How important is clean indoor air to reducing Covid-19 infections?

SARS-Cov2 is almost always transmitted by breathing in viral particles that have been exhaled by somebody with an acute infection. The same is true for many other viruses, such as those causing flu or the cold. When somebody is infected, they exhale virus in the form of aerosols, which are tiny liquid, solid or semisolid particles that some call **virosols**. A small percentage of those aerosols or virosols are so large that they fall out of the air within seconds, however, most are so small that they remain in the air for more than half an hour and sometimes more than 12 hours.

Outdoors, aerosols disperse very quickly. Fortunately, you won't get infected by breathing in one or two virus particles. Precisely how much virus somebody needs to inhale to become infected is not clear, but one of the lowest estimates is 100 particles.

Without high levels of ventilation and/or air filtering, virosols remain in the air much longer indoors. Anyone who remembers the time when people were allowed to smoke in pubs, restaurants or on public transport will remember how tobacco smoke would slowly build up across indoor spaces. The build-up of virosol-laden air can be imagined in the same way. When an infected person sits for example at one end of a restaurant, they will continually exhale virus particles, and those will spread across the room so that people sitting at the other end of the same restaurant can get infected. Air conditioning not designed for infection control can even spread air with high viral load to other rooms in the same building.

And just as cigarette smoke remains in poorly ventilated air after the smoker has left, people can get infected from breathing in virus-laden indoor air after the infected person has left the room or building (or, for that matter, a public toilet).

A study in Italy showed that children in well-ventilated classrooms were 80% less likely to become infected with Covid-19 than those in less ventilated ones. Note, however, that children were also wearing masks for the duration of that study.

Does that mean I am safe from infection as long as I socialise outdoors or in well-ventilated buildings?

Not quite. Outdoors or in very clean indoor air, virosols will disperse, so there should be no realistic risk of becoming infected from somebody sitting, for example, a few tables away. However, directly breathing in air exhaled by somebody infected can still cause you to develop Covid-19. How far apart you'd need to be for this to be a risk depends on what the infected person is doing. Singing and shouting spread more virus particles across more of a distance than speaking quietly, let alone walking in silence. Click here to find out more about infection risks linked to different activities. Thus, outdoors, or in very clean indoor air, an additional layer of mitigation will still be important, i.e. social distancing or masks, particularly now that free Covid tests have been withdrawn.

What is good ventilation?

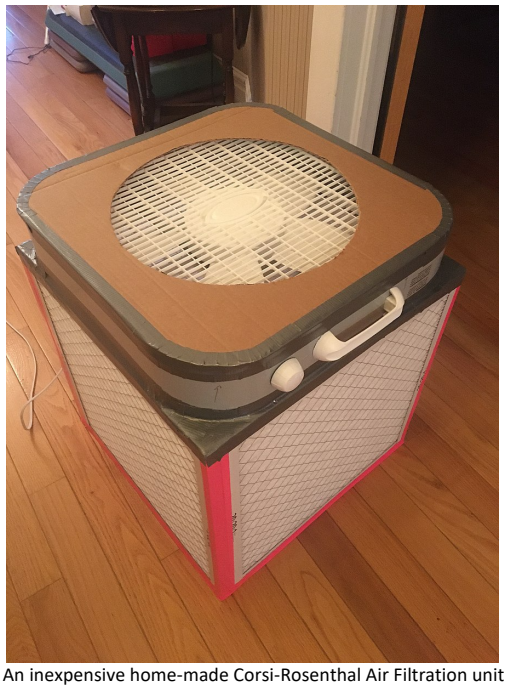
How effective ventilation is can be measured in terms of CO2 concentrations. CO2 levels in the atmosphere are now around 415 ppm, so the closer CO2 readings indoors are to that figure, the better the ventilation is. Note however, that air filters, unlike ventilation, do not reduce CO2.

Unfortunately, the Health and Safety Executive's Code of Practice on Workplace Health, Safety and Wellbeing has not been updated since 2013. It says that "The fresh-air supply rate should not normally fall below 5 to 8 litres per second, per occupant." It is a standard designed to stop workers from suffering ill effects of excessive CO2 levels, such as headaches, not to reduce viral infections. The HSE website does, however, link to the post-lockdown ventilation guide by the Chartered Institution of Building Services Engineers (CIBSE), and that recommends a minimum of 10 litres per second of fresh air per occupant, stating that this "will result in a maximum CO2 concentration of 800-1000 ppm". Yet there is no scientific evidence that this level of ventilation is sufficient for example for keeping children in school or people in restaurants safe from being infected by somebody not sitting close to them. In September 2021, Professor Trisha Greenhalgh, a health expert specialising in airborne virus transmissions, commented: "start worrying when levels rise above ~700 ppm."

Since then, the far more infectious Omicron variants have emerged, with a recent study suggesting that people infected with Omicron may shed up to 1,000 times as many virus particles compared to previous variants. Thus, ***unless CO2 levels are similar indoors as outdoors, we must assume that another layer of mitigation (masks or air filters) is needed to prevent infection from somebody not close by***, even more so for prolonged contact.

Air filters:

HEPA [high efficiency particulate air] filters are mechanical air filters, which use electricity to force air through a filter that traps small particulates such as air pollutants from cars outside, pollen and other allergens - and particles carrying viruses. There are also DIY versions, such as Corsi-Rosenthal boxes, which, while not certified HEPA filters, operate effectively following the same principle. HEPA filters are designed to capture 99.97% of aerosols even below the smallest size at which virosols occur in air. How efficiently an HEPA filter cleans the air depends on what is called the clean air delivery rate (CADR). The higher the CDR, the more air the filters will clean in the same amount of time. Please see below for links for further information.



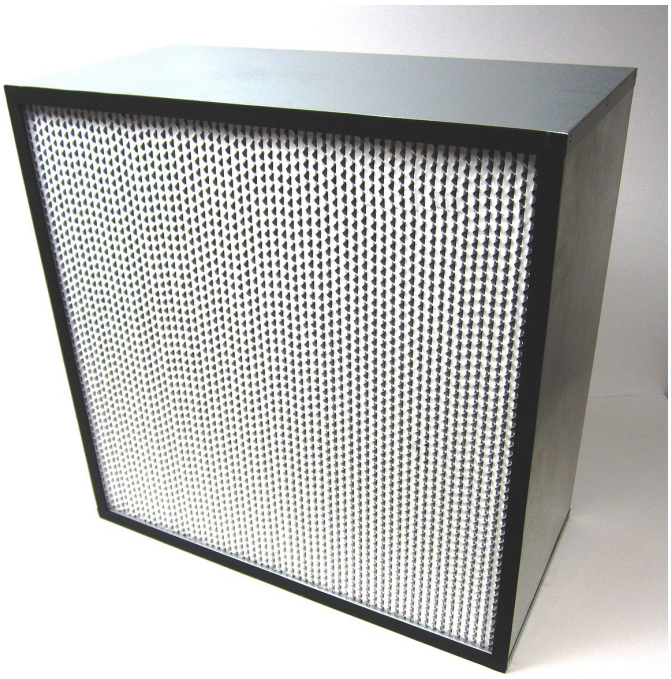
An inexpensive home-made Corsi-Rosenthal Air Filtration unit

Sadly, the Scottish Government has not so far recommended the use of HEPA filters including in schools, claiming that they cannot replace adequate ventilation. It is true that ventilation will always be important, not least to prevent unhealthy concentrations of CO2. In reality, however, ***achieving CO2 levels below 700 ppm, let alone indoor CO2 levels similar to those outdoors will be impossible in many schools and other buildings without extensive investments, including mechanical ventilation. Air filters should be regarded as necessary, not controversial.*** Also, operating an air filter will require far less energy than heating classrooms and other spaces to a comfortable temperature while trying to get CO2 levels below 700 ppm by opening windows.

What about getting a different type of 'air cleaning' system such as an ioniser?

The only proven ways of cleaning indoor air are mechanical air filters (including HEPA filters and also DIY Corsi-Rosenthal boxes), and germicidal UV light. As explained by architect and ventilation expert Michelle Wong at an Independent SAGE event, germicidal UV light requires specialist advice and installation as well as high ceilings, unlike mechanical air filters which are portable and can be used by anyone. Ionisers and other systems that add chemicals to the air are not only unproven as far as infection control is concerned but can be harmful to health. Ionisers increase indoor ozone levels which is bad for respiratory health.

Where can I find out more about ventilation systems and air filters?



Hepa Air Filter

- The Independent SAGE Practical Guide to Creating Safer Air to Reduce COVID-19 Transmission with examples of different HEPA filters and government-approved CO2 metres: https://www.independentsage.org/wp-content/uploads/2022/03/The-Independent-SAGE-Practical-Guide-V7-complete.pdf
- Instructions for building a Cosi-Rosenthal box air filter: https://engineering.ucdavis.edu/news/science-action-how-build-corsi-rosenthal-box
- Hazards Campaign presentation on ventilation and air filters in workplaces (including schools) with links to more information: https://drive.google.com/file/d/1h3r20G_BTJsqUkg6qOJnzEcIOxeQvUmh/view

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