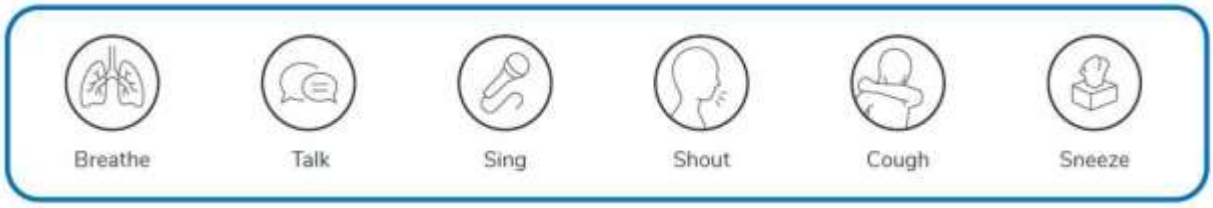
Carbon Dioxide (CO2) Monitoring for Indoor Air Quality (IAQ)

Where Does Indoor CO2 Come from and Why is it Important?

When we exhale, we add CO2 (carbon dioxide) to the air. In fact, each breath from an average adult contains 35,000 parts per million (ppm) of CO2. As more people remain in a room, CO2 levels increase quickly if there is not enough fresh air coming into the space.

High indoor CO2 levels can cause tiredness, headaches, and other symptoms. Increasing CO2 levels show you that the space is not well ventilated. Other indoor pollutants can also increase within a poorly ventilated space. This includes respiratory particles and the viruses they carry. For example, COVID-19 spreads from person to person through droplets and airborne transmission.

Due to gravity, larger and heavier droplets fall quickly. Respiratory particles spread in the air are called aerosols. Smaller and lighter aerosols remain suspended in the air longer than droplets. Viruses and pollutants can live on aerosols depending on factors such as temperature, pH, humidity, and airflow. Aerosols come from when we:



Poorly ventilated indoor spaces increase your risk of COVID-19. To be clear, the reading on a CO2 monitor is not a direct indicator of risk for COVID-19. CO2 readings will help you determine if you should take simple steps to lower the risk of transmission. This includes things like opening a window or reducing the number of people in a room.

What's the Difference between Carbon Monoxide (CO) and CO2?

CO (carbon monoxide) is a gas that is often called the silent killer because it contains no smell, colour, or taste and can cause illness or death. CO is produced when things like coal, gasoline, natural gas, oil, propane, wood, or tobacco are burned. CO risks are present year-round, but can be riskier in the winter when people are heating their homes. Other sources of CO include vehicle exhaust, BBQs, and lawn equipment.

CO2 is another gas, but is mainly produced when people exhale. Reducing CO2 can be done by increasing ventilation and decreasing the number of people in one space.

How Much Indoor CO2 is Acceptable?

Health Canada has set the long-term exposure limit for CO2 in residential settings (i.e. in your home) at 1,000 ppm, averaged over a 24-hour period. However, it is normal for CO2 levels to fluctuate and serious health effects are not expected below 5,000 ppm. For example, if you are monitoring CO2 in your home, you may see higher readings if you have friends over for a social gathering. The increase in number of people, talking and laughing increases the production of CO2.

If CO2 levels begin to rise, this indicates that not enough fresh air is coming in for the number of people present. Generally, you should aim to keep CO2 levels below 1000 ppm, or ideally, as close to outdoor levels as possible.

Indoor CO_2 in parts per million	Ventilation performance, with respect to the number and activity level of people in the space
600 or under	Excellent ventilation
601-800	Good ventilation
801-1000	Fair ventilation
1001-5000	Poor ventilation
Over 5001	Dangerous ventilation

Why Ventilation and Filtration is Important

Increasing air circulation, using air filtration, and removing pollutants can improve IAQ. Risk of illness (from exhaled breath that might have viruses or bacteria in it) can be reduced with good ventilation and air filtration. Reducing the number of people in the room will also decrease risk. Air filtration units (i.e. HEPA (High Efficiency Particulate Air) filters) will only remove particles from the air, not CO2.

How to Place/Install a CO2 Monitor

CO2 monitors should be placed on a wall at a height of 1-2 metres and well away from windows or air supply vents, and at least 2 metres away from people or open flames. Once installed, you should see CO2 levels change a lot as people enter and leave the space, or when windows and doors are opened.

The Aranet4 carbon dioxide monitor provides measurement data on its screen. Excellent CO2 level is under 600 ppm. Levels over 5,000 ppm is considered high concentration – level typically associated with complaints of drowsiness and poor air quality.

What Do High Levels of Carbon Dioxide (CO2) Mean?

High CO2 levels can mean that ventilation is insufficient for the number of people present, which might also be causing other IAQ issues. CO2 levels can be affected by many different things, such as:

- Age of a building (not designed with current ventilation needs in mind);
- Design of a building (built for one purpose, but now used for another);
- Function of the building (may have windows that cannot open for certain reasons);
- Size of the building (may not allow for people to spread out);
- Number of people in the building;
- Other CO2 sources, such as smoking, stoves, furnaces, water heaters, and pets.

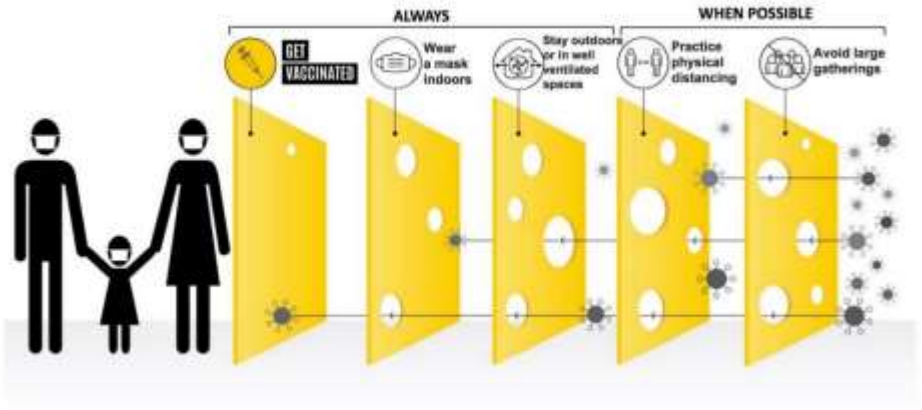
Also consider:

CO2 sensors can tell you if the ventilation is okay, but dangerous indoor air pollutants can still be present even if CO2 levels are low.

- Remove other sources of indoor air pollutants using Health Canada's IAQ resources
- Wildfires, extreme heat, and other sources of outdoor pollution may impact IAQ.
- If outdoor pollution is present, indoor air filtration becomes more important

Multiple Public Health Measures Needed

It is very clear that no one prevention measure alone will reduce the spread of COVID-19. A combination of measures (or layers) are needed. Improving ventilation is just one way that may help to reduce the spread of COVID-19, indoors. This is often viewed as the “Swiss Cheese Model”, shown below.



Increasing Ventilation and Decreasing CO2 Concentration

If your CO2 monitor is showing higher levels of CO2, you may consider one or more of the following:

- Reducing the number of people in the building;
- Avoiding strenuous activities like singing, dancing, and shouting
- Servicing or upgrading your HVAC system; Consider using HEPA filters in your HVAC system to reduce particles in the air that may contain viruses or bacteria
- Increasing the amount of outdoor air being drawn into your HVAC system, to decrease the recirculation of 'stale' air;
- Placing portable air filtration systems throughout the building;
- Opening windows and doors where the safety of occupants won't be jeopardized, and the function HVAC system won't be affected;
- Installing screens so that windows and doors can be opened without the risk of pests (e.g. flies) coming in; and/or
- Increasing the humidity of your space.

Conclusion

Using a CO2 monitor helps to identify three kinds of risk:

1. the negative effects of CO2 exposure,
2. the potential for other pollutants to accumulate in a poorly ventilated space, and
3. the risk of being in a poorly ventilated space during the COVID-19 pandemic. Many factors need to be considered when a high (or low) CO2 reading is recorded.

Additionally, readings need to be interpreted with caution. Simple and effective ways to improve ventilation exist, but increasing ventilation alone is not enough to stop the spread of respiratory diseases (like COVID-19) or decrease risks. Other important strategies to reduce the spread of COVID-19 include:

- getting vaccinated,
- wearing a mask,
- maintaining physical distance from others, and
- maintaining proper hand hygiene.