Carbon dioxide levels reflect COVID-19 risk

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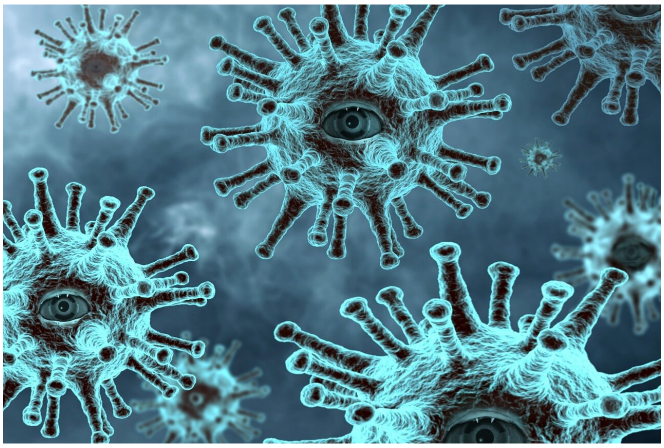

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Tracking carbon dioxide levels indoors is an inexpensive and powerful way to monitor the risk of people getting COVID-19, according to new research from the Cooperative Institute for Research in Environmental Sciences (CIRES) and the University of Colorado Boulder. In any given indoor environment, when excess CO_2 levels double, the risk of transmission also roughly doubles, two scientists reported this week in *Environmental Science & Technology Letters*.

The chemists relied on a simple fact already put to use by other researchers more than a decade ago: Infectious people exhale airborne viruses at the same time as they exhale carbon dioxide. That means CO_2 can serve as a "proxy" for the number of viruses in the air.

"You're never safe indoors sharing air with others, but you can reduce the risk," said Jose-Luis Jimenez, co-author of the new assessment, a CIRES Fellow and professor of chemistry at the University of Colorado Boulder.

"And CO_2 monitoring is really the only low-cost and practical option we have for monitoring," said Zhe Peng, a CIRES and chemistry researcher, and lead author of the new paper. "There is nothing else."

For many months, researchers around the world have been searching for a way to continually monitor COVID-19 infection risk indoors, whether in churches or bars, buses or hospitals. Some are developing instruments that can detect viruses in the air continually, to warn of a spike or to indicate relative safety. Others tested existing laboratory-grade equipment that costs tens of thousands of dollars.

Jimenez and colleagues turned to commercially available carbon dioxide monitors, which can cost just a few hundred dollars. First, they confirmed in the laboratory that the detectors were accurate. Then, they created a mathematical "box model" of how an infected person exhales viruses and CO_2, how others in the room inhaled and exhaled, and how the viruses and gas accumulate in the air of a room or are removed by ventilation. The model takes into consideration infection numbers in the local community, but it does not detail air flow through rooms—that kind of modeling requires expensive, custom analysis for each room.

It's important to understand that there is no single CO_2 level at which a person can assume a shared indoor space is "safe," Peng emphasized. That's partly because activity matters: Are people in the room singing and talking loudly or exercising, or are they sitting quietly and reading or resting? A CO_2 level of 1,000 ppm, which is well above outside levels of about 400 ppm, could be relatively safe in a quiet library with masks but not in an active gym without masks.

But in each indoor space, the model can illuminate "relative" risk: If CO_2 levels in a gym drop from 2,800 to 1,000 ppm (~2,400 above background levels to 600), the risk of COVID-19 transmission drops, too, to one-quarter of the original risk. In the library, if an influx of people makes CO_2 jump from 800 to 1,600 (400 to 1,200 above background), COVID transmission risk triples.

In the new paper, Peng and Jimenez also shared a set of mathematical formulae and tools that experts in building systems and public health can use to pin down actual, not just relative, risk. But the most important conclusion is that to minimize risk, keep the CO_2 levels in all the spaces where we share air as low as practically possible.

"Wherever you are sharing air, the lower the CO_2, the lower risk of infection," Jimenez said.

More information: Zhe Peng et al, Exhaled CO2 as a COVID-19 Infection Risk Proxy for Different Indoor Environments and Activities, *Environmental Science & Technology Letters* (2021). DOI: 10.1021/acs.estlett.1c00183