Annex 1. Systematic review results

Searches included studies published before the 26/04/2022

Q 1: Respiratory activities-specific exhaled particle emission

Search strings

(droplet* OR particle* OR *aerosol*) AND (size diameter OR volume* OR CM OR centimetre OR centimeter) AND ("expiratory activity" OR "Respiratory Activity" OR "Respiratory Activities" OR breath* OR speak* OR talk* OR shout* OR sing* OR cough* OR sneez*)

Eligibility criteria for study selection

Experimental studies that measured the 1) article number size distribution (µm) per second (number of particles per second/particles size); 2) total particle mass concentration with an aerodynamic diameter within a given size ranges (number of particles cm-3) 3) Total particle volume concentration per unit diameter (in mL m-3 µm -1)

Main outcome measures

1. Particles size distribution
2. volumetric particle emission concentration
3. Mass

Results

Experts independently screened the titles and abstracts and excluded studies that did not match the inclusion criteria. Discrepancies were resolved in discussion with the other experts. The same experts retrieved full text articles and determined whether to include or exclude studies on the basis of predetermined selection criteria. A total of 1125 studies were initially screened, of which 1088 were considered irrelevant. After exclusions, 26 studies were eligible for full text review and 15 met the inclusion criteria.

Data synthesis

Reference	Study design		Respiratory activity		
		Range size	Breathing	Talking	Singing
Alsved et al.[1]	Experimental study	0.5 – 10 µm	Median mas: 135 particle/s (85-691)	Talking: Median mas: 270 (120-1380) Loud talking: Median mas 570 (180-1760)	Singing: Median mas: 980 (390-2870) Loud singing: Median mas 1480 (500-2820)
Bagheri et al. [2]	Experimental study				
Chao et al. [3]	Experimental study	mean diameter 16.0 µm		Total number 112–6720 Concentration 0.004–0.223cm^{-3}	
Ding et al. [4]	Experimental study	0.3–10 µm		315 particles/s	413 particles/s
Good et al. [5]	Experimental study	0.25 – 33 µm	239 particles/s (<56 - 909) 1915 particles/L^{-1} (<450 - 7269)		411 particles/s (<56 -1194) 3289 particles/L^{-1} (<450 - 9551)
Kappelt et al. [6]	Experimental study	< 10 µm	6210 ± 5630 min^{-1}	14,600 ± 16,800 min^{-1}	
Murbe et al. [7]	Experimental study	0.3–10 µm	5 particles/sec (0 – 28)	66 particles/sec (14 – 391)	1537 particles/sec (753 – 6093)
			>99 % of all detected particles were ≤5 µm (>80% of all particles ≤1 µm)		
Murbe et al. [8]	Experimental study	>0.3 µm—25.0 µm		16 – 267 particles/s	141 – 1240 particles/s
Mimura et al. [9]	Experimental study	PM 2.5	23.1 ± 9.9 µg/m3	32.3 ± 14.7 µg/m3	
		PM 10	40.4 ± 17.8 µg/m3	40.4 ± 17.8 µg/m3	
J. Duguid [10]	Experimental study	> 20 µm	0 particle	0 – 650 particles	
Papineni et al. [11]	Experimental study	< 1 µm	12.5 (83.2) particles L^{-1}		
		> 1 µm	1.9 (13.4) particles L^{-1}		
Morawska et al. [12]	Experimental study	0.5-20 µm	98 particles L^{-1}	672 particles L^{-1}	1088 particles L^{-1}
Asadi et al. [13]	Experimental study	<5 µm	1 – 50 particles/s		

Stadnytskyi et al. [14]	Experimental study	0.5 – 5 µm		2600 particles/s			
Morawska et al. [12] Johnson et al. [15]		Mode	$C_{n,i}$ (cm^{-3})	μ_{Di} (µm)	GM (µm)	σ_{Di} (µm)	GSD (µm)
		B (bronchial)	0.06	0.99	2.69	0.26	1.30
		L (larynx)	0.2	1.39	4.01	0.51	1.67
		O (oral)	0.001	4.98	145.5	0.59	1.80

BLO model details [12,15]			
	Breathing	Talking	Singing
Total volumetric particle emission concentration (ml m^{-3})	8.4 E -7	2.2 E -5	1.1 E -4
Total particle emission concentration (particles L-1)	60	260	1060
Size range (long range) (µm)	0.1 - 30		
Size range (Short-range) (µm)	0.1 - 100		

Q 2: Viral load

Search strings

("viral load"~3 OR "viral loads"~3 OR "virus load"~3 OR "virus loads"~3 OR "virus burden"~3 OR "viral burden"~3 OR "virus titre" OR "viral titre"~3 OR "virus titer" OR "viral titer"~3 OR "virus titres" OR "viral titres"~3 OR "virus titers" OR "viral titers"~3 OR "viral level"~3 OR "Viral levels"~3 OR "virus level"~3 OR "Virus levels"~3 OR "RNA load"~3 OR "RNA loads"~3) AND (metaanaly* OR metanaly* OR "meta analysis" OR "meta analyses" OR meta-analysis OR meta-analyses OR "research overview" OR "research overviews" OR "collaborative review" OR "collaborative overview" OR "systematic review"~3 OR "systematic reviews" OR "systematic overviews" OR "systematic overview" OR "systematized review" OR "systematized reviews" OR "rapid review" OR "rapid reviews" OR "narrative review" OR "literature review" OR "literature reviews" OR "living guidelines" OR "living guideline" OR "living review" OR "living reviews" OR "scoping review" OR "scoping reviews" OR "umbrella reviews" OR "umbrella review" OR "evidence mapping" OR "evidence map" OR "evidence maps" OR "mapping review" OR "mapping reviews" OR "critical review" OR "critical reviews" OR "mixed studies review" OR "mixed methods review" OR "mixed studies reviews" OR "mixed methods reviews" OR "evidence synthesis" OR "evidence syntheses" OR "health technology assessment" OR "biomedical technology assessment" OR "bio-medical technology assessment" OR "technology overview" OR "technology assessment" OR "technology assessments" OR "technology overviews" OR HTA OR HTAs OR "methodological overview" OR "methodological overviews" OR "methodologic overview" OR "methodological overviews" OR "methodological review" OR "methodological reviews" OR "quantitative review" OR "quantitative reviews" OR "quantitative overview" OR "quantitative overviews" OR "quantitative syntheses" OR "quantitative synthesis" OR "systematic search" OR "systematic searching" OR "systematic searches" OR "pooled analysis" OR "pooled analyses" OR pubmed OR medline OR embase OR ti:Cochrane OR ab:Cochrane OR ti:Campbell OR ab:Campell OR "grey literature" OR handsearch* OR "hand searching" OR "hand searched" OR "citation searching" OR "reference searching" OR "pearl growing" OR "data mining" OR "citation mining" OR snowballing OR "meta regression" OR metaregression* OR "data synthesis" OR "data synthesis" OR "data extraction" OR "data abstraction" OR "data abstractions" OR "mantel haenszel" OR ab:peto OR der-simonian OR dersimonian OR "der simonion")

Eligibility criteria for study selection

Studies that measured the distribution of Viral Load through NP across multiple patients (>15.000), systematic reviews, or meta-analysis

Main outcome measures

1. Viral load distribution
2. Range of log_{10} RNA copies per mL

Results

Experts independently screened the titles and abstracts and excluded studies that did not match the inclusion criteria. Discrepancies were resolved in discussion with the other experts. The same experts retrieved full text articles and determined whether to include or exclude studies on the basis of predetermined selection criteria. A total of 201 studies were initially screened, of which 187 were considered irrelevant. After exclusions, 14 studies were eligible for full text review and 3 met the inclusion criteria.

Data synthesis

Reference	Study design	Viral load			
		Min copies/mL	**Max copies/mL**	**Median copies/mL**	**Mean (SD) log_{10} RNA copies per ml**
Gilad et al. [16]	Systematic review	1.2×10^3		8.14×10^6	
Chen et al. [17]	Systematic review				8.63 (95% CI: 8.04–9.26) and 6.01 (95% CI: 4.65–7.78) log_{10} copies/ml for severe and non severe disease, respectively
Jacot et al. [18]	Retrospective case serie				6.6 log_{10} copies/ml
Chen et al. [19]	Systematic review and meta-analysis			8.91 (95% CI: 8.83–9.00) log_{10}	2.04 log_{10}

Q 3: Biological decay in air

Search strings

(air OR particl* OR *aerosol*) AND ("biological decay" OR inactivat* OR decay OR stability)

Eligibility criteria for study selection

Studies that measured the SARS-CoV-2 biological decay in aerosol.

Main outcome measures

1. Range of estimated biological decay constant k (min-1 or h-1)

Results

Experts independently screened the titles and abstracts and excluded studies that did not match the inclusion criteria. Discrepancies were resolved in discussion with the other experts. The same experts retrieved full text articles and determined whether to include or exclude studies on the basis of predetermined selection criteria. A total of 941 studies were initially screened, of which 632 were considered irrelevant. After exclusions, 72 studies were eligible for full text review and 7 met the inclusion criteria.

Data synthesis

Reference	Study design	Conditions						Decay				
		Temp. (˚C)	HR (%)	Time (m)	Light	Measure	Lineage	Start concentration	End concentration	$K_{Infectivity}$	Minutes for 50% decay	Decay Rate
Van Doremalen et al.[20]	Experimental	23	65	180	NR	$TCID_{50}$	NR	$10^{3.5}$	$10^{2.7}$	1.1 h^{-1}		
Robey et al.[21]	Modeling	22	40	240	NR	$TCID_{50}$	NR			0.108 h^{-1}		
		22	65	240	NR	$TCID_{50}$	NR			0.288 h^{-1}		
Schuit et al.[22]	Experimental	20.1 ± 0.3	70	60	No light	$K_{Infectivity}$ min^{-1} Decay Rate, %/min	hCoV-19/USA/WA-1/2020			0.008 ± 0.011 min^{-1}		0.8 ± 1.1 %/min
		20.1 ± 0.3	70	60	Simulated sunlight mild intensity					0.121 ± 0.017 min^{-1}		11.4 ± 1.5 %/min
		20.1 ± 0.3	70	60	Simulated sunlight high intensity					0.306 ± 0.097 min^{-1}		26.1 ± 7.1 %/min
Schuit et al. [23]	Experimental	40	20	60	Simulated sunlight		hCoV-19/USA/WA-1/2020			0.216 ± 0.056 min−1		
		40	20	60			hCoV-19/USA/CA_CDC_5574/2020			0.209 ± 0.063 min^{-1}		
		40	20	60			hCoV-19/USA/NY-PV08449/2020			0.299 ± 0.047 min^{-1}		
		40	20	60			hCoV-19/France/IDF0372/2020			0.312 ± 0.051 min^{-1}		
		20	20	60	Darkness		All above lineages			0.000 ± 0.011 min^{-1}		
		40	20	60	Darkness					0.012 ± 0.008 min^{-1}		
Oswin et al. [24]	Experimental	18-21	40-70	5	Simulated sunlight	Decay rate	REMRQ0001				10	
Chatterjee et al. [25]	Modeling	21	65	180	NR	$TCID_{50}$	NR	$10^{3.5}$	$10^{2.7}$	1.1 h^{-1}		

Smither et al. [26]	Experimental	19-22	40-60	300	Darkness	$TCID_{50}$	SARS-CoV-2 England-2	10^6		0.75 h^{-1}		0.91 – 2.27 % min−1
		19-22	68-88	300	Darkness	$TCID_{50}$	SARS-CoV-2 England-2			0.80 h^{-1}		0.40 – 1.59 % min−1
Dabisch et al. [27]	Experimental / Regression	10 – 30	20 – 70	20 - 60	Simulated sunlight and darkness	$TCID_{50}$	SARS-CoV-2 (Passage 4; BetaCoV/USA/WA1/2020)			Max values: 0.066 ± 0.028 min^{-1} (Darkness) 0.488 ± 0.146 min^{-1} (Sunlight) Empirical regression in Eq 1.		Max values: 6.3 ± 2.6 % min^{-1} (Darkness) 38.1 ± 8.9 % min^{-1} (Sunlight)

Q 4: Host immune response

Range of vaccine effectiveness against SARS-CoV-2 infection stratified by vaccine formulation, time, age and VoC

A search of the grey, preprint, and published literature for COVID-19 Vaccine Effectiveness and Impact studies is conducted daily.

Details here https://view-hub.org/covid-19/effectiveness-studies?target=variant&field_covid_studies_variant_tabl=9872

The model uses data published on the: ''Results of COVID-19 Vaccine Effectiveness Studies: An Ongoing Systematic Review'', Weekly Summary Tables, Updated 8th September 2022. https://view-hub.org/sites/default/files/2022-09/COVID19_Vaccine_Effectiveness_Transmission_Studies_Summary_Tables_20220908.pdf

Q 5: Particle to PFU ratio (PFU> TCID50%)

Search strings

("viral load"~3 OR "viral loads"~3 OR "virus load"~3 OR "virus loads"~3 OR "virus burden"~3 OR "viral burden"~3 OR "virus titre" OR "viral titre"~3 OR "virus titer" OR "viral titer"~3 OR "virus titres" OR "viral titres"~3 OR "virus titers" OR "viral titers"~3 OR "viral level"~3 OR "viral levels"~3 OR "virus level"~3 OR "Virus levels"~3 OR "RNA load"~3 OR "RNA loads"~3) AND ("viable RNA"~3 OR culturable OR "live virus" OR "viral culture" OR "viable virus" OR PFU OR "plaque forming unit" OR "live sars-cov-2" OR "positive culture" OR "positive cultures" OR infectious OR infective OR "virus isolation"~2 OR ratio* OR "culture positivity" OR "positive culture" OR "positive cultures") AND (Exhal* OR expirat* OR *aerosol* OR breath* OR air)

Eligibility criteria for study selection

Studies relating SARS-CoV-2 Viral Loads and viable virus in exhaled breath (EB) and air expressed as CPE (PFU), TCID50% or multiplicity of infection (moi). VoCs VS wild virus

Main outcome measures

1. Range of ratio of viral copies in aerosol to plaque forming units (PFU) ratio for SARS-CoV-2 (log10) OR TCID50% or moi

Results

Experts independently screened the titles and abstracts and excluded studies that did not match the inclusion criteria. Discrepancies were resolved in discussion with the other experts. The same experts retrieved full text articles and determined whether to include or exclude studies on the basis of predetermined selection criteria. A total of 259 studies were initially screened, of which 195 were considered irrelevant. After exclusions, 61 studies were eligible for full text review and 5 met the inclusion criteria.

Data synthesis

Full vaccination (defined as >2weeks after reception of 2nd dose during primary vaccination series) FFA: focus forming assay

Reference	Study design		Conditions							Viable-to-RNA virus ratio			
		Cohort	Sampling method	DPOS	Clinical manifestation	Vaccination status	Lineage	qRT-PCR	CT threshold for culturability assay	culturability assay	Successful viral cell culture	Viral titre	RNA to PFU
Puhach et al. [28]	Experimental	565	NPS	5	Mild	NA	Wild	0.4744 log_{10}	<27	FFA	91.9%		
						No	Delta	0.44 log_{10}			91.7%	0.343 log_{10}	
						Fully	Delta				83.8%		
						No	Omicron				95%		
						Fully	Omicron				85.7%		
Heitzman-Breen et al. [29]	Modeling from animal studies	NA	NA	NA	NA	NA	Wild						10^3:1 to 10^6:1
Hawks et al. [30]	Animal study	NA	EB	2	NA	NA	USA-WA1/2020	1.4-log_{10} PFU/hour		Vero cell plaque assay			10^2:1
Basile et al.	Experimental	195	URT/LRT	4.5	Mix				<32		24% (CPE)		
Lednicky et al. [31]	Experimental	2	Air sample	2 -4	NA	No	Wild	94 Viral genome equ/L air	NA	$TCID_{50}$ tests		74 virus/L air	2.68E+04 $TCID_{50}$/100 µm
								30 Viral genome equ/L air				18 virus/L air	6.31E+03 $TCID_{50}$/100 µm
								44 Viral genome equ/L air				27 virus/L air	1.00E+04 $TCID_{50}$/100 µm
								16 Viral genome equ/L air				6 virus/L air	2.15E+03 $TCID_{50}$/100 µm

Q 6: VoC increased transmissibility

Increased transmissibility and global spread of SARSCoV- 2 variants of concern as at June 2021[32]

Analysis

1,722,652 SARS-CoV-2 sequences uploaded to the Global Initiative On Sharing All Influenza Data (GISAID) hCoV-19 database, considering only VOC or VOI reported at least 25 times in at least three countries (see Supplementary Tables S1 and S2 for sequence numbers per variant per country). GISAID sequences used for this work are acknowledged in Supplement 2. Multinomial logistic model of competitive growth was used to estimate the effective reproduction number of each variant relative to that of the non-VOC/VOI viral population for each reporting country. It is assumed that the generation time of VOC/VOI remained unchanged compared with previously circulating variants.

Results

Despite differences between countries, our analysis showed a statistically significant increase in the pooled mean effective reproduction number relative to non-VOC/VOI of B.1.1.7 at 29% (95% confidence interval (CI): 24–33), B.1.351 at 25% (95% CI: 20–30), P.1 at 38% (95% CI: 29–48) and B.1.617.2 at 97% (95% CI: 76–117) (Figure 1). Of the six variants currently designated as VOI, five were considered in our analysis and among these, only B.1.617.1 and B.1.525 demonstrated a statistically significant increase in the effective reproduction number of 48% (95% CI: 28–69) and 29% (95% CI: 23–35), respectively. In line with these estimates, our results showed rapid replacement of previously circulating variants by VOC/VOI in nearly all countries; of the 64 countries considered in this analysis, we estimate VOC/VOI to be the most frequently circulating lineage on the last day of available data in 52 countries, the most common variants being B.1.1.7 (40 countries) and B.1.617.2 (India, Singapore, United Kingdom and Australia).

Given the widespread co-circulation of VOC/VOI, we also compared the effective reproduction numbers of these variants against each in order to estimate the nature of future competitive growth between them (Figure 3, excluding P.2 and B.1.427/B.1.429). Notably, the pooled mean difference in the effective production number between the VOC B.1.1.7 and B.1.351 was small at 4% (95% CI: 0–8), while P.1 demonstrated an increase relative to B.1.1.7 and B.1.351 of 10% (95% CI: 3–17) and 17% (95% CI: 6–30). Given these estimates, the longer-term trends of competitive growth between these three VOC remain unclear. In contrast, the rapid observed growth of B.1.617.2 suggests a clear competitive advantage compared with B.1.1.7, B.1.351 and P.1, with estimated increases in the effective reproduction number of 55% (95% CI: 43–68), 60% (95% CI: 48–73) and 34% (95% CI: 26–43) respectively.

A systematic review results show that the effective reproduction number and basic reproduction number of the Omicron variant elicited 3.8- and 2.5-times higher transmissibility than the Delta variant, respectively. The Omicron variant has an average basic reproduction number of 9.5 and a range from 5.5 to 24 (median 10 and interquartile range, IQR: 7.25, 11.88). The average effective reproduction number for Omicron is 3.4 with a range from 0.88 to 9.4 (median 2.8 and IQR: 2.03, 3.85) [33].

Q 7: Dose-response model

Search strings

("Infectious Dose" OR "infective dose" OR "ID50" OR "TCID50" OR PFU OR "plaque forming unit" OR ("dose response" AND model*) OR "infectious particle"~5) AND (Seroconver* OR seropositive* OR "sero epidemiological" OR infection* OR infected OR "antibody positivity" OR "antibody positive"~3)

Eligibility criteria for study selection

Published studies estimating the SARS-CoV-2 and other coronaviruses infectious dose for airborne transmission

Main outcome measures

- Number of infectious viral particles needed to cause an infection OR Range of ID^{50} for airborne transmission OR PFU range inhalation for TCID50%

Results

Experts independently screened the titles and abstracts and excluded studies that did not match the inclusion criteria. Discrepancies were resolved in discussion with the other experts. The same experts retrieved full text articles and determined whether to include or exclude studies on the basis of predetermined selection criteria. A total of 656 studies were initially screened, of which 585 were considered irrelevant. After exclusions, 71 studies were eligible for full text review and 11 met the inclusion criteria.

Data synthesis

FFU: 1. Focus-forming unit

Reference	Study design	Virus / Lineage	Exposure	Sample	Cell line	Control	Infectious dose	
							ID_{50}	**$TCID_{50}$**
Blaurock et al. [34]	Animal study	SARS-CoV-2 2019_nCoV Muc-IMB-1	orotracheal	Golden Syrian hamsters	Vero E6 cells and Vero E6 in DMEM with 2% FCS	Symptoms, Histopathology		(MID) $10x10^{-3}$ $TCID_{50}$
Killingley et al. [35]	Human challenge	SARS-CoV-2/human/GBR/484861/2020	Intranasal drops	36 naïve volunteers 18-36 y	cGMP Vero cell	Symptoms, Seroconversion, virus shedding	55 FFU	10 $TCID_{50}$
Martins et al. [36]	Animal study	NYI67-20 (B.1 lineage)	Intranasal drops	Ferret	Vero E6 (ATCC CRL-1586) and Vero E6/TMPRSS2	Symptoms, Seroconversion, virus shedding	31.6 PFU (aged animals) 100.1 PFU (young animals)	
Totura et al. [37]	Animal study	MERS-CoV EMC/2012, #NR–44260	aerosol	African green monkey	Vero E6 cells and Vero (CCL-81)	Symptoms, Seroconversion, histopathology	103-105 PFU	
Watanabe et al. [38]	Modeling, pooled data	HCoV-229E	NA	mice	NA	NA	9 PFU	13 $TCID_{50}$
		SARS-CoV-1	NA				280 PFU	400 $TCID_{50}$
Hayden et al. [39]	Human challenge	H1N1 influenza A/Texas/91	Intranasal drops	166 adult volunteers	Madin-Darby canine kidney (MDCK) cells	Symptoms, Seroconversion	700 PFU	$1.0x10^{3}$ $TCID_{50}$
Alford et al. [40]	Human challenge	H2N2	aerosol	Adult volunteers			0.42 – 2.1 PFU	0.6 – 3 $TCID_{50}$
Treanor et al. [41]	Human challenge	H3N2	Intranasal drops	130 Adult volunteers	Rhesus Monkey Kidney (RhMK) cells	Symptoms, Seroconversion	7 000 000 PFU	$1.0x10^{7}$ $TCID_{50}$
Riediker et al. [42]	Modeling	WT	aerosol	NA	NA	NA	500 PFU	
		Delta	aerosol	NA		NA	300 PFU	
		Omicron	aerosol	NA		NA	100 PFU	
Dabish et al. [43]	Animal study	SARS-CoV-2 hCoV-19/USA/WA-1/2020	aerosol	16 young adult cynomolgus macaques	Vero cells (ATCC CCL-81) and Vero E6 cells (ATCC CRL-1586)	Seroconversion	36.4 PFU	52 (23 – 363) $TCID_{50}$
						Fever	179.2 PFU	256 (102 – 603) $TCID_{50}$
Prentiss et al. [44]	Modeling from case studies	NA	NA	NA	NA	NA	250 – 1400 PFU	

Q 8: Mask filtration efficiency

Search strings

((mask* OR facemask* OR facepiece* OR n95 OR masking OR N100 OR FFP* OR FFP2 OR FFP3 OR FFR OR "neck gaiters" OR "face shield"~3 OR "face piece"~3 OR "facial piece"~3 OR "facial shield"~3 OR "face covering"~3 OR "facial covering"~3 OR "face cover"~3 OR "facial cover"~3 OR (("personal protection" OR PPE) AND (face OR facial))) AND (filtration OR effectiveness)) AND (metaanaly* OR metanaly* OR "meta analysis" OR "meta analyses" OR meta-analysis OR meta-analyses OR "research overview" OR "research overviews" OR "collaborative review" OR "collaborative overview" OR "systematic review"~3 OR "systematic reviews" OR "systematic overviews" OR "systematic overview" OR "systematized review" OR "systematized reviews" OR "rapid review" OR "rapid reviews" OR "narrative review" OR "literature review" OR "literature reviews" OR "living guidelines" OR "living guideline" OR "living review" OR "living reviews" OR "scoping review" OR "scoping reviews" OR "umbrella reviews" OR "umbrella review" OR "evidence mapping" OR "evidence map" OR "evidence maps" OR "mapping review" OR "mapping reviews" OR "critical review" OR "critical reviews" OR "mixed studies review" OR "mixed methods review" OR "mixed studies reviews" OR "mixed methods reviews" OR "evidence synthesis" OR "evidence syntheses" OR "health technology assessment" OR "biomedical technology assessment" OR "bio-medical technology assessment" OR "technology overview" OR "technology assessment" OR "technology assessments" OR "technology overviews" OR HTA OR HTAs OR "methodological overview" OR "methodological overviews" OR "methodologic overview" OR "methodological overviews" OR "methodological review" OR "methodological reviews" OR "quantitative review" OR "quantitative reviews" OR "quantitative overview" OR "quantitative overviews" OR "quantitative syntheses" OR "quantitative synthesis" OR "systematic search" OR "systematic searching" OR "systematic searches" OR "pooled analysis" OR "pooled analyses" OR pubmed OR medline OR embase OR ti:Cochrane OR ab:Cochrane OR ti:Campbell OR ab:Campell OR "grey literature" OR handsearch* OR "hand searching" OR "hand searched" OR "citation searching" OR "reference searching" OR "pearl growing" OR "data mining" OR "citation mining" OR snowballing OR "meta regression" OR metaregression* OR "data synthesis" OR "data synthesis" OR "data extraction" OR "data abstraction" OR "data abstractions" OR "mantel haenszel" OR ab:peto OR der-simonian OR dersimonian OR "der simonion")

Eligibility criteria for study selection

Studies that measured the inward and outward filtration efficiency of different type of masks for a given size of particles with information on particles ranges and/or respiratory activity/particle velocity/airflow.

Main outcome measures

1. Inward and outward filtration efficiency per type of mask or respiratory activity or particle range

Results

Experts independently screened the titles and abstracts and excluded studies that did not match the inclusion criteria. Discrepancies were resolved in discussion with the other experts. The same experts retrieved full text articles and determined whether to include or exclude studies on the basis of predetermined selection criteria. A total of 230 studies were initially screened, of which 147 were considered irrelevant. After exclusions, 83 studies were eligible for full text review and 14 met the inclusion criteria.

Data synthesis

CM: Cloth mask C: cotton L: layer ML: multiple layer NR: not reported Y: yes N: not PES: polyester PP: polypropylene

Reference	Study design	Type of mask	Fit test (Y/N/NR)	Particles ranges	Respiratory activity/flow rate/velocity	Filtration efficiency		
						inward	outward	not specified
Asadi et al. [45]	Experimental	Surgical	n	0.3 – 20 µm	breathing, talking, and coughing		90%	
		Unvented KN95					74%	
Sousa et al. [46]	Literature review	CM 100% C 1L	NR	20 – 1000 nm 20 – 1000 nm	Aerosol dispersion speed 16.5 cm/s	69%		
		CM 100% C 2L				70%		
		CM Linen 1L				60%		
		Surgical				96%		
Konda et al. [47]	Experimental	N95	NR	>300 nm	3.2 CFM or ~90 L/min	99%		
				<300 nm		85%		
		Surgical		>300 nm		99%		
				<300 nm		76%		
Maher et al. [48]	Experimental	CM 1,2,3L	NR	1 µm	300 L/min			74.4–95.2%
Xiao et al. [49]	Experimental	CM 6L	NR	0.75 µm	4440 cm/s			53.2–93.8%
				8.2 µm				36.7–90.4%

O'Kelly et al. [50]	Experimental	CM ML	NR	0.02–0.1 µm	1650 cm/s			10–62%
Park and Jayaraman [51]	Experimental	CM PES/PP	N	0.3 µm	8.7 cm/			9 – 88%
Lindsley et al. [52]	Experimental	CM C 3L	N	<0.6 µm	28.3 L/min			30%
Liu et al. [53]	Experimental	CM reusable	N	0.075 µm	85 L/min			20%
Li et al. [54]	Experimental	CM 100% C	N	0.01–1 µm	20.5 L/min		77%	
Davies et al. [55]	Experimental	CM 100% C	N	0.023 µm	30 L/min	50.85%		
		Surgical	N			89.52%		
Neupane et al. [56]	Experimental	CM	Yes (Sealed)	<10 µm	2.7 m/s	63-84%		
		Surgical				94%		
Shakya et al. [57]	Experimental	N95	N	<1 µm	8 L/min	65 – 97%		
		CM	N	<1 µm	8 L/min	50 – 90%		
		Surgical	N	<1 µm	8 L/min	86 – 93%		
		CM	N	<1 µm	19 L/min	10 – 82%		
		Surgical	N	<1 µm	19 L/min	60 – 65%		
		N95	N	<1 µm	19 L/min	75 – 90%		
Ma et al. [58]	Experimental	CM 4L	N	Median 3.9 µm	2.2 m/s to 9.9 m/s	99.98%		
		Surgical	N			97.14%		
		N95	N			95.15%		
Pan et al. [59]	Experimental	Surgical mask	N	Outward experiment 0.04 – 1 µm Inward experiment 0.5 – 2 µm	Outward experiment 5.3 L/m 3.2 to 3.4 m/s Inward experiment 15 L/m	80%	50 – 75%	
		Thin cotton	N			50%	30 – 50%	
		Thin acrylic	N			5 – 40%	75% (2µm)	
		CDC non-sewn	N			5 – 40%		
		CDC sewn	N			5 – 40%	50% (2µm)	
		Microfiber	N				<25% (2µm)	
Huang et al. [60]	Experimental (*in vivo* bacterial filtration efficiency)	N95	Yes	bacterial pneumonia patients			99.95%	
		Surgical mask	Yes				99.91%	
Gawn et al. [61]	Experimental	Surgical (tie)	Yes	< 1 µm to > 200 µm Distribution ~50% <20 µm 10% >100 µm	Mean values of the reduction factor for ambient particles and simulated sneeze	2 – 4		
		Surgical (strap)	Yes			2 – 9		
		FFP2	Yes			52 – 258		
		FFP3	Yes			145 – 766		
Milton et al. [62]	Experimental	Surgical	No	> 5 µm	Breathing Fold reduction of exhaled particles	2.8 (95%CI 1.5 – 5.2)		
		Surgical	No	< 5 µm		25 (95%CI 3.5 – 150)		

Q 9: close encounter interactions

Social contact patterns and implications for infectious disease transmission: A systematic review and meta-analysis of contact surveys[63]

Methods

Systematic review and individual-participant meta-analysis of surveys carried out in low- and middle-income countries and compare patterns of contact in these settings to surveys previously carried out in high-income countries. Using individual-level data from 28,503 participants and 413,069 contacts across 27 surveys, we explored how contact characteristics (number, location, duration, and whether physical) vary across income settings). A negative binomial regression model was used to explore the association between the total number of daily contacts and the participant's age, sex, employment/student status, and household size, as well as methodology and survey day. Incidence rate ratios from these regressions are referred to as 'contact rate ratios' (CRRs

Results

The median number of contacts made per day across all the studies was 9 (IQR = 5–17), and was similar across income strata (LIC/LMIC = 10[5–17], UMIC = 8[5–16], HIC = 9[5–17]. Contact rates declined with age in high- and upper-middle-income settings, but not in low-income settings, where adults aged 65+ made similar numbers of contacts as younger individuals and mixed with all age groups. Across all settings, increasing household size was a key determinant of contact frequency and characteristics, with low-income settings characterised by the largest, most intergenerational households. A higher proportion of contacts were made at home in low-income settings, and work/school contacts were more frequent in high-income strata. We also observed contrasting effects of gender across income strata on the frequency, duration, and type of contacts individuals made.

Data

The total number of observations, as well as the mean, median, and interquartile range (p25 and p75) of total daily contacts shown by participant and study characteristics.

Group	Categorization	Observation (N)	Mean	P25	Median	P75
Overall		28,503	14.5	5	9	17
Gender	Male	13,218	15.3	5	9	18
	Female	14,598	13.7	5	9	16
Age	<15	8,561	14.6	6	10	19
	15 – 65	8,330	14.9	5	9	17
	>65	10,267	10.4	3	6	12
Income status	LIC/LMIC	9,906	15.4	5	10	17
	UMIC	8,330	14.4	5	8	16
	HIC	10,267	13.7	5	9	17
Day type	Weekend	4,308	14.7	5	9	16
	Weekday	21,579	14.1	5	9	17
Employment (in those aged >18)	Yes	8,879	15.4	5	9	17
	No	6,158	9.8	4	7	12
Student (in those aged 5 – 18)	Yes	4,438	18.4	8	14	24
	No	600	10.4	5	8	14
Household size	1	1,479	10.4	3	6	12
	2	3,220	11.8	4	7	14
	3	4,130	12.0	4	7	14
	4	5,240	13.4	5	8	17
	5	3,109	12.5	4	8	14
	6+	8,873	17.7	7	11	20

Data on the duration of contact (<1 or ≥1 hr) were available for 22,822 participants. The percentage of contacts lasting at least 1 hr was 63.2% and was highest for UMICs (76.0%) and lowest for LICs/ LMICs (53.1%). Across both UMICs and HICs, duration of contacts was lower in individuals aged over 15 years compared to those aged 0–15, with the extent of this disparity most stark for HICs (for ages 65+ compared to <15 years: adjCRR [95%CrI]: LIC/LMIC = 0.61[0.57–0.64], UMIC = 0.61[0.58– 0.65], HIC = 0.35[0.33–0.37].

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