Impact of Ceiling Fans on the Risk of Infectious Aerosol Transmission

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Research gaps

We know well
- Using fans can save energy and improve comfort

We know little
- The impact of using fans on indoor air quality and infectious aerosol transmission

https://cbe.berkeley.edu/research-category/indoor-environmental-quality/fans/
Inconsistent recommendations – CDC, WHO, and ASHRAE

Ceiling fans help to improve air flow

Use ceiling fans to help improve air flow in the home whether or not windows are open.

Inconsistent recommendations – CDC, WHO, and ASHRAE

Use fans only when opening windows and doors

The limit of 50 fpm rules out using fans

Air moving devices and air inlets shall be designed such that no lateral flow with a velocity greater than 50 fpm occurs within the breathing zone.


Comments on the requirement of “no lateral flow with a velocity greater than 50 fpm occurs within the breathing zone” in Clause 6.1.3 and Clause 6.4.6

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Transmission routes

**Short-range inhalation** of fine respiratory particles ($< 0.5 \mu m$) is the predominant transmission route of SARS-CoV-2 viruses.

Methodology

Ceiling fans:
• On and off

Ventilation:
• 200, 400, and 800 m$^3$/h
  [1.6, 3.2, and 6.4 Air changes per hour]
Repeated measurement at 16 sampling points at both short and long ranges.

Source

Short range
(< 1.5 m)

Long range
(> 1.5 m)
Results – tracer particle concentrations

- Simply increasing ventilation is not an effective way to reduce short-range exposure (a presumed predominant transmission route for COVID-19).
- Using the ceiling fan largely reduced the exposure to tracer airborne particles from the proximate source.

![Graph showing the impact of ventilation rate and ceiling fan on tracer particle concentrations.](image)
Results – tracer particle concentrations

![Graph showing tracer particle concentrations in relation to ventilation rate for short- and long-range routes with ceiling fan on and off.](image-url)
From airborne particle exposure to infection risks

Dilution-based Wells-Riley model

Quanta emission rate measures how quickly a sick person releases tiny infectious particles into the air every hour.

Inhaling one quantum of an infectious agent implies a 63% chance of becoming infected.
Infection risks

![Graph showing infection risks with and without fans on for short-range and long-range routes.](image-url)
Decision tool

https://jiayuli.shinyapps.io/fan_infectious_aerosols/
Decision tool

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ASHRAE 241 recommendation 36.0 to 154.0 m³/h/person
Decision tool

The benefits of fans are highest when:
- the room is well-ventilated
- the pathogen is not highly contagious
- masking measures are in place
Q&A

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Reference

- Li, Zuraimi, and Schiavon. 2024. Should we use ceiling fans indoors to reduce the risk of transmission of infectious aerosols? (under review)
- Web tool
  https://jiayuli.shinyapps.io/fan_infectious_aerosols/