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Supplementary information

The physics of respiratory particle generation, fate in the air, and inhalation

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Supplementary information for: The physics of respiratory particle generation, fate in the air, and inhalation

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Table S1. The methodology and instrumentation adopted to investigate airflow from human respiratory activities and the main findings from the studies.

	Methodology and instrumentation	Main findings
Savory et al. (2014)	Particle image velocimetry, an experimental cough chamber facility has been developed to study the far-field aerodynamics and aerosol transport of particles produced by the coughs from 12 humans naturally-infected with influenza	The spatially averaged maximum velocity was determined and the average value was 0.41 m s^{-1} across 27 coughs of good data quality.
Kwon et al. (2012)	To analyze the initial velocity and the angle of the exhaled airflow from coughing and speaking of 17 males and 9 females using Particle Image Velocimetry (PIV) and acrylic indoor chamber.	The average initial coughing velocity was 15.3 (10.6) m s^{-1} for the males (females), while for speaking it was 4.07 (2.31) m/s, respectively. The angle of the exhaled air from coughing was around 38° (32°) for the males (females), while from speaking it was around 49° and 78° respectively.
VanSciver et al. (2011)	The velocity field of human cough was measured using particle image velocimetry (PIV). 29 subjects coughed into an enclosure seeded with stage	Maximum cough velocities ranged from 1.5 m s^{-1} to 28.8 m s^{-1}. The average width of all coughs ranged between 35 to 45 mm.

	fog. Cough flow velocity profiles, average widths of the cough jet, and maximum cough velocities were measured.	
Cortellessa et al. (2021)	Particle image velocimetry (PIV) technique was employed for the determination of speak velocity for a "face-to-face" interaction. Speaking activity was recorded for the duration of 50 s (500 images).	Peak velocities ranged from 1.5 m s^{-1} to 5 m s^{-1}.
Zhu et al. (2006)	The transport characteristics of saliva droplets produced by 3 subjects coughing are examined through PIV in a calm indoor environment	More than 6.7 mg of saliva is expelled and travel further than 2 m at speeds of up to 22 m s^{-1} during each individual cough
Bourouiba et al. (2014)	A visualization of the real human coughs and sneezes is presented through an experimental set-up using high-speed cameras.	The turbulent multiphase cloud plays a critical role in extending the range of the majority respiratory particles that can remain suspended long enough to reach heights where ventilation systems can be contaminated (4-6 m).
Gupta et al. (2009) Gupta et al. (2010)	A spirometer based on Fleish type pneumotachograph was used to measure the flow rates generated over time with a frequency of 330 Hz. The flow directions were visualized through moderate-speed photography (120 Hz) with 1 Mega Pixel resolution.	The flow rate, flow direction, and mouth opening area were measured for 25 human subjects during breathing, coughing and speaking.
Xu et al. (2017)	Airflow dynamics of human exhalation were obtained through nonhazardous schlieren photography technique. The visualization and quantification of turbulent exhaled airflow was estimated from 18 healthy human subjects whilst standing and lying.	The mean peak centerline velocity was found to decay with increasing horizontal distance and the mean propagation velocity was found to correlate with physiological parameters of human subjects.
Tang et al. (2009)	Video records are obtained of human volunteers coughing with and without wearing standard surgical and N95 masks through the schlieren optical method	Wearing a surgical or N95 mask blocks the formation of the jet (N95 mask) or redirect it in a less harmful direction (surgical mask) during human coughing.

Table S2. Summary of the studies reporting experimental data of total deposition fraction graphed in Figure 4: information on particle range, number of volunteers, breathing pattern, and type of aerosol are reported. All the study under investigation refer to healthy adult subjects.

Study	**Particle range**	**volunteers**	**breathing pattern**	**Type of aerosol**
Lin et al. (2019)	20 nm – 1 μm,	15 volunteers (males and females)	tidal volume of 500 mL and breathing frequency of 15 breaths min^{-1}	di-2-ethylhexyle sebacate
Heyder et al. (1986)	5 nm – 15 μm	3 volunteers	tidal volume of 500 mL and breathing frequency of 15 breaths min^{-1}	di-2-ethylhexyl sebacateaerosols & iron oxide aerosols & silver aerosol
Morawska et al. (2005)	16 -626 nm	14 volunteers (males and females)	their own tidal volume and breathing frequency	Petrol-generated aerosols; Diesel-generated aerosols; Environmental tobacco smoke aerosols
Rissler et al. (2017)	15 nm – 5 μm	60 volunteers (males and females)	their own tidal volume and breathing frequency	carnauba wax (in the size range of 15– 500 nm), and manufactured spherical glass particles (in the range 500–5000 nm)
Kim et al. (2004)	40 – 100 nm	22 volunteers (males and females)	tidal volume of 500 mL and breathing frequency of 15 breaths min^{-1}	di-2-ethylhexyle sebacate
Guo et al. (2020b)	10 – 400 nm	1 volunteer	his own tidal volume and breathing frequency	ambient aerosol

Emmett et al. (1982)	3.5-10 μm	12 volunteers (males)	their own tidal volume and breathing frequency	polystyrene particles radioactively labelled with 99 mTc
Foord et al. (1978)	2.5 - 7.5 μm.	16 volunteers (males)	tidal volume of 1 L and breathing frequency of 10 breaths min^{-1}	polystyrene particles radioactively labelled with 99 mTc
Giacomelli-Maltoni et al. (1972)	2.5 - 2.0 μm	25 volunteers (males and females)	tidal volume of 1 L and breathing frequency of 12 breaths min^{-1}	carnauba wax
Altshuler et al. (1957)	0.14 – 3.2 μm	3 volunteers	tidal volume of 500 mL and breathing frequency of 15 breaths min^{-1}	Triphenyl phosphate
Stahlhofen et al. (1980)	2 - 10 μm	3 volunteers (males)	tidal volume of 1 L and breathing frequency of 7.5 breaths min^{-1}	Fe_2O_3 particles radioactively labelled with ^{198}Au