How Effective Are Bath Exhaust Fans in Controlling Bathroom Pollutants?

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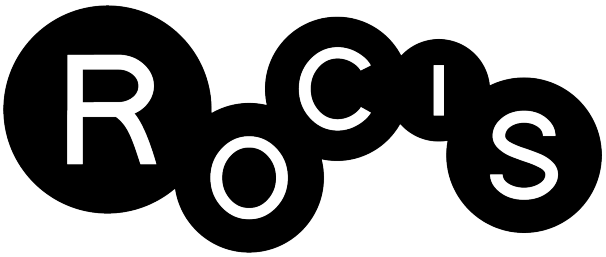

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BACKGROUND

Residential bathrooms can have significant sources of various indoor pollutants from consumer products, cleaning products, and bathing and showering that present increased risks for asthma, cancer, immune responses, and mucosal irritation. (Wang et al., 2026;Tang, 2026; Adcock et al., 2026; Salonen et al., 2024; EWG, 2023). Estimated bathroom exposures to VOCs from consumer and cleaning products can exceed acute health hazard criteria (Nazaroff et al., 2006). In addition, indoor VOCs can produce toxic or irritant compounds and secondary organic aerosols from reactions with ozone or nitrate radicals (Wang et al., 2026). The bathroom was also a hot spot for molecular diversity and chemically transformed compounds on the surfaces of a Texas test home (Aksenov et al., 2022).

Bathroom exhaust fans have been used as local exhaust for bathrooms and for whole house ventilation in new and existing homes. Bathroom exhaust fans running continuously have substantially reduced indoor levels of indoor Total VOCs, radon, formaldehyde, and moisture balance in older, weatherized single family homes in Illinois and Indiana (Francisco et al., 2016). The bath fans were also significantly more effective that natural ventilation. Both supply and exhaust fans helped reduce levels of some indoor air pollutants, but supply fans were more effective in reducing indoor PM2.5 levels in existing single-family homes in Illinois (Francisco et al., 2025). As with most mechanical ventilation systems, the real-world, life cycle effectiveness depends on the proper installation, operation and maintenance of the system.

A few studies have examined the question of which mechanical exhaust ventilation methods are most effective in reducing levels of indoor pollutants in bathrooms and in improving health.

For example:

1) Kim, O. & Yang, J. H. (2016). On the Design to Improve the Bathroom Exhaust Performance in Multi-Unit Residential Building. *Journal of Asian Architecture and Building Engineering*, *15*(2), 349–356

   Field measurements in different floors of a multifamily building in Korea were conducted to determine if the bathroom exhaust fans met the 8 air change/hour criteria. The installed fans did not meet the ventilation criteria, and most occupant complaints were due to odor and mold problems. Fan performance problems were due to excessive duct length, air leaks in the exhaust duct, variable proficiency of the fan installers, and lack of fan testing, adjusting, and balancing. Fan run time was also inadequate: after a 10 minute shower, a fan run time of 70 minutes was needed to control moisture sufficiently. In addition, laboratory tests were

conducted to offer a design standard of the fan′s components and a standard installation method for the fans.

Recommended solutions included limiting the exhaust duct length to no more than 1,500 mm, commissioning of the fan flow, installing the fan at the bottom of the shower stall partition. The air flow calculations also need to be adjusted for pressure drops from different diffuser type, the fan and duct work, and the manufacture's pressure-flow curves.

2) Kang, I., et al. (2025). Effects of Residential Ventilation and Filtration Interventions on Adult Asthma Outcomes. *Building and Environment,* 285B.

News item: Breathing room: UTA study clears the air on asthma (UT Arlington, 2025).

Researchers installed one of three types of ventilation systems in homes of 51 adult asthma patients in Chicago: upgraded bathroom exhaust fans that run continuously to draw air in from the outside; a supply fan connected to the central heating and cooling system set that ran intermittently to push air into the home; or an energy recovery ventilator (ERV) that continuously exchanged indoor and outdoor air. The supply and balanced systems circulated and filtered air, while the ERVs also conserved heating and cooling energy. Several homes with upgraded bathroom exhaust fans did not initially have a bath exhaust fan, a functioning fan, or one in every bathroom.

After adjustment for demographic factors and seasonality, all three systems led to measurable and significant improvements in indoor air quality and asthma outcomes during the study's second year, when ventilation was activated. Greater improvements in asthma control were

observed with ERV systems (8.4%), followed by CFIS (7.1%) and exhaust-only systems (3.8%), and these improvements gradually increased over the year. Reduced indoor NO_2 levels were significantly associated with improved asthma control and marginally associated with reduced indoor CO_2 levels. Asthma improvements were significantly greater in participants' ≥ 45 years, Black, White, or with incomes < $75K.

MORE INFORMATION AND RESOURCES

BATHROOM VENTILATION

Turns, M., and Wolfgang, B. (2013). Obtaining Proper Ventilation: A Case Study in Residential Exhaust Fan Performance. *Pennsylvania Housing Research Center*, PSU. Builder Brief 0713.

Slipstream, 2021. Exhaust Fan Flow Assessment (YouTube video).

Green Building Advisor:

Bailes, A. (2024). Venting Bathroom Exhaust Air. *Green Building Advisor.*

- Recommended: related article links

Williams, R. (2021). Two Methods for Testing a Bath Fan for Air Flow. *Green Building Advisor.*

Energy Vanguard:

Bailes, A. (2024). Don't Vent Bath Fans to the Attic! *Energy Vanguard*

Bailes, A. (2016). Installing an Exhaust Fan During a Bathroom Remodel. *Energy Vanguard*

Bailes, A. (2011). 5 Reasons Bath Fans Have Such Poor Air Flow. *Energy Vanguard*

The Journal of Light Construction:

Glogowski, P. (2020). Fixing Bathroom Ventilation Problems – Poorly Installed Ductwork and Insulation. *The Journal of Light Construction.*

Easley, S. (2025). Practical Ventilation Control. *The Journal of Light Construction.*

Miller, A. (2023). Running a Bath Fan Exhaust Through Metal Roofing. *The Journal of Light Construction.*

Uhler, B. (2020). A Simple, Cost-Effective Ventilation Strategy. *The Journal of Light Construction.*

Consumer Reports:

Bailey, M. (2026). 6 Best Bathroom Exhaust Fans of 2026, Lab-Tested and Reviewed. *Consumer Reports.*

BATHROOM POLLUTANTS, TOXICITY, INDOOR EXPOSURE, AND PREVENTION MEASURES

Wang, F., et al. (2026). Volatile Organic Compound Emissions and Key Drivers of Acute Inhalation Risk and Secondary Organic Aerosol Formation From Consumer Volatile Chemical Products. *Indoor Air,* 6015959.

Tang, Y., et al. (2026). Advanced Characterization of Associations Between VOC Exposure, Immune Markers, and Cardio-Oncologic Multimorbidity Using 13 Machine-Learning Models: Insights From NHANES 2011–2020. *Indoor Air,* 1135003.

Adcock, L., et al. (2026). Differential and Sex-Specific Toxicity of Aspirated Quaternary Ammonium Compounds. *Environ. Sci. Technol.,* 60(13), 9872–9880.

- *News item:* Common Disinfectant Chemicals Far More Toxic When Inhaled, Study Finds (Quinton, A., *UC Davis*, 30 March 2026)

Salonen, H., et al. (2024). Cleaning products: Their chemistry, effects on indoor air quality, and implications for human health. *Environment International,* 190.

Wang, N., et al. (2024). How Does Personal Hygiene Influence Indoor Air Quality? *Environ. Sci. Technol.,* 58(22), 9750–9759.

- *News item*: Personal hygiene habits affect indoor air quality (Wilke, C., *C&EN*, 10 June 2024)

Wu, T., et al (2024). Indoor Emission, Oxidation, and New Particle Formation of Personal Care Product Related Volatile Organic Compounds. *Environ. Sci. Technol. Lett.,* 11(10), 1053–1061.

- *News item:* How personal care products affect indoor air quality (Perroud, S., *Phys.org*, 2024)

Quinn, M. M., et al. (2024). Respiratory quaternary ammonium and volatile organic compound exposures experienced by home care aides during residential bathroom cleaning using conventional and green products. *Annals of Work Exposures and Health*, 69(2), 173–190.

Boulier, L. et al. (2024). Numerical performance evaluation of ventilation systems for energy-efficient retrofitting of existing houses in France. 44th AIVC - 12th TightVent - 10th venticool Conference – Dublin, Ireland - 9-10 October 2024.

- Part of the JUSTAIR Project
- Eight different types of whole house ventilation systems, including several with bathroom exhaust, were modeled for IEQ in a test house in France, to address different types of air balance, run time, controls (RH, CO_2) and

integration with heat pump systems. Three of the studied ventilation systems will be implemented in the experimental house for the model's validation. The validated models will be used to perform sensitivity analysis under different configurations and climate conditions.

The Environmental Working Group (13 September 2023). Cleaning products emit hundreds of hazardous chemicals, new study finds. *EWG.org.*

Nazaroff, W. W., et al. (2006). Indoor Air Chemistry: Cleaning Agents, Ozone and Toxic Air Contaminants. Prepared for CARB Research Division, Final Report: Contract No. 01-336.

- *News item:* Study warns of cleaning product risks (Greensfelder, L., *Phys.org*, 22 May 2006)

ADDITIONAL RESOURCES

Zhu, Y. (2026, in press). Indoor Air Quality in California: New Evidence and Environmental Justice Implications. *California Air Resources Board (CARB).*

- Update to 2005 Report to Legislature, AB 1173. Final report and research webinar.

US EPA (2026, June). Volatile Organic Compounds' Impact on Indoor Air Quality.

- Sources, health effects, and steps to reduce exposure are summarized.

American Lung Association (2026). Cleaning Supplies and Household Chemicals.

- Fact sheets and prevention resources.

CARB (2020). Cleaning Products & Indoor Air Pollution.

- Indoor sources are discussed, and exposure reduction measures are recommended, including ventilation for several hours after using cleaning products.

Boor, B., et al. (2026). Indoor atmospheric nanoparticle formation from scented cleaning products. American Chemical Society Fall 2026 Conference.

- *News item:* Scented cleaning products create invisible air pollution (ACS news, 27 August 2026)
- Conventional and botanical products were tested for nanoparticle reactions with ozone. Rapid nanoparticle growth enabled survival to sizes that efficiently deposit throughout the human respiratory system, yielding inhalation dose rates comparable to or exceeding those from primary combustion sources such as traffic emissions. Several exposure reduction measures are recommended.