

Appendix 2 (as supplied by the authors): Summary of data from surrogate exposure studies

Study	Method*	Size of challenge particle	Range of particle size measured (µm)	Filter penetration		Face-seal leakage		Total inward leakage		MPPS (um)	
				N95	Surgical	N95	Surgical	N95	Surgical	N95	Surgical
Bařazy 2006 ¹	-Manikin -30, 85L/min constant flow -MS2 virion -Two N95 respirators -Two surgical masks	0.025 µm	0.01-0.08 µm	GM: 4.9% ^{est} GSD: 1.14 Range: 4.3-5.6%	GM: 41.6% GSD: 2.03 Range: 20.5-84.5 %	NR	NR	NR	NR	0.05 (filter)	0.05-0.08 (filter)
Bischoff 2011 ^{**2}	-Human -Live attenuated influenza vaccine -One N95 respirator -One surgical mask	GM: 4.9 µm GSD: <1.13	All sizes	NR	NR	NR	NR	NR	NR	NR	NR
Checchi 2005 ³	-Manikin -8.33, 150 L/min constant flow -Polydisperse bicarbonate dust -One FFP2 respirator -Two surgical masks	<1-300 µm	All sizes	NR	NR	NR	NR	4%	GM: 11% GSD: 1.3 Range: 8-14%	NR	NR
Davidson 2011 ⁴	-Manikin -10 L/min cyclic flow at 20 breaths/minute - <i>B. anthracis</i> vegetative cell aerosol -Six N95 respirators -Five Surgical masks	1.0-1.5 µm diameter, 1-8 µm length CMAD: 1.2 µm GSD: 1.5 MMAD: 2.1 µm GSD: 1.5	0.8-15 µm	NR	NR	NR	NR	GM: 39% GSD: 1.3 Range: 31-66%	GM: 43% GSD: 1.3 Range: 33-66%	NR	NR

Davidson 2013 ⁵	-Manikin -10 L/min cyclic flow at 20 breaths/min -Monodisperse polystyrene latex beads of various sizes and <i>B. anthracis</i> endospore aerosol -Six N95 respirators -Five surgical masks	Polystyrene latex bead size: 1.3 µm	All sizes	GM: 0.2% GSD: 0 Range: 0-1%	GM: 15% GSD: 1.48 Range: 9-26%	NR	NR	GM: 41.4% ^{est} GSD: 1.34 Range: 23.0-53.1 %	GM: 40.4% ^{est} GSD: 1.26 Range: 28.1-54.1 %	NR	NR
Derrick 2006 ⁶	-Human -Polydisperse NaCl -One FFP2 respirator -One laser mask and one surgical mask	CMD: 0.04 µm GSD: 2.2	0.02-1.0 µm	NR	Data omitted***	NR	NR	GM: 1.0%	GM: 29.6% GSD: 1.1 Range: 26.3-33.3 %	NR	NR
Diaz 2010 ⁷	-Manikin -7.5 L/min cyclic flow at 15 breaths/min -Polydisperse radiolabeled NaCl -One N95 respirator -One surgical mask tested in two configurations	No air flow MMAD: 0.950 µm 95% CI: 0.909-0.991	All sizes	Data omitted***	NR	NR	NR	Mean: 49%	Mean: 100%	NR	NR
Duling 2007 ⁸ and Lawrence 2006 ⁹	-Human -Polydisperse NaCl -Fifteen N95 respirators -Six surgical masks	CMD: 0.04 µm GSD: 2.2	0.02-1.0 µm	NR	NR	NR	NR	GM: 4.7% GSD: 2.1 Range: 1.8-33.3%	GM: 38.2% GSD: 1.4 Range: 25-62.5%	NR	NR
Gawn 2008 ¹⁰	-Manikin and human -40 L/min cyclic flow at 20 breaths/min -Polydisperse artificial saliva and live influenza bioaerosol -Four FFP2 respirators -Eight surgical masks	CMD (artificial saliva): 20 µm	0.03-0.06 µm (face-seal leakage) 0.2-1.2 µm (TIL)	NR	NR	GM: 0.9% GSD: 3.0 Range: 0.2-4.3%	GM: 14.8% GSD: 8.5 Range: 0.3-100 %	GM: 1.20% GSD: 2.07 Range: 0.55-3.85 %	GM: 36.4% GSD: 2.4 Range: 5.9-100%	NR	NR

Grinshpun 2009 ¹¹	-Manikin and human -Breath recording and simulation system -Polydisperse NaCl -One N95 respirator -One surgical mask	NR	0.029-0.99 0 µm	Mean: 0.7% ^{est}	Mean: 7.1% ^{est}	Mean: 5.0% ^{est}	Mean: 37.6% ^{est}	Mean: 5.7% ^{est}	Mean: 44.7% ^{est}	0.04 (filter) 0.13 (face-seal) 0.04-0.13 (TIL)	0.04-0.13 (filter) 0.13 (face-seal) 0.13 (TIL)
He 2013 ¹²	-Manikin -15, 30, 55, 85 L/min cyclic flow at 10, 15, 20, 25, 30 breaths/min -Polydisperse NaCl -One N95 respirator -One surgical mask	CMD: 0.125 µm GSD: 1.68	0.02-0.5 µm	Mean: 0.7% ^{est}	Mean: 13.4% ^{est}	NR	NR	Mean: 2.5% ^{est}	Mean: 41.1% ^{est}	0.03-0.04 µm (filter)	0.3 µm (filter)
He 2014 ¹³	-Manikin -15, 30, 55, 85 L/min cyclic flow at 10, 15, 20, 25, 30 breaths/min -Polydisperse NaCl -One N95 respirator -One surgical mask	CMD: 0.125 µm GSD: 1.68	0.02-0.5 µm	Mean: 0.72%	Mean: 9.65%	NR	NR	Mean: 1.94%	Mean: 30.0%	NR	NR
Lee 2008 ¹⁴	-Human -Polydisperse NaCl -Four N95 respirators -Three surgical masks	NR	0.0414-1.2 625 µm	NR	NR	NR	NR	GM: 4.7%	GM: 42.7%	0.08-0.2 µm (TIL)	0.04-0.32 µm (TIL)
Li 2006 ¹⁵	-Human -Polydisperse Fluorescein-KCl -One N95 respirator -One surgical mask	NR	NR	NR	NR	NR	NR	Mean: 3%	Mean 5%	NR	NR
Lindsley 2012 ¹⁶	-Manikin -32, 85, 95 L/min constant flow and 32, 85 L/min cyclic flow (breathing frequency not reported) -Polydisperse NaCl and KCl -Six N95 respirators -Three surgical masks	Filter tester CMD: 0.075 µm GSD: 1.86	0.3->20 µm	GM: 1.1% GSD: 2.82 Range: 0.3-7.0%	GM: 26.0% GSD: 1.07 Range: 24.8-28.7 %	NR	NR	NR	NR	0.3-0.5 µm (filter)	0.3-0.5 µm (filter)

Mansour 2013 ¹⁷	-Manikin -7.5 L/min cyclic flow at 15 breaths/min -Polydisperse radiolabeled NaCl -One N95 respirator -One surgical mask tested in two configurations	MMAD: 0.69 µm 95% CI: 0.6237-0.7563	All sizes	Data omitted***	NR	NR	NR	Mean: 7.72%	Mean: 67.32%	NR	NR
Mitakakis 2002 ¹⁸	-Human -Polydisperse Hev b 5 latex allergen-containing particles -One N95 respirator -One face mask	NR	NR	NR	NR	NR	NR	Mean: 26.7% ^{est}	Mean: 79.2% ^{est}	NR	NR
Noti 2012 ¹⁹	-Manikin -32 L/min cyclic flow (breathing frequency not reported) -Polydisperse influenza virus aerosol -One N95 respirator -One surgical mask	NR	<1, 1-4, >4 µm	Mean: 0.2%	Mean: 5.5%	NR	NR	Mean: 30.1%	Mean: 31.1%	NR	NR
Qian 1998 ²⁰	-Manikin -32, 85 L/min constant flow -Polydisperse NaCl, monodisperse PSL, <i>B. subtilis</i> and <i>B. megatherium</i> -Three N95 respirators -One surgical mask	NaCl: <70 µm	NaCl: 0.1-0.7 µm PSL: 0.60, 1.02, 2.94, 3.96, 5.10 µm All sizes measured for bacteria	Mean: 4%	Mean: 29%	NR	NR	NR	NR	0.1-0.3 (filter)	0.1-0.3 (filter)

Rengasamy 2013 ²¹	-Manikin -10, 40 L/min constant flow, 10, 40L/min cyclic flow at 20, 26.67 breaths/min -Polydisperse NaCl -Two N95 respirators -One surgical mask	Filter tester CMD: 0.075 µm GSD: 1.86	All sizes	GM: 0.252% GSD: 2.43 Range: 0.104-0.614 %	Mean: 9.04%	NR	NR	NR	NR	NR	NR
Rengasamy 2014 ²²	-Manikin -85 L/min constant flow and 8, 40 L/min cyclic flow at 16, 26.67 breaths/min -Polydisperse NaCl -Two N95 respirators -Two surgical masks	Filter tester CMD: 0.075 µm GSD: 1.86	Filter tester: All sizes NaCl: 0.02-0.8 µm	GM: 0.38% GSD: 2.25 Range: 0.17-0.86%	GM: 11.8% GSD: 7.47 Range: 1.58-88.1 %	NR	NR	NR	NR	~45 (filter)	~350 (filter)
Wen 2013 ²³	-Manikin and human -28.3 L/min constant flow -Bacteriophage SM702 -Two N95 respirators -Five surgical masks	MMAD: 0.744 µm GSD: 1.29	0.5-20 µm	GM: 0.71% GSD: 2.8 Range: 0.25-2.02%	GM: 0.28% GSD: 2.8 Range: 0.07-1.72%	GM: 2.5% GSD: 4.9 Range: 0.5-12.2%	GM: 21% GSD: 1.5 Range: 14-40%	NR	NR	NR	NR
Zou 2014 ²⁴	-Manikin - 12.5, 30, 85 L/min-Ambient outdoor and indoor particles -Three N95 respirators -One surgical mask, one doctor's mask, one activated carbon mask	NR	0.5-20 µm	****	****	NR	NR	****	****	****	****

Abbreviations: CMD: count median diameter; CMAD: count median aerodynamic diameter; GM: geometric mean; GSD: geometric standard deviation; IQR: interquartile range; MMAD: mass median aerodynamic diameter; MPPS: most penetrating particle size; NR: not reported; PSL: polystyrene latex beads; TIL: total inward leakage.

*Where methods included various testing conditions the following rules were applied: data from humans was preferred; the filter penetration using the highest air flow was recorded; the face-seal leakage and TIL using the closest air flow to 15 L/min was recorded; data using the highest breathing frequency was recorded; in Diaz 2010, data was recorded on no environmental air flow and loose mask; in Noti 2012, total virus blocked (PCR) data was recorded; in Zou 2014 85 L/min outdoor data for filter penetration and 12.5 L/min indoor data for total inward leakage were used.

**Bischoff and colleagues demonstrated artificially generated aerosol transmission of virus to human participants. Live attenuated influenza virus was aerosolized. Test conditions where virus could be detected by RT-PCR in nasal washes were no PPE, no PPE with ocular exposure only, surgical mask, N95 respirator, surgical mask with goggles, and N95 respirator with goggles.

***Data was omitted since no comparison can be made when either surgical mask or N95 comparator had no data.

****Written data was not available and reasonable estimates could not be made from the figures.

^{Est} Used Engauge Digitizer 5.1 [<http://digitizer.sourceforge.net>] to estimate minimum filter efficiencies where written data was unavailable.

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