

How does building ventilation affect infection control?



The ventilation system refers to equipment that moves air throughout a building, bringing outdoor air inside and filtering air in the building. Ventilation is important for good indoor air quality in a building. It also plays a role in reducing the transmission of airborne viruses like SARS-CoV-2, the virus that causes COVID-19, and other diseases, chemicals and odors.

HVAC

Heating, Ventilation, and Air Conditioning. These systems are installed in many commercial and school buildings to circulate and filter the air. There are several different types but the most common in commercial buildings are installed in the ceiling or as wall mounted units. HVAC systems do two things:



- 1 **ventilation:** they bring outside air into the room
- 2 **filtration:** they filter germs, odors and dust/pollen out of the air

There are a range of options to improve existing ventilation systems for microbe (germ) control. Options will depend on the type, age and condition of the ventilation system in each space.

COVID-19

Breathing virus-containing air is how we get sick with COVID-19. We now know that we are much less likely to get sick from touching surfaces where the virus particles have landed. So it is very important to do everything we can to reduce the risk of breathing in these virus-containing particles. Multi-layered masks help to protect wearers from breathing in the particles, and social distancing reduces the number of particles in the air around us. Proper hand washing can remove the virus from hands, and disinfecting inactivates particles that have landed on hard surfaces.

All of these ventilation and filtration systems must be combined with use of masks, social distancing and hand washing in order to reduce the risk of exposure to the virus. When all of these actions are combined, there is a 92% reduction in risk of infection in a classroom.



When we breathe, talk, cough, sneeze or sing, we deliver small particles (a clump of liquid or solids) containing germs into the air. Smaller particles, called aerosols, can stay in the air longer, up to 8 hours, but larger particles, called droplets, can fall out of the air and land on surfaces after a few minutes.

Ventilation is an important way to both *remove* these smaller particles from the air and *dilute* their number with air from the outside. There are several types of equipment to improve ventilation including:

Adequate ventilation and filter changes on ventilation systems can help break the chain of infection by providing fresh air that dilutes the virus particles or removes some or all particles by filtering them out.

Buildings with HVAC systems will generally have a building or facilities manager to change filters and maintain the system. Check with them or your landlord to determine how you can improve your system by using filters and having the correct number of air changes per hour (ACH).

Filters in HVAC systems remove particles such as smoke, dust, dirt, pollen, mold, bacteria and viruses. They are rated for what they filter out of the air. The highest minimum efficiency reporting value (MERV) filter your HVAC system can handle (a rating of 13 and above is recommended) will help to filter out the SARS-CoV-2 virus. High Efficiency Particulate Air (HEPA) filters can remove a higher percentage of microbes but not all HVAC systems are designed for their use. Make sure you follow the manufacturer's instructions for how often to change the filter and always have a spare filter

on hand. Wear an N95 mask and gloves when you change the filter. Place in a trash bag and tape it closed before disposing of it in the trash.

It's important to have the right size and MERV rating of filters and settings that achieve 5-6 room air changes per hour (ACH) as recommended by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). For classrooms which have more people in the space, especially during times of increased illness, ventilation should ideally increase to 6-12 ACH.

ASHRAE has provided guidance on their website to address the transmission of the SARS-CoV-2 virus [here](#). The guidance includes how to evaluate HVAC systems in order to improve existing systems and determine the highest rated filter the system can handle.

Air Cleaners/Air Purifiers

Some buildings have out of date HVAC equipment, and some buildings have none. Portable room air cleaners that filter the air in a room can be used in addition to, or in place of, an HVAC system. They can also be used in climates where it is very costly to condition outside air when it is very cold outside. Conditioning outside air in a cold climate also emits significant CO₂ to the atmosphere. Look for an air cleaner that uses high-efficiency particulate air (HEPA) filters. Air cleaner brands will list the contaminants they are effective against such as smoke, dust, pollen etc. Look for devices that list viruses. Some air cleaners produce ozone in quantities that are hazardous to human health. The California Air Resources Board (CARB) has a list of air cleaners that limit ozone production to low levels [here](#). Look for a cleaner on the CARB list that is mechanical (not electronic), with a filter. Air purifiers with extra add-ons such as UV-lights and ionizers are not recommended for child care or schools. The technology is new and not well studied. These add-ons increase cost and may pose additional health risks for students or teachers when operating in child care facilities or school classrooms.

"When a person coughs, talks or breathes, they throw anywhere between 900 to 300,000 liquid particles from their mouth. These particles range in size from microscopic — a thousandth the width of a hair — up to the size of a grain of fine beach sand. A cough can send them traveling at speeds up to 60 mph."

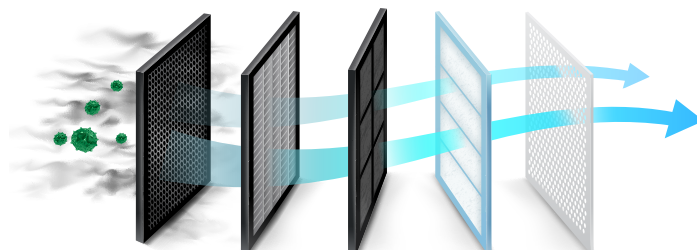


—*The Conversation. Coronavirus drifts through the air in microscopic droplets — here's the science of infectious aerosols.*
Shelley Miller, PhD.

Air cleaners can be effective at filtering the air in individual rooms. It's important to direct the airflow so that it does not blow directly from one person onto another, possibly spreading particles that contain germs. Research shows that a properly placed air cleaner with a HEPA filter can remove 99.97% of particles in air going through the filter. Air cleaners must be the proper size and placed correctly to have an impact on air quality. Many manufacturers use the Clean Air Delivery Rate (CADR) rating system to show air cleaner performance. The Association of Home Appliance Manufacturers (AHAM) has a portable room air cleaner certification program. Look for their label certifying the unit's clean air delivery rate (CADR) when you are buying an air cleaner.



To determine what size unit is needed, the cubic feet of the room must be determined. [The Harvard-CU Boulder Portable Air Cleaner Calculator](#) for Schools can help you find the proper size.



Fans

A window fan can help to control the spread of germs if the outside air is acceptable. The air won't be filtered but it will dilute the germs and other pollutants in the room. Placing box fans in a window to exhaust or blow out air helps to remove the particles containing germs.

A window air conditioner that has an outdoor air intake or vent, can be used with the vent open to exhaust air. Also, running a bathroom or kitchen fan pulls air to the outside.

Windows/Doors

Opening windows and/or doors is the simplest way to remove contaminated air and bring fresh air into a building. This doesn't allow for filtration of the incoming air so the quality depends on pollutants in the outside air.

Remember that ventilation and filtration must be combined with other hygiene measures like social distancing, handwashing and covering your mouth and nose to reduce transmission of infectious diseases.

Resources

Allen, J, Spengler, J, Jones, E, Cedeno-Laurent, J, Harvard Healthy Buildings Program (2020) [5-step guide to checking ventilation rates in classrooms](#)

ASHRAE, (2021) [ASHRAE Position Document on Filtration and Air Cleaning](#)

California Air Resources Board [list of approved air cleaners](#)

Caring for Our Children. Chapter 5: Facilities, Supplies, Equipment, and Environmental Health. 5.2 Quality of the Outdoor and Indoor Environment. 5.2.1 Ventilation, Heating, Cooling, and Hot Water

Corsi, Richard, (2020) "[Indoor Air Quality in K-12 Schools: Addressing the Concept of Layered Risk Amidst COVID-19](#)". Mechanical and Materials Engineering Faculty Publications and Presentations. 325.

Curtius J, Granzin M, Schrod J. Testing mobile air purifiers in a school classroom: Reducing the airborne transmission risk for SARS-CoV-2. *Aerosol Science and Technology*. 2021;55(5):586-99. doi: 10.1080/02786826.2021.1877257.

EPA. [Heating, Ventilation and Air-Conditioning Systems, Part of Indoor Air Quality Design Tools for Schools](#)

EPA. [Indoor Air in Homes and Corona Virus \(COVID-19\)](#).

EPA [Indoor Air Quality, Ozone Generators Sold as Air Cleaners](#)

Harriman, L, Stephens, B, Brennan, T, (2019) [New Guidance for Residential Air Cleaners](#), ASHRAE Journal, September, 2019, pp 14-23.

Harvard T.H. Chan School of Public Health, Schools For Health: COVID-19 [Healthy Schools: Risk Reduction Strategies for Reopening Schools](#)

Harvard UC – Boulder [Portable Air Cleaner Calculator for Schools](#)

Kirkman, S., Zhai, J., Miller, S., (May 2020) [Effectiveness of Air Cleaners for Removal of Virus-Containing Respiratory Droplets: Recommendations for Air Cleaner Selection for Campus Spaces](#).

Miller, Shelly, The Conversation (April 4, 2020) [From your lungs into the air around you, aerosols carry coronavirus](#).

Robertson, P. (2020) [ASHRAE Recommended Air Changes Per Hour](#)

The SAFEAIRSPACES [COVID-19 Aerosol Relative Risk Estimator](#)