Exhaled air: A problem in buildings?

By Janet Raloff / October 30, 2012

There are standards — rules, essentially — for how much outdoor air should be cycled through buildings to keep people inside healthy. That circulating air is known as ventilation. And when there isn't enough new air coming in to push the stale air out, pollutants can build up. One of those pollutants, carbon dioxide, or CO_2, increases with every breath we exhale. Indoor-air scientists have always used this CO_2 as a harmless yardstick for measuring the staleness of indoor air. A new study now suggests that yardstick might not be so harmless after all.

Classrooms are one environment where carbon dioxide levels can be high. They're also one of the last places anyone would want to risk harming reasoning abilities and thought processes. Credit: iStockphoto

While attending a meeting in Europe six years ago, William Fisk of Lawrence Berkeley National Laboratory in California ran across surprising research by some Hungarian scientists. The findings seemed hard to believe. But László Kajtár of the Budapest University of Technology and Economics and his coworkers reported that people had a hard time concentrating and accurately

performing paperwork tasks if indoor CO_2 levels were high.

The concentration needed to show this impact was 3,000 parts per million (also known as 3,000 ppm) in air, or five times the roughly 600 ppm usually considered normal.

Curious about whether the Hungarian findings might be a fluke — some meaningless chance observation — Fisk decided to essentially repeat the experiment at his lab. So his team recruited college students to show up for a day that would be divided into three 2.5-hour periods. During each of those periods, CO_2 levels were maintained at one of three different concentrations: 600 ppm, 1,000 ppm, or 2,500. It took six days to run all of the participants through the testing. Which CO_2 concentration came first, second or third changed on each day, in a random order.

Most of the time, the students could read or do whatever they wanted. But during part of every test period, each recruit had to participate in a role-playing game on a computer. The students were told they were managers and the organization they were running was having some problems. At times, simulated crises would develop. Throughout each role-playing period, the students were graded on how carefully they thought out and made decisions to minimize the problems experienced by the virtual people in their organization. And it turns out that the recruits' ability to make careful, smart decisions declined as the CO_2 in the room's air rose.

The students knew that the CO_2 values were changing throughout the day, but none seemed to recognize when concentrations of this gas rose or fell in their air. To them, it seemed about the same in each session.

At 1,000 ppm of CO_2, student scores on six of nine different types of decision-making skills were notably worse than at 600 ppm. "And the magnitude of effects at 2,500 ppm was astonishing — so astonishing that it was almost hard to believe," noted one of the scientists, Mark Mendell. At this level, students performed far worse, and now on seven of the nine types of measured skills. His team's findings are due to appear in an upcoming issue of the journal *Environmental Health Perspectives.*

Roger Hedrick expressed surprise at the findings, noting that "1,000 ppm of CO_2 used to be considered a benchmark of good ventilation." An environmental engineer with Architectural Energy Corp. in Boulder, Colo., he's quite familiar with CO_2 measurements in buildings. In fact, he chairs a committee that writes commercial ventilation standards for U.S. buildings.

Hedrick notes that the recommended limits on indoor CO_2 had been developed largely to limit the potential buildup of body odors. There had been no thought that the pollutant might affect health.

It would be hard to keep indoor CO_2 as low as 600 ppm in most U.S. offices and schools, he says.

These buildings tend to have lots of people in them, all exhaling CO_2 all day long. But even building managers who follow good practices could end up with some occupied rooms where CO_2 levels reach 2,500 ppm, or close to it, Hedrick told *Science News for Kids.* And this is especially true for schools, he says. One reason: There can be lots of people in those rooms for long hours every day. What's more, as communities try to reduce their energy costs, many schools have reduced their ventilation rates.

A second study by the Lawrence Berkeley National Laboratory scientists offers extra incentive to understand the impacts of too little ventilation in schools. In this new study, the scientists surveyed 100 California classrooms. "And we found a clear relationship between higher CO_2 levels and increased absences among the kids for illnesses," Mendell says.

This link appeared even in schools that were supposedly meeting current standard ventilation rates. Schools that offered more ventilation than that had lower absences for sickness.

No one is suggesting that schools or any other organization change their ventilation practices on the basis of one or two small studies, such as these. However, Hedrick cautions, if future studies (and there will be some) confirm the new findings, "It would be very strong evidence that ventilation rates need to be increased."

That would require higher costs to heat and cool all of the extra outdoor air being brought into these buildings. But few people are likely to object if it turns out that this is what it takes to keep kids healthy and primed to learn.

Power Words

carbon dioxide An odorless, colorless gas present in the air. It is released by the burning of any fuel containing carbon. It is also exhaled by most animals as they breathe.

ventilation The circulation of air within an indoor space, or a mechanical system that provides fresh air to indoor spaces.