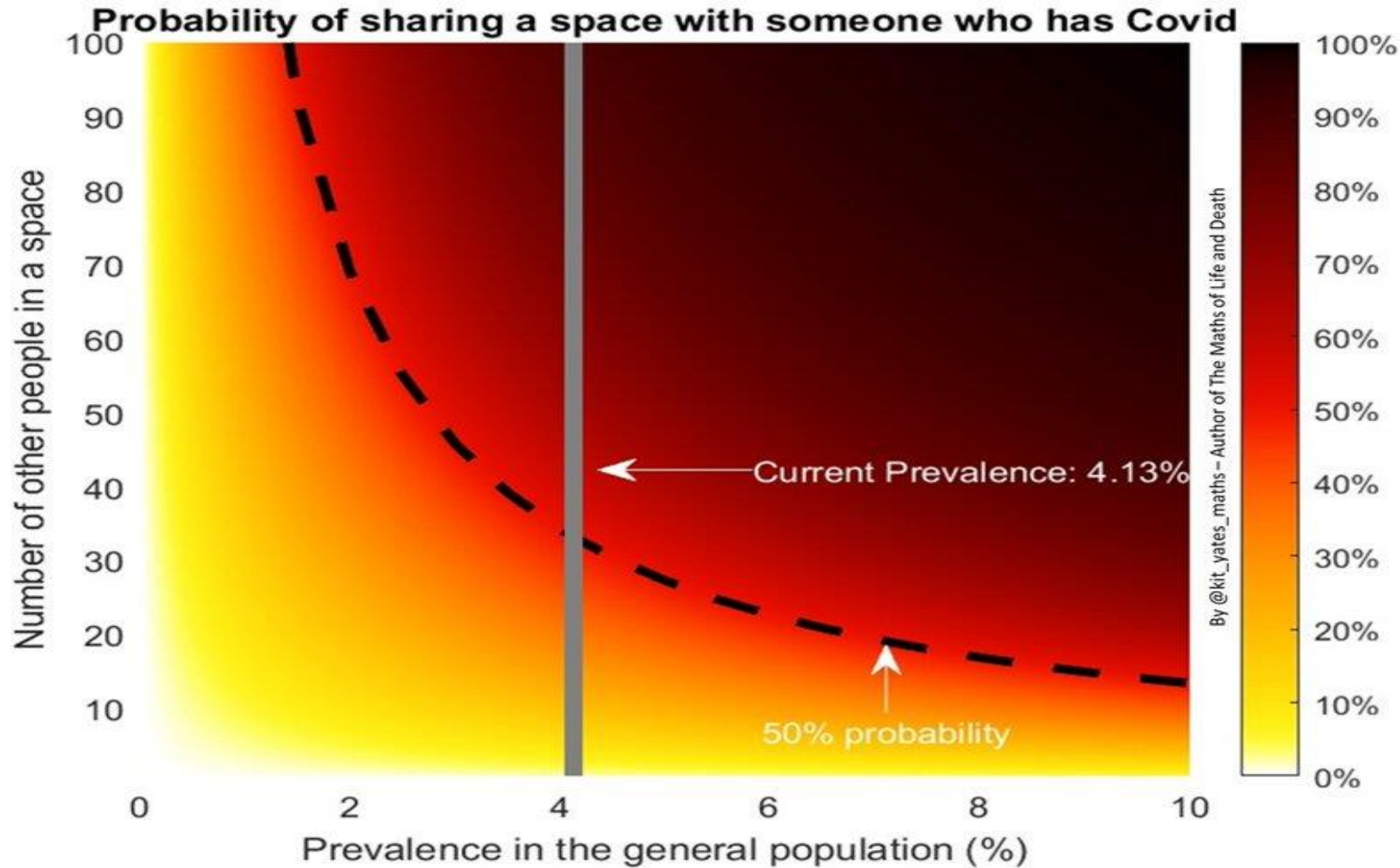
Activity <i>i</i> Coughing	Location Small room	Ventilation Off	Physical contact <i>i</i> No direct cont
	Distance Less than 2m		Surface type <i>i</i> Wood



© 2021 BMJ Publishing Group Ltd.  
 Disclaimer: This infographic is not a validated clinical decision aid. This information is provided without any representations, conditions, or warranties that it is accurate or up to date. BMJ and its licensors assume no responsibility for any aspect of treatment administered with the aid of this information. Any reliance placed on this information is strictly at the user's own risk.

<https://www.bmj.com/content/375/bmj-2021-065312>

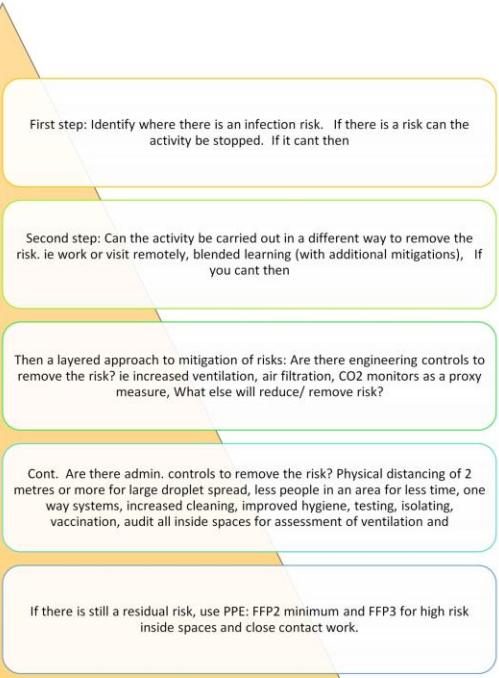
# Risk assessing according to Covid prevalence in community via @Kit\_Yates\_Maths



# Following the Hierarchy of Controls for Risks Assessed -

*All inside spaces must improve Covid-19 mitigations in order to reduce and remove the infection risks*

By assessing and controlling the infection risks including travel to and from work and using a control hierarchy approach, infections should be removed. Here's how



*In addition: individual risk assessments must be carried out for everyone with high risks from infection also individuals must be supported to isolate or stay at home with sick pay if necessary*

*And*

*Negative test results or full vaccinations do not mean other controls aren't necessary*

## Controlling COVID-19 in the Workplace

### Apply the Hierarchy of Controls

Use multiple workplace control measures in a layered approach, starting from the most effective, to reduce the risk of COVID-19 exposure.

Include public health measures such as:

- vaccination
- good hand hygiene
- cleaning and disinfecting
- physical distancing
- wearing a mask
- respiratory etiquette

#### Engineering Controls

Change the workplace:

- Improve indoor air ventilation and filtration.
- Install physical barriers.
- Install touchless controls for payments, water taps, doors, and bin lids.
- Install hand hygiene equipment: sinks and sanitizer dispensers.
- Adjust layout of furniture, equipment, and workstations to maximize physical distancing.

#### Elimination and Substitution

Remove the hazard or replace it with something less hazardous:

- If possible, allow or require workers to work remotely.
- Provide reasonable accommodations where required.
- Use technologies to facilitate working remotely, such as teleconferencing and online forms.

#### Administrative Controls

Change how people work:

- Communicate risks, rules and procedures.
- Limit occupancy, stagger shifts/teams.
- Screen workers, visitors, and customers.
- Practice the greatest possible physical distancing, good hand hygiene and respiratory etiquette.
- Create a cleaning and disinfecting program for high-touch surfaces and shared objects.
- Update emergency response and business continuity plans.
- Implement a vaccination policy that complies with the requirements in your jurisdiction, and update as required.

#### Personal Protective Equipment (PPE)

Protect the worker:

- PPE is regulated and must be appropriate to the workplace hazards and activities.
- Workers must be trained how to properly use and maintain their PPE.

\*Respirators used as PPE must be fit tested

#### Most effective

#### Least effective

#### MASKS

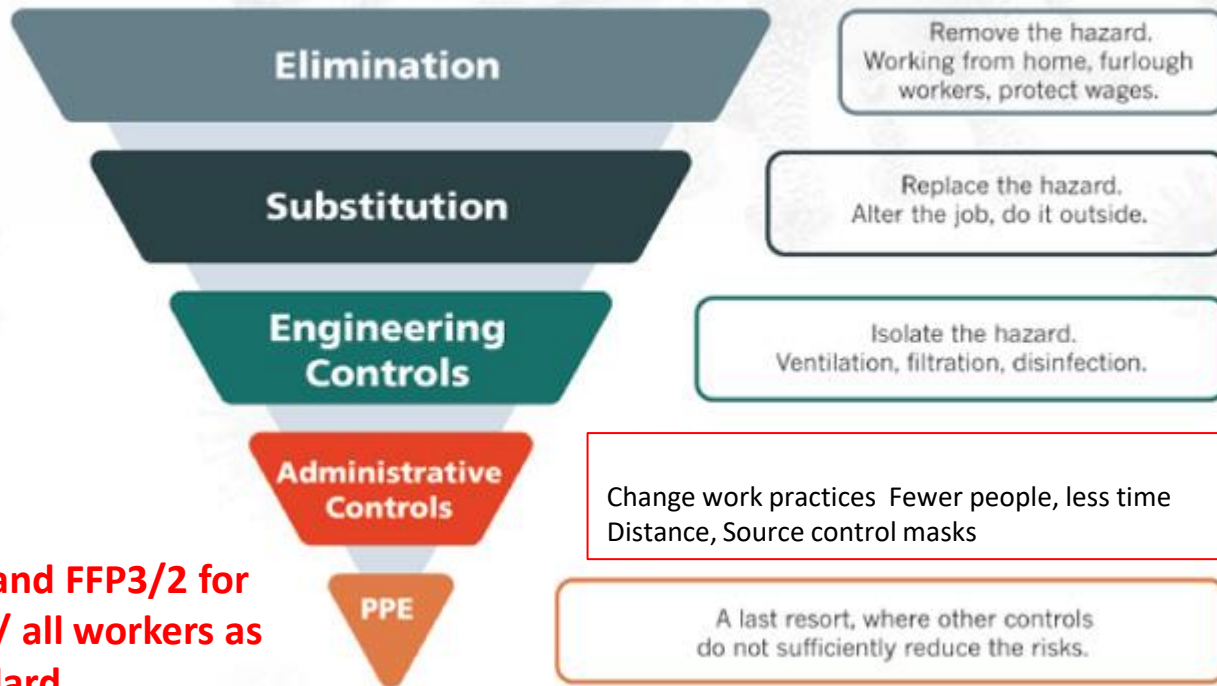
Source Control	PPE
<p>Masks and respirators used as 'source control' are:</p> <ul style="list-style-type: none"> <li>Intended to control the hazard at the source (infected individual) to help protect others.</li> <li>Meant to limit the spread of the wearer's exhaled respiratory particles.</li> <li>Not required to be fit tested but should be as well-constructed and well-fitting as possible.</li> </ul>	<p>Masks and respirators used as PPE are:</p> <ul style="list-style-type: none"> <li>Intended to control the hazard (exposure to COVID-19) at the worker level.</li> <li>Meant to act as a barrier or limit the inhalation of infectious respiratory particles.</li> <li>Required to be manufactured to applicable standards and must meet all regulatory requirements, including worker fit testing and training.</li> </ul>



# Risk Control Hierarchy From Collective Prevention first to Individual Protection

## REDUCING THE RISKS

Follow the hierarchy of prevention.  
In order of priority, utilise:

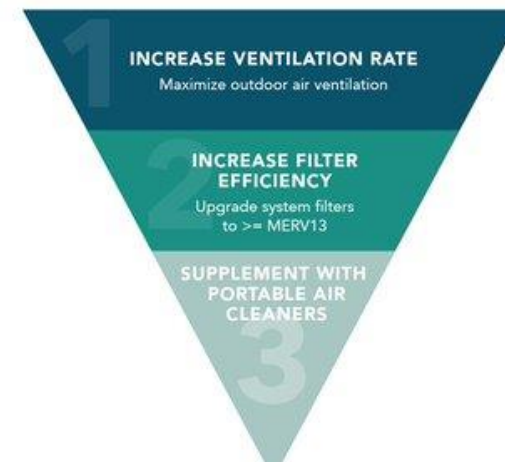


**Demand FFP3/2 for HCW/ all workers as standard**

## BUILDING FOR HEALTH



SCHOOL OF PUBLIC HEALTH



	Ideal (6 ACH)
	Excellent (5-6 ACH)
	Good (4-5 ACH)
	Bare minimum (3-4 ACH)
	Low (<3 ACH)

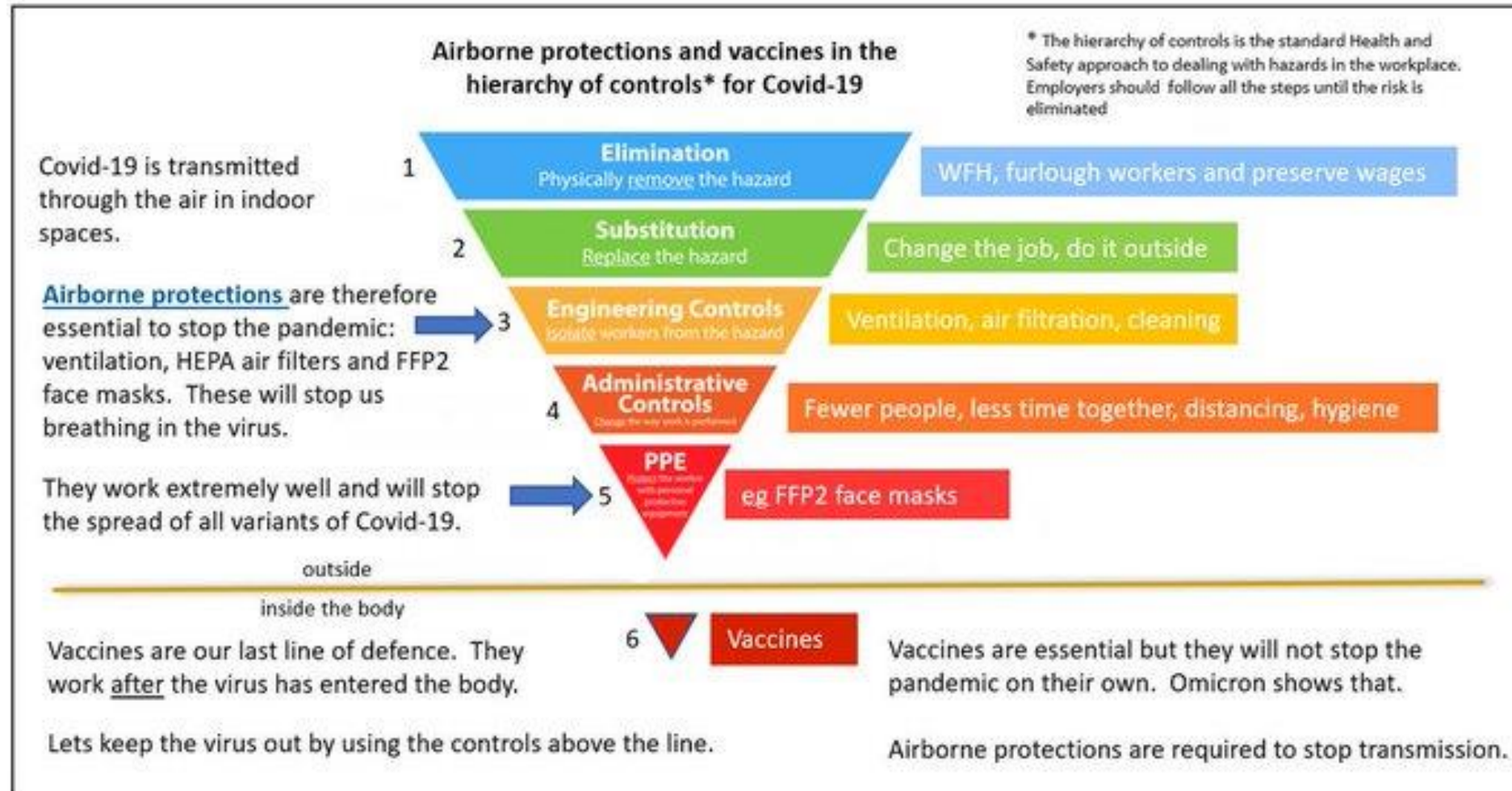
$$\text{Air changes per hour} = \frac{\text{"clean" air rate}}{\text{room volume}} = \frac{\text{cubic feet per minute} \times 60 \text{ minutes}}{\text{length} \times \text{width} \times \text{height (in feet)}}$$

## Better ventilation must be for life not just for Covid

Dr Richard Corsi: 'I do not believe aiming for 4 or 6 ACH in schools or other indoor spaces is sufficiently aspirational & have written about how a combo of increased outdoor air supply and use of #CorsiRosenthalBoxes can get us close to 10 equivalent ACH in classrooms'

# Multiple layered preventions: Collective prevention first in Hierarchy of Control

@docjon Doctors in Unite



German doctors are sending this around on Twitter.

#coronavirus #Covid\_19

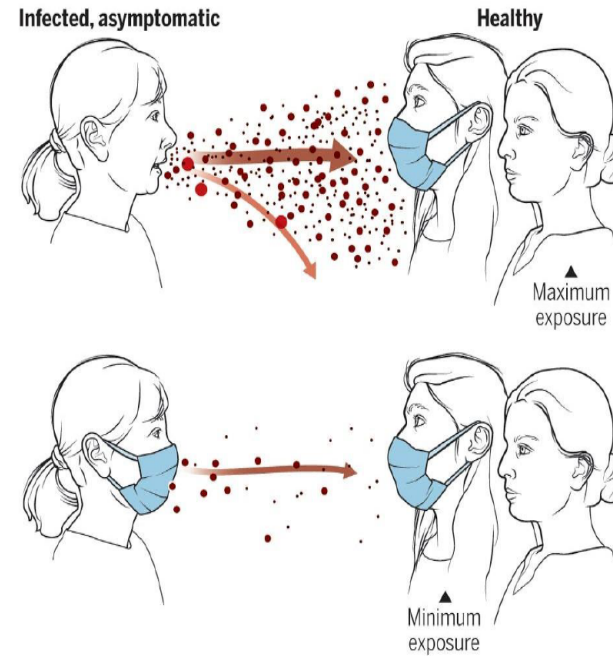
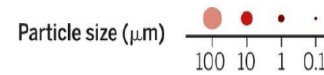


### FFP2 masks



### Masks reduce airborne transmission

Infectious aerosol particles can be released during breathing and speaking by asymptomatic infected individuals. No masking maximizes exposure, whereas universal masking results in the least exposure.



GRAPHIC: V. ALTOUNIAN/SCIENCE

### Mask effectiveness

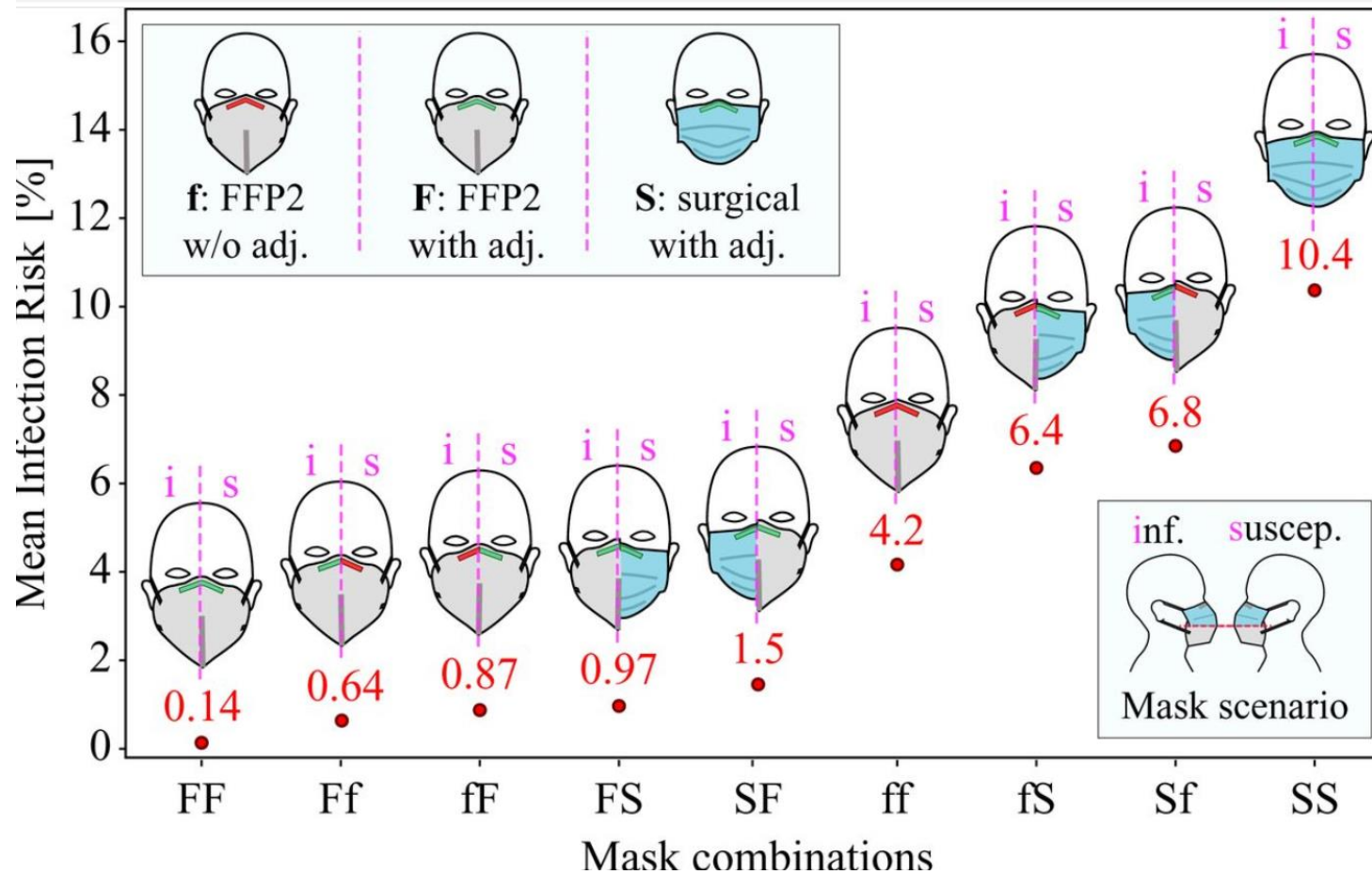
- MASKS WORK!
- ~50% reduction in exhaling virus
- ~30% reduction in inhaling virus
- Average figures; if fit is good even better
- Don't take it off to talk!
- Wear at all times indoors with other people NOT ONLY when you can't social distance
- 2-3 layers material better, but something always better than nothing

See also [Astounding Physics of N95 Masks - YouTube](https://tinyurl.com/r9s3t6z5) <https://tinyurl.com/r9s3t6z5>

Trish Greenhalgh links on masks <https://twitter.com/trishgreenhalgh/status/1414294003479089154>

[An upper bound on one-to-one exposure to infectious human respiratory particles | PNAS](https://www.pnas.org/content/118/49/e2110117118)

<https://www.pnas.org/content/118/49/e2110117118> [COVID-19 Fact Sheet: Workers Need Respirators – ACGIH](https://www.acgih.org/covid-19-fact-sheet-worker-resp/) <https://www.acgih.org/covid-19-fact-sheet-worker-resp/> [Update Alert 8: Masks for Prevention of Respiratory Virus Infections, Including SARS-CoV-2, in Health Care and Community Settings | Annals of Internal Medicine \(acpjournals.org\)](https://www.acpjournals.org/doi/10.7326/L22-0272) <https://www.acpjournals.org/doi/10.7326/L22-0272>



**Even with good ventilation and air filtration, still need to wear good masks - preferably FFP2/3 everywhere indoors in shared air whether close or distanced**

See also [Astounding Physics of N95 Masks - YouTube](https://www.youtube.com/watch?v=astounding-physics-of-n95-masks)  
<https://tinyurl.com/r9s3t6z5> Trish Greenhalgh links on mask effectiveness  
<https://twitter.com/trishgreenhalgh/status/1414294003479089154>

[An upper bound on one-to-one exposure to infectious human respiratory particles | PNAS](https://www.pnas.org/content/118/49/e2110117118)  
<https://www.pnas.org/content/118/49/e2110117118>

- “We find a very low risk of infection when everyone wears a face mask, even if it doesn’t fit perfectly on the face.”  
<https://www.pnas.org/content/118/49/e2110117118>
- Sept 2002 Just an 80% reduction in per capita #COVID death in countries that had mask policies. Peer reviewed.  
[https://www.ajpmonline.org/article/S0749-3797\(21\)00557-2/fulltext#%20](https://www.ajpmonline.org/article/S0749-3797(21)00557-2/fulltext#%20)
- Another study in the US showed that 80% of people using N95 masks (FFP2 equivalent) without formal fit testing, achieved better protection than with a surgical mask. Dr Lisa Brosseau, Bioaerosol scientist.  
<https://www.tandfonline.com/doi/full/10.1080/15459624.2010.514782?journalCode=uoeh20>

**Table 1. Time to Infectious Dose for an Uninfected Person (Receiver)\***

<https://www.cidrap.umn.edu/news-perspective/2021/10/commentary-what-can-masks-do-part-1-science-behind-covid-19-protection>

		Receiver is wearing (% inward leakage)				
		Nothing	Typical cloth mask	Typical surgical mask	Non-fit-tested N95 FFR	Fit-tested N95 FFR
Source is wearing (% outward leakage)		100%	75%	50%	20%	10%
Nothing	100%	15 min	20 min	30 min	1.25 hr	2.5 hr
Typical cloth mask	75%	20 min	26 min	40 min	1.7 hr	3.3 hr
Typical surgical mask	50%	30 min	40 min	1 hr	2.5 hr	5 hr
Non-fit-tested N95 FFR**	20%	1.25 hr	1.7 hr	2.5 hr	6.25 hr	12.5 hr
Fit-tested N95 FFR	10%	2.5 hr	3.3 hr	5 hr	12.5 hr	25 hr

\*The data for % inward and outward leakage of cloth and surgical masks were derived from a study by Lindsley et al (2021). Data for non-fit-tested N95 FFRs come from a study by Brosseau (2020). Data for fit-tested N95 FFRs are derived from the OSHA-assigned protection factor of 10 for half-facepiece respirators. Also, times were established before wide circulation of the more transmissible Delta variant.

\*\*FFR = filtering facepiece respirator; N95 = not oil-proof, 95% efficient at NIOSH filter test conditions

Time required to reach infectious dose inhaled by the vulnerable person  
Wild vs **Delta** strain

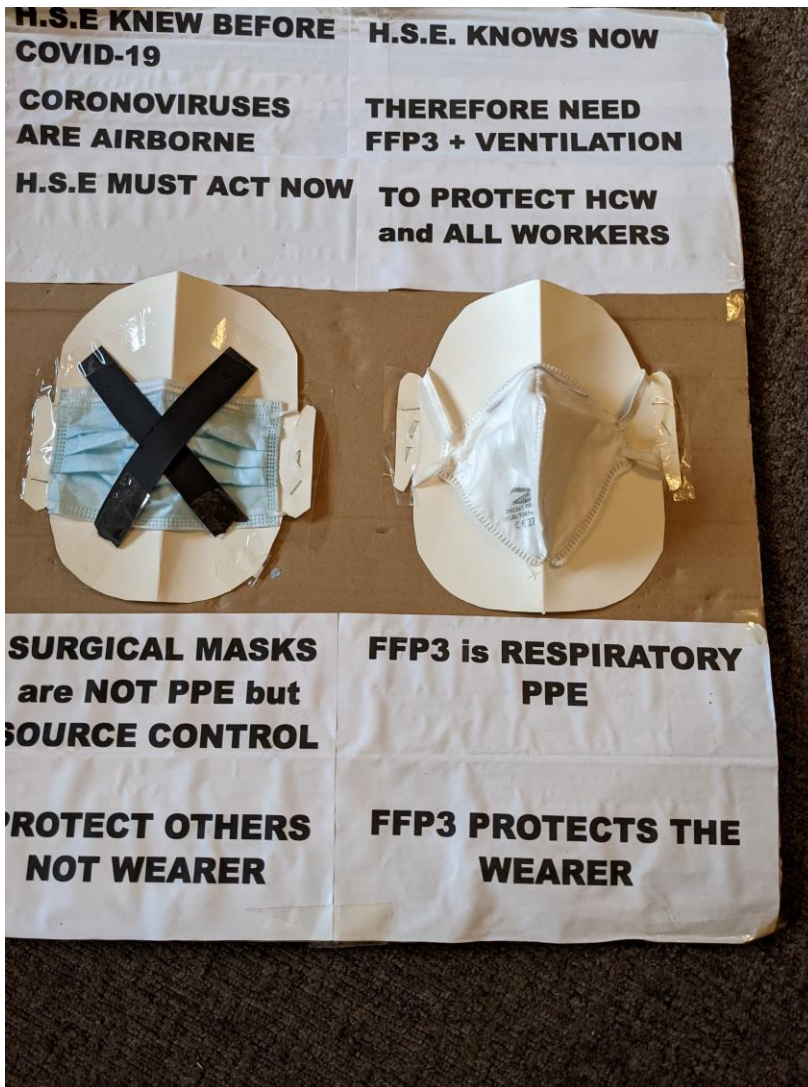
**Vulnerable person is wearing**

		Nothing	Cloth	SM	SM, fit	N95	N95, fit
Infectious person is wearing	Nothing	10 min 4 min	14 min 6 min	20 min 8 min	50 min 20 min	1.7 hours 41 min	16.7 hours 6.8 hours
	Cloth	17 min 7 min	24 min 10 min	33 min 13 min	83 min 34 min	2.8 hours 68 min	28 hours 11 hours
	SM	20 min 8 min	29 min 12 min	40 min 16	1.7 hours 41 min	3.3 hours 81 min	33 hours 14 hours
	SM, fit	50 min 20 min	71 min 29 min	2 hours 41 min	4.2 hours 1.7 hours	8.3 hours 3.4 hours	83 hours 34 hours
	N95	1.7 hours 40 min	2.4 hours 58 min	3 hours 81 min	8.3 hours 3.4 hours	17 hours 6.8 hours	167 hours 68 hours
	N95, fit	16.7 hours 6.8 hours	24 hours 10 hours	33 hours 14 hours	83 hours 34 hours	167 hours 68 hours	<b>1667 hours</b> <b>677 hours</b>

**Vulnerable person is wearing**

		Nothing	Cloth	SM	SM, fit	N95	N95, fit
Infectious person is wearing	Nothing	X 0.4X	1.4X 0.6X	2X 0.8X	5X 2X	10X 4X	100X 41X
	Cloth	1.7X 0.7X	2.4X X	3.3X 1.3X	8X 3.4X	17X 7X	168X 66X
	SM	2X 0.8X	3X 1.2X	4X 1.6X	10X 4X	20X 8X	198X 84X
	SM, fit	5X 2X	7X 3X	12X 4.1X	25X 10X	50X 20X	498X 204X
	N95	10X 4X	14.4X 5.8X	18X 8X	50X 20.4X	102X 41X	1,002X 408X
	N95, fit	100X 40X	144X 60X	198X 84X	498X 204X	1,002X 408X	<b>10,002X</b> <b>4,062X</b>

SM = surgical mask; SM, fit = surgical mask with fit-enhancing brace;



## HSE Research Report 2008 RR619 Evaluating the protection afforded by surgical masks against influenza bioaerosols

### Main Findings

This study focussed on the effectiveness of surgical masks against a range of airborne particles. Using separate tests to measure levels of inert particles and live aerosolised influenza virus, **our findings show that surgical masks provide around a 6-fold reduction in exposure. Live viruses could be detected in the air behind all surgical masks tested. By contrast, properly fitted respirators could provide at least a 100-fold reduction.**

<https://www.hse.gov.uk/research/rrhtm/rr619.htm>

Health Care Workers let down by HSE and Infection Prevention Control bodies based on false info: only AGP procedures risky, droplet dogma, denying airborne transmission. HCW organised themselves to demand FFP3 and HEPA filters in hospitals

The Lancet says \*

**AGPs are BS**

Everyone is an  
Aerosol Generating Person  
*everywhere and all the time*

That's why we need  
**respiratory protection**  
*everywhere and all the time*

\*[https://www.thelancet.com/journals/lanres/article/PIIS2213-2600\(21\)00216-2/fulltext](https://www.thelancet.com/journals/lanres/article/PIIS2213-2600(21)00216-2/fulltext)

Doctors in Unite

# We need cleaner air at work to prevent Covid + other airborne infections, for better health, less sickness, for ALWAYS

HSE removed need for specific risk assessment for Covid [Coronavirus \(COVID-19\) – Advice for workplaces \(hse.gov.uk\)](https://www.hse.gov.uk/coronavirus/)

<https://www.hse.gov.uk/coronavirus/> following Govt advice that Covid is so widespread it is now only a Public Health not Occupational Health issue.

But HSE reiterates general legal duties under HASAW Act, plus specific legal requirements for risk assessment + control hierarchy in Management Regs, COSHH Regs and Workplace Health, Safety and Welfare Regs especially ventilation still apply [Ventilation in the workplace \(hse.gov.uk\)](https://www.hse.gov.uk/ventilation/index.htm)

<https://www.hse.gov.uk/ventilation/index.htm>

Because Covid is causing so much sickness amongst staff, infections, reinfections and Long Covid, massive sickness absence and disruption at work, maybe use the Independent Sage Pledge to reopen discussions with management + negotiate better collective action.

[THE NEW COVID-19 SAFETY PLEDGE | Independent SAGE](https://www.independentsage.org/the-new-covid-19-safety-pledge/)

<https://www.independentsage.org/the-new-covid-19-safety-pledge/> is supported by Hazards Campaign and many unions

## The COVID-19 Safety Pledge



We pledge to protect our staff, users and customers from Covid-19.



We will assess our physical environment and working practices according to Health and Safety law, including Risk Assessments, in order to ensure that they are designed to safeguard against the spread of infection.

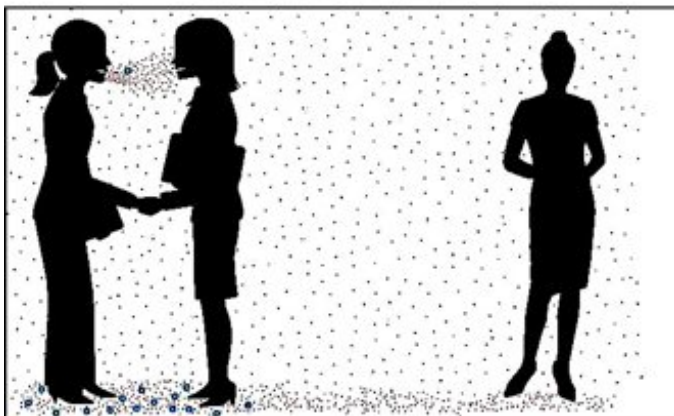


We will abide by best public health advice and ensure that all workers who test positive for Covid are both asked to self-isolate and given adequate support to stay at home.

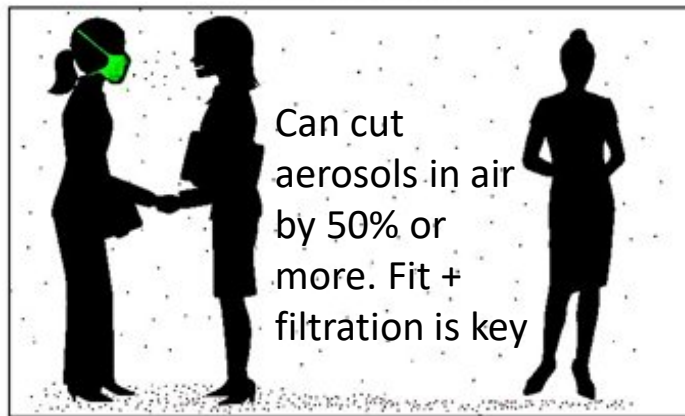


# Employers must implement multiple control measures – no one silver bullet

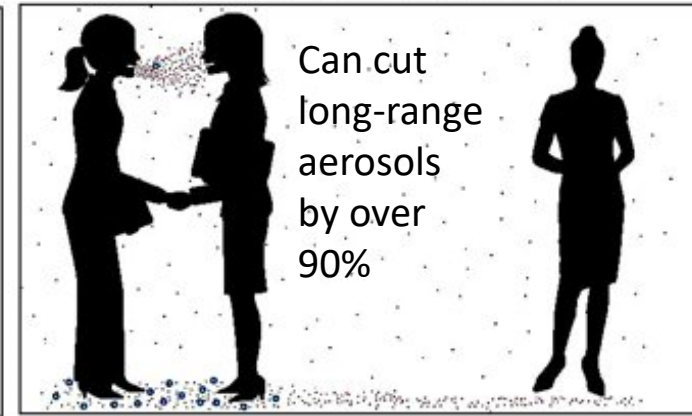
No interventions



1. Source control



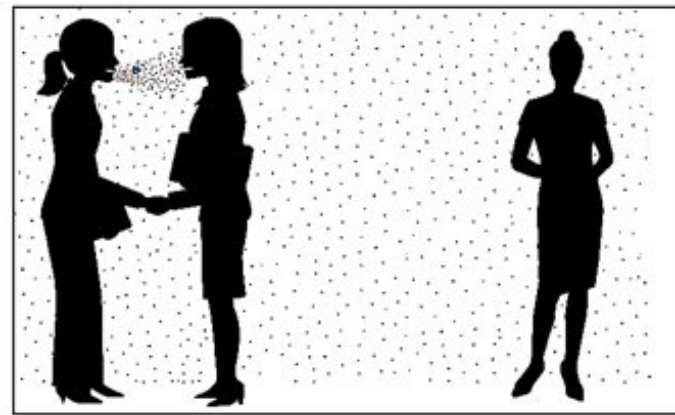
2. Ventilation and filtration



3. Distance and PPE



4. Hygiene



All interventions



Useful modelling tools that show how changing different factors affect ventilation allows visual comparison of the risks factors and the effects of control measures and mitigations:

[https://www.zeit.de/wissen/gesundheit/2020-11/coronavirus-aerosols-infection-risk-hotspot-interiors?utm\\_referrer=https%3A%2F%2Ft.co%2F](https://www.zeit.de/wissen/gesundheit/2020-11/coronavirus-aerosols-infection-risk-hotspot-interiors?utm_referrer=https%3A%2F%2Ft.co%2F)

Evaluate COVID-19 risk of infection from airborne transmission <https://airborne.cam/> <https://indoor-covid-safety.herokuapp.com/apps/advanced>

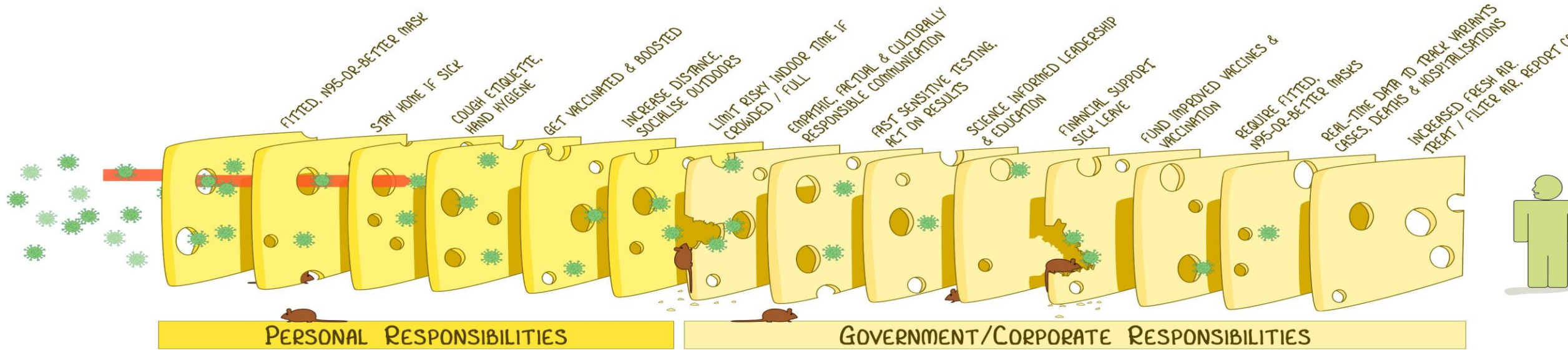
<https://safeairspaces.com/safeairspaces-estimator> <https://schools.forhealth.org/covid-19-tools/> BOHS <https://tinyurl.com/k8pb332z> <https://www.bmj.com/content/375/bmj-2021-065312>

[https://docs.google.com/spreadsheets/d/1NEhk1IEdbEi\\_b3wa6gl\\_zNs8uBJjISS-86d4b7bW098/edit#gid=1882881703](https://docs.google.com/spreadsheets/d/1NEhk1IEdbEi_b3wa6gl_zNs8uBJjISS-86d4b7bW098/edit#gid=1882881703)

# THE SWISS CHEESE VACCINE-PLUS RESPIRATORY VIRUS DEFENCE GRAPHIC

Ian M Mackay PhD  
@MackayIM

RECOGNISING THAT NO SINGLE INTERVENTION IS PERFECT AT PREVENTING SPREAD



EVERY INTERVENTION (SLICE/LAYER) HAS IMPERFECTIONS (HOLES) WHICH CHANGE IN SIZE, NUMBER AND POSITION DEPENDING ON VIRUS BURDEN, HOW THE INTERVENTION IS ROLLED OUT & COMPLIANCE.  
MULTIPLE LAYERS IMPROVE SUCCESS.  
LAYER ORDER IS NOT RELEVANT.

 MISINFORMATION MOUSE

IAN M MACKAY & KATHERINE E ARDEN  
VIROLOGYDOWNUNDER.COM  
BASED ON THE WORK OF JAMES T REASON, 1990  
VERSION 5.3  
UPDATE: 17OCT2022

<https://www.bohs.org/media-resources/press-releases/detail/vaccination-not-enough-to-protect-workers-from-covid-19/>

<https://www.bbc.co.uk/news/resources/idt-40ac92b1-1750-4e86-9936-2cda6b0acb3f>

# Air Pollution – All in a day's work?

- We work/live in toxic soup of chemicals
- Workers are the canaries, exposed first, exposed most + considered last
- All workers exposed to air pollution at work including COVID virus
- Public health emergency BUT also an Occupational health emergency for decades: 30,000 deaths p.a. in UK, millions? of workers every year by toxic air @work
- Equality and Justice - lowest paid at most risk and multiply exposed to toxic substances in air at work, at home, commuting everywhere, and their families most affected
- Air Pollution including airborne pandemics , Climate Change, Plastic/other Pollution effects on workers and public are all linked = Trade Union issue
- We need collective Integrated Action to cut toxic substances at source, @work to :
  - ❖ Protect workers lives + health – stronger enforced health + safety laws
  - ❖ Get toxics out of work, our homes, environment, bodies & our lives – Toxics Use Reduction lives – Toxics Use Reduction [https://www.researchgate.net/publication/348564404\\_Toxics\\_Use\\_Reduction\\_beyond\\_analysis\\_to\\_action\\_Linking\\_public\\_health\\_occupational\\_health\\_and\\_safety\\_environmental\\_sustainability\\_and\\_new\\_or\\_better\\_employment\\_a\\_position\\_paper](https://www.researchgate.net/publication/348564404_Toxics_Use_Reduction_beyond_analysis_to_action_Linking_public_health_occupational_health_and_safety_environmental_sustainability_and_new_or_better_employment_a_position_paper) Create Decent jobs for Decent lives for Decent Lives, and
  - ❖ Justice, Equality + the Just Transition to a cleaner, greener, fairer world – solutions must be fair and reduce inequalities in health and wealth
  - ❖ Safety Reps role is in organising the fight for cleaner air and healthier work

## HAZARDS CAMPAIGN

**GreenerJobsAlliance**

