Why School Boards Need a Clean Indoor Air Quality Policy for Schools

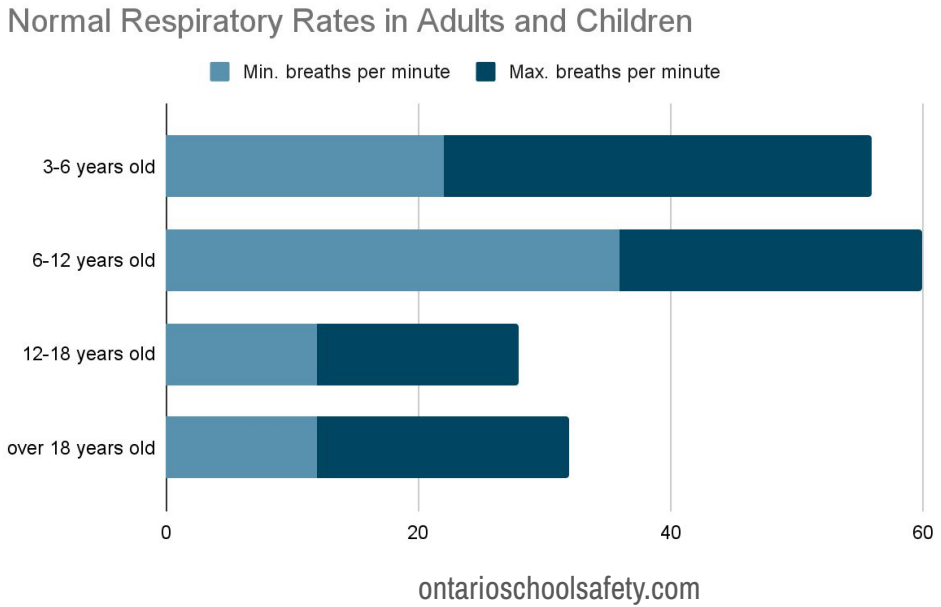
“Breathing clean air shouldn’t be a luxury…”
— Environmental Protection Agency (EPA)

Clean air is essential for children's health and well-being

Photo Credit: Isaac Quesada

Health impacts of breathing poor quality air

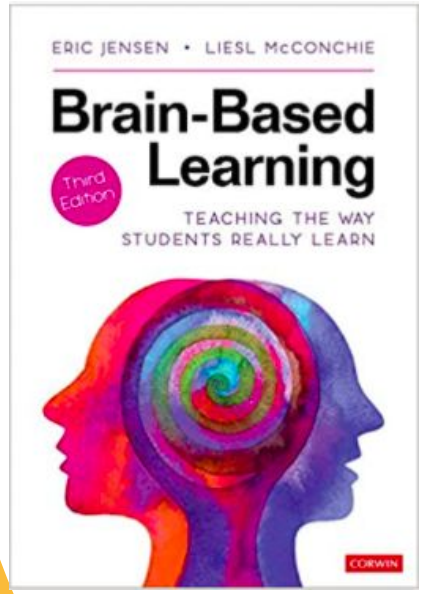
Young children take approximately twice as many breaths per minute[1] as adults, meaning their exposure to harmful particles in the air is much higher. Because their bodies are also still developing, damage to their lungs from poor air quality has greater long-term effects.



Improved indoor air quality (IAQ) boosts academic performance including math and reading test scores

- Cognition
- Literacy
- Math
- Problem-solving

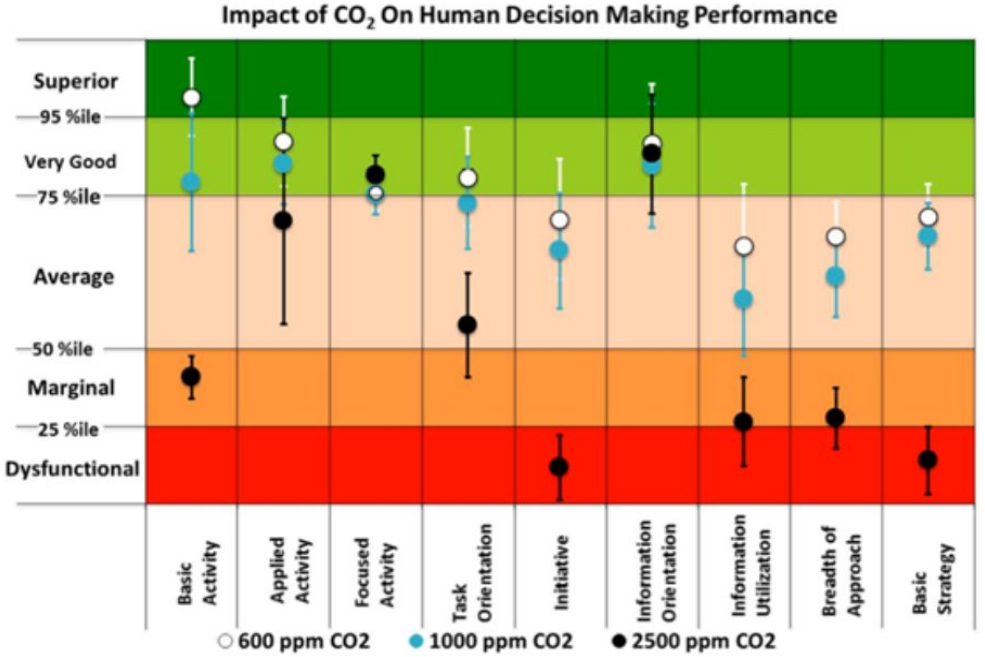
Why is indoor air quality in schools so important?



"...the quality and purity of the air impact the brain and, consequently, learning. People inhale up to 15,000 L of air each day. Any contaminants present in the air can have an effect. As an example, carbon dioxide (CO_2) emissions can be very harmful — they can impair cognitive and behavioral development, increase the likelihood of developing a respiratory illness, and cause multiple chronic diseases. Poor air quality hurts learning and concentration in schools, plus they are a health hazard for kids and teachers."

— Eric Jensen and Liesl McConchie, *Brain-Based Learning: Teaching the Way Students Really Learn*

Poor IAQ impairs learning and cognition



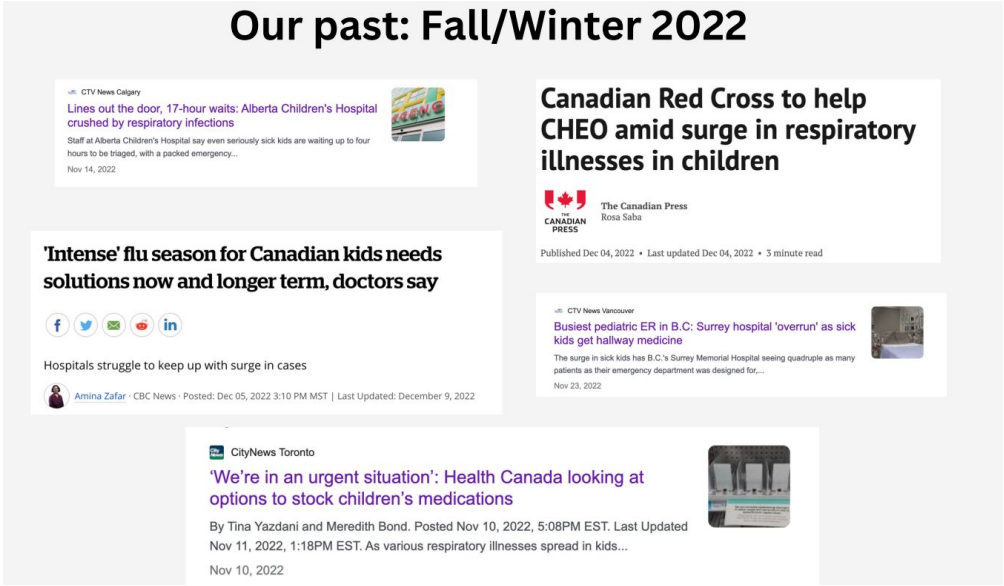
Source: https://ehp.niehs.nih.gov/doi/10.1289/ehp.1104789

The recent wildfire season taught us that we can't always just open a window to get clean air.

- "It is the fine particles ($PM_{2.5}$), not visible to the human eye, that get deep into our lungs and bloodstream."[2]
- "There is no evidence of a safe level of exposure for most of these pollutants. This means that smoke can impact your health even at very low levels. As smoke levels increase, your health risks increase. Air quality may be decreased even if you can't see or smell smoke."[3]
- Young children are at higher risk than adults when exposed to $PM_{2.5}$.

Improved IAQ reduces:

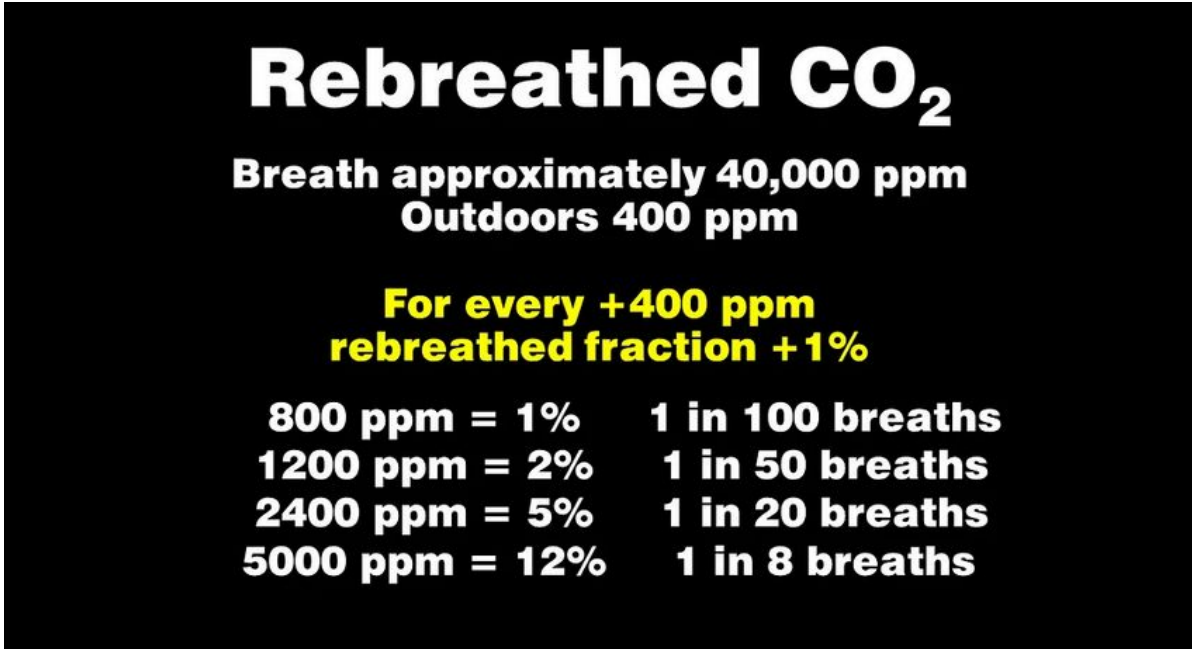
- absences due to respiratory illnesses, and hospitalizations[4] for children



Sources: Collaboration for a Clean Air Future - OHCOW

We expect clean water. Shouldn’t we also expect clean air?

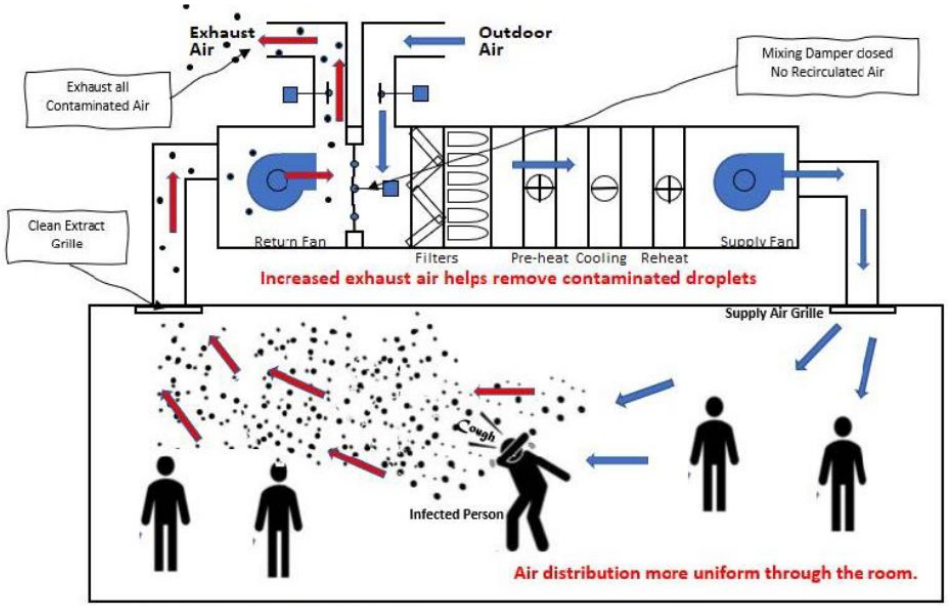
Carbon Dioxide (CO_2) concentrations are a proxy for ventilation



Credit: David Elfstrom, P. Eng. Retrieved from https://itsairborne.com/intro-to-monitoring-co2-20f191dd8f60

Increasing ventilation reduces exposure[5] to infectious aerosols (and other indoor pollutants)

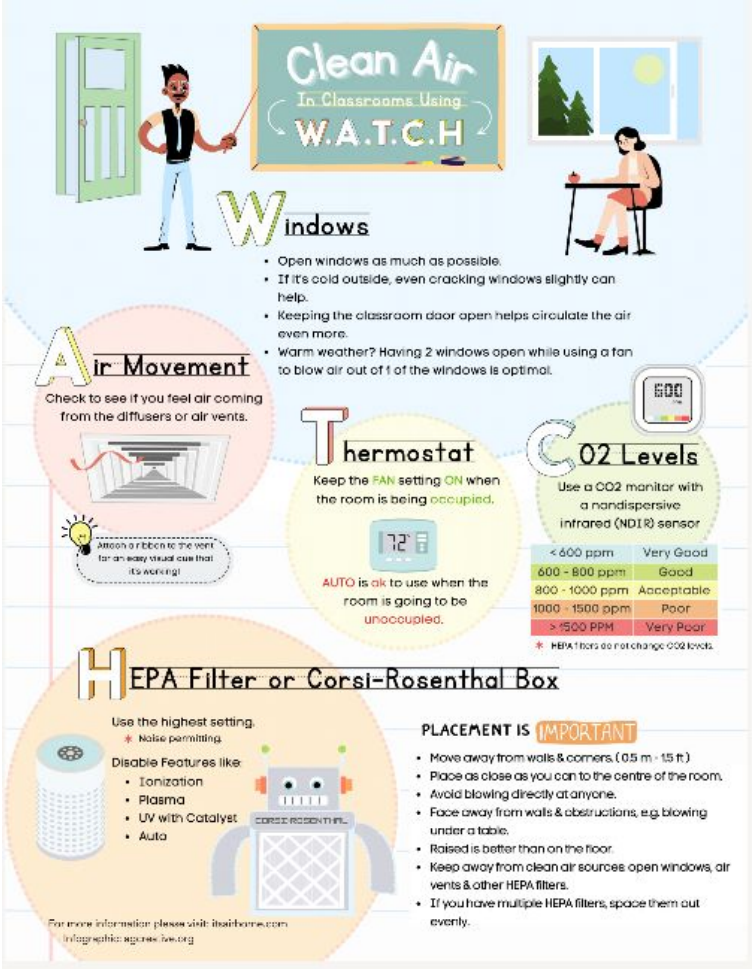
Figure 19: How (mechanical) ventilation reduces risk of disease exposure



Notes: The benefit is from increased dilution at a higher ventilation rate rather than the distribution of air. The same concept applies for natural ventilation (e.g., open windows or trickle vents). *Source:* NAADUK (2022).

Right now, we don't know the air quality in schools, but what we do know is concerning

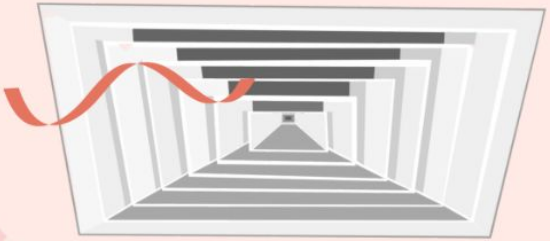
- Schools tend to have high levels of CO_2 and high concentration of particulate matter such as dust.
- CO_2 monitors can be a proxy for ventilation.
- CO_2 monitors are used in schools in Québec and elsewhere to monitor ventilation.
- Real-time reporting could help schools determine when to take steps to improve air quality.


Clean Air
In Classrooms Using
W.A.T.C.H
Windows
Open windows as much as possible.
If it's cold outside, even cracking windows slightly can help.
Keeping the classroom door open helps circulate the air even more.
Warm weather? Having 2 windows open while using a fan to blow air out of 1 of the windows is optimal.
Air Movement
Check to see if you feel air coming from the diffusers or air vents.
Attach a ribbon to the vent for an easy visual cue that it's working!
Thermostat
Keep the FAN setting ON when the room is being occupied.
AUTO is ok to use when the room is going to be unoccupied.
CO2 Levels
Use a CO2 monitor with a nondispersive infrared (NDIR) sensor
< 600 ppm | Very Good
600 - 800 ppm | Good
800 - 1000 ppm | Acceptable
1000 - 1500 ppm | Poor
> 1500 PPM | Very Poor
* HEPA filters do not change CO2 levels.
HEPA Filter or Corsi-Rosenthal Box
Use the highest setting.
* Noise permitting
Disable Features like
Ionization
Plasma
UV with Catalyst
Auto
CORSI-ROSENTHAL
For more information please visit: itsairborne.com
Infographic: agnes-lee.org
PLACEMENT IS IMPORTANT
Move away from walls & corners. (0.5 m - 1.5 ft.)
Place as close as you can to the centre of the room.
Avoid blowing directly at anyone.
Face away from walls & obstructions, e.g. blowing under a table.
Raised is better than on the floor.
Keep away from clean air sources open windows, air vents & other HEPA filters.
If you have multiple HEPA filters, space them out evenly.

- Open windows as much as possible.
- If it’s cold outside, even cracking windows slightly can help.
- Keeping the classroom door open helps circulate the air even more.
- Warm weather? Having two windows open while using a fan to blow air out of one of the two windows is optimal.

Air Movement

Check to see if you feel air coming from the diffusers or air vents.



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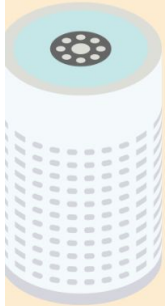
HEPA Filter or Corsi-Rosenthal Box

* HEPA filters do not change CO2 levels.

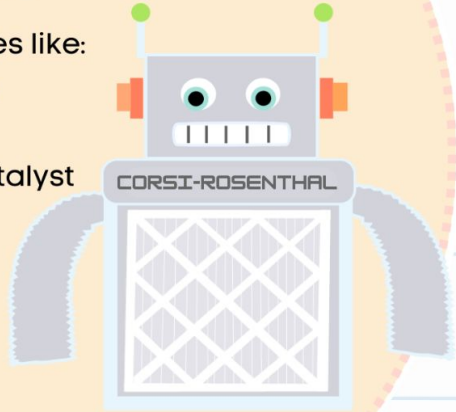


Use the highest setting.

* Noise permitting.

Disable Features like:

- Ionization
- Plasma
- UV with Catalyst
- Auto



For more information please visit: itsairborne.com

Infographic: agcreative.org

PLACEMENT IS IMPORTANT

- Move away from walls & corners. (0.5 m - 1.5 ft)
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- Face away from walls & obstructions, e.g. blowing under a table.
- Raised is better than on the floor.
- Keep away from clean air sources: open windows, air vents & other HEPA filters.
- If you have multiple HEPA filters, space them out evenly.

Improving indoor air quality (IAQ) in schools is an equity issue...

Equity is about providing all students with what they need to succeed.

- some schools are overcrowded and subject to more pollution,
- not all schools have the same quality of HVAC and maintenance,
  - or HEPA filtration,
  - or even windows that open.

School Boards need an IAQ policy

Efforts by School Boards to upgrade furnace filters, and to supply HEPA filters to Kindergartens and schools without HVAC are a step in the right direction.The next step is to create an air quality policy.

IAQ policies are necessary and feasible

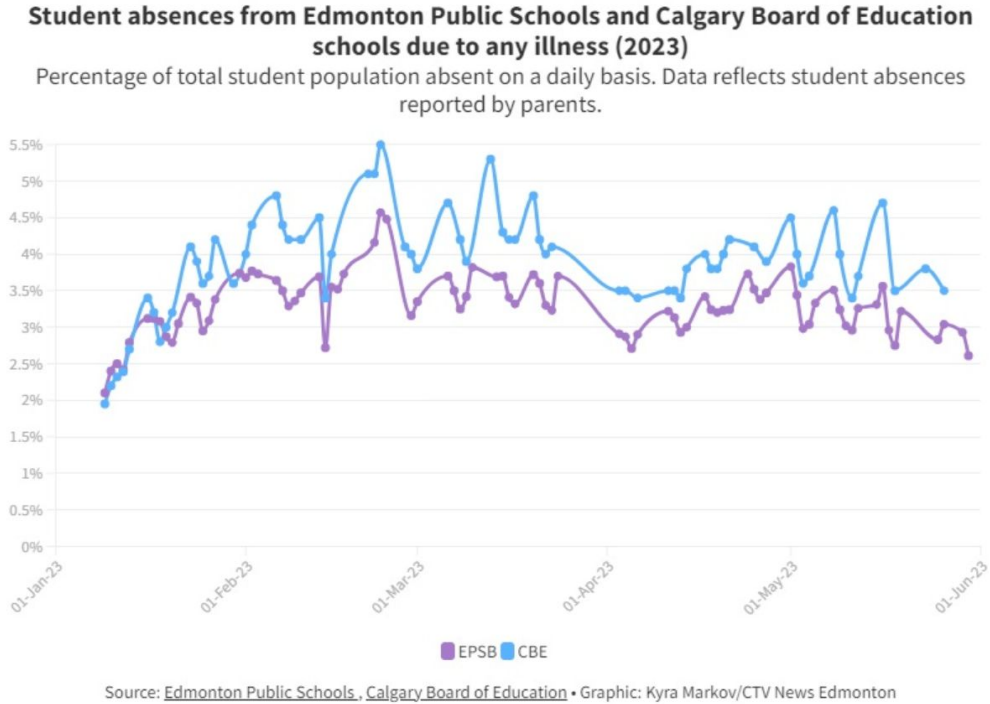
- School Boards need a policy to ensure a minimum indoor air quality standard in every school so that all students and education workers have clean air.
- Thankfully, there are already tools to create a minimum standard. Air filtration with HEPA filters or CR boxes could be an interim strategy.

OSPE recommends six air changes per hour in schools

- A new ASHRAE Standard 241 was released in June 2023, which aims to reduce the transmission of viruses and bacteria in buildings.
- The new ASHRAE 241 sets a standard of 6.7 ACH in schools.
- The old ASHRAE Standard 62.1 set a standard of 2.5 ACH in schools. It does not take into account the reality of crowded classrooms and poorly ventilated spaces.
- Professional engineers recommend 6 ACH in Ontario schools.

Sources: https://itsairborne.com/ashrae-241-control-of-infectious-aerosols-part-1-the-history-of-the-standard-ef6abd43c59c
https://itsairborne.com/ashrae-241-control-of-infectious-aerosols-part-2-equivalent-clean-airflow-rates-76a511769d4d
https://ospe.on.ca/advocacy/ospe-supports-adoption-of-ashrae-standard-241-in-the-canadian-national-building-code/#:~:text=ASHRAE%20Standard%20241%20provides%20comprehensive,the%20spread%20of%20airborne%20pathogens
https://www.ashrae.org/about/news/2023/ashrae-publishes-standard-241-control-of-infectious-aerosols

Filtering the Air Supplements Ventilation and Reduces Absences



HEPA Filters are used in Edmonton Public Schools but not in Calgary Board of Education

Filter the air to improve IAQ in classrooms with insufficient ventilation

- Filtering the air in classrooms reduces airborne particles, including infectious aerosols (respiratory viruses and some bacteria) and particulate matter ($PM_{2.5}$), like soot and dust, can reduce the burden of illness when it isn't practical to increase ventilation sufficiently.
- Ensuring classrooms support the needs of all students includes air quality.

How Can Schools Filter the Air?

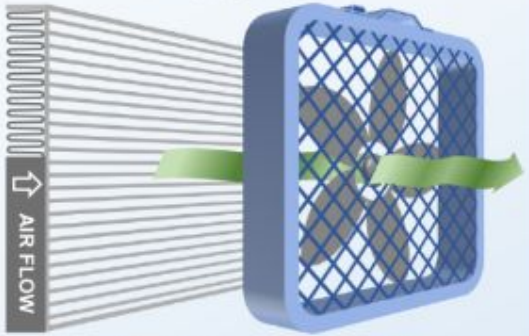
- Use MERV-13 filters if the HVAC system can handle them.
- Use HEPA filters at the highest setting and place them away from the wall to ensure air flow.
- Use CR boxes as a cost-effective alternative to HEPA filters.

What is a CR box?

- Corsi-Rosenthal boxes are Do-It-Yourself air filters made from a new box fan filter, four MERV-13 furnace filters, and duct tape.
- CR boxes remove particulate matter like wildfire smoke, as well as infectious viruses and bacteria from the air.
- There are several different configurations to suit rooms of different sizes.
- A CR box costs about $100 to make–less than the cost of half a day of supply teacher coverage.
- CR boxes make clean air more accessible in schools.

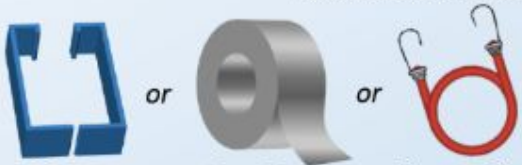
DIY Air Cleaner to Reduce Wildfire Smoke Indoors: Basic Design

Materials



20" X 20" X 1" or 4" air filter
Suggested rating: MERV 13

20" X 20" box fan
Only use certified fans with UL or ETL marking (2012 model or newer)



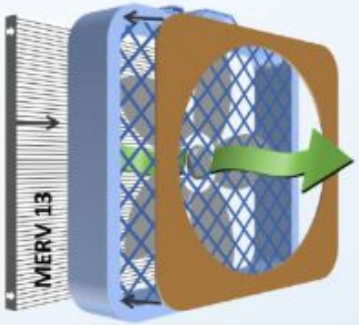
Clamps or Duct Tape or Bungee Cords

Assembly

1. Attach the air filter to the back of the box fan using either clamps, duct tape or bungee cords.
2. Check the filter for the direction of the air flow (marked on the side of the filter).
3. Replace filters when dirty.

Learn about box fan safety tips:
https://www.epa.gov/air-research/research-diy-air-cleaners-reduce-wildfire-smoke-indoors#FAQ

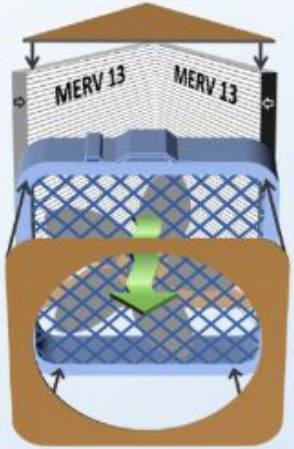
DIY Air Cleaner Designs: Beyond the Basic



Good

Basic Supplies:

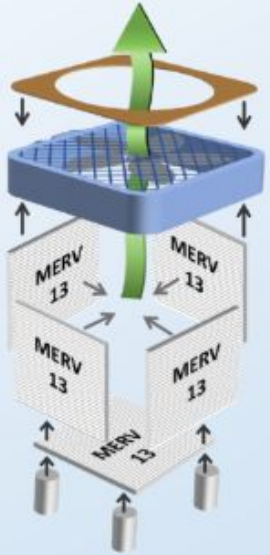
- 20" x 20" box fan
- 20" x 20" x 1" or 4" MERV 13 air filter
- 20" x 20" cardboard shroud (cutout the size of the fan blades)
- Clamps, duct tape, or bungee cords



Better

Additional Supplies:

- Two - MERV 13 air filters
- Triangle cardboard cutout for base on top



Best

Additional Supplies:

- Four or five - MERV 13 air filters
- If using five filter design, use leg supports (e.g., blocks) to allow airflow through bottom

Ways to Improve Effectiveness:

- Add a cardboard shroud (no-cost improvement)
- Use thicker filters (4" rather than 1" MERV 13 filters)
- Use multiple filters (2-5 filter designs)

Key Reminders:

- Only use certified fans with UL or ETL marking (2012 model or newer)
- Keep extra filters on hand
- Replace filters when dirty

Source: https://www.epa.gov/air-research/research-diy-air-cleaners-reduce-wildfire-smoke-indoors

CR boxes are...

- **Safe**
  - see information from the EPA[6] and Underwriters Laboratories [7]
- **Effective**
  - Recommended by engineers as an additional tool to achieve IAQ targets
- **Cheaper** than HEPA (approx. $100), and
- ultra energy-efficient and quiet when made with PC fans, which lowers energy costs

CR boxes: a cross-curricular STEM learning opportunity

- Building CR boxes is an authentic cross-curricular STEM learning opportunity for students.
- This is a rich task that teaches students problem solving skills and practical applications for technology.
- This task fits current curriculum expectations (2022 Science curriculum).

Grade 2	Grade 6
• Fluids: Air and Water (Properties of air) • STEM investigations/skills • Practical applications of technology • Art (3D objects)	• Matter and Energy: (Properties of air) • STEM investigations/skills • Practical applications of technology • Art (3D objects)
Grade 8	**Grade 9**
• Geometry: Calculate the surface area and volume of solids • Fluid mechanics • STEM investigations/skills • Practical applications of technology	• Air flow calculations • Static electricity • Earn volunteer hours by building CR boxes for schools

“Designing the Corsi-Rosenthal box has been one of the most gratifying things that I have done in my career as an engineer,” he said. "I am thrilled to be part of something that is so accessible to people around the world, helping to protect children in school and families in their homes, all the while inspiring children about the power of STEM.”

— Dr. Richard Corsi, Dean of Engineering, UC Davis

Source: https://news.3m.com/2022-02-24-3M-scientists-This-Corsi-Rosenthal-box-movement-is-legit

Grade 5 students made “Air Force One,” a CR box, donated to the White House Office of Science and Technology

Source:https://today.ucsd.edu/story/uc-san-diego-professor-presents-air-filtration-fan-to-the-white-house-to-help-fight-covid

What can school boards do?

- Commission equipment and ensure it is running properly
- Increase the amount of outdoor air supplied to the space
  - Increase the percentage of outdoor air
  - Increase the total airflow to the space
- Upgrade filters to MERV-13
- Supplement with HEPA filters to achieve target rates
- Monitor air quality, especially CO_2

Image Source: OSPE. Retrieved from https://www.ohcow.on.ca/posts/collaborating-on-solutions-for-cleaner-school-air/

School Boards already have the tools

Summary of Tools

	HVAC/Building Wide	In-Room
Ventilation	➢ Increase outdoor airflow	➢ Thermostat Fan setting On ➢ Windows
Filtration	➢ Upgrade to MERV-13	➢ HEPA filter or CR Box
Verification & Transparency	➢ Commission HVAC systems ➢ Building Readiness Plan	➢ Monitor CO_2 ➢ Check airflow

Image Source: OSPE. Retrieved from https://www.ohcow.on.ca/posts/collaborating-on-solutions-for-cleaner-school-air/

- IAQ experts can monitor CO_2 and check airflow
- Sometimes it's as simple as switching the HVAC setting from "AUTO" to "FAN"

When we consider the consequences of poor indoor air quality as well as the benefits to improving it, including improved academic performance, and fewer absences, the wise choice becomes clear: **A clean air policy would position your school board as a leader, align with your values that support student well-being, and enhance your reputation**. Let's take steps to analyze and improve air quality in schools to help keep kids healthy.

Thank You

ontarioschoolsafety.com

Endnotes

[1] Rowden, A. (2024, January 9). *Normal respiration rate: For adults and all ages, and how to measure*. https://www.medicalnewstoday.com/articles/324409

[2, 3] Health Canada. (2021). *Wildfire smoke 101: Wildfire smoke and your health.* https://www.canada.ca/en/health-canada/services/publications/healthy-living/wildfire-smoke-health.html

[4] Public Health Ontario. (2022, November 18). *Environmental Scan: COVID-19 and Other Respiratory Illnesses in Pediatric Populations.* https://www.publichealthontario.ca/-/media/Documents/nCoV/phm/2022/11/covid-respiratory-Illnesses-pediatric-populations-fall-2022.pdf?rev=0fd12bb2aaa84145b7470a4492746ab3&sc_lang=en#:~:text=Up%20to%20October%201%2C%202022,per%20week%20(Figure%202).&text=Pediatric%20ICU%20admissions%20ranged%20from,2022%20to%20early%20March%202022.

[5] Royal Academy of Engineering. (2022, June). *Infection Resilient Environments Social Cost Benefit Analysis.* https://raeng.org.uk/media/fupdixju/nera-social-cost-benefit-analysis.pdf

[6] EPA. (2023, December 12). *Research on DIY Air Cleaners to Reduce Wildfire Smoke Indoors.* https://www.epa.gov/air-research/research-diy-air-cleaners-reduce-wildfire-smoke-indoors

[7] Davis, A. and Black, M. *Wildfire Safety Research: An Evaluation of DIY Air Filtration.* https://chemicalinsights.org/wp-content/uploads/2022/03/DIY-Box-Fan-Report-2021.pdf

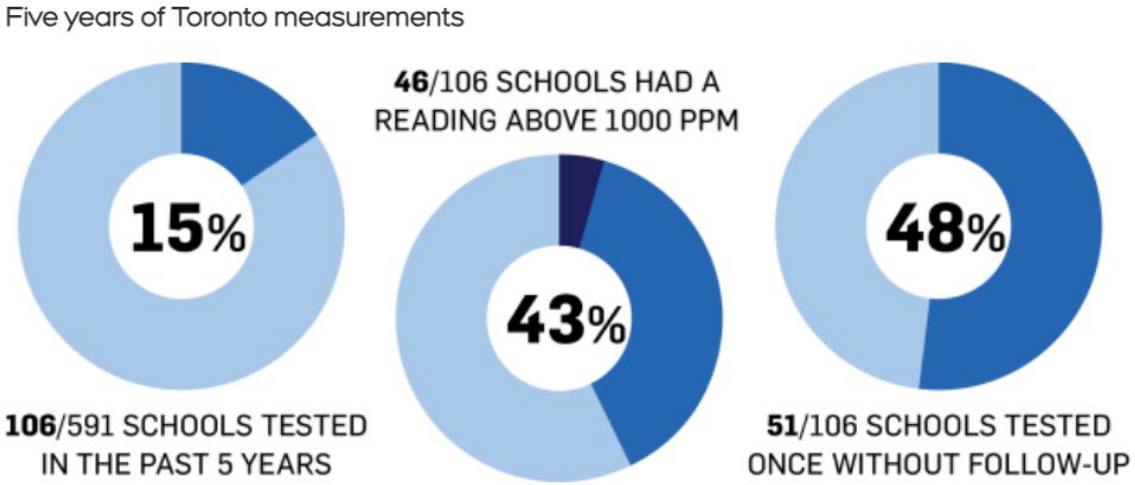
Additional References

Improved IAQ reduces the burden of asthma and allergies

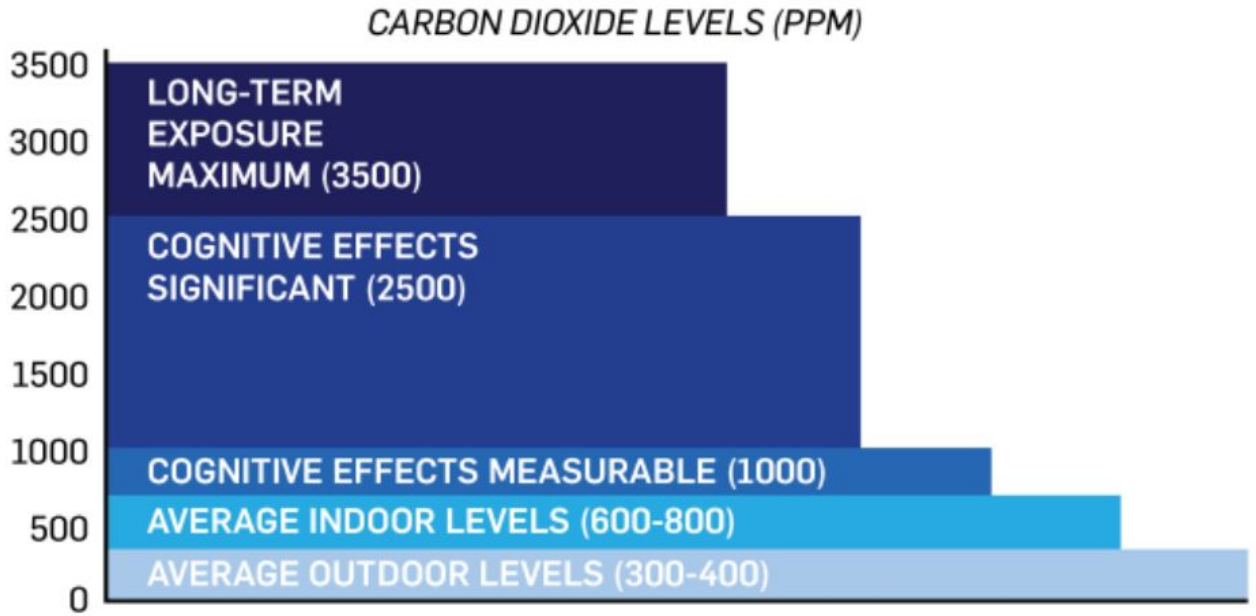
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3266016/

https://www.epa.gov/indoor-air-quality-iaq

Classrooms are often underventilated, especially crowded portables



Source: https://toronto.ctvnews.ca/poor-air-quality-in-toronto-schools-could-impair-learning-environment-1.2219342, 2015.



A problem for students in particular

Current average outdoor levels of CO_2 are now 420 ppm. Current federal building code < 1000 ppm.

Source: https://toronto.ctvnews.ca/poor-air-quality-in-toronto-schools-could-impair-learning-environment-1.2219342 , 2015.)

https://www.epa.gov/iaq-schools/why-indoor-air-quality-important-schools

https://www.epa.gov/iaq-schools/indoor-air-quality-high-performance-schools

https://www.epa.gov/iaq-schools/evidence-scientific-literature-about-improved-academic-performance

https://www.epa.gov/sites/default/files/2014-08/documents/student_performance_findings.pdf

https://www.cdph.ca.gov/Programs/CID/DCDC/Pages/COVID-19/COVID-19-and-Improving-Indoor-Air-Quality-in-Schools.aspx#

https://education-forum.ca/2022/11/08/corsi-rosenthal-boxes-as-school-based-learning-activities/

Speaker Notes

- **Slide 9** We breathe over 11,000 L of air every day - far more than the 2L of water most adults need each day. When we breathe recirculated air, some of that air has been inside other people's lungs. Most of us wouldn't drink from other people's water bottles, so why settle for re-breathed air?
- **Slide 14** Free downloadable infographic to help education workers improve air quality in classrooms. Source: Joey Fox, P. Eng., Chair of the IAQ Committee for the Ontario Society of Professional Engineers. https://itsairborne.com/how-can-you-clean-the-air-w-a-t-c-h-f1fc3f11fba5
- Children need clean indoor air in all spaces where they gather (e.g., including gyms, cafeterias, locker rooms, library commons, portables, buses, etc.)