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Energy Recovery Ventilation

SUPPORT GROWS FOR INCREASED BUILDING VENTILATION TO COUNTER COVID-19

By Nick Agopian

March 8, 2021

In July 2020, I published the following paper, Mitigate COVID-19 Transmission via Increased Building Ventilation. Since then, much research on this topic was conducted, and leading organizations released new guidelines. Hence, I decided to write this current paper, which serves as an update to the original one.

In this paper, we'll first look at airborne transmission of the novel coronavirus (SARS-CoV-2 virus, which causes COVID-19 disease). Then we'll discuss the vital role of increased building ventilation in stopping the spread. Finally, we'll analyze the relationship between indoor air quality (IAQ) and the impact of COVID-19.

All of the below information is up to date as of this paper's publication. That said, knowledge of SARS-CoV-2 and COVID-19 is moving quickly, so some of the information could soon be outdated. Certainly, another paper will be required in the near future. Without further ado, let's jump in.

Update: Airborne Transmission of SARS-CoV-2

After many studies on the transmission routes of SARS-CoV-2, it's certain that one of the main ways the virus spreads is through the air. Below are the most recent statements from the world's leading authorities, as well as new research, on this topic.

Centers for Disease Control and Prevention (CDC)

On October 5, 2020, the CDC released comprehensive information on the potential airborne transmission of SARS-CoV-2. It states that the main way people are infected with SARS-CoV-2 is through exposure to respiratory droplets carrying infectious virus particles. Such droplets can be divided into two categories:[1]

- **Larger droplets:** These are visible and fall out of the air rapidly within seconds to minutes while close to the source.
- **Smaller droplets and particles:** These are formed when small droplets dry very quickly in the airstream and can remain suspended for many minutes to hours. Such particles can travel far from the source on air currents.

In terms of how the above-mentioned droplets are transmitted, the CDC says there are three principal ways:[2]

- **Contact transmission:** This is infection spread through direct contact with an infectious person, such as a handshake, or with an article or surface that has become contaminated. The latter is can be referred to as "fomite transmission."
- **Droplet transmission:** This is infection spread through exposure to virus-containing respiratory droplets, such as larger and smaller droplets and particles exhaled by an infectious person. Transmission is most likely to occur when someone is close to the infectious person, generally within about six feet.
- **Airborne transmission:** This is infection spread through exposure to those virus-containing respiratory droplets comprised of smaller droplets and particles. They can remain suspended in the air over long distances (usually greater than six feet) and time (typically hours).

In terms of airborne transmission of SARS-CoV-2 specifically, the CDC says it can occur under the following circumstances:[3]

- **Enclosed spaces:** In an enclosed space, people can be exposed when together indoors with an infectious person or shortly after the infectious person left the space.
- **Prolonged exposure to respiratory particles:** Such infectious particles are often generated with expiratory exertion, such as shouting, singing or exercising, which increases the concentration of suspended respiratory droplets.
- **Inadequate ventilation or air handling:** When ventilation is limited, this allows a build-up of suspended small respiratory droplets and particles.

[1] All information in this paragraph and subsequent bullets sourced from: "Scientific Brief: SARS-CoV-2 and Potential Airborne Transmission," Centers for Disease Control and Prevention (CDC), October 5, 2020, https://www.cdc.gov/coronavirus/2019-ncov/more/scientific-brief-sars-cov-2.html.

[2] All information in this paragraph and subsequent bullets sourced from: "Scientific Brief: SARS-CoV-2 and Potential Airborne Transmission," Centers for Disease Control and Prevention (CDC), October 5, 2020, https://www.cdc.gov/coronavirus/2019-ncov/more/scientific-brief-sars-cov-2.html.

[3] All information in this paragraph and subsequent bullets sourced from: "Scientific Brief: SARS-CoV-2 and Potential Airborne Transmission," Centers for Disease Control and Prevention (CDC), October 5, 2020, https://www.cdc.gov/coronavirus/2019-ncov/more/scientific-brief-sars-cov-2.html.

Environmental Protection Agency (EPA)
On December 16, 2020, the EPA released updated information on the transmission routes of SARS-CoV-2. Specifically, it states:[4]

- COVID-19 is thought to spread mainly through close contact from person-to-person. However, some uncertainty remains about the relative importance of different routes of transmission of SARS-CoV-2, the virus that causes COVID-19.
- Evidence now confirms that this virus can remain airborne for longer times and further distances than originally thought. In addition to close contact with infected people and contaminated surfaces, spread of COVID-19 may also occur via airborne particles in indoor environments, in some circumstances beyond the two-meter (six-feet) range encouraged by some social distancing recommendations.

The Federation of European Heating, Ventilation and Air Conditioning (REHVA)
On August 3, 2020, REHVA updated its COVID-19 guidance document to add "long-range airborne transmission" as a second way COVID-19 is spread. Regarding all of the transmission routes specifically, it states:[5]

For COVID-19, and for many other respiratory viruses, three transmission routes are dominant: (1) combined droplet and airborne transmission in 1-2 meters (3-6 feet) close contact region arising from droplets and aerosols emitted when sneezing, coughing, singing, shouting, talking and breathing; (2) long-range airborne (aerosol-based) transmission; and (3) surface (fomite) contact through hand-hand, hand-surface, etc. contacts.

Harvard T.H. Chan School of Public Health, University of California (San Diego, San Francisco), University of Maryland, Virginia Tech
On October 16, 2020 researchers from the above-mentioned universities published a report on the airborne transmission of SARS-CoV-2. They say overwhelming evidence exists that inhalation of SARS-CoV-2 represents a major transmission route for COVID-19. The researchers state that both larger and smaller droplets are the main routes of virus inhalation, but they stress the main role of the smaller ones (aerosols). Specifically, the paper states:[6]

- We must clarify the terminology to distinguish between aerosols and droplets using a size threshold of 100 µm, not the historical 5 µm. This size more effectively separates their aerodynamic behavior, ability to be inhaled and efficacy of interventions.
- Viruses in droplets (larger than 100 µm) typically fall to the ground in seconds within two meters (six feet) of the source and can be sprayed like tiny cannonballs onto nearby individuals. Because of their limited travel range, physical distancing reduces exposure to these droplets.
- Viruses in aerosols (smaller than 100 µm) can remain suspended in the air for many seconds to hours, like smoke, and be inhaled. They are highly concentrated near an infected person, so they can infect people most easily in close proximity. But aerosols containing infectious virus can also travel more than two meters (six feet) and accumulate in poorly ventilated indoor air, leading to superspreading events.
- Individuals with COVID-19, many of whom have no symptoms, release thousands of virus-laden aerosols and far fewer droplets when breathing and talking. Thus, one is far more likely to inhale aerosols than be sprayed by a droplet.
- Therefore, the balance of attention must be shifted to protecting against airborne transmission.

The Lancet Respiratory Medicine
The Lancet Respiratory Medicine is a top medical journal on the forefront of providing current research and information on SARS-CoV-2 and COVID-19. On October 29, 2020, the journal published an editorial on the risks posed by airborne aerosols. Specifically, it states:[7]

- Initially it was thought that airborne transmission of SARS-CoV-2 was unlikely, but growing evidence has highlighted that infective microdroplets are small enough to remain suspended in the air and expose individuals at distances beyond two meters (six feet) from an infected person.
- Whether droplet or airborne transmission is the main route, the risk of infection is known to be much lower outside where ventilation is better. Public health guidance now needs to advise people how to navigate risk in indoor settings.
- Facemasks and shields offer protection from larger droplets but their effectiveness against airborne transmission is less certain. Advice on spending time indoors should also focus on improved ventilation and avoiding crowded spaces.

Multiple universities, including: University of California (Berkeley), Pennsylvania State University, University of Colorado-Boulder, Virginia Tech, McGill University
In a research paper from January 12, 2021, authors from multiple universities, including the above-mentioned ones, sought to clarify the science underpinning airborne virus transmission. Specifically, they found that:[8]

- There is mounting evidence to support the presence and transmissibility of SARS-CoV-2 through inhalation of airborne viruses.
- Exposure to small airborne particles is just as–or even more–likely to lead to infection with SARS-CoV-2 as the more widely recognized transmission via larger respiratory droplets and/or direct contact with infected people or contaminated surfaces.

[4] All information in this paragraph and subsequent bullets sourced from: "Indoor Air and Coronavirus (COVID-19)," Environmental Protection Agency (EPA), December 16, 2020, https://www.epa.gov/coronavirus/indoor-air-and-coronavirus-covid-19.

[5] All information in this paragraph and subsequent bullets sourced from: "REHVA COVID-19 guidance document, August 3, 2020," The Federation of European Heating, Ventilation and Air Conditioning (REHVA), August 3, 2020, https://www.rehva.eu/fileadmin/user_upload/REHVA_COVID-19_guidance_document_V3_03082020.pdf.

[6] All information in this paragraph and subsequent bullets sourced from: Kimberly A. Prather, Linsey C. Marr, Robert T. Schooley, Melissa A. McDiarmid, Mary E. Wilson, Donald K. Milton, "Airborne transmission of SARS-CoV-2," Science Magazine, October 16 2020, https://science.sciencemag.org/content/370/6514/303.2.

[7] All information in this paragraph and subsequent bullets sourced from: "COVID-19 transmission—up in the air," Editorial by The Lancet, October 29, 2020, https://doi.org/10.1016/S2213-2600(20)30514-2.

[8] All information in this paragraph and subsequent bullets sourced from: Julian W. Tang, William P. Bahnfleth, Philomena M. Bluyssen, Giorgio Buonanno, Jose L. Jimenez, Jarek Kurnitski, Yuguo Li, Shelly Miller, Chandra Sekhar, Lidia Morawska, Linsey C. Marr, Arsen Krikor Melikov, William W. Nazaroff, Peter V. Nielsen, Raymond Tellier, Pawel Wargocki, Stephanie J. Dancer, "Dismantling myths on the airborne transmission of severe acute respiratory syndrome coronavirus (SARS-CoV-2)," The Journal of Hospital Infection, January 12, 2021, https://doi.org/10.1016/j.jhin.2020.12.022.

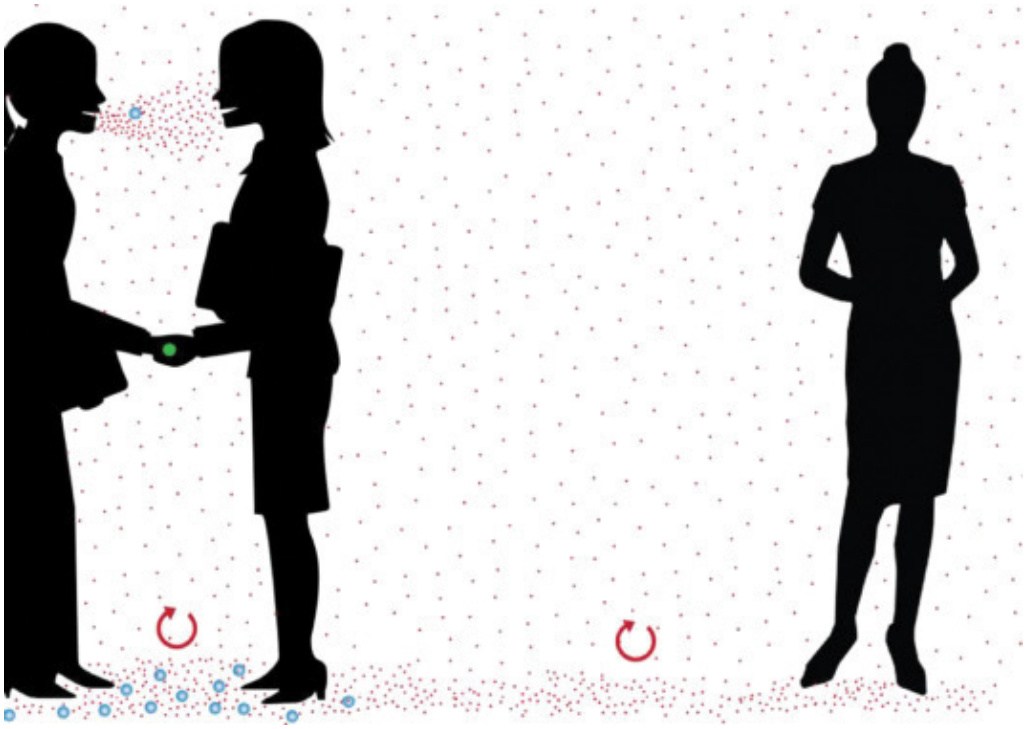

Figure 1: *Range of respiratory particles and potential spread over distance. Blue particles represent droplets, typically >100-µm diameter, that fall to the floor under gravity within two meters of the source. Red particles represent aerosols, typically <100 µm, that stay suspended for longer, but eventually fall to the ground if the air is motionless for long enough (at least 30 minutes). Source: The Journal of Hospital Infection*[9]

Update: Building Ventilation Strategies to Mitigate SARS-CoV-2 Transmission

Close to the start of the COVID-19 pandemic, organizations worldwide offered helpful guidance on how building ventilation can help to stop the spread. Now more and more groups are backing the useful role of increased building ventilation. Below are updated statements on this topic from the experts.

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

In the face of the pandemic, ASHRAE created a new building readiness report, with the latest update being on February 1, 2021. Regarding building ventilation specifically, updated guidelines include:[10]

- **Pre- or post-occupancy flushing strategy:** The intent is to ensure that while the building is operating, your ventilation schedule should assist in removing bioburden during, pre- or post-occupancy of the building. Flush the building for a duration sufficient to reduce concentration of airborne infectious particles by 95%. For a well-mixed space, this would require three changes of building volume using outdoor air (or equivalent outdoor air including the effect of filtration and air cleaners) as detailed in the calculation methodology.

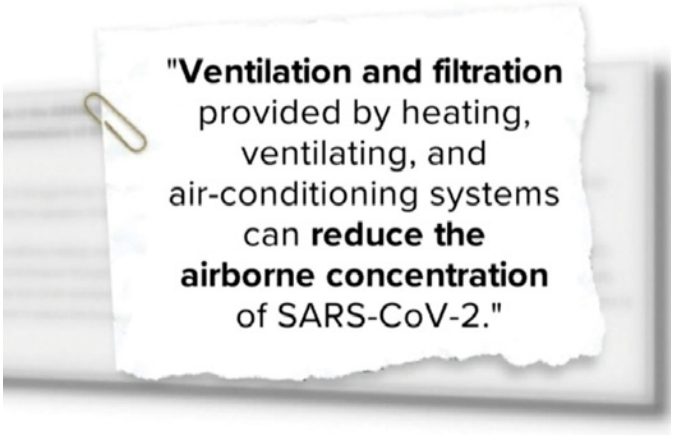

Figure 2: *ASHRAE states that ventilation and filtration provided by HVAC systems can reduce the airborne concentration of SARS-CoV-2. Source: WUSA*[11]

The Federation of European Heating, Ventilation and Air Conditioning (REHVA)

REHVA also updated its COVID-19 guidance document with more information on building ventilation. Specifically, the organization states:[12]

- New evidence on SARS-CoV-2 airborne transmission and general recognition of long-range aerosol-based transmission have developed recently. This has made ventilation measures the most important engineering controls in the infection control. While physical distancing is important to avoid a close contact, the risk of an aerosol concentration and cross-infection from 1.5 m (about five feet) onward from an infected person can be reduced with adequate ventilation and effective air distribution solutions.

[9] W. Tang, William P. Bahnfleth, Philomena M. Bluyssen, Giorgio Buonanno, Jose L. Jimenez, Jarek Kurnitski, Yuguo Li, Shelly Miller, Chandra Sekhar, Lidia Morawska, Linsey C. Marr, Arsen Krikor Melikov, William W. Nazaroff, Peter V. Nielsen, Raymond Tellier, Pawel Wargocki, Stephanie J. Dancer, "Dismantling myths on the airborne transmission of severe acute respiratory syndrome coronavirus (SARS-CoV-2)," The Journal of Hospital Infection, January 12, 2021, https://doi.org/10.1016/j.jhin.2020.12.022.

[10] All information in this paragraph and subsequent bullets sourced from: "ASHRAE EPIDEMIC TASK FORCE BUILDING READINESS," ASHRAE, February 1, 2021, https://www.ashrae.org/file%20library/technical%20resources/covid-19/ashrae-building-readiness.pdf.

[11] Gio Insignares, "VERIFY: Can COVID-19 be spread by air conditioners?," WUSA9, May 12, 2020, https://www.wusa9.com/article/news/verify/verify-can-air-conditioners-spread-covid-19/65-d2b45dc2-057c-4ae3-b15c-54badb5e6d78.

[12] All information in this paragraph and subsequent bullets sourced from: "REHVA COVID-19 guidance document, August 3, 2020," The Federation of European Heating, Ventilation and Air Conditioning (REHVA), August 3, 2020, https://www.rehva.eu/fileadmin/user_upload/REHVA_COVID-19_guidance_document_V3_03082020.pdf.

- In such, at least three levels of guidance are required: (1) how to operate HVAC and other building services in existing buildings right now during an epidemic; (2) how to conduct a risk assessment and assess the safety of different buildings and rooms; and (3) what would be more far-reaching actions to further reduce the spread of viral diseases in future in buildings with improved ventilation systems.

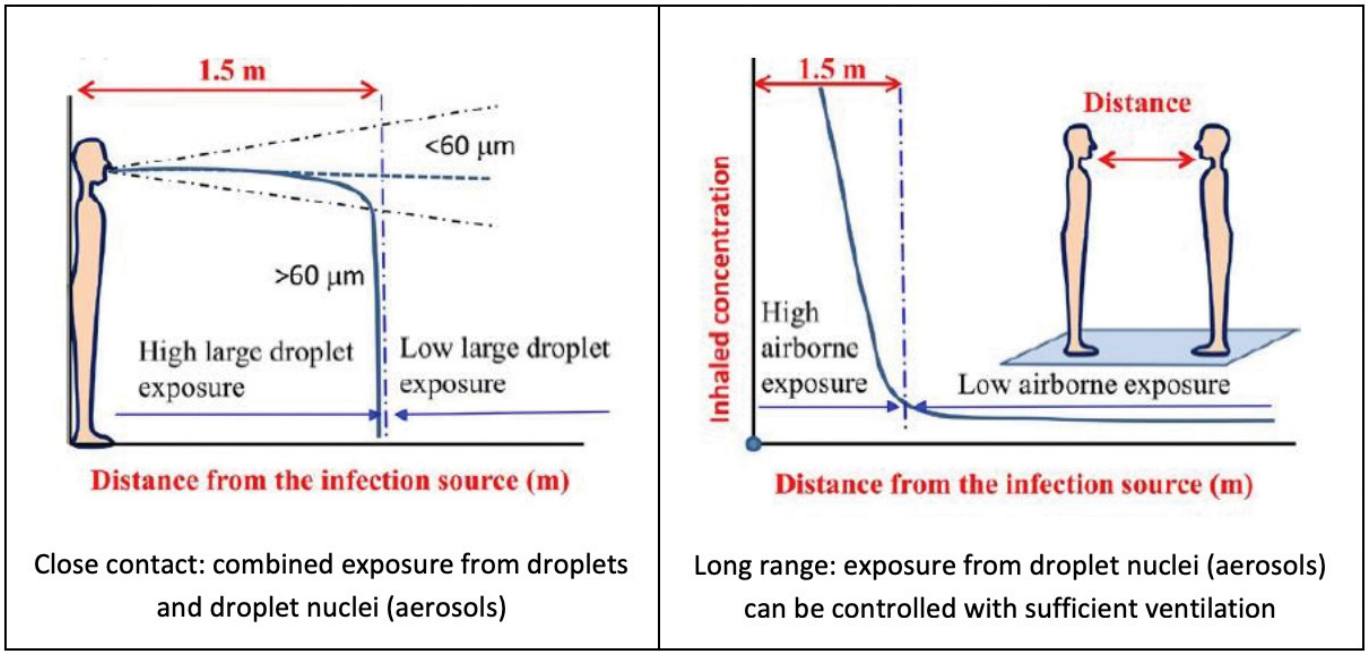

Figure 3: *The distinction between close contact combined droplet and aerosol transmission (left) and long-range aerosol transmission (right), which can be controlled with ventilation diluting the virus concentration to a low level. (Figure: courtesy L. Liu, Y. Li, P. V. Nielsen et al.). Source: REHVA*[13]

Centers for Disease Control and Prevention (CDC)

As of February 9, 2021, the CDC recommends a layered ventilation strategy to reduce exposure to SARS-CoV-2. Specifically, the CDC states:[14]

- SARS-CoV-2 viral particles spread between people more readily indoors than outdoors. When outdoors, the concentration of viral particles rapidly reduces with the wind, even a very light wind.
- When indoors, ventilation mitigation strategies help to offset the absence of natural wind and reduce the concentration of viral particles in the indoor air. The lower the concentration, the less likely some of those viral particles can be inhaled into lungs; contact eyes, nose and mouth; or fall out of the air to accumulate on surfaces.
- Protective ventilation practices and interventions can reduce the airborne concentration, which reduces the overall viral dose to occupants.

In the same document, the CDC states there are several building ventilation interventions to help reduce the concentration of virus particles in the air, such as SARS-CoV-2. The specific CDC considerations include:[15]

- Consider ventilation system upgrades or improvements and other steps to increase the delivery of clean air and dilute potential contaminants.
- Increase outdoor air ventilation, using caution in highly polluted areas.
- When weather conditions allow, increase fresh outdoor air by opening windows and doors. Do not open windows and doors if doing so poses a safety or health risk to occupants in the building.
- Use fans to increase the effectiveness of open windows.
- Decrease occupancy in areas where outdoor ventilation cannot be increased.
- Ensure ventilation systems operate properly and provide acceptable indoor air quality for the current occupancy level for each space.
- Increase airflow to occupied spaces when possible.
- Turn off any demand-controlled ventilation (DCV) controls that reduce air supply based on occupancy or temperature during occupied hours. In homes and buildings where the HVAC fan operation can be controlled at the thermostat, set the fan to the "on" position instead of "auto," which will operate the fan continuously, even when heating or air-conditioning is not required.
- Open outdoor air dampers beyond minimum settings to reduce or eliminate HVAC air recirculation. In mild weather, this will not affect thermal comfort or humidity. However, this may be difficult to do in cold, hot or humid weather.

[13] "REHVA COVID-19 guidance document, August 3, 2020," The Federation of European Heating, Ventilation and Air Conditioning (REHVA), August 3, 2020, https://www.rehva.eu/fileadmin/user_upload/REHVA_COVID-19_guidance_document_V3_03082020.pdf.

[14] All information in this paragraph and subsequent bullets sourced from: "Ventilation in Buildings," Centers for Disease Control and Prevention (CDC), February 9, 2021, https://www.cdc.gov/coronavirus/2019-ncov/community/ventilation.html.

[15] All information in this paragraph and subsequent bullets sourced from: "Ventilation in Buildings," Centers for Disease Control and Prevention (CDC), February 9, 2021, https://www.cdc.gov/coronavirus/2019-ncov/community/ventilation.html.

- Improve central air filtration:
    - Increase air filtration to as high as possible without significantly reducing design airflow.
    - Inspect filter housing and racks to ensure appropriate filter fit and check for ways to minimize filter bypass.
    - Check filters to ensure they are within their service life and appropriately installed.
- Ensure restroom exhaust fans are functional and operating at full capacity when the building is occupied.
- Inspect and maintain local exhaust ventilation in areas such as kitchens, cooking areas, etc. Operate these systems any time these spaces are occupied. Consider operating these systems even when the specific space is not occupied to increase overall ventilation within the occupied building.
- Consider portable high-efficiency particulate air (HEPA) fan/filtration systems to help enhance air cleaning (especially in higher risk areas, such as a nurse's office or areas frequently inhabited by persons with higher likelihood of COVID-19 and/or increased risk of getting COVID-19).
- Generate clean-to-less-clean air movement by re-evaluating the positioning of supply and exhaust air diffusers and/or dampers (especially in higher risk areas).
- Consider using ultraviolet germicidal irradiation (UVGI) as a supplement to help inactivate SARS-CoV-2, especially if options for increasing room ventilation are limited. Upper-room UVGI systems can be used to provide air cleaning within occupied spaces, and in-duct UVGI systems can help enhance air cleaning inside central ventilation systems.
- In non-residential settings, consider running the HVAC system at maximum outside airflow for two hours before and after the building is occupied.

World Health Organization (WHO)

Even in the face of widespread and expert acceptance of airborne transmission as a primary means of SARS-CoV-2 spreading, the WHO still remains hesitant. In fact, the organization continues to maintain that, "The role and extent of airborne transmission outside of health care facilities, and in particular in close settings with poor ventilation, also requires further study."[16]

However, the WHO is supportive of the essential role building ventilation plays in mitigating the spread of SARS-CoV-2. On March 1, 2021, the WHO published updated ventilation guidance in a "Roadmap to improve and ensure good indoor ventilation in the context of COVID-19." In this document the WHO states:[17]

- The risk of getting COVID-19 is higher in crowded and inadequately ventilated spaces where infected people spend long periods of time together in close proximity.
- These environments are where the virus appears to spread by respiratory droplets or aerosols more efficiently, so taking precautions is even more important.
- Understanding and controlling building ventilation can improve the quality of the air we breathe and reduce the risk of indoor health concerns including prevent the virus that causes COVID-19 from spreading indoors.

Occupational Safety and Health Administration (OSHA)

OSHA seeks to protect the health and safety of the U.S.'s workers, and therefore, they created a document on COVID-19 guidance on ventilation in the workplace. In it, OSHA says the following:[18]

- Ensuring adequate ventilation throughout the work environment can help to maintain a safe and healthy workplace.
- Employers should work with a qualified HVAC professional to determine steps necessary to optimize building ventilation.
- An HVAC professional can ensure that the ventilation system is operating as intended.

In addition, on January 29, 2021, OSHA released new guidance on mitigating the spread of COVID-19 in the workplace. In it, there's a section on improving ventilation with several recommendations that are a combination of CDC and ASHRAE guidelines. Specifically, the OSHA document includes the below points on ventilation:[19]

- Ensure ventilation systems operate properly and provide acceptable indoor air quality for the current occupancy level for each space.
- Increase ventilation rates when possible.
- When weather conditions allow, increase fresh outdoor air by opening windows and doors. Do not open windows and doors if doing so poses a safety or health risk (e.g., risk of falling, triggering asthma symptoms) to occupants in the building.
- Use fans to increase the effectiveness of open windows. To safely achieve this, fan placement is important. Avoid placing fans in a way that could potentially cause contaminated air to flow directly from one person over another. One helpful strategy is to use a window fan, placed safely and securely in a window, to exhaust room air to the outdoors. This will help draw fresh air into the room via other open windows and doors without generating strong room air currents.
- Disable demand-controlled ventilation (DCV).

[16] "Transmission of SARS-CoV-2: implications for infection prevention precautions," World Health Organization (WHO), July 9, 2020, https://www.who.int/news-room/commentaries/detail/transmission-of-sars-cov-2-implications-for-infection-prevention-precautions.

[17] All information in this paragraph and subsequent bullets sourced from: "Roadmap to improve and ensure good indoor ventilation in the context of COVID-19," World Health Organization (WHO), March 1, 2021, https://www.who.int/publications/i/item/9789240021280.

[18] All information in this paragraph and subsequent bullets sourced from: "COVID-19 Guidance on Ventilation in the Workplace," Occupational Safety and Health Administration (OSHA), https://www.osha.gov/sites/default/files/publications/OSHA4103.pdf.

[19] All information in this paragraph and subsequent bullets sourced from: "Protecting Workers: Guidance on Mitigating and Preventing the Spread of COVID-19 in the Workplace," Occupational Safety and Health Administration (OSHA), January 29, 2021, https://www.osha.gov/coronavirus/safework#improving-ventilation.

- Reduce or eliminate recirculation, for example by opening minimum outdoor air dampers. In mild weather, this will not affect thermal comfort or humidity. However, this may be difficult to do in cold or hot weather.
- Improve central air filtration to the MERV-13 (the grade of filter recommended by ASHRAE) or the highest compatible with the filter rack, and seal edges of the filter to limit bypass.
- Check filters to ensure they are within service life and appropriately installed.
- Keep systems running longer hours, 24/7 if possible, to enhance air exchanges in the building space.
- Ensure restroom exhaust fans are functional and operating at full capacity.
- Inspect and maintain local exhaust ventilation in areas such as kitchens and cooking areas.
- Use portable high-efficiency particulate air (HEPA) fan/filtration systems to help enhance air cleaning (especially in higher-risk areas such as a nurse's office or areas frequently inhabited by persons with higher likelihood of COVID-19 and/or increased risk of getting COVID-19).
- Generate clean-to-less-clean air movement by re-evaluating the positioning of supply and exhaust air diffusers and/or dampers (especially in higher-risk areas).
- Consider using ultraviolet germicidal irradiation (UVGI) as a supplement to help inactivate SARS-CoV-2, especially if options for increasing room ventilation are limited. Upper-room UVGI systems can be used to provide air cleaning within occupied spaces, and in-duct UVGI systems can help enhance air cleaning inside central ventilation systems.
- If ventilation cannot be increased, reduce occupancy level in the building. This increases the effective dilution ventilation per person.

Environmental Protection Agency (EPA)

The EPA also now recognizes that SARS-CoV-2 can be airborne, and acknowledges the crucial role of building ventilation. This information was published in an EPA document on indoor air and COVID-19. Specifically, the EPA states:[20]

- SARS-CoV-2 can remain airborne in indoor environments for hours, potentially increasing in concentration over time. Therefore, unless adequate precautions are taken, the longer a space is occupied and the more people that are present, the greater the potential for airborne transmission of the virus.

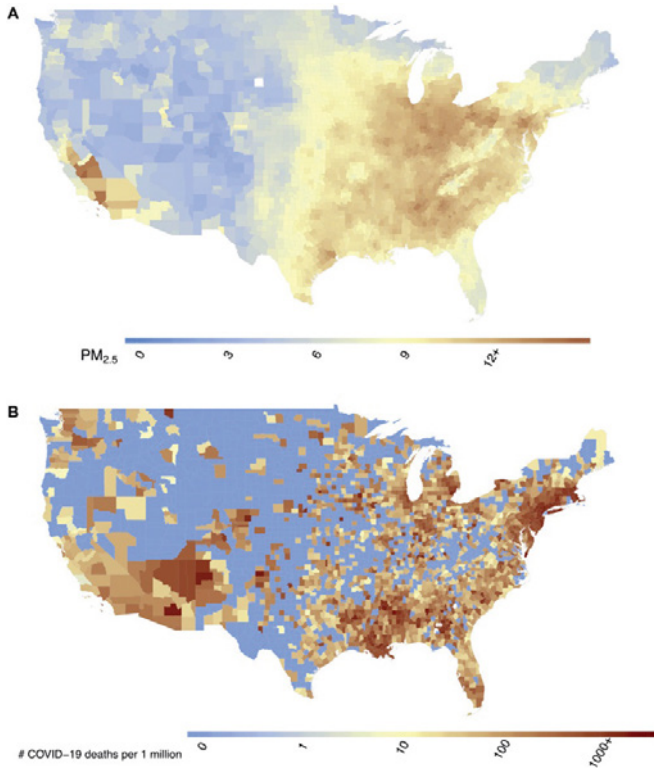

Figure 4: *National maps of historical PM2.5 concentrations and COVID-19 deaths. Maps show (A) county-level 17-year long-term average of PM2.5 concentrations (2000–2016) in the United States in µg/m3 and (B) county-level number of COVID-19 deaths per one million population in the United States up to and including June 18, 2020. Source: Science Advances*[22]

- Lowering the concentration of SARS CoV-2 by means of ventilation and filtration can play a role in controlling transmission of the virus that causes COVID-19, in addition to wearing masks, social distancing, cleaning and disinfection.
- Ventilation is also a critical measure that can be taken to reduce exposure to cleaning products, disinfectants and the byproducts they produce as a result of chemical reactions in indoor air.

Update: How IAQ Affects SARS-CoV-2 Transmission

The amount of PM2.5 (fine inhalable particles, with diameters that are generally 2.5 micrometers and smaller) in the air was found to exacerbate the impact of COVID-19. PM2.5 can be found in both indoor and outdoor air, and has the same negative affect on people's health. The below updated research focuses on air pollution caused by PM2.5. This information is relevant to how the quality of both indoor and outdoor air is central in determining the level of harm caused by COVID-19.

Harvard T.H. Chan School of Public Health, Dana-Farber Cancer Institute

On November 4, 2020, Harvard T.H. Chan School of Public Health and Dana-Farber Cancer Institute published an article on air pollution and COVID-19. They found a striking correlation between higher levels of PM2.5 and an increase in the COVID-19 mortality rate. Specifically, the study states:[21]

- In the U.S., we found that higher historical PM2.5 exposures are positively associated with higher county-level COVID-19 mortality rates after accounting for many area-level confounders.
- We found that an increase of 1 µg/m^3 in the long-term average PM2.5 is associated with a statistically significant 11% (95% CI, 6 to 17%) increase in the county's COVID-19 mortality rate; this association continues to be stable as more data accumulate.

[20] All information in this paragraph and subsequent bullets sourced from: "Science and Technical Resources related to Indoor Air and Coronavirus (COVID-19)," Environmental Protection Agency (EPA), https://www.epa.gov/coronavirus/science-and-technical-resources-related-indoor-air-and-coronavirus-covid-19.

[21] All information in this paragraph and subsequent bullets sourced from: X. Wu, R. C. Nethery, M. B. Sabath, D. Braun, F. Dominici, "Air pollution and COVID-19 mortality in the United States: Strengths and limitations of an ecological regression analysis," Science Advances, November 4, 2020, https://advances.sciencemag.org/content/6/45/eabd4049.

[22] X. Wu, R. C. Nethery, M. B. Sabath, D. Braun, F. Dominici, "Air pollution and COVID-19 mortality in the United States: Strengths and limitations of an ecological regression analysis," Science Advances, November 4, 2020, https://advances.sciencemag.org/content/6/45/eabd4049.

SUNY Environmental Science and Forestry, ProPublica

On September 11, 2020, SUNY Environmental Science and Forestry and ProPublica published an article on the relation between air pollution and COVID-19. Specifically, it states:[23]

- We examine the relationship between hazardous air pollutants (HAP) exposure and U.S.-based COVID-19 mortality, while controlling for socioeconomic status, population health indicators and exposure to PM2.5 and ozone.
- We find that an increase in the respiratory hazard index is associated with a 9% increase in COVID-19 mortality. Although differing in magnitude, this association holds for individual HAPs acetaldehyde and diesel PM. These findings help us to understand variations in U.S.-based COVID-19 mortality rates, reinforce existing research linking air pollution to mortality, and emphasize the importance of regulatory efforts to limit air pollution exposure risk.

Update: The Critical Role of Energy Recovery Ventilation

Considerable evidence exists that increased building ventilation can help clear out SARS-CoV-2 particles from the indoor air to protect occupant health. However, extra ventilation requires more energy, and this increases greenhouse-gas emissions and costs. Therefore, homes and buildings of every type and in every climate can benefit from energy recovery ventilation.

Energy Recovery Ventilators (ERVs) use otherwise-wasted total energy (heat and humidity) from the exhaust airstream to condition incoming outdoor air. This process enhances IAQ while cutting energy consumption and costs. For more information on energy recovery ventilation and SARS-CoV-2, please see my original white paper on this topic.

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

Recognizing the important role of energy recovery ventilation in fighting the spread of COVID-19, ASHRAE added updated ERV guidelines in its building readiness report. As of February 1, 2021, highlights of the ERV portion include:[24]

- Well-designed and well-maintained air-to-air energy recovery systems should remain operating in residences, commercial buildings and medical facilities during the COVID-19 pandemic. This is because maintaining at least normal outside air ventilation rates, with proper temperature and humidity conditioning of the inside space, is important for maintaining health and combatting infectious aerosols.
- Dilution of contaminants, including infectious aerosols, by outdoor air ventilation is an integral IAQ strategy in ASHRAE Standard 62.1. A properly designed system also includes filtration in many forms, along with proper building pressurization controls.

In Summary

Over the last several months, substantial new research has been conducted on the airborne transmission of SARS-CoV-2 and the key role of increased building ventilation. Although we continue to face an uphill battle to regain a sense of normality, advances in these areas certainly will help us to achieve this goal. I'll continue to monitor the latest information and add updates as necessary. Please stay tuned.

In the meantime, for more information on how increased building ventilation can help stop the spread of SARS-CoV-2, visit RenewAire's COVID-19 Response website.

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[23] All information in this paragraph and subsequent bullets sourced from: Michael Petroni, Dustin Hill, Lylla Younes, Liesl Barkman, Sarah Howard, I Brielle Howell, Jaime Mirowsky, and Mary B Collins, "Hazardous air pollutant exposure as a contributing factor to COVID-19 mortality in the United States," IOPscience, September 11, 2020, https://iopscience.iop.org/article/10.1088/1748-9326/abaf86.

[24] All information in this paragraph and subsequent bullets sourced from: "ASHRAE EPIDEMIC TASK FORCE BUILDING READINESS," ASHRAE, February 1, 2021, https://www.ashrae.org/file%20library/technical%20resources/covid-19/ashrae-building-readiness.pdf.