Model for estimating relative airborne transmission risk in buildings

Arto Säämänen

Principal scientist

VTT Technical Research Centre of Finland

Anticipation, recognition

- Who?
- Where?
- When?

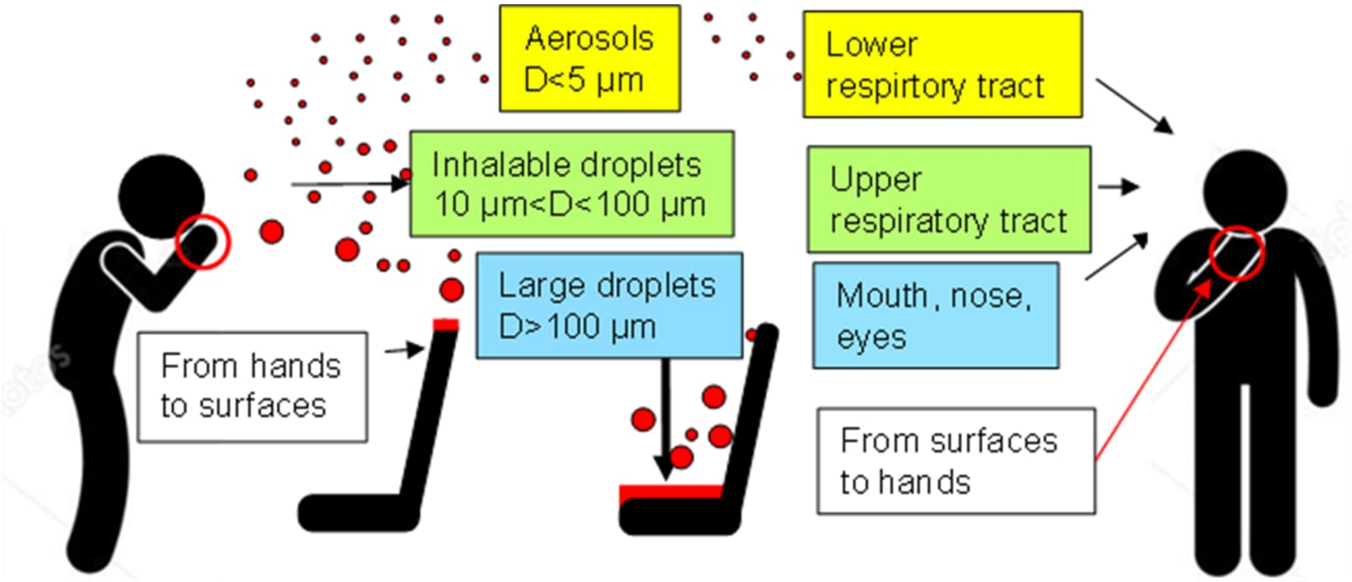
Francis, M. R., Gidado, S., & Nuorti, J. P. (2024). The Risk of SARS-CoV-2 Transmission in Community Indoor Settings: A Systematic Review and Meta-analysis. The Journal of Infectious Diseases. https://doi.org/10.1093/infdis/jiae261

- Quantifying the risk of SARS-CoV-2 transmission in indoor settings is crucial for developing effective non-vaccine prevention strategies and policies.
- However, summary evidence on the transmission risks in settings other than **households, schools, elderly care and healthcare facilities** is limited.
- In this study the **pooled Secondary Attack Rate (SAR) for community indoor settings** was 20.4% (95% confidence interval [CI] 12.0–32.5%).
- The setting-specific SARs were highest for **singing events** (SAR 44.9%, 95% CI 14.5–79.7%) and **fitness centres** (28.9%, 9.9–60.1%).

Source - Dispersion – Receiver
Index – Transmission routes - Susceptible

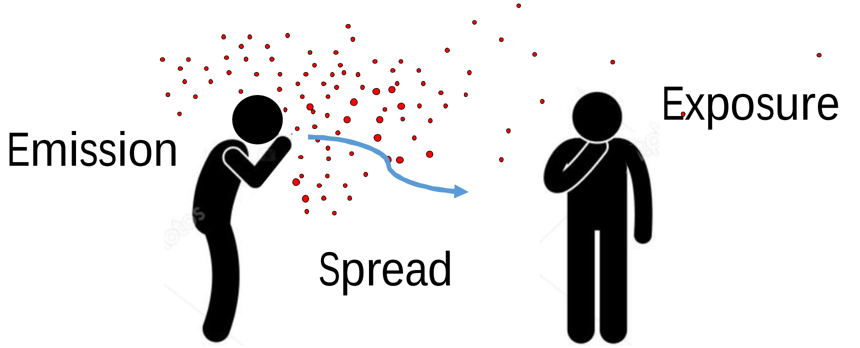
- How?

- Short range - Droplets
- Fomite
- Long range - Airborne



Airborne transmission risk modelling

Kulmala, I., Taipale, A., Sanmark, E., Lastovets, N., Sormunen, P., Nuorti, P., Saari, S., Luoto, A., & Säämänen, A. (2024). Estimated relative potential for airborne SARS-CoV-2 transmission in a day care centre. *Heliyon, 10(9), e30724.* *https://doi.org/10.1016/j.heliyon.2024.e30724*



$$C = \frac{G}{(\lambda + \lambda_{IA} + \lambda_D)V + q_{AC}E}$$

$$D = C \cdot t \cdot Br \cdot fi$$

$$R = 1 - \exp(-0.693\frac{D}{D_{50}})$$

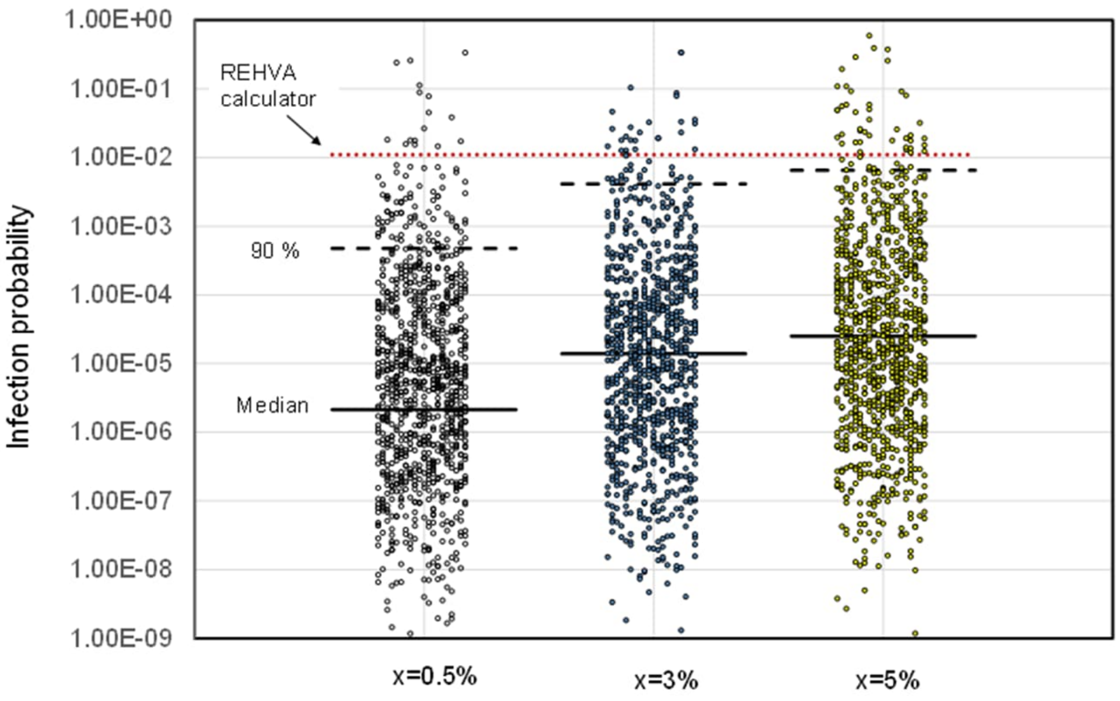
Airborne concentration → **Inhalation dose** → **Infection risk**

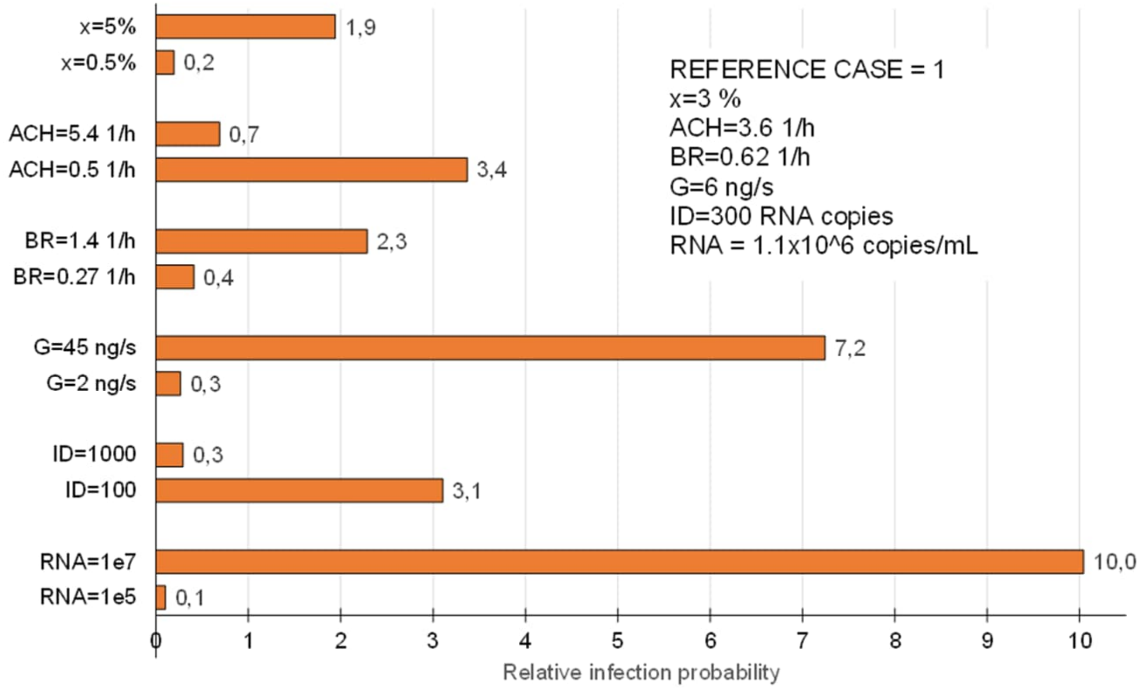
Emission rate G
Inactivation rate λ_{IA}
Deposition rate λ_D
Ventilation rate λ
Room volume V
Air cleaner CADR $q_{AC}E$

Airborne concentration
Exposure time t
Breathing rate Br
Deposited fraction f_i

Infective dose D_{50}
infection risk of a single viral RNA copy p_{RNA}

Exact probabilities for transmission are hard to predict





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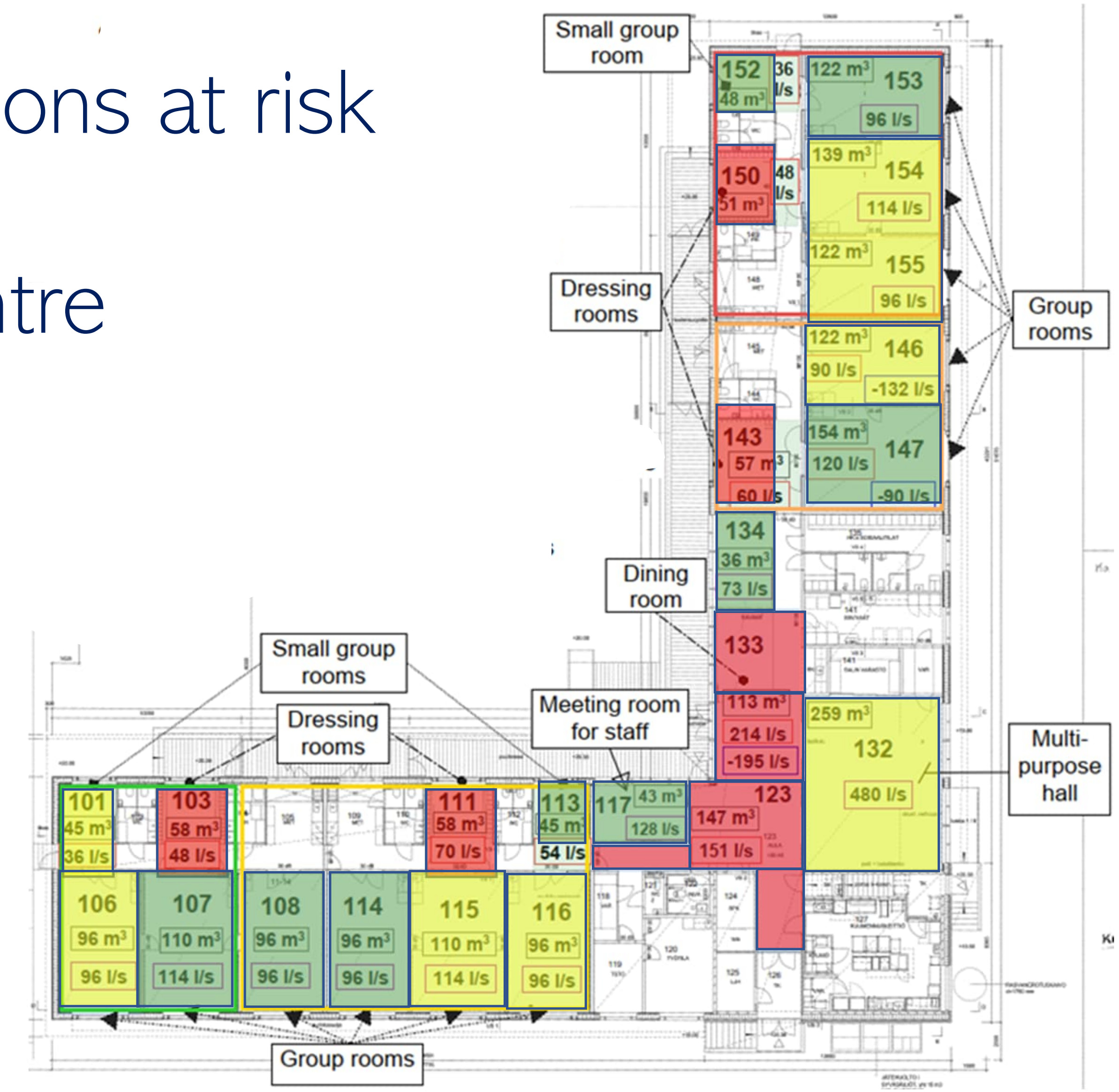
The relative number of persons at risk

Case study in a daycare centre

- Number of persons: High
- Number of persons: Medium
- Number of persons: Low



Control measures Airborne route

- **Lowering Pathogen Emissions:**
  - Proper coughing/sneezing etiquette, masks, and PPE
  - Voice control, activity
  - Most studies (131 out of 158) found masks effectively reduce infections.
- **Ventilation**:
  - Increased dilution through outdoor air ventilation or portable air cleaners
  - Adjust ventilation rates based on activity and occupancy.
- **Facility Management:**
  - Key role in infection control;
  - Focus on HVAC, cleaning, and space management.

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Transmission route	Mitigation and control measures		
	Source	Dispersion	Receiver
Airborne	Surgical mask or FFP2 respirators without valve Reducing voice use Avoiding heavy physical exercise indoors	Stay-home policy Mask mandate Enhanced ventilation Air cleaners UV irradiation RH control	FFP2/FFP3 respirators + their fit testing at work Avoiding crowds Reduced time spent in mass gatherings Avoiding physical exercise with increased breathing rate indoors
Droplet	Surgical masks Reducing voice use Coughing and sneezing etiquette	Stay-home policy Mask mandate Physical barriers Physical distancing	Surgical masks or FFP2 respirators + Face shield in inpatient care
Contact	Surgical masks Coughing and sneezing etiquette Hand hygiene	Cleaning of frequently touched surfaces Contactless operations	Hand hygiene Avoidance of face touching Avoidance of shaking hands

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Take home messages

- Risk assessment
- Consider all transmission pathways
- No single silver bullet
- Use a combination of several mitigation measures

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