Supplementary Material for

Statistical data analysis of expiratory droplet mass during talking and prediction of SARS-CoV-2 number concentrations using dispersion models

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*Calculations from S-1 to S-4 were performed using Microsoft Excel. Then I converted Excel to pdf.

S-1. Data used for analysis, mass of exhaled droplets during talking. (Table 1, Figure 2)

Table 1. Mass of exhaled droplets by droplet size provided by Loudon and Roberts during talking loudly counting from 1 to 100 in 100 seconds. (mg / 100 seconds)

Original data of "Loudon and Roberts"

Loudon and Roberts [6]; Table 2 Numbers of droplet produced by three subjects during talking.
R, L, E : subjects; Two experiments per subject (R, L, E); for each experiment the subject counted loudly from 1 to 100.

size range d(μm)*	diameter d (μm)	n_T: Total number of droplets in 6 experiments	n: Number of droplets per experiment						
			n: Average number of droplets in 6 experiments	R1	R2	L1	L2	E1	E2
2-4	3	460	77	15	134	61	143	46	61
4-8	6	212	35	0	80	15	71	0	46
8-19	11	195	33	120	0	30	0	30	15
19-32	26	600	100	75	90	210	30	120	75
32-71	56	1545	258	210	330	270	135	225	375
71-100	85	2505	418	450	435	420	390	225	585
100-129	114	1860	310	285	375	330	150	225	495
129-157	143	1125	188	240	225	90	135	120	315
157-188	173	525	88	150	60	90	105	30	90
188-217	202	300	50	30	90	60	45	15	60
217-247	232	300	50	15	75	0	45	30	135
247-277	262	135	23	0	0	60	30	15	30
277-321	291	120	20	0	0	0	15	15	90
321-395	350	315	53	0	45	30	30	75	135
395-508	439	180	30	60	15	0	15	0	90
508-657	580	90	15	0	30	0	0	0	60
657-808	734	60	10	0	0	60	0	0	0
808-955	881	15	2.5	0	15	0	0	0	0
955-1103	1029	0	0	0	0	0	0	0	0
1103-1324	1176	0	0	0	0	0	0	0	0
1324-1500	1471	45	7.5	0	0	0	15	0	30
Total		10587	1765	1650	1999	1726	1354	1171	2687

* Size range is calculated by H. Kono from diameter.

reference

6. Loudon RG, Roberts RM (1967). Droplet expulsion from the respiratory tract, Am. Rev. Respir. Dis. 95, 435–442.

Table 1. Mass of exhaled droplets by droplet size during talking loudly counting from 1 to 100 in 100 seconds. (mg / 100 seconds)

Original data of "L & R - IMI"

C.Y. Chao et al.[23]; Table 4 Estimated total expiratory droplet numbers produced during speaking using the measured size profile at 10mm.

size range (μm)	size class d (μm)	expiratory droplet numbers n
2-4	3	191
4-8	6	2972
8-16	12	1018
16-24	20	534
24-32	28	353
32-40	36	181
40-50	45	191
50-75	63	201
75-100	88	141
100-125	113	191
125-150	138	181
150-200	175	191
200-250	225	161
250-500	375	151
500-1000	750	60
1000-2000	1500	0
Total		6717

reference

23. Chao CYH, Wan MP, Morawska L, Johnson GR, Ristovski ZD, Hargreaves M, Mengersen K, Corbett S, Li Y, Xie X, Katoshevski D (2009). Characterization of expiration air jets and droplet size distributions immediately at the mouth opening. J. Aerosol Sci 40(2), 122–133.

Table 1. Mass of exhaled droplets by droplet size during talking loudly counting from 1 to 100 in 100 seconds. (mg / 100 seconds)

Original data of Xie et al.

Xie et al [8]; Table 2 Estimated total number of droplets in different diameter ranges emitted during talking. (M, male subject; F, female subject; the sizes of droplets used the values at sampling positions.

size range d (μm)	diameter d (μm)*	number of droplets											
		no food dye							food dye		food dye with sugar		
		M1	M2	M3	F1	F2	F3	F4	M1	F1	M1	M3	F1
0-5	2.5	0	0	0	0	0	12	0	0	0	66	92	0
5-10	7.5	0	0	5	0	0	6	7	24	0	303	309	115
10-15	12.5	2	11	24	0	0	0	2	14	0	158	208	138
15-20	17.5	12	35	11	0	9	7	0	165	14	82	108	79
20-25	22.5	14	86	13	7	28	0	4	230	28	87	72	72
25-30	27.5	28	154	7	12	32	0	7	280	43	115	93	43
30-35	32.5	40	187	0	2	58	3	7	345	43	122	86	57
35-40	37.5	65	239	4	0	79	0	0	302	36	72	93	43
40-45	42.5	84	229	0	0	65	2	9	338	50	72	57	43
45-50	47.5	50	246	0	9	65	2	9	259	43	152	86	57
50-75	62.5	271	854	16	57	236	20	31	763	237	230	446	216
75-100	87.5	256	369	7	62	147	7	19	420	159	299	316	180
100-150	125	180	233	7	48	103	29	24	335	100	251	259	161
150-200	175	54	58	2	14	56	6	14	146	28	121	36	28
200-250	225	15	23	0	4	25	2	0	74	21	61	28	53
250-300	275	9	14	2	2	7	2	2	7	7	0	36	7
300-350	325	4	4	2	2	2	2	0	15	0	0	92	30
350-400	375	7	4	0	4	2	0	0	7	0	0	8	0
400-450	425	0	0	0	2	2	0	0	0	0	0	0	0
450-500	475	0	0	0	0	2	0	0	14	0	8	0	0
500-1000	750	0	3	0	0	0	0	0	0	0	14	0	0
1000-1500	1250	0	0	0	0	0	0	0	0	0	0	0	0
Total		1091	2749	100	225	918	100	135	3738	809	2213	2425	1322

* Diameter is calculated by H. Kono from the size range 'd'.

Xie et al. [8] Table 6. Total mass of droplets calculated using measured droplet number and size data during talking counting from 1 to 100.

		no food dye							food dye		food dye with sugar		
		M1	M2	M3	F1	F2	F3	F4	M1	F1	M1	M3	F1
sampling point	mg	0.94	1.41	0.29	0.49	0.97	0.15	0.11	3.23	0.52	3.67	3.56	1.36
mouth origin	mg	1	1.53	0.3	0.5	1.02	0.15	0.12	3.43	0.56	3.8	3.71	1.43

Xie et al.[8] Table 4 Total mass of droplets collected using surgical face mask during talking counting from 1 to 100.

	M1	M2	M3	M4	M5	M6	M7	F1	F2	average(mg)
mask	3.7	41.8	61.3					15.7	1	18.7
	5.5							12.3	7.7	

reference

8. Xie X, Li Y, Sun H, Liu L (2009). Exhaled droplets due to talking and coughing, J. R. Soc. Interface 6, S703–S714 (doi:10 1098/rsif.2009.0388.focus)

Table 1. Mass of exhaled droplets by droplet size during talking loudly counting from 1 to 100 in 100 seconds. (mg / 100 seconds)

Original data of Duguid

Duguid [7]; Table 3 Composite size-distribution table for the droplets expelled during speaking

size range d (μm)	diameter d (μm)	number of droplets
1-4	3	14
4-8	6	52
8-16	12	78
16-24	20	40
24-32	28	24
32-40	36	12
40-50	45	6
50-75	63	7
75-100	88	5
100-125	113	4
125-150	138	3
150-200	175	2
200-250	225	1
250-500	375	3
500-1000	750	1
1000-2000	-	0
Approx. total		250

reference

7. Duguid JP (1946). The size and the duration of air-carriage of respiratory droplets and droplet-nuclei, J Hyg (Lond.) 44, 471–479.

S2. Dispersion models and the parameters

EPA HIWAY-2 model [35]

The dispersion parameters σ_{ya} and σ_{za} for the EPA HIWAY-2 model [35] are given in

$$\sigma_{za} = ax^b \qquad (1)$$

The values of "*a*" and "*b*" are used to compute σ_{za} (m)

stability regime	a	b
Unstable	0.18	0.93198
Neutral	0.15	0.92332
Stable	0.11	0.91465

The formulae and constant used to compute σ_{ya} are

$$\sigma_{ya} = 0.4651x\, tan\theta_p \qquad (2)$$

where: x is the downwind distance from the source to the receptor in meters and θ_p is the half angle of the horizontal plume spread, in degrees

$$\theta_p = c - d\, ln(x/x_0) \qquad (3)$$

$$x_0 = 1000\ m$$

The following values of "*c*" and "*d*" are used to compute, θp

stability regime	c	d
Unstable	18.333	1.8096
Neutral	14.333	1.7706
Stable	12.5	1.0857

OML model [36]

The OML model uses the following equations to calculate σ_{ya} and σ_{za} from the ground level source under neutral atmospheric conditions.

$$\sigma_{ya} = u_* t = u_* \frac{x}{U} \qquad (4)$$

$$\sigma_{za} = \{1.2u_*{}^2 \exp(-0.6)\}^{0.5} t = 0.81 u_* t = 0.81 u_* \frac{x}{U} \qquad (5)$$

where: u_* = friction velocity in m s^{-1}

t = travel time in s

x = downwind distance in m

U = wind speed in m s^{-1}

The value of u_* is computed using the logarithmic law.

$$\frac{U}{u_*} = \frac{1}{k} ln \frac{z}{z_0} \qquad (6)$$

where: k = 0.4 (von Karman constant)

z_0 = 1 m (surface roughness)

z = height above the ground in m

When the wind speed at 1.5 m in height is 1 m s^{-1}, the wind speed at 50 m in height is estimated using a power law.

$$\frac{U}{U_1} = \left(\frac{z}{z_1}\right)^p \qquad (7)$$

where: U = wind speed at z m in height

U_1 = wind speed at z_1 m in height

p = 0.3 (z_0 = 1 m in urban areas under neutral atmospheric conditions) [46]

Since 50 m is the central height of the surface layer, it is regarded as the reference height. Using the logarithmic law, u_* is calculated given the surface roughness and U at 50 m in height.

OMG volume-source model [37, 38]

$$\mathrm{C} = \frac{N_{v,gen}}{4\pi} \sqrt{\frac{(m+1)(n+1)}{K_y K_z x^2}}\ exp\left\{-\frac{u(m+1)y^2}{4K_y x}\right\}$$

$$\times \left[exp\left\{-\frac{u(n+1)(z-h)^2}{4K_z x}\right\} + exp\left\{-\frac{u(n+1)(z+h)^2}{4K_z x}\right\}\right] \qquad (8)$$

$$K_y = \left(\frac{\sigma_v{}^2}{u}\right) x^{0.86} \quad (9)$$

$$K_z = k_2(x/L) = \alpha^2(\sigma_w/u)x\sigma_w \quad (10)$$

$$k_2 = B \times u \quad (11)$$

where: C = concentration (m^{-3})

(x, y, z) = coordinate of receptor (m)

h = point source release height (m)

$N_{v,gen}$ = emission rate of virus (s^{-1})

K_y, K_z = eddy diffusivities in y and z directions ($m^2\ s^{-1}$)

k_1, k_2 = eddy diffusivities in y and z directions at $x = L$ ($m^2\ s^{-1}$)

L = scaling parameter (10 m)

m = 0.86, n = 1

The following is a summary of the eddy diffusivity parameters above buildings (1-h values):

	Kz			Ky	
wind speed ($m\ s^{-1}$)	α all	B ≥ 1	k2 < 1	σ_v/u ≥ 1	σ_v/u < 1
Unstable	1.1	0.76	1.6	0.59	$0.56\ u^{-0.82}$
Neutral	0.81	0.27	0.33	0.43	
Stable	0.55	0.17	0.31	0.39	

In the OMG model, the relationship between the eddy diffusivities and σ_{ya} and σ_{za} is given by the following equations.

$$\sigma_y = \left\{\frac{\frac{2k_1}{10^{0.86}}\ x^{1.86}}{1.86U}\right\}^{0.5} \quad (12)$$

$$\sigma_z = \left\{\frac{\frac{2k_2}{10}\ x^2}{2U}\right\}^{0.5} \quad (13)$$

References

35. Petersen WB, User's Guide for HIWAY-2, A Highway air pollution model, 1–69, US EPA, EPA-600/8-80-018 May 1980.

36. Berkowicz R, Olesen HR, Torp U (1986). The Danish Gaussian air pollution model (OML):

Description, test and sensitivity analysis in view of regulatory applications, Air Pollution Modeling and its Application V., 453-481, De Wispelaere C, Schiermeier, FA, Gillani, NV (eds.), Springer, Boston MA.
37. Kono H, Ito S (1990). A micro-scale dispersion model for motor vehicle exhaust gas in urban areas-OMG volume-source dispersion model, Atmospheric Environment **24B**(2), 243–251.
38. Kono H Ito S (1990). A comparison of concentration estimates by the OMG volume-source dispersion model with three line source dispersion models, Atmospheric Environment **24B**(2), 253–260.
46. Adachi T (1981), Basic Study of Estimation Method of Wind Speed below 150m by Power Law, Tenki 28(4), 244–252, Table 2 (in Japanese).
(https://www.metsoc.jp/tenki/pdf/1981/1981_04_0244.pdf)

S3-1. Relationship between virus number concentration for each droplet size, $C_{v,d}$ (n_0 =10^8 mL^{-1}) and ventilation rate

The droplet size d_0 is the initial one before shrinkage.

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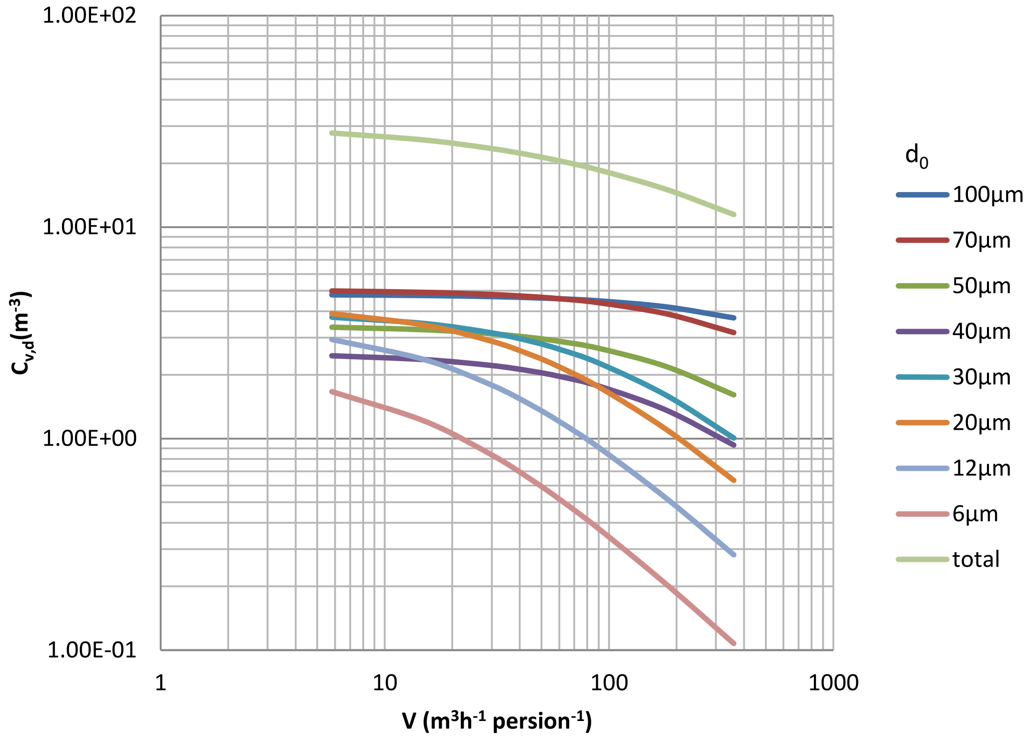
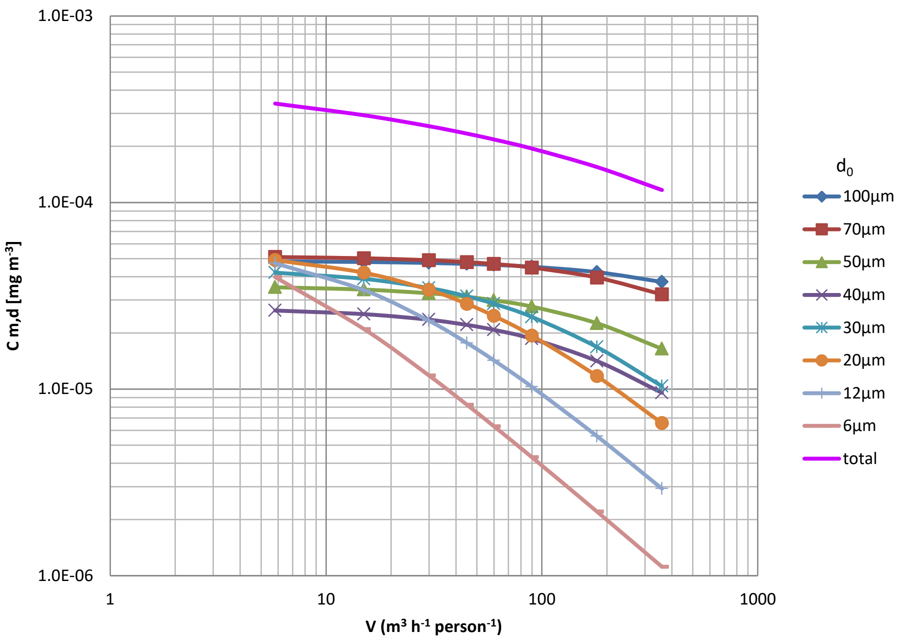


S3-2 - Relationship between droplet mass concentration for each initial size, $C_{m,d}$ and ventilation rate The droplet size d_0 is the initial one before shrinkage.



The mass concentrations $C_{m,d}$ (mg m^{-3}) of droplets floating in the room are expressed by the following equation (1), where d is the diameter of the droplets. Note that d is the diameter after shrinkage to 27% of the initial diameter due to evaporation immediately after release. Let the total mass of the suspended droplet size d be m_d (mg), so $C_{m,d} = m_d / V_r$ where V_r = 700 m^3 is the volume of the room. Let the mass of droplets released in conversation be $m_{d0,\,gen}$ (mg s^{-1}). The emitted droplet diameter d_0 (µm) is the diameter before shrink. The mass concentration is

$$\frac{dC_{m,d}}{dt} = m_{d0,\,gen}/V_r - \{\kappa + (T_{AC})^{-1}\}C_{m,d} \qquad (1)$$

where κ is the gravitational settling rate [s^{-1}] and T_{AC} is the air change time, with

$T_{AC} = 1 / ACH$. ACH is the air change per hour. $(T_{AC})^{-1} = V / V_r$, where V (m^3 s^{-1}) is the ventilation volume of the room.

Supplementary material 4: Calculation process and data used for analysis

<Figure 1 and Table 1>

Figure 1 Terminal velocity of droplets, U (cm s^{-1})

d(μm)	r(μm)	U(cm/s)	Re=Ud/ν	
0.2	0.1	1.20E-04	1.60E-08	
2	1	1.20E-02	1.60E-05	
4	2	4.81E-02	1.28E-04	
6	3	1.08E-01	4.33E-04	
10	5	3.01E-01	2.01E-03	
20	10	1.20E+00	1.60E-02	
40	20	4.81E+00	1.28E-01	
60	30	1.08E+01	4.33E-01	
80	40	19.5	1.04E+00	*
100	50	23.3	1.55E+00	*
200	100	38.6	5.14E+00	*

* iterative method for solving a system of nonlinear equations of (4), (7) and (6).

$$Re = \frac{U \times d}{\mu / \rho_a} \quad (4)$$

Re < 1

$$U = \frac{2r^2 \rho_m g}{9\mu} \quad \text{Stokes (5)}$$

C_D=24/Re

1 < Re < 5

$$U = \left(\frac{8\pi r^3 \rho_m g}{3 C_D A \rho_a} \right)^{1/2} \quad (7)$$

Empirical formula

$$C_D = \left\{ \sqrt{\frac{24}{Re}} + 0.5407 \right\}^2 \quad (6)\ [17]$$

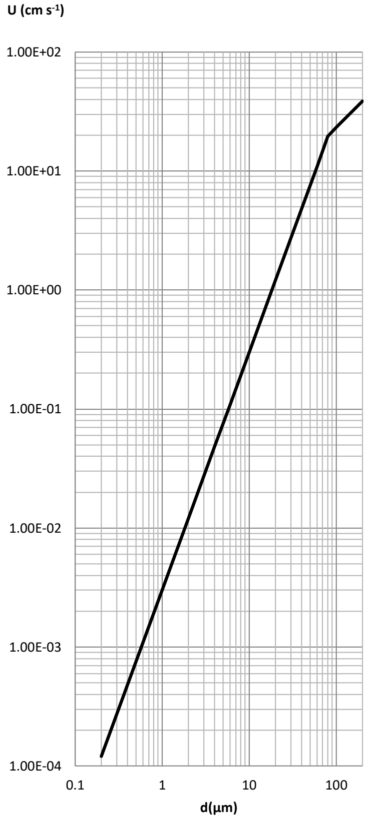
A = π r^2 is the projected area of the sphere, and ρ_a is the air density.

ρ_a=1.205 kg m^{-3} 20℃

ρ_m=1×10^3 kg m^{-3}

μ = 1.813×10^{-5} Nm^{2}s^{-1} 20℃

ν = 1.50×10^{-5}(m^{2}s^{-1}) 20℃



initial diameter d_0 (μm)	final diameter d_f (μm) RH = 0 - 0.6	evaporation time (s) **	vt (m s^{-1})	setting time t =1.5/ vt (s)	time ratio to 1 hour (TR)	d_0 range (μm)	release rate of initial droplet mass (mg s^{-1})
100	27	15-20	* 0.022	69	0.019	75-100	4.9E-04
70	19	10	0.0107	140	0.039	50-75	2.6E-04
50	14	5	0.0055	274	0.076	40-50	9.1E-05
40	11	3.3	0.0035	428	0.12	32-40	4.4E-05
30	8.1	1.6	0.00197	760	0.21	24-32	4.1E-05
20	5.4	0.7	0.00088	1710	0.48	16-24	2.2E-05
12	3.2	0.2	0.00032	4750	1	8-16	9.2E-06
6	1.6	0.1	0.000079	19001	1	< 8	3.4E-06
						total	0.00096

* initial diameter

** Olibeira Fig. 7a (low protein, RH = 0.6)

Appendix Table 1 Calculation of water droplet mass contributing to the number of inhaled viruses per hour

<Table 1 Interval estimation>

Table 1 **Mass of exhaled droplets by droplet size during talking loudly counting from 1 to 100 in 100 seconds. (mg / 100 seconds)**

	author	methods	Statistical parameters	total mass	diameter 2～150 µm	diameter 2～130 µm	diameter 2～100 µm	diameter 2～75 µm	ratio <150µm to <100µm	ratio <130µm to <100µm	ratio <75µm to <100µm	sample size n
(1)	L and R [6]	solid impaction	mean	**21.4**	**0.69**	**0.40**	**0.159**	**0.025**	4.3	2.5	0.15	6
			σ_{n-1}	6.4	0.25	0.131	0.042	0.0081	-	-	-	
			C.V.(%)	30	36	33	27	33	-	-	-	
(1a)	correction the data in (1) to the data without dye		mean	**5.1**	**0.30**	**0.176**	**0.076**	**0.0128**	4.0	2.3	0.17	6
(1b)	L & R-IMI [23]	corrected by IMI	mean	**19.4**	**0.48**	**0.24**	**0.096**	**0.047**	5.0	2.5	0.49	6
(1c)	correction the data in (1b) to the data without dye		mean	**4.7**	**0.21**	**0.105**	**0.046**	**0.024**	4.6	2.3	0.53	6
(2)	Duguid [7]	solid impaction	mean	0.33	0.0108	0.0067	0.0037	0.00199	2.9	1.8	0.53	10-22
(3)	Xie [8]	solid impaction without dye	mean	**0.61**	**0.170**	-	**0.079**	**0.035**	2.2	-	0.45	7
			σ_{n-1}	0.64	0.187	-	0.099	0.051	-	-	-	
			C.V.(%)	104	110	-	126	146	-	-	-	
(4)		solid impaction with dye	mean	**2.44**	**0.39**	-	**0.163**	**0.067**	2.4	-	0.41	5
			σ_{n-1}	1.44	0.171	-	0.081	0.046	-	-	-	
			C.V.(%)	59	44	-	49	68	-	-	-	
(5)		mask	mean	**18.7**	-	-	-	-	-	-	-	8
			σ_{n-1}	21.5	-	-	-	-	-	-	-	
			C.V.(%)	115	-	-	-	-	-	-	-	
(1a)+(3) mean (*) (**)			mean	-	**0.23 (1)***	-	**0.078 (1)***	**0.035****	2.9	-	0.45**	13
		95% confidence interval of the polulation mean (ratio)			**0.14～0.33 (0.59～1.4)**	-	**0.036～0.12 (0.47～1.5)**	-	-	-	-	
			σ_{n-1}	-	0.158	-	0.069	-	-	-	-	
(1)+(4)			mean	-	**0.55 (1)**	-	**0.161 (1)**	**0.044 (1)**	3.4	-	-	11
		95 % confidence interval of the polulation mean (ratio)			0.38～0.72 (0.69～1.31)	-	0.12～0.20 (0.76～1.24)	0.019～0.068 (0.44～1.56)	-	-	-	
			σ_{n-1}	-	0.26	-	0.059	0.037	-	-	-	

The data of Xie et al (table 2)[8] does not divide the size range by 130 µm and is 100-150 µm, so 130 µm or less is not calculated.

* average of (1a) and (3).

** Geometric mean of mass ratio of 75 µm or less to 100 µm or less of (1b), (3) and (4).

σ_{n-1}: standard deviation, C.V.: coefficient of variation

Table 1 Interval estimation

95% confidence interval of the polulation mean

	xie without dye	L & R + Xie with dye						L & R+Xie without dye					
	<100µm	<150µm		<100µm		<75µm		< 150µm		<100µm		<75µm	
mean	0.079	0.55		0.16	1	0.044	1	0.231		0.078	1	0.035	1.000
σn-1	0.099	0.26		0.059		0.037		0.158		0.069			
C.V.(%)	126	47		37		84		68		89			
n	7	11		11		11		13		13			
tα=0.05	2.37	2.2		2.20		2.20		2.16		2.16			
$t_{\alpha}\times\sigma_{n-1}/\sqrt{n}$	0.089	0.17		0.039		0.024		0.095		0.041			
lower limit	-0.010	0.38	0.69	0.12	0.76	0.019	0.44	0.14	0.59	0.036	0.47		
upper limit	0.17	0.72	1.31	0.20	1.24	0.068	1.56	0.33	1.41	0.12	1.53		

<Original data for Figure 2>

C.Y. Chao et al. 2009, Table 4 [23]

L & R - IMI corrected by Chao

count 1 to 100 for 100s

size range (µm)	size class d (µm)	V(cm^3) volume of droplet sphere	numbers of droplets	cummurative V(cm^3) by droplet size	Below this droplet size Cumulative V (mg)	Cumulative volume ratio below this droplet size to cumulative volume below 100 µm	Cumulative volume ratio below this droplet size to cumulative volume below 75 µm
2-4	3	1.41E-11	191	2.70E-09			
4-8	6	1.13E-10	2972	3.36E-07			
8-16	12	9.04E-10	1018	9.21E-07	1.26E-03	1.31E-02	2.69E-02
16-24	20	4.19E-09	534	2.24E-06	3.49E-03	3.63E-02	7.47E-02
24-32	28	1.15E-08	353	4.06E-06	7.55E-03	7.85E-02	1.61E-01
32-40	36	2.44E-08	181	4.42E-06	1.20E-02	1.24E-01	2.56E-01
40-50	45	4.77E-08	191	9.11E-06	2.11E-02	2.19E-01	4.51E-01
50-75	62.5	1.28E-07	201	2.57E-05	4.68E-02	4.86E-01	1.00E+00
75-100	87.5	3.51E-07	141	4.94E-05	9.62E-02	1.00E+00	
100-125	112.5	7.45E-07	191	1.42E-04	2.39E-01		
125-150	137.5	1.36E-06	181	2.46E-04	4.84E-01		
150-200	175	2.80E-06	191	5.36E-04	1.02E+00		
200-250	225	5.96E-06	161	9.60E-04	1.98E+00		
250-500	375	2.75977E-05	151	4.17E-03	6.14E+00		
500-1000	750	0.00022	60	1.32E-02	1.94E+01		
1000-2000	1500	0.00177		0.00E+00	1.94E+01		
	total	0.0020	6717	0.0194			
			19.39				
		cc, g	mg	1.94E+01			

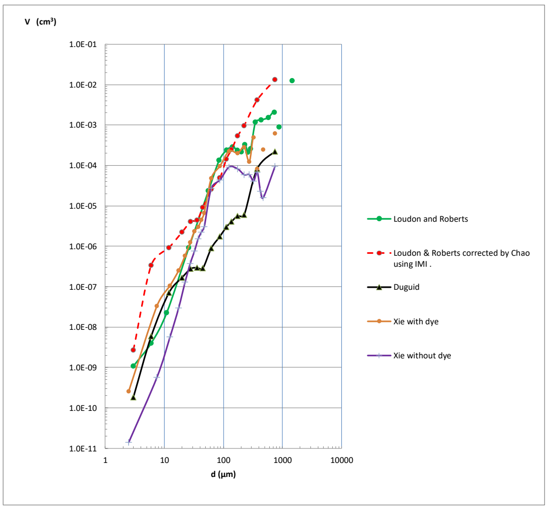


Figure 2 Cumulative volume distribution by size of droplets released during talking.
Loudon and Roberts (L & R), L & R corrected by Chao using IMI, Duguid,Xie (with dye), Xie(without dye)

Loudon and Roberts **Table 2 Numbers of droplet produced by three subjects during talking. [6]**

original	count one to 100 for 100 s						
size rage	size range	size class	n	n			
size range d(µm)	d(µm)	d (µm)	total numbers of droplets for six experiments	average number of droplets in 6 experiments	V(cm^3) volume of droplet sphere	cummurative volume (cm^3) by droplet size	Below this droplet size Cumulative mass (mg)
2-4	2-4	3	460	77	1.41E-11	1.08E-09	
4-8	4-8	6	212	35	1.13E-10	3.99E-09	
8-16	8-19	11	195	33	6.97E-10	2.26E-08	
23-45	19-32	26	600	100	9.20E-09	9.20E-07	
45-75	32-71	56	1545	258	9.19E-08	2.37E-05	2.46E-02
75-105	71-100	85	2505	418	3.21E-07	1.34E-04	1.59E-01
105-135	100-129	114	1860	310	7.75E-07	2.40E-04	
135-165	129-157	143	1125	188	1.53E-06	2.87E-04	
164-195	157-188	173	525	88	2.71E-06	2.37E-04	
195-225	188-217	202	300	50	4.31E-06	2.16E-04	
225-255	217-247	232	300	50	6.53E-06	3.27E-04	
255-285	247-277	262	135	23	9.41E-06	2.12E-04	
285-330	277-321	291	120	20	1.29E-05	2.58E-04	
330-405	321-395	350	315	53	2.24E-05	1.18E-03	
405-525	395-508	439	180	30	4.43E-05	1.33E-03	
525-675	508-657	580	90	15	1.02E-04	1.53E-03	
675-825	657-808	734	60	10	2.07E-04	2.07E-03	
825-975	808-955	881	15	2.5	3.58E-04	8.95E-04	
975-1125	955-1103	1029	0	0	5.70E-04	0.00E+00	
1125-1350	1103-1324	1176	0	0	8.51E-04	0.00E+00	
1350-1500	1324-1500	1471	45	7.5	1.67E-03	1.25E-02	
		total	10587	1765	3.86E-03	2.14E-02	
						2.14E+01	
						mg	

Duguid Table 3 [7]

count one to 100 for 100 s

size range	size class					
d(µm)	d (µm)	one experiment	V(cm3) volume of droplet sphere	cummurative volume (cm3) by droplet size	Below this droplet size Cumulative V (cm3)	Below this droplet size Cumulative V (mg)
1-4	3	13	1.41E-11	1.84E-10		
4-8	6	52	1.13E-10	5.88E-09		
8-16	12	78	9.04E-10	7.05E-08		
16-24	20	40	4.19E-09	1.67E-07		
24-32	28	24	1.15E-08	2.76E-07		
32-40	36	12	2.44E-08	2.93E-07		
40-50	45	6	4.77E-08	2.86E-07		
50-75	62.5	7	1.28E-07	8.94E-07	1.99E-06	1.99E-03
75-100	87.5	5	3.51E-07	1.75E-06	3.75E-06	3.75E-03
100-125	112.5	4	7.45E-07	2.98E-06	6.73E-06	6.73E-03
125-150	137.5	3	1.36E-06	4.08E-06	1.08E-05	1.08E-02
150-200	175	2	2.80E-06	5.61E-06		
200-250	225	1	5.96E-06	5.96E-06		
250-500	375	3	2.76E-05	8.28E-05		
500-1000	750	1	2.21E-04	2.21E-04		
	total	251		3.26E-04		
		Table 3		3.26E-01		
				mg		

Xie et al [8]. **Table 2** **Estimated total number of droplets in different diameter ranges emitted during talking .**

Xie

size range diameter (µm)	diameter	V(cm3) volume of droplet sphere	ave. of no food dye	ave. of food dye and food dye with sugar
µm	µm	ave.		
0-5	2.5	8.18E-12	1.40E-11	2.58E-10
5-10	7.5	2.21E-10	5.68E-10	3.32E-08
10-15	12.5	1.02E-09	5.69E-09	1.06E-07
15-20	17.5	2.80E-09	2.97E-08	2.51E-07
20-25	22.5	5.96E-09	1.29E-07	5.83E-07
25-30	27.5	1.09E-08	3.73E-07	1.25E-06
30-35	32.5	1.80E-08	7.62E-07	2.35E-06
35-40	37.5	2.76E-08	1.53E-06	3.01E-06
40-45	42.5	4.02E-08	2.23E-06	4.50E-06
45-50	47.5	5.61E-08	3.05E-06	6.70E-06
50-75	62.5	1.28E-07	2.71E-05	4.83E-05
75-100	87.5	3.51E-07	4.34E-05	9.63E-05
100-150	125	1.02E-06	9.11E-05	2.26E-04
150-200	175	2.80E-06	8.17E-05	2.01E-04
200-250	225	5.96E-06	5.88E-05	2.83E-04
250-300	275	1.09E-05	5.91E-05	1.24E-04
300-350	325	1.80E-05	4.11E-05	4.92E-04
350-400	375	2.76E-05	6.70E-05	8.28E-05
400-450	425	4.02E-05	2.30E-05	0.00E+00
450-500	475	5.61E-05	1.60E-05	2.47E-04
500-1000	750	2.21E-04	9.46E-05	6.18E-04
1000-1500	1250	1.02E-03	0.00E+00	0.00E+00
total			6.11E-04	

<Original data of "Loudon and Roberts" in Table 1>

Table 1 Mass of exhaled droplets by droplet size provided by Loudon and Roberts during talking loudly counting from 1 to 100 in 100 seconds. (mg / 100 seconds)

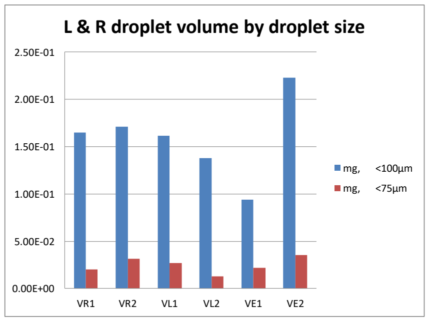
Loudon and Roberts [6] 1967 Table 2 Numbers of droplets produced by three subjects during talking.
count from 1 to 100 in 100 s

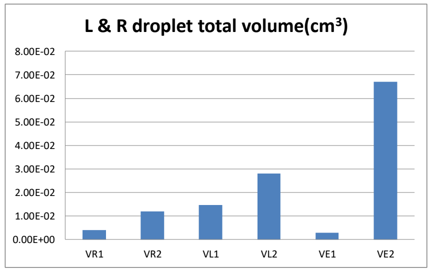
R, L, E : subjects Two experiments per subject(R, L, E).

Table 1

	diameter					n: Number of droplets per experiment						
size range d(µm)	size class d (µm)	V(cm^3): Volume of droplet sphere	n_T: Total number of droplets in 6 experiments	n: Average number of droplets in 6 experiments	V×n (cm^3)	R1	R2	L1	L2	E1	E2	average
2-4	3	1.41E-11	460	77	1.08E-09	15	134	61	143	46	61	77
4-8	6	1.13E-10	212	35	3.99E-09		80	15	71		46	53
8-19	11	6.97E-10	195	33	2.26E-08	120		30		30	15	49
19-32	26	9.20E-09	600	100	9.20E-07	75	90	210	30	120	75	100
32-71	56	9.19E-08	1545	258	2.37E-05	210	330	270	135	225	375	258
71-100	85	3.21E-07	2505	418	1.34E-04	450	435	420	390	225	585	418
100-129	114	7.75E-07	1860	310	2.40E-04	285	375	330	150	225	495	310
129-157	143	1.53E-06	1125	188	2.87E-04	240	225	90	135	120	315	188
157-188	173	2.71E-06	525	88	2.37E-04	150	60	90	105	30	90	88
188-217	202	4.31E-06	300	50	2.16E-04	30	90	60	45	15	60	50
217-247	232	6.53E-06	300	50	3.27E-04	15	75		45	30	135	60
247-277	262	9.41E-06	135	23	2.12E-04			60	30	15	30	34
277-321	291	1.29E-05	120	20	2.58E-04				15	15	90	40
321-395	350	2.24E-05	315	53	1.18E-03		45	30	30	75	135	63
395-508	439	4.43E-05	180	30	1.33E-03	60	15		15		90	45
508-657	580	1.02E-04	90	15	1.53E-03		30				60	45
657-808	734	2.07E-04	60	10	2.07E-03			60				60
808-955	881	3.58E-04	15	2.5	8.95E-04		15					15
955-1103	1029	5.70E-04	0	0	0.00E+00							0
1103-1324	1176	8.51E-04	0	0	0.00E+00							0
1324-1500	1471	1.67E-03	45	7.5	1.25E-02				15		30	22.5
	Total		10587	1765	2.14E-02	1650	1999	1726	1354	1171	2687	1973
					2.14E+01							
					mg							

		V×n (cm^3) : cummulative volume by droplet size						average of six experiments			
size range d(µm)		VR1	VR2	VL1	VL2	VE1	VE2	cummulative volume (cm^3) by droplet size	Below this droplet size Cumulative volume (cm^3)	Cumulative volume ratio below this droplet size to cumulative volume below 100 µm	Cumulative volume ratio below this droplet size to cumulative volume below 75 µm
2-4		2.12E-10	1.89E-09	8.62E-10	2.02E-09	6.50E-10	8.62E-10	1.08E-09	1.08E-09	6.82E-06	4.40E-05
4-8		0.00E+00	9.04E-09	1.70E-09	8.03E-09	0.00E+00	5.20E-09	3.99E-09	5.08E-09	3.20E-05	2.06E-04
8-19		8.36E-08	0.00E+00	2.09E-08	0.00E+00	2.09E-08	1.04E-08	2.26E-08	2.77E-08	1.75E-04	1.13E-03
19-32		6.90E-07	8.28E-07	1.93E-06	2.76E-07	1.10E-06	6.90E-07	9.20E-07	9.48E-07	5.97E-03	3.85E-02
32-71		1.93E-05	3.03E-05	2.48E-05	1.24E-05	2.07E-05	3.45E-05	2.37E-05	2.46E-05	1.55E-01	1.00E+00
71-100		1.45E-04	1.40E-04	1.35E-04	1.25E-04	7.23E-05	1.88E-04	1.34E-04	1.59E-04	1.00E+00	
100-129		2.21E-04	2.91E-04	2.56E-04	1.16E-04	1.74E-04	3.84E-04	2.40E-04	3.99E-04		
129-157		3.67E-04	3.44E-04	1.38E-04	2.07E-04	1.84E-04	4.82E-04	2.87E-04	6.86E-04		
157-188		4.06E-04	1.63E-04	2.44E-04	2.85E-04	8.13E-05	2.44E-04	2.37E-04	9.23E-04		
188-217		1.29E-04	3.88E-04	2.59E-04	1.94E-04	6.47E-05	2.59E-04	2.16E-04	1.14E-03		
217-247		9.80E-05	4.90E-04	0.00E+00	2.94E-04	1.96E-04	8.82E-04	3.27E-04	1.47E-03		
247-277		0.00E+00	0.00E+00	5.65E-04	2.82E-04	1.41E-04	2.82E-04	2.12E-04	1.68E-03		
277-321		0.00E+00	0.00E+00	0.00E+00	1.93E-04	1.93E-04	1.16E-03	2.58E-04	1.94E-03		
321-395		0.00E+00	1.01E-03	6.73E-04	6.73E-04	1.68E-03	3.03E-03	1.18E-03	3.11E-03		
395-508		2.66E-03	6.64E-04	0.00E+00	6.64E-04	0.00E+00	3.98E-03	1.33E-03	4.44E-03		
508-657		0.00E+00	3.06E-03	0.00E+00	0.00E+00	0.00E+00	6.13E-03	1.53E-03	5.97E-03		
657-808		0.00E+00	0.00E+00	1.24E-02	0.00E+00	0.00E+00	0.00E+00	2.07E-03	8.04E-03		
808-955		0.00E+00	5.37E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.95E-04	8.94E-03		
955-1103		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.94E-03		
1103-1324		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.94E-03		
1324-1500		0.00E+00	0.00E+00	0.00E+00	2.50E-02	0.00E+00	5.00E-02	1.25E-02	2.14E-02		
	Total	4.04E-03	1.20E-02	1.47E-02	2.80E-02	2.81E-03	6.70E-02	2.14E-02	2.41E-02	1.13E+02	
	<160µm	7.53E-04	8.06E-04	5.55E-04	4.61E-04	4.52E-04	1.09E-03	6.86E-04	2.46E-04	3.59E+01	
	<130µm	3.86E-04	4.62E-04	4.18E-04	2.54E-04	2.69E-04	6.07E-04	3.99E-04	1.31E-04	3.28E+01	
	<100µm	1.65E-04	1.71E-04	1.62E-04	1.38E-04	9.41E-05	2.23E-04	1.59E-04	4.23E-05	2.66E+01	
	<75µm	2.01E-05	3.12E-05	2.68E-05	1.27E-05	2.18E-05	3.52E-05	2.46E-05	8.12E-06	3.30E+01	
	mg <160µm	7.53E-01	8.06E-01	5.55E-01	4.61E-01	4.52E-01	1.09E+00	6.86E-01	2.46E-01	3.59E+01	
	mg <130µm	2.01E-02	3.12E-02	2.68E-02	1.27E-02	2.18E-02	3.52E-02	3.99E-01	1.31E-01	3.28E+01	
	mg, <100µm	1.65E-01	1.71E-01	1.62E-01	1.38E-01	9.41E-02	2.23E-01	1.59E-01	4.23E-02	2.66E+01	
	mg, <75µm	2.01E-02	3.12E-02	2.68E-02	1.27E-02	2.18E-02	3.52E-02	2.46E-02	8.12E-03	3.30E+01	
								average of six experiments	standard deviation of six experiments σ_{n-1}	C.V.%	





<Original data of "L & R - IMI" in Table 1 and calculation of mean mass by droplet size>

Table 1 Mass of exhaled droplets by droplet size during talking loudly counting from 1 to 100 in 100 seconds. (mg / 100 seconds)

C.Y. Chao et al.[23] Table 4 Estimated total expiratory droplet numbers produced during

Numbers in **green boxes** refer to data from the original paper.

size range (µm)	size class d (µm)	V(cm^3) volume of droplet sphere	expiratory droplet numbers n	cummurative volume (cm^3) by droplet size	Below this droplet size Cumulative mass (mg)	Cumulative mass ratio below this droplet size to cumulative mass below 100 µm	Cumulative mass ratio below this droplet size to cumulative mass below 75 µm	Cumulative mass ratio below this droplet size to cumulative mass below 150 µm
2-4	3	1.41E-11	191	2.70E-09	2.70E-06	2.81E-05	5.77E-05	
4-8	6	1.13E-10	2972	3.36E-07	3.39E-04	3.52E-03	7.24E-03	
8-16	12	9.04E-10	1018	9.21E-07	1.26E-03	1.31E-02	2.69E-02	
16-24	20	4.19E-09	534	2.24E-06	3.49E-03	3.63E-02	7.47E-02	
24-32	28	1.15E-08	353	4.06E-06	7.55E-03	7.85E-02	1.61E-01	
32-40	36	2.44E-08	181	4.42E-06	1.20E-02	1.24E-01	2.56E-01	
40-50	45	4.77E-08	191	9.11E-06	2.11E-02	2.19E-01	4.51E-01	
50-75	62.5	1.28E-07	201	2.57E-05	4.68E-02	4.86E-01	1.00E+00	
75-100	87.5	3.51E-07	141	4.94E-05	9.62E-02	1.00E+00		1.99E-01
100-125	112.5	7.45E-07	191	1.42E-04	2.39E-01			4.93E-01
125-150	137.5	1.36E-06	181	2.46E-04	4.84E-01			1
150-200	175	2.80E-06	191	5.36E-04	1.02E+00			
200-250	225	5.96E-06	161	9.60E-04	1.98E+00			
250-500	375	2.76E-05	151	4.17E-03	6.14E+00			
500-1000	750	0.00022	60	1.32E-02	1.94E+01			
1000-2000	1500	0.00177	0	0.00E+00	1.94E+01			
	total	0.0020	6717	0.0194				
			19.39					
	total	cc, g	mg	1.94E+01				

reference

23. Chao CYH, Wan MP, Morawska L, Johnson GR, Ristovski ZD, Hargreaves M, Mengersen K, Corbett S, Li Y, Xie X, Katoshevski D (2009). Characterization of expiration air jets and droplet size distributions immediately at the mouth opening. J. Aerosol Sci 40(2), 122–133.

<Original data of Xie et al. in Table 1>

Table 1 Mass of exhaled droplets by droplet size during talking loudly counting from 1 to 100 in 100 seconds. (mg / 100 seconds)

Xie et al [8]. Table 2 Estimated total number of droplets in different diameter ranges emitted during talking .(M, male subject; F, female subject;the sizes of droplets usend the values at sampling positions.

size range d (µm)	number of droplets											
	no food dye							food dye		food dye with sugar		
	M1	M2	M3	F1	F2	F3	F4	M1	F1	M1	M3	F1
0-5	0	0	0	0	0	12	0	0	0	66	92	0
5-10	0	0	5	0	0	6	7	24	0	303	309	115
10-15	2	11	24	0	0	0	2	14	0	158	208	138
15-20	12	35	11	0	9	7	0	165	14	82	108	79
20-25	14	86	13	7	28	0	4	230	28	87	72	72
25-30	28	154	7	12	32	0	7	280	43	115	93	43
30-35	40	187	0	2	58	3	7	345	43	122	86	57
35-40	65	239	4	0	79	0	0	302	36	72	93	43
40-45	84	229	0	0	65	2	9	338	50	72	57	43
45-50	50	246	0	9	65	2	9	259	43	152	86	57
50-75	271	854	16	57	236	20	31	763	237	230	446	216
75-100	256	369	7	62	147	7	19	420	159	299	316	180
100-150	180	233	7	48	103	29	24	335	100	251	259	161
150-200	54	58	2	14	56	6	14	146	28	121	36	28
200-250	15	23	0	4	25	2	0	74	21	61	28	53
250-300	9	14	2	2	7	2	2	7	7	0	36	7
300-350	4	4	2	2	2	2		15		0	92	30
350-400	7	4		4	2			7		0	8	
400-450		0		2	2			0		0		
450-500		0			2			14		8		
500-1000		3								14		
1000-1500												
Total	1091	2749	100	225	918	100	135	3738	809	2213	2425	1322

reference

8. Xie X, Li Y, Sun H, Liu L (2009). Exhaled droplets due to talking and coughing, J. R. Soc. Interface 6, S703 –S714 (doi:10 1098/rsif.2009.0388.focus)

Volume and mass by particle size calculated from Table 2 of Xie et al.

size range diameter (µm)	radius (µm)	V (cm^3) droplet volume	cummurative volume by droplet size (cm^3)																
			no food dye							food dye		food dye with sugar							
			M1	M2	M3	F1	F2	F3	F4	M1	F1	M1	M3	F1	ave. of no food dye	mouth origin ave. of no food dye	sum of mouth origin no food dye	mouth origin no food dye/ ave.	ave. all	ave. of food dye and food dye with sugar
0-5	1.3	8.18E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.81E-11	0.00E+00	0.00E+00	0.00E+00	5.40E-10	7.52E-10	0.00E+00	1.40E-11	0.00E+00	0.00E+00		1.16E-10	2.58E-10
5-10	3.8	2.21E-10	0.00E+00	0.00E+00	1.10E-09	0.00E+00	0.00E+00	1.32E-09	1.55E-09	5.30E-09	0.00E+00	6.69E-08	6.82E-08	2.54E-08	5.68E-10	1.89E-10	1.89E-10		1.41E-08	3.32E-08
10-15	6.3	1.02E-09	2.04E-09	1.12E-08	2.45E-08	0.00E+00	0.00E+00	0.00E+00	2.04E-09	1.43E-08	0.00E+00	1.61E-07	2.13E-07	1.41E-07	5.69E-09	1.55E-09	1.74E-09		4.74E-08	1.06E-07
15-20	8.8	2.80E-09	3.37E-08	9.82E-08	3.09E-08	0.00E+00	2.52E-08	1.96E-08	0.00E+00	4.63E-07	3.93E-08	2.30E-07	3.03E-07	2.22E-07	2.97E-08	8.98E-10	2.64E-09		1.22E-07	2.51E-07
20-25	11.3	5.96E-09	8.35E-08	5.13E-07	7.75E-08	4.17E-08	1.67E-07	0.00E+00	2.38E-08	1.37E-06	1.67E-07	5.19E-07	4.29E-07	4.29E-07	1.29E-07	3.92E-09	6.56E-09		3.18E-07	5.83E-07
25-30	13.8	1.09E-08	3.05E-07	1.68E-06	7.62E-08	1.31E-07	3.48E-07	0.00E+00	7.62E-08	3.05E-06	4.68E-07	1.25E-06	1.01E-06	4.68E-07	3.73E-07	9.82E-09	1.64E-08		7.38E-07	1.25E-06
30-35	16.3	1.80E-08	7.19E-07	3.36E-06	0.00E+00	3.59E-08	1.04E-06	5.39E-08	1.26E-07	6.20E-06	7.72E-07	2.19E-06	1.54E-06	1.02E-06	7.62E-07	1.47E-08	3.10E-08		1.42E-06	2.35E-06
35-40	18.8	2.76E-08	1.79E-06	6.60E-06	1.10E-07	0.00E+00	2.18E-06	0.00E+00	0.00E+00	8.33E-06	9.94E-07	1.99E-06	2.57E-06	1.19E-06	1.53E-06	2.93E-08	6.04E-08		2.15E-06	3.01E-06
40-45	21.3	4.02E-08	3.37E-06	9.20E-06	0.00E+00	0.00E+00	2.61E-06	8.03E-08	3.62E-07	1.36E-05	2.01E-06	2.89E-06	2.29E-06	1.73E-06	2.23E-06	1.38E-06	1.44E-06		3.18E-06	4.50E-06
45-50	23.8	5.61E-08	2.80E-06	1.38E-05	0.00E+00	5.05E-07	3.65E-06	1.12E-07	5.05E-07	1.45E-05	2.41E-06	8.53E-06	4.82E-06	3.20E-06	3.05E-06	1.89E-06	3.33E-06		4.57E-06	6.70E-06
50-75	31.3	1.28E-07	3.46E-05	1.09E-04	2.04E-06	7.28E-06	3.02E-05	2.56E-06	3.96E-06	9.75E-05	3.03E-05	2.94E-05	5.70E-05	2.76E-05	2.71E-05	5.08E-05	5.41E-05	1.11E-03	3.60E-05	4.83E-05
75-100	43.8	3.51E-07	8.98E-05	1.29E-04	2.45E-06	2.17E-05	5.15E-05	2.45E-06	6.66E-06	1.47E-04	5.57E-05	1.05E-04	1.11E-04	6.31E-05	4.34E-05	5.08E-05	1.05E-04	9.20E-04	6.55E-05	9.63E-05
100-150	62.5	1.02E-06	1.84E-04	2.38E-04	7.15E-06	4.91E-05	1.05E-04	2.96E-05	2.45E-05	3.42E-04	1.02E-04	2.57E-04	2.65E-04	1.65E-04	9.11E-05	1.29E-04	2.34E-04		1.47E-04	2.26E-04
150-200	87.5	2.80E-06	1.51E-04	1.63E-04	5.61E-06	3.93E-05	1.57E-04	1.68E-05	3.93E-05	4.09E-04	7.85E-05	3.39E-04	1.01E-04	7.85E-05	8.17E-05	8.38E-05	3.18E-04		1.32E-04	2.01E-04
200-250	112.5	5.96E-06	8.94E-05	1.37E-04	0.00E+00	2.38E-05	1.49E-04	1.19E-05	0.00E+00	4.41E-04	1.25E-04	3.64E-04	1.67E-04	3.16E-04	5.88E-05	5.88E+07	5.88E+07		1.52E-04	2.83E-04
250-300	137.5	1.09E-05	9.80E-05	1.52E-04	2.18E-05	2.18E-05	7.62E-05	2.18E-05	2.18E-05	7.62E-05	7.62E-05	0.00E+00	3.92E-04	7.62E-05	5.91E-05	5.91E+07	1.18E+08		8.62E-05	1.24E-04
300-350	162.5	1.80E-05	7.19E-05	7.19E-05	3.59E-05	3.59E-05	3.59E-05	3.59E-05	0.00E+00	2.69E-04	0.00E+00	0.00E+00	1.65E-03	5.39E-04	4.11E-05	4.11E+07	1.59E+08		2.29E-04	4.92E-04
350-400	187.5	2.76E-05	1.93E-04	1.10E-04	0.00E+00	1.10E-04	5.52E-05	0.00E+00	0.00E+00	1.93E-04	0.00E+00	0.00E+00	2.21E-04	0.00E+00	6.70E-05	6.70E+07	2.26E+08		7.36E-05	8.28E-05
400-450	212.5	4.02E-05	0.00E+00	0.00E+00	0.00E+00	8.03E-05	8.03E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.30E-05	2.30E+07	2.49E+08		1.34E-05	0.00E+00
450-500	237.5	5.61E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.12E-04	0.00E+00	0.00E+00	7.85E-04	0.00E+00	4.49E-04	0.00E+00	0.00E+00	1.60E-05	1.60E+07	2.65E+08		1.12E-04	2.47E-04
500-1000	375	2.21E-04	0.00E+00	6.62E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.09E-03	0.00E+00	0.00E+00	9.46E-05	9.46E+07	3.60E+08		3.13E-04	6.18E-04
1000-1500	625	1.02E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.60E+08		0.00E+00	0.00E+00
Total			9.21E-04	1.81E-03	7.53E-05	3.90E-04	8.63E-04	1.21E-04	9.73E-05	2.81E-03	4.75E-04	4.65E-03	2.98E-03	1.27E-03	6.11E-04				1.37E-03	2.44E-03
	sampling point	mg	0.92	1.81	0.08	0.39	0.86	0.12	0.10	2.81	0.48	4.65	2.98	1.27	0.61	0.00	0.00	0.00	1.37	2.44
Xie et al. Table 6 [8]	sampling point	mg	0.94	1.41	0.29	0.49	0.97	0.15	0.11	3.23	0.52	3.67	3.56	1.36					σn-1	1.44
	mouth origin	mg	1	1.53	0.3	0.5	1.02	0.15	0.12	3.43	0.56	3.8	3.71	1.43					CV	59
													σ	0.64						
													CV	104						

size range diameter (µm)	Below this droplet size cumulative volume (cm^3)																									
	no food dye							food dye		food dye with sugar			no food dye (n=7)				food dye and food dye with sugar (n=5)				all						
	M1	M2	M3	F1	F2	F3	F4	M1	F1	M1	M3	F1	average of without food dye (mg)	σn-1 (mg)	CV	ratio	average of food dye and food dye with sugar (mg)	σ (mg)	CV (%)		average (mg)	σ(mg)	C.V.%	ratio	ratio	no dye / dye and dye with sugar	no dye/ all	size range d (µm)
0-5	0	0	0	0	0	9.8E-11	0																					0-5
5-10	0.00E+00	0.00E+00	1.10E-09	0.00E+00	0.00E+00	1.42E-09	1.55E-09	5.30E-09	0.00E+00	6.74E-08	6.90E-08	2.54E-08	5.82E-07			7.40E-06	3.34E-05				1.43E-05			1.25E-04	2.94E-04			5-10
10-15	2.04E-09	1.12E-08	2.56E-08	0.00E+00	0.00E+00	1.42E-09	3.59E-09	1.96E-08	0.00E+00	2.29E-07	2.82E-07	1.66E-07	6.28E-06			7.98E-05	1.39E-04				6.17E-05			5.41E-04	1.27E-03			10-15
15-20	3.57E-08	1.09E-07	5.65E-08	0.00E+00	2.52E-08	2.11E-08	3.59E-09	4.82E-07	3.93E-08	4.59E-07	5.84E-07	3.88E-07	3.59E-05			4.57E-04	3.91E-04				1.84E-04			1.61E-03	3.79E-03			15-20
20-25	1.19E-07	6.22E-07	1.34E-07	4.17E-08	1.92E-07	2.11E-08	2.74E-08	1.85E-06	2.06E-07	9.78E-07	1.01E-06	8.17E-07	1.65E-04			2.10E-03	9.74E-04				5.02E-04			4.41E-03	1.04E-02			20-25
25-30	4.24E-07	2.30E-06	2.10E-07	1.72E-07	5.40E-07	2.11E-08	1.04E-07	4.90E-06	6.74E-07	2.23E-06	2.03E-06	1.29E-06	5.39E-04			6.85E-03	2.22E-03				1.24E-03			1.09E-02	2.56E-02			25-30
30-35	1.14E-06	5.66E-06	2.10E-07	2.08E-07	1.58E-06	7.50E-08	2.29E-07	1.11E-05	1.45E-06	4.42E-06	3.57E-06	2.31E-06	1.30E-03			1.65E-02	4.57E-03				2.66E-03			2.34E-02	5.49E-02			30-35
35-40	2.94E-06	1.23E-05	3.21E-07	2.08E-07	3.76E-06	7.50E-08	2.29E-07	1.94E-05	2.44E-06	6.41E-06	6.14E-06	3.50E-06	2.83E-03			3.59E-02	7.58E-03				4.81E-03			4.22E-02	9.91E-02			35-40
40-45	6.31E-06	2.15E-05	3.21E-07	2.08E-07	6.37E-06	1.55E-07	5.91E-07	3.30E-05	4.45E-06	9.30E-06	8.43E-06	5.22E-06	5.06E-03			6.43E-02	1.21E-02				7.99E-03			7.01E-02	1.65E-01			40-45
45-50	9.12E-06	3.53E-05	3.21E-07	7.13E-07	1.00E-05	2.67E-07	1.10E-06	4.75E-05	6.86E-06	1.78E-05	1.33E-05	8.42E-06	8.11E-03			1.03E-01	1.88E-02				1.26E-02			1.10E-01	2.59E-01			45-50
50-75	4.37E-05	1.44E-04	2.36E-06	8.00E-06	4.02E-05	2.82E-06	5.06E-06	1.45E-04	3.71E-05	4.72E-05	7.02E-05	3.60E-05	3.52E-02	5.13E-02	1.46E+02	4.48E-01	6.71E-02	4.57E-02	6.80E+01		4.85E-02	4.96E-02	1.02E+02	4.26E-01	1.00E+00	0.52	0.73	50-75
75-100	1.33E-04	2.74E-04	4.82E-06	2.97E-05	9.17E-05	5.28E-06	1.17E-05	2.92E-04	9.29E-05	1.52E-04	1.81E-04	9.91E-05	7.86E-02	9.91E-02	1.26E+02	1.00E+00	1.63E-01	6.09E-02	3.95E+01		1.14E-01	9.82E-02	8.62E+01	1.00E+00		0.48	0.69	75-100
100-150	3.17E-04	5.12E-04	1.20E-05	7.88E-05	1.97E-04	3.49E-05	3.62E-05	6.35E-04	1.95E-04	4.09E-04	4.46E-04	2.64E-04	1.70E-01	1.87E-01	1.10E+02		3.90E-01	1.71E-01	4.40E+01		2.61E-01	2.06E-01	7.88E+01			0.44	0.65	100-150
150-200																												150-200
200-250																												200-250
250-300																												250-300
300-350																												300-350
350-400																												350-400
400-450																												400-450
450-500																												450-500
500-1000																												500-1000
1000-1500																												1000-1500
Total	921345603	1.809E+09	7.5281E+07	390341863	8.6E+08	1.2E+08	97282752	2.8E+09	4.8E+08	4.7E+09	3E+09	1.3E+09																Total

	all average	σ	min	max	max/min
sampling point	1.37	1.44	0.075	4.7	62
sampling point	1.39	1.34	0.110	3.7	33
mouth origin	1.46	1.40	0.120	3.8	32

Xie et al.[8]

Table 4 **Total mass of droplets collected using surgical face mask.**

talking counting from 1 to 100

	M1	M2	M3	M4	M5	M6	M7	F1	F2	average(mg	σn-1	CV
mask	3.7	41.8	61.3					15.7	1	18.7	21.5	115
	5.5							12.6	7.7			

<Outdoor diffusion calculataions>

$$C_v = \frac{N_s}{2\pi\sigma_y\sigma_z u} exp\left(-\frac{y^2}{2\sigma_y{}^2}\right)\left[exp\left\{-\frac{(z-h)^2}{2\sigma_z{}^2}\right\} + exp\left\{-\frac{(z+h)^2}{2\sigma_z{}^2}\right\}\right]$$

The average breathing volume of Japanese adults

indoor	Sitting posture	0.000167	m^3/s	table on the right	0.6	m3/h
outdoor	standing posture	0.000253	m^3/s	table on the right	0.91	m3/h

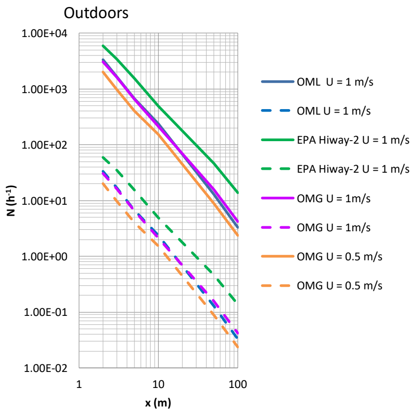
https://unit.aist.go.jp/riss/crm/exposurefactors/documents/factor/body/breathing_rate.pdf

h = 1.5 m, z = 1.5 m, y = 0 m

	average	maximum
number of viruses in expiratory droplets	10^8 copies ml^{-1}	10^{10} copies ml^{-1}
	1.00E+08	1.00E+10

<100µm

mass of expiratory droplets counting from 1 to 100 in 100 seconds (mg s^{-1})	7.8E-04	
virus release rate Ns (s^{-1})	7.8E+01	7.8E+03



C_v/N_s : normalized number concentration of the virus on the plume centerline

OMG volume source model **U=1m/s**

x(m)	C_v/N_s (m^{-3})	C_{max}(m^{-3})	C_{ave} (m^{-3})	$N_{in\ max}$ (h^{-1})	$N_{in\ ave}$ (h^{-1})
2	4.35E-01	3396.7	3.4E+01	3.09E+03	3.09E+01
3	2.28E-01	1778.3	1.8E+01	1.62E+03	1.62E+01
5	9.26E-02	722.0	7.2E+00	6.57E+02	6.57E+00
10	3.01E-02	235.0	2.4E+00	2.14E+02	2.14E+00
50	2.21E-03	17.2	1.7E-01	1.57E+01	1.57E-01
100	5.95E-04	4.6	4.6E-02	4.22E+00	4.22E-02

OMG volume source model **U=0.5m/s**

x(m)	C_v/N_s (m^{-3})	C_{max}(m^{-3})	C_{ave} (m^{-3})	$N_{in\ max}$ (h^{-1})	$N_{in\ ave}$ (h^{-1})
2	2.83E-01	2207.7	2.2E+01	2.01E+03	2.01E+01
3	1.38E-01	1073.6	1.1E+01	9.77E+02	9.77E+00
5	5.69E-02	443.8	4.4E+00	4.04E+02	4.04E+00
10	2.13E-02	166.4	1.7E+00	1.51E+02	1.51E+00
50	1.25E-03	9.8	9.8E-02	8.91E+00	8.91E-02
100	3.33E-04	2.6	2.6E-02	2.36E+00	2.36E-02

OML model z_0 = 1m **U=1m/s**

z_0=1m

x(m)	C_v/N_s (m^{-3})	C_{max}(m^{-3})	C_{ave} (m^{-3})	$N_{in\ max}$ (h^{-1})	$N_{in\ ave}$ (h^{-1})
2	4.74E-01	3695	3.70E+01	3.36E+03	3.36E+01
3	2.35E-01	1836	1.84E+01	1.67E+03	1.67E+01
5	9.41E-02	734	7.34E+00	6.68E+02	6.68E+00
10	3.35E-02	261	2.61E+00	2.38E+02	2.38E+00
50	1.84E-03	14	1.43E-01	1.31E+01	1.31E-01
100	4.66E-04	4	3.63E-02	3.30E+00	3.30E-02

EPA Hiway-2 **U=1m/s**

x(m)	C_v/N_s (m^{-3})	C_{max}(m^{-3})	C_{ave} (m^{-3})	$N_{in\ max}$ (h^{-1})	$N_{in\ ave}$ (h^{-1})
2	8.40E-01	6552	6.55E+01	5.96E+03	5.96E+01
3	4.87E-01	3801	3.80E+01	3.46E+03	3.46E+01
5	2.18E-01	1698	1.70E+01	1.55E+03	1.55E+01
10	6.91E-02	539	5.39E+00	4.90E+02	4.90E+00
50	6.55E-03	51	5.11E-01	4.65E+01	4.65E-01
100	1.95E-03	15	1.52E-01	1.39E+01	1.39E-01

dispersion parameters

σ_{y0} = 0.25m, σ_{z0} = 0.25m

OMG volume source model **U=1m/s**

x(m)	σy(m)	σz(m)	$\sigma_y = [\sigma_{ya}{}^2 + \sigma_{y0}{}^2]^{0.5}$	$\sigma_z = [\sigma_{za}{}^2 + \sigma_{z0}{}^2]^{0.5}$
2	0.8	0.3	0.9	0.4
3	1.2	0.5	1.3	0.6
5	2.0	0.8	2.0	0.9
10	3.8	1.6	3.8	1.7
50	17.0	8.2	17.0	8.2
100	32.3	16.4	32.3	16.4

OMG volume source model **U=0.5m/s**

x(m)	σy(m)	σz(m)	$\sigma_y = [\sigma_{ya}{}^2 + \sigma_{y0}{}^2]^{0.5}$	$\sigma_z = [\sigma_{za}{}^2 + \sigma_{z0}{}^2]^{0.5}$
2	2.0	0.51	2.0	0.57
3	2.8	0.77	2.9	0.81
5	4.6	1.3	4.6	1.3
10	8.7	2.6	8.7	2.6
50	39.0	12.8	39.0	12.8
100	74.3	25.7	74.3	25.7

OML model z_0 = 1m **U=1m/s**

x(m)	σya(m)	σza(m)	$\sigma_y = [\sigma_{ya}{}^2 + \sigma_{y0}{}^2]^{0.5}$	$\sigma_z = [\sigma_{za}{}^2 + \sigma_{z0}{}^2]^{0.5}$
2	0.58	0.47	0.6	0.53
3	0.87	0.70	0.9	0.75
5	1.45	1.17	1.5	1.20
10	2.9	2.3	2.9	2.36
50	14.5	11.745	14.5	11.75
100	29	23.49	29.0	23.49

EPA Hiway-2 **U=1m/s**

x(m)	σy(m)	σz(m)	$\sigma_y = [\sigma_{ya}{}^2 + \sigma_{y0}{}^2]^{0.5}$	$\sigma_z = [\sigma_{za}{}^2 + \sigma_{z0}{}^2]^{0.5}$
2	0.44	0.28	0.5	0.4
3	0.64	0.41	0.7	0.5
5	1.02	0.65	1.1	0.7
10	1.93	1.23	1.9	1.3
50	8.3	5.4	8.3	5.4
100	15.5	10.3	15.5	10.3

reference

35. Petersen WB, User's Guide for HIWAY-2, A Highway air pollution model, 1–69, US EPA, EPA-600/8-80-018 May 1980.
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37. Kono H, Ito S (1990). A micro-scale dispersion model for motor vehicle exhaust gas in urban areas-OMG volume-source dispersion model, Atmospheric Environment 24B(2), 243–251.
38. Kono H Ito S (1990). A comparison of concentration estimates by the OMG volume-source dispersion model with three line source dispersion models, Atmospheric Environment 24B(2), 253–260.

<Dispersion parameters in EPA HIWAY-2 model, OML model and OMG volume-source model>

Dispersion parameters σ_{ya} and σ_{za} for EPA HIWAY-2 model [35]

σ_{ya}: horizontal dispersion parameter due to ambient turbulence
σ_{za}: vertical dispersion parameter due to ambient turbulence

$$\sigma_{za} = ax^b \quad (1)$$

Values of "a" and "b" used to compute σ_{za}(m)

stability regime	a	b
Unstable	0.18	0.93198
Neutral	0.15	0.92332
Stable	0.11	0.91465

formulae and constant to compute σ_{ya}

$$\sigma_{ya} = 0.4651x \tan\theta_p \quad (2)$$

where: x = downwind distance from source to receptor, m

θp = half angle of horizontal plume spreading, degree

$$\theta_p = c - d\ ln(x/x_0) \quad (3)$$

x_0 = 1000 m

values of "c" and "d" used to compute, θp

stability regime	c	d
Unstable	18.333	1.8096
Neutral	14.333	1.7706
Stable	12.5	1.0857

neutral x=100m

θp (degree)	18.407
σ_{ya} (m)	15.4634
σ_{za} (m)	10.5373

EPA Hiway-2 model [35]

x(m)	σ_{ya}(m)	σ_{za}(m)	$\sigma_y = [\sigma_{ya}^2 + \sigma_{y0}^2]^{0.5}$	$\sigma_z = [\sigma_{za}^2 + \sigma_{z0}^2]^{0.5}$
2	0.44	0.28	0.5	0.37
3	0.64	0.41	0.7	0.48
5	1.02	0.65	1.1	0.70
10	1.93	1.23	1.9	1.26
50	8.30	5.44	8.3	5.45
100	15.48	10.32	15.5	10.32

σ_{y0}: initial horizontal dispersion parameter due to wake of human body (= 0.25 m)
σ_{z0}: initial vertical dispersion patameter due to wake of human body (= 0.25 m)

OML model [36]

The OML model uses the following equations to calculate σ_{ya} and σ_{za} from the ground level source under neutral atmospheric condition.

σ_{ya}: horizontal dispersion parameter due to ambient turbulence
σ_{za}: vertical dispersion parameter due to ambient turbulence

$$\sigma_{ya} = u_* t = u_* \frac{x}{U} \quad (4)$$

$$\sigma_{za} = \{1.2u_*^2 \exp(-0.6)\}^{0.5} t = 0.81u_* t = 0.81u_* \frac{x}{U} \quad (5)$$

where u_* = friction velocity, m s^{-1}
t = travel time, s
x = downwind distance, m
U = wind speed, m s^{-1}

When the wind speed at 1.5m in height is 1m s^1, the wind speed at 50m in height is estimated using the power law. Since 50m is the middle height of the surface layer, that is regarded to be the reference height. Using the logarithmic law, calculate u_* / U given the surface roughness and height of 50m.

$$\frac{U}{U_1} = \left(\frac{z}{z_1}\right)^p \qquad \frac{U}{u_*} = \frac{1}{k} ln \frac{z-d}{z_0} \quad (6)$$

von Karman constant k = 0.4, displacement height d = 0 m

p = 0.3 [46] z_0 = 1m urban

z_1 = 1.5 m	U_1(m/s)	1
z = 50 m	U (m/s)	2.9
	u_*	0.29
	u_*/U_1	0.29

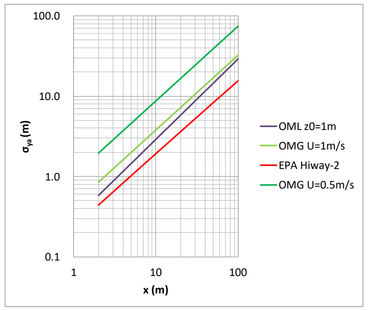
Adachi, T. [46]

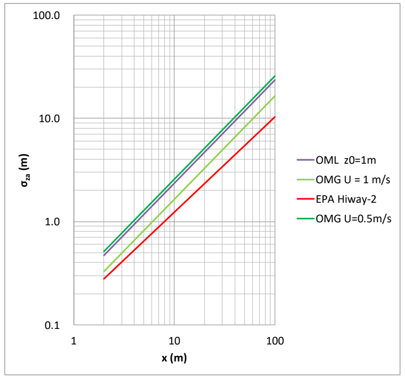
OML model [36] **surface roughness z_0=1m**

x(m)	σ_{ya}(m)	σ_{za}(m)	$\sigma_y = [\sigma_{ya}^2 + \sigma_{y0}^2]^{0.5}$	$\sigma_z = [\sigma_{za}^2 + \sigma_{z0}^2]^{0.5}$
2	0.58	0.47	0.63	0.53
3	0.87	0.70	0.91	0.75
5	1.5	1.17	1.5	1.20
10	2.9	2.35	2.9	2.36
50	14.5	11.75	14.5	11.75
100	29.0	23.49	29.0	23.49

Initial dispersion parameter σ_{y0} and σ_{z0} due to wake of human body

σ_{y0} (m)	0.25
σ_{z0} (m)	0.25





OMG volume-source model [37]

$$C = \frac{Q_p}{4\pi}\sqrt{\frac{(m+1)(n+1)}{K_y K_z x^2}} \exp\left\{-\frac{u_a(m+1)y^2}{4K_y x}\right\} \times \left[\exp\left\{-\frac{u_a(n+1)(z-z')^2}{4K_z x}\right\} + \exp\left\{-\frac{u_a(n+1)(z+z')^2}{4K_z x}\right\}\right] \quad (1)$$

$$\left.\begin{aligned} K_y &= k_1 (x/L)^m \\ K_z &= k_2 (x/L)^n \end{aligned}\right\} \quad (2)$$

where C = concentration of pollutant ($m^3\ m^{-3}$),
(x, y, z) = coordinates of receptor (m),
z' = point source release height (m),
Q_p = emission rate ($m^3\ s^{-1}$),
u_a = advection speed of plume ($m\ s^{-1}$),
K_y, K_z = eddy diffusivities in y and z directions ($m^2\ s^{-1}$),
k_1, k_2 = eddy diffusivities in y and z directions at $x = L$ ($m^2\ s^{-1}$),
L = scaling parameter (10 m),
m, n = empirical parameters.

Summary of parameters of eddy diffusivities above buildings

	Kz			Ky	
wind speed ($m\ s^{-1}$)	α all	B ≥ 1	k2 < 1	σ_v/u ≥ 1	σ_v/u < 1
Unstable	1.1	0.76	1.6	0.59	0.56 $u^{-0.82}$
Neutral	0.81	0.27	0.33	0.43	
Stable	0.55	0.17	0.31	0.39	

In order to calculate the concentration averaged for 1-h, the values of σv/u averaged for 20 minutes were converted to those averaged for 1-h using Gifford's formula: σv/u ∝ $t^{0.2}$, where t is the averaging time.

$m = 0.86, \quad n = 1$

$$\sigma_y = \left\{\frac{\frac{2k_1}{10^{0.86}} * x^{1.86}}{1.86U}\right\}^{0.5} \qquad \sigma_z = \left\{\frac{\frac{2k_2}{10} * x^2}{2U}\right\}^{0.5}$$

Micro-scale dispersion model for exhaust gas

Table 3. Summary of parameters of eddy diffusivities above buildings

Wind speed ($m\ s^{-1}$)	K_z: α all	B ≥1	k_2 <1	K_y: σ_v/u_a ≥1	σ_v/u_a <1
Unstable (A ~ B)	1.1 (2)	0.76 (2)	1.6 (6)	0.59 (28)	
Neutral (BC ~ D)	0.81 (11)	0.27 (11)	0.33 (4)	0.43 (42)	$0.56u_a^{-0.82}$ (12)
Stable (E ~ G)	0.55 (3)	0.17 (3)	0.31 (1)	0.39 (12)	

( ) = Sample size

In order to calculate the concentration of pollutants averaged for 1-h, the values of σ_v/u_a averaged for 20 minutes in Equation (17) were converted to those averaged for 1-h by using Gifford's formula:

$$\sigma_v/u_a \propto t^{0.2},$$

where t is the averaging time.

$$K_y = (\sigma_v^2/u_a)x^{0.86}.$$

$$K_z = \alpha^2(\sigma_w/u_a)x\sigma_w. \qquad k_2 = B(\zeta, z_0)u_a,$$

OMG volume-source model [37]

k_1 = 1.34 k_2 = 0.27

U=1ms^{-1} σ_v/U = 0.43 B = 0.27 m = 0.86 n=1 σ_{y0} = 0.25m

Qp = 1 σ_{z0} = 0.25m

x(m)	σ_{ya}(m)	σ_{za}(m)	Ky	Kz	C(y=0, z=1.5m, z'=1.5m)	$\sigma_y = [\sigma_{ya}^2 + \sigma_{y0}^2]^{0.5}$	$\sigma_z = [\sigma_{za}^2 + \sigma_{z0}^2]^{0.5}$
2	0.8	0.3	0.34	0.054	5.70E-01	0.9	0.41
3	1.2	0.5	0.48	0.081	2.61E-01	1.3	0.55
5	2.0	0.8	0.74	0.135	9.74E-02	2.0	0.86
10	3.8	1.6	1.34	0.27	3.04E-02	3.8	1.66
50	17.0	8.2	5.35	1.35	2.21E-03	17.0	8.22
100	32.3	16.4	9.70	2.7	5.95E-04	32.3	16.43

k2=0.33 U < 1ms^{-1}

U = 0.5ms^{-1} σy/U=0.56 $U^{-0.82}$

σy/U 0.98862736

σ_{y0} = 0.25m

k1 3.54026076 σ_{z0} = 0.25m

x(m)	σ_{ya}(m)	σ_{za}(m)	Ky	Kz	C(y=0, z=1.5m, z'=1.5m)	$\sigma_y = [\sigma_{ya}^2 + \sigma_{y0}^2]^{0.5}$	$\sigma_z = [\sigma_{za}^2 + \sigma_{z0}^2]^{0.5}$
2	2.0	0.51	0.89	0.066	3.17E-01	2.0	0.57
3	2.8	0.77	1.26	0.099	1.45E-01	2.9	0.81
5	4.6	1.3	1.95	0.165	5.77E-02	4.6	1.31
10	8.7	2.6	3.5	0.33	2.14E-02	8.7	2.58
50	39	13	14	1.65	1.25E-03	39.0	12.85
100	74	26	26	3.3	3.33E-04	74.3	25.69

<Indoor difussion calculation-1>

Figure 3 **Calculated number of viruses inhaled from the nose and mouth for 1 hour indoors.**

S-3-1 **S3-1. Relationship between virus number concentration for each droplet size, $C_{v,d}$ ($n_0=10^8$ mL^{-1}) and ventilation rate.**

initial diameter d_0 (μm)	final diameter df (μm) RH = 0 - 0.6	evaporation time (s) **	terminal velocity vt (m s^{-1})	setting time t =1.5/ vt (s)	time ratio to 1 hour (TR)	d_0 range (μm)	initial mass (mg s^{-1})	initial mass ×TR (mg s^{-1})	gravitational setting decay rate κ = 1/t [s^{-1}]	time decay of virus in aerosol, exponetial decay constant λ [s^{-1}]
100	27	15-20	* 0.022	69	0.02	75-100	0.00049	9.44E-06	1.45E-02	1.69E-04
70	18.9	10	0.0106858	140	0.04	50-75	0.00026	1.00E-05	7.12E-03	1.69E-04
50	13.5	5	0.0054519	275	0.08	40-50	9.1E-05	6.96E-06	3.63E-03	1.69E-04
40	10.8	3.3	0.0034892	430	0.12	32-40	4.4E-05	5.28E-06	2.33E-03	1.69E-04
30	8.1	1.6	0.0019627	764	0.21	24-32	4.1E-05	8.61E-06	1.31E-03	1.69E-04
20	5.4	0.7	0.0008723	1,720	0.48	16-24	2.2E-05	1.07E-05	5.82E-04	1.69E-04
12	3.24	0.2	0.0002181	4,777	1.00	8-16	9.2E-06	9.21E-06	2.09E-04	1.69E-04
6	1.62	0.1	0.00013	19,106	1.00	< 8	3.4E-06	3.39E-06	5.23385E-05	1.69E-04
total						total	0.00096	6.36E-05		

room CO_2 concentration, Q = ventiration volume flow rate [m^3s^{-1}], Q / V_{room} [s^{-1}], Tres[s] mass concentration $C_{m,d} = m_d / V_{room}$ [mg / m^3], The suffix d is the diameter of droples. virus number concentration $C_v = N / V_{room}$ [m^{-3}], V_{room} = 700 m^3,

	CO_2 (ppm)	450ppm	500ppm	600ppm	700ppm	800ppm	1000pp	1600ppm	3500ppm
	Q [m^3s^{-1}]	3	1.5	0.75	0.5	0.375	0.25	0.125	0.048
	Q/V_{room}	4.29E-03	2.14E-03	1.07E-03	7.14E-04	5.36E-04	3.57E-04	1.79E-04	6.91E-05
	Tres [s]	233	467	933	1,400	1,867	2,800	5,600	14,467
	Tres [h]	0.06	0.13	0.26	0.39	0.52	0.78	1.56	4.02
$C_{m,d}$ (mg m^{-3})	100μm	3.72E-05	4.19E-05	4.48E-05	4.58E-05	4.63E-05	4.69E-05	4.74E-05	4.78E-05
	70μm	3.17E-05	3.89E-05	4.39E-05	4.58E-05	4.69E-05	4.80E-05	4.91E-05	4.98E-05
	50μm	1.61E-05	2.19E-05	2.67E-05	2.88E-05	3.00E-05	3.13E-05	3.27E-05	3.36E-05
	40μm	9.31E-06	1.36E-05	1.77E-05	1.97E-05	2.08E-05	2.21E-05	2.36E-05	2.46E-05
	30μm	1.01E-05	1.60E-05	2.27E-05	2.64E-05	2.88E-05	3.16E-05	3.50E-05	3.75E-05
	20μm	6.34E-06	1.10E-05	1.75E-05	2.18E-05	2.48E-05	2.88E-05	3.44E-05	3.90E-05
	12μm	2.82E-06	5.22E-06	9.07E-06	1.20E-05	1.44E-05	1.79E-05	2.36E-05	2.94E-05
	6μm	1.07E-06	2.05E-06	3.74E-06	5.17E-06	6.39E-06	8.36E-06	1.21E-05	1.67E-05
	total	1.15E-04	1.51E-04	1.86E-04	2.06E-04	2.18E-04	2.35E-04	2.58E-04	2.78E-04
C_v (m^{-3})	$n_0 = 10^{10}$ cm^{-3}	1.15E+03	1.51E+03	1.86E+03	2.06E+03	2.18E+03	2.35E+03	2.58E+03	2.78E+03
	$n_0 = 10^8$ cm^{-3}	1.15E+01	1.51E+01	1.86E+01	2.06E+01	2.18E+01	2.35E+01	2.58E+01	2.78E+01

Room

V_{room}=700m^3 1000ppm=30m^3/h

CO_2(ppm)	C - C_{out}	Q [m^3/(person・h)]	Q [m^3/(person・s)]
450	50	360	0.1
500	100	180	0.05
600	200	90	0.025
700	300	60	0.01667
800	400	45	0.0125
1000	600	30	0.00833
1600	1200	15	0.00417
3500	3100	5.80645	0.00161

* initial diameter

** Olibeira Fig. 7a (low protein, RH = 0.6)

The average breathing volume of Japanese adults = 0.6m^3h^{-1} Sitting posture

n_0: number of virus in saliva

total virus count concentraion, C_v

	CO_2	$Vm^3 h^{-1}$ $person^{-1}$	$n_0=10^{10}$ mL^{-1}	$n_0=10^8$ mL^{-1}
Cv (m^{-3})	450ppm	360	1146	11.5
	500ppm	180	1506	15.1
	600ppm	90	1861	18.6
	700ppm	60	2055	20.6
	800ppm	45	2184	21.8
	1000ppm	30	2349	23.5
	1600ppm	15	2579	25.8
	3500ppm	5.8	2783	27.8

Ventilation rate and mass concentration corresponding to the initial droplet size.

	$Vm^3 h^{-1}$ $person^{-1}$	100μm	70μm	50μm	40μm	30μm	20μm	12μm	6μm	total
$C_{m,d}$ (mg m^{-3})	360	3.7E-05	3.2E-05	1.6E-05	9.3E-06	1.0E-05	6.3E-06	2.8E-06	1.1E-06	1.1E-04
	180	4.2E-05	3.9E-05	2.2E-05	1.4E-05	1.6E-05	1.1E-05	5.2E-06	2.0E-06	1.5E-04
	90	4.5E-05	4.4E-05	2.7E-05	1.8E-05	2.3E-05	1.8E-05	9.1E-06	3.7E-06	1.9E-04
	60	4.6E-05	4.6E-05	2.9E-05	2.0E-05	2.6E-05	2.2E-05	1.2E-05	5.2E-06	2.1E-04
	45	4.6E-05	4.7E-05	3.0E-05	2.1E-05	2.9E-05	2.5E-05	1.4E-05	6.4E-06	2.2E-04
	30	4.7E-05	4.8E-05	3.1E-05	2.2E-05	3.2E-05	2.9E-05	1.8E-05	8.4E-06	2.3E-04
	15	4.7E-05	4.9E-05	3.3E-05	2.4E-05	3.5E-05	3.4E-05	2.4E-05	1.2E-05	2.6E-04
	5.8	4.8E-05	5.0E-05	3.4E-05	2.5E-05	3.7E-05	3.9E-05	2.9E-05	1.7E-05	2.8E-04

number of inhaled viruses in the room N_{in} (h^{-1})

	CO_2	$Vm^3 h^{-1}$ $person^{-1}$	$n_0=10^{10}$ mL^{-1}	$n_0=10^8$ mL^{-1}
N_{in} (h^{-1})	450ppm	360	687	6.9
	500ppm	180	904	9.0
	600ppm	90	1116	11.2
	700ppm	60	1233	12.3
	800ppm	45	1310	13.1
	1000ppm	30	1409	14.1
	1600ppm	15	1547	15.5
	3500ppm	5.8	1670	16.7

$n_0=10^8$ mL^{-1}

Relationship between virus count concentration for each initial droplet size, $C_{v,d}$ ($n_0=10^8$ mL^{-1}) and ventilation rate.

	Vm^3 h^{-1} $person^{-1}$	100μm	70μm	50μm	40μm	30μm	20μm	12μm	6μm	total
Cv,d (m^{-3})	360	3.72E+00	3.17E+00	1.61E+00	9.31E-01	1.01E+00	6.34E-01	2.82E-01	1.07E-01	1.15E+01
	180	4.19E+00	3.89E+00	2.19E+00	1.36E+00	1.60E+00	1.10E+00	5.22E-01	2.05E-01	1.51E+01
	90	4.48E+00	4.39E+00	2.67E+00	1.77E+00	2.27E+00	1.75E+00	9.07E-01	3.74E-01	1.86E+01
	60	4.58E+00	4.58E+00	2.88E+00	1.97E+00	2.64E+00	2.18E+00	1.20E+00	5.17E-01	2.06E+01
	45	4.63E+00	4.69E+00	3.00E+00	2.08E+00	2.88E+00	2.48E+00	1.44E+00	6.39E-01	2.18E+01
	30	4.69E+00	4.80E+00	3.13E+00	2.21E+00	3.16E+00	2.88E+00	1.79E+00	8.36E-01	2.35E+01
	15	4.74E+00	4.91E+00	3.27E+00	2.36E+00	3.50E+00	3.44E+00	2.36E+00	1.21E+00	2.58E+01
	5.8	4.8	5.0	3.4	2.5	3.7	3.9	2.9	1.7	27.8

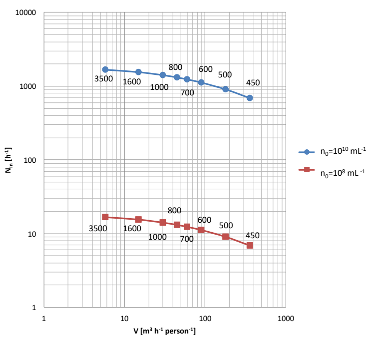
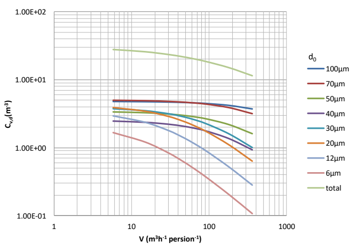


Figure 3 **Calculated number of viruses inhaled from the nose and mouth for 1 hour indoors, N_{in} (h^{-1})**



S3-1. Relationship between virus number concentration for each droplet size, $C_{v,d}$ ($n_0=10^8$ mL^{-1}) and ventilation rate.
The droplet size d_0 is the initial one before shrinkage.

Table Parameter of three removal processes (ventilation [Q/V_{room}], gravitational settting decay [κ], inactivation of virus [λ])

gravitational setting decay rate κ = 1 / t [s^{-1}]	time decay of virus in aerosol, exponetial decay constant λ [s^{-1}]	Q / Vroom							
		450ppm	500ppm	600ppm	700ppm	800ppm	1000pp	1600ppm	3500ppm
1.5.E-02	1.69E-04	4.3.E-03	2.1.E-03	1.1.E-03	7.1.E-04	5.4.E-04	3.57E-04	1.79E-04	6.91E-05
7.1.E-03	1.69E-04	4.3.E-03	2.1.E-03	1.1.E-03	7.1.E-04	5.4.E-04	3.57E-04	1.79E-04	6.91E-05
3.6.E-03	1.69E-04	4.3.E-03	2.1.E-03	1.1.E-03	7.1.E-04	5.4.E-04	3.57E-04	1.79E-04	6.91E-05
2.3.E-03	1.69E-04	4.3.E-03	2.1.E-03	1.1.E-03	7.1.E-04	5.4.E-04	3.57E-04	1.79E-04	6.91E-05
1.3.E-03	1.69E-04	4.3.E-03	2.1.E-03	1.1.E-03	7.1.E-04	5.4.E-04	3.57E-04	1.79E-04	6.91E-05
5.8.E-04	1.69E-04	4.3.E-03	2.1.E-03	1.1.E-03	7.1.E-04	5.4.E-04	3.57E-04	1.79E-04	6.91E-05
2.1.E-04	1.69E-04	4.3.E-03	2.1.E-03	1.1.E-03	7.1.E-04	5.4.E-04	3.57E-04	1.79E-04	6.91E-05
5.2.E-05	1.69E-04	4.3.E-03	2.1.E-03	1.1.E-03	7.1.E-04	5.4.E-04	3.57E-04	1.79E-04	6.91E-05

<Indoor difussion calculation-2>

S3-2. Relationship between droplet mass concentration for each initial size and ventilation rate. (λ= 0)

initial diameter d_0 (µm)	final diameter df (µm) RH = 0 - 0.6	evaporation time (s) **	terminal velocity vt ($m\ s^{-1}$)	setting time t =1.5/ vt (s)	time ratio to 1 hour (TR)	d_0 range (µm)	initial mass released in conversation, $m_{d0,\ gen}$ ($mg\ s^{-1}$)	initial mass ×TR ($mg\ s^{-1}$)	gravitational setting decay rate κ = 1/t [s^{-1}]	time decay of virus in aerosol, exponetial decay constant λ [s^{-1}]
100	27	15-20	* 0.022	69	0.02	75-100	0.00049	9.44E-06	1.45E-02	0.00E+00
70	18.9	10	0.0106858	140	0.04	50-75	0.00026	1.00E-05	7.12E-03	0.00E+00
50	13.5	5	0.0054519	275	0.08	40-50	0.000091	6.96E-06	3.63E-03	0.00E+00
40	10.8	3.3	0.0034892	430	0.12	32-40	0.000044	5.28E-06	2.33E-03	0.00E+00
30	8.1	1.6	0.0019627	764	0.21	24-32	0.000041	8.61E-06	1.31E-03	0.00E+00
20	5.4	0.7	0.0008723	1,720	0.48	16-24	0.000022	1.07E-05	5.82E-04	0.00E+00
12	3.24	0.2	0.0002181	4,777	1.00	8-16	0.0000092	9.21E-06	2.09E-04	0.00E+00
6	1.62	0.1	0.00013	19,106	1.00	< 8	0.0000034	3.39E-06	5.23E-05	0.00E+00
total						total	0.00096	6.36E-05		

room CO_2 concentration, Q = ventiration volume flow rate [m^3s^{-1}], Q / V_{room} [s^{-1}], Tres[s]
mass concentration $C_{m,d} = m_d / V_{room}$ [mg / m^3], The suffix d is the diameter of droples. virus count concentration $C_v = N / V_{room}$ [m^{-3}], V_{room} = 700 m^3,

	CO_2 (ppm)	450ppm	500ppm	600ppm	700ppm	800ppm	1000pp	1600ppm	3500ppm
	Q [m^3s^{-1}]	3	1.5	0.75	0.5	0.375	0.25	0.125	0.048
	Q/V_{room}	4.29E-03	2.14E-03	1.07E-03	7.14E-04	5.36E-04	3.57E-04	1.79E-04	6.91E-05
	Tres [s]	233	467	933	1,400	1,867	2,800	5,600	14,467
	Tres [h]	0.06	0.13	0.26	0.39	0.52	0.78	1.56	4.02
$C_{m,d}$ (mg/m^3)	100µm	3.75E-05	4.23E-05	4.52E-05	4.63E-05	4.68E-05	4.74E-05	4.80E-05	4.83E-05
	70µm	3.22E-05	3.96E-05	4.48E-05	4.68E-05	4.79E-05	4.90E-05	5.02E-05	5.10E-05
	50µm	1.64E-05	2.25E-05	2.77E-05	2.99E-05	3.12E-05	3.26E-05	3.41E-05	3.51E-05
	40µm	9.55E-06	1.41E-05	1.86E-05	2.08E-05	2.21E-05	2.35E-05	2.52E-05	2.64E-05
	30µm	1.04E-05	1.68E-05	2.43E-05	2.86E-05	3.14E-05	3.48E-05	3.90E-05	4.21E-05
	20µm	6.56E-06	1.17E-05	1.93E-05	2.46E-05	2.86E-05	3.40E-05	4.20E-05	4.91E-05
	12µm	2.93E-06	5.59E-06	1.03E-05	1.42E-05	1.77E-05	2.32E-05	3.39E-05	4.72E-05
	6µm	1.12E-06	2.20E-06	4.31E-06	6.31E-06	8.23E-06	1.18E-05	2.10E-05	3.98E-05
	total	1.17E-04	1.55E-04	1.94E-04	2.18E-04	2.34E-04	2.56E-04	2.93E-04	3.39E-04

Room

V_{room}=700m^3 1000ppm=30m^3/h

CO2(ppm)	C-Cout	Q [m^3/(person・h)]	Q [m^3/(person・s)]
450	50	360	0.1
500	100	180	0.05
600	200	90	0.025
700	300	60	0.016667
800	400	45	0.0125
1000	600	30	0.008333
1600	1200	15	0.004167
3500	3100	5.806452	0.001613

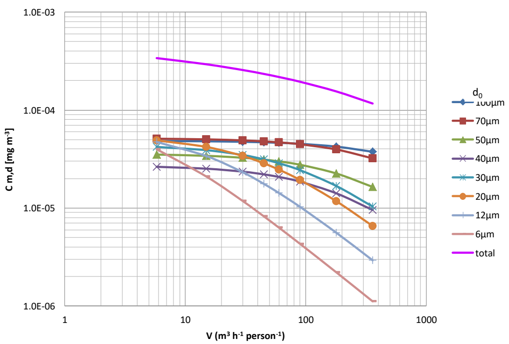
* initial diameter
** Olibeira Fig. 7a (low protein, RH = 0.6)

Relationship between droplet mass concentration for each initial size and ventilation rate. (λ= 0)

	$Vm^3h^{-1}person^{-1}$	100µm	70µm	50µm	40µm	30µm	20µm	12µm	6µm	total
$C_{m,d}$ ($mg\ m^{-3}$)	360	3.8E-05	3.2E-05	1.6E-05	9.5E-06	1.0E-05	6.6E-06	2.9E-06	1.1E-06	1.2E-04
	180	4.2E-05	4.0E-05	2.3E-05	1.4E-05	1.7E-05	1.2E-05	5.6E-06	2.2E-06	1.5E-04
	90	4.5E-05	4.5E-05	2.8E-05	1.9E-05	2.4E-05	1.9E-05	1.0E-05	4.3E-06	1.9E-04
	60	4.6E-05	4.7E-05	3.0E-05	2.1E-05	2.9E-05	2.5E-05	1.4E-05	6.3E-06	2.2E-04
	45	4.7E-05	4.8E-05	3.1E-05	2.2E-05	3.1E-05	2.9E-05	1.8E-05	8.2E-06	2.3E-04
	30	4.7E-05	4.9E-05	3.3E-05	2.4E-05	3.5E-05	3.4E-05	2.3E-05	1.2E-05	2.6E-04
	15	4.8E-05	5.0E-05	3.4E-05	2.5E-05	3.9E-05	4.2E-05	3.4E-05	2.1E-05	2.9E-04
	5.8	4.8E-05	5.1E-05	3.5E-05	2.6E-05	4.2E-05	4.9E-05	4.7E-05	4.0E-05	3.4E-04

Table Parameter of three removal precesses (ventilation [Q/V_{room}], gravitational settting decay [κ], inactivation of virus [λ])

initial diameter d_0 (µm)	final diameter df (µm) RH = 0 - 0.6	gravitational setting decay rate κ = 1/t [s-1]	time decay of virus in aerosol, exponetial decay constant λ [s^{-1}]	Q/Vroom							
				450ppm	500ppm	600ppm	700ppm	800ppm	1000pp	1600ppm	3500ppm
100	27	1.5.E-02	0.00E+00	4.3.E-03	2.1.E-03	1.1.E-03	7.1.E-04	5.4.E-04	3.57E-04	1.79E-04	6.91E-05
70	18.9	7.1.E-03	0.00E+00	4.3.E-03	2.1.E-03	1.1.E-03	7.1.E-04	5.4.E-04	3.57E-04	1.79E-04	6.91E-05
50	13.5	3.6.E-03	0.00E+00	4.3.E-03	2.1.E-03	1.1.E-03	7.1.E-04	5.4.E-04	3.57E-04	1.79E-04	6.91E-05
40	10.8	2.3.E-03	0.00E+00	4.3.E-03	2.1.E-03	1.1.E-03	7.1.E-04	5.4.E-04	3.57E-04	1.79E-04	6.91E-05
30	8.1	1.3.E-03	0.00E+00	4.3.E-03	2.1.E-03	1.1.E-03	7.1.E-04	5.4.E-04	3.57E-04	1.79E-04	6.91E-05
20	5.4	5.8.E-04	0.00E+00	4.3.E-03	2.1.E-03	1.1.E-03	7.1.E-04	5.4.E-04	3.57E-04	1.79E-04	6.91E-05
12	3.24	2.1.E-04	0.00E+00	4.3.E-03	2.1.E-03	1.1.E-03	7.1.E-04	5.4.E-04	3.57E-04	1.79E-04	6.91E-05
6	1.62	5.2.E-05	0.00E+00	4.3.E-03	2.1.E-03	1.1.E-03	7.1.E-04	5.4.E-04	3.57E-04	1.79E-04	6.91E-05

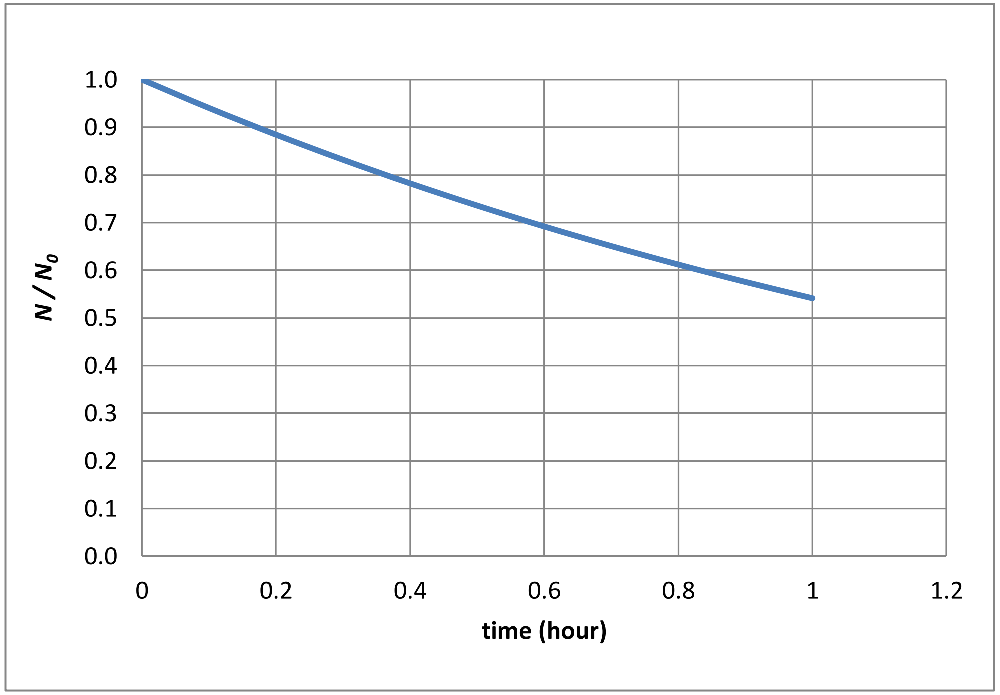


S3-2. **Relationship between droplet mass concentration for each initial size and ventilation rate. (λ= 0)**
The droplet size d_0 is the initial one before shrinkage.

<Virus decay due to the inactivation>

[32] Neeltje van Doremalen et al., 2020.
Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1

t(min)	t(h)	N/N0	$\frac{1}{N_0}\int_0^t N(t)dt$
0	0	1.00	
6	0.1	0.94	0.97
12	0.2	0.88	0.94
18	0.3	0.83	0.91
24	0.4	0.78	0.89
30	0.5	0.74	0.86
36	0.6	0.69	0.84
42	0.7	0.65	0.81
48	0.8	0.61	0.79
54	0.9	0.58	0.77
60	1	0.54	0.75
66	1.1	0.51	
68	1.1	0.50	



Virus decay due to the inactivation

<Comparison of Pöhlker mdel and Kono model>

Pöhlker 's a multimode lognormal fit function for speaking, O_1 mode + O_2 mode

$\dot{V} = 194\ (cm^3 s^{-1})$

diameter of droplets	Volume concentration distribution of droplets			Volume concentration	Cumulative concentration (μm3/cm3)	Cumulative concentration (cm3/cm3)	Volume emission rate		
D(μm)	dCv/d(log d) = fv(D) [$\mu m^3\ cm^{-3}$ / μm]	log D (μm)	d(log D) (μm)	Cv ($\mu m^3\ cm^{-3}$)	Σ Cv ($\mu m^3/cm^3$)	Σ Cv (cm^3/cm^3)	Qv ($cm^3\ s^{-1}$)	Qv ($\mu m^3\ h^{-1}$)	Qv (Pohlker) / Qv (Kono)
5.8	2.25.E+00	0.763428	0.181055	4.08.E-01	4.08.E-01				
9	1.07.E+01	0.944483	0.172789	1.84.E+00	2.25.E+00	2.25.E-12			
13	3.57.E+01	1.117271	0.179394	6.40.E+00	8.65.E+00	8.65.E-12			
20	1.24.E+02	1.296665	0.174627	2.16.E+01	3.03.E+01	3.03.E-11			
30	6.49.E+02	1.471292	0.176091	1.14.E+02	1.45.E+02	1.45.E-10			
44	4.28.E+03	1.647383	0.176547	7.55.E+02	8.99.E+02	8.99.E-10			
67	2.30.E+04	1.82393	0.17607	4.05.E+03	4.95.E+03	4.95.E-09			
100	8.89.E+04	2	0.176091	1.56.E+04	2.06.E+04	2.06.E-08	4.00.E-06		5.1
150	2.43.E+05	2.176091	0.176091	4.28.E+04	6.34.E+04	6.34.E-08	1.23.E-05		5.3
225	4.69.E+05	2.352183	0.176091	8.25.E+04	1.46.E+05	1.46.E-07			
338	6.38.E+05	2.528274	0.176091	1.12.E+05	2.58.E+05	2.58.E-07			
506	6.11.E+05	2.704365	0.176091	1.08.E+05	3.66.E+05	3.66.E-07			
759	4.13.E+05	2.880456	0.176091	7.28.E+04	4.39.E+05	4.39.E-07			
1139	1.97.E+05	3.056548	0.176091	3.47.E+04	4.73.E+05	4.73.E-07			
1709	6.62.E+04	3.232639	0.176091	1.17.E+04	4.85.E+05	4.85.E-07			
2563	1.57.E+04	3.40873	0.176091	2.76.E+03	4.88.E+05	4.88.E-07	9.5.E-05	3.4.E+11	
3844	2.62.E+03	3.584821							

Kono

7.8E-07 g/s **D <100μm**

2.3.E-06 g/s **D <150μm**

Pölker et al. [42]

Pöhlker 's a multimode lognormal fit function for speaking, O_1 mode+ O_2 mode

$$V_p = \frac{\pi}{6} D^3 \sum_{i=1}^{2} \left\{ A_i Exp\left[-\left(\frac{ln\left({}^{D}/_{D_i} \right)}{\sigma_i} \right)^2 \right] \right\}$$

Cv = Vp / Vair

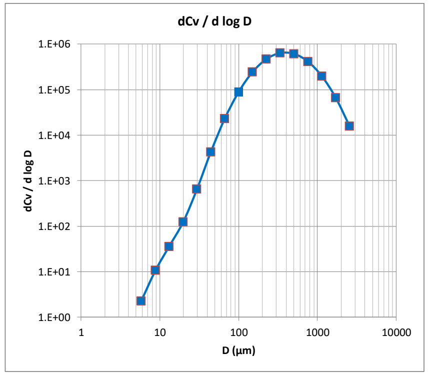
Vair = 200 $cm^3\ s^{-1}$

$Q_v = C_v \times \dot{V}$

$\dot{V} = V_{air} \times f$

TABLE VI Average fit parameters for breathing (see Fig. 11), speaking and singing (see Fig. 13) as well as coughing (see Fig. 15) size distributions in dN/dlog$D$ representation. Table specifies the mode-specific parameters: height (A_i), position (D_i), width (σ_i), integral particle number and volume concentrations (C_N, C_V) as well as emission rates (Q_N, Q_V). Q_N and Q_V were obtained from C_N and C_V by applying Eq. 6 with q from Table I.

Respiratory activity	Mode	A_i [cm^{-3}]	D_i [μm]	σ_i	C_N [cm^{-3}]	C_V [$\mu m^3 cm^{-3}$]	Q_N [h^{-1}]	Q_V [$\mu m^3 h^{-1}$]
Tidal breathe	B1	7.7	0.07	0.90	5.33	$5.93 \cdot 10^{-3}$	$1.92 \cdot 10^6$	$2.13 \cdot 10^3$
	B2	1.1	0.30	0.90	0.76	$6.67 \cdot 10^{-2}$	$2.74 \cdot 10^5$	$2.40 \cdot 10^4$
Breathe with airway closure	B1	$2.00 \cdot 10^1$	0.07	0.90	$1.39 \cdot 10^1$	$1.54 \cdot 10^{-2}$	$4.99 \cdot 10^6$	$5.54 \cdot 10^3$
	B2	$2.60 \cdot 10^1$	0.30	0.90	$1.80 \cdot 10^1$	1.57	$6.48 \cdot 10^3$	$5.67 \cdot 10^5$
Speak	B1	9.8	0.07	0.90	6.79	$7.54 \cdot 10^{-5}$	$4.75 \cdot 10^6$	$5.28 \cdot 10^3$
	B2	1.4	0.3	0.90	0.97	$8.48 \cdot 10^{-2}$	$6.79 \cdot 10^5$	$5.94 \cdot 10^4$
	LT	1.7	1	0.90	1.18	3.81	$8.24 \cdot 10^5$	$2.67 \cdot 10^6$
	O1	0.03	$1.00 \cdot 10^1$	0.98	$2.26 \cdot 10^{-2}$	$1.03 \cdot 10^{-2}$	$1.58 \cdot 10^4$	$7.20 \cdot 10^7$
	O2	0.17	$9.60 \cdot 10^1$	0.97	0.127	$4.46 \cdot 10^5$	$8.88 \cdot 10^4$	$3.12 \cdot 10^{11}$



Figure, Pöhlker 's a multimode lognormal fit function for speaking, O_1 mode + O_2 mode

Pölker et al. [42]

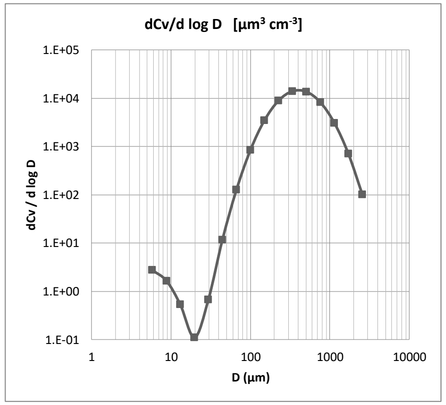
TABLE I Parameters of different respiratory activities/events, summarized from previous studies. The following events are specified: breathe (event = one exhalation), speak (event = one spoken word of average length), cough (event = one cough), and sneeze (event = one sneeze). Relevant event-specific parameters are the emitted air volume (V_{air}), duration (Δt), and peak flow rate (q) per event. Relevant time-averaged parameters are the event rate (f), which is the number of event repetitions per hour, and the average air emission rate ($\dot{V}$), obtained through $\dot{V} = V_{air} \cdot f$ (Tortora and Derrickson, 2017). For speaking, two (short) words spoken per second were assumed to obtain a speaking-related f, according to Johnson *et al.* (2011). Several parameters show an inherently high inter- and intrasubject variability, which is reflected in the table as typical parameter ranges. The values in brackets show the characteristic values used in calculations in this review article (e.g., Sect. III.C and Sect. III.D). Values represent the average of male and female adults. Values mostly represent healthy subjects – only for the cough rate, healthy and diseased subjects are distinguished.

	Properties per respiratory event			Time-averaged properties	
	Exhaled volume V_{air} [L]	Duration Δt [s]	Peak flow rate q [$L s^{-1}$]	Event rate f [h^{-1}]	Air emission rate $\dot{V}$ [$L h^{-1}$]
Tidal breath	0.4 – 1.7 [b,h,k,n] [0.5] [c,g,p]	1.5 – 2.5 [f,j] [2] [c]	0.2 – 0.7 [i,j,k]	600 – 1200 [b,h,n] [720] [c,g,p]	360 – 800 [g,j,l] [360] [*]
Spoken word	[0.1] [*]	0.5 [l]	0.3 – 1.6 [a,e,j]	[7200] [l]	450 – 700 [j,l] [700] [j]
Cough	0.3 – 4 [b,c,d,i,l,m,p,v] [1.5] [r]	0.2 – 1 [b,c,i,q,v]	0.2 – 15 [b,i,j,m,r,w]	healthy: 0 – 4 [s,t,x] healthy smoker: 0 – 8 [t,x] diseased: 0 – 140 [o,p,s,t,u,x] [10] [c]	[15] [*]
Sneeze	1 – 4 [c] [2] [p]	0.1 – 0.2 [c]	10 – 20 [*]	5 – 30 [c] [10] [†]	[20] [*]

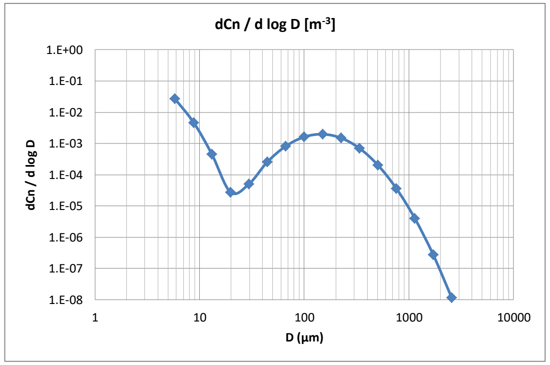
<Johnson, Morawska et al. BLO tri-modal model, speaking [22]>

Expiratory flow rate = 210 $cm^3\ s^{-1}$ [5]

diameter of droplets	Number concentration of droplets	Volume concentration distribution of droplets			Volume concentration	Cumulative concentration (µm3/cm3)	Cumulative concentration (cm3/cm3)	Volume emission rate				
D(µm)	dCn / d log D	dCv/d(log d) = fv(D) [$µm^3\ cm^{-3}$ / µm]	log D (µm)	d(log D) (µm)	Cv ($µm^3\ cm^{-3}$)	Σ Cv ($µm^3/cm^3$)	Σ Cv (cm^3/cm^3)	Qv ($cm^3\ s^{-1}$)	Qv ($µm^3\ h^{-1}$)	Qv (Johnson) / Qv (Kono)		
5.8	2.72.E-02	2.78.E+00	0.763428	0.181055	5.04.E-01	5.04.E-01						
9	4.64.E-03	1.65.E+00	0.944483	0.172789	2.86.E-01	7.90.E-01	7.90.E-13					
13	4.56.E-04	5.37.E-01	1.117271	0.179394	9.62.E-02	8.86.E-01	8.86.E-13					
20	2.74.E-05	1.11.E-01	1.296665	0.174627	1.94.E-02	9.05.E-01	9.05.E-13					
30	5.01.E-05	6.79.E-01	1.471292	0.176091	1.20.E-01	1.02.E+00	1.02.E-12					
44	2.56.E-04	1.17.E+01	1.647383	0.176547	2.07.E+00	3.09.E+00	3.09.E-12					
67	8.19.E-04	1.27.E+02	1.82393	0.17607	2.24.E+01	2.55.E+01	2.55.E-11					
100	1.62.E-03	8.47.E+02	2	0.176091	1.49.E+02	1.75.E+02	1.75.E-10	3.67.E-08		0.047	7.8E-07 g/s	Kono <100µm
150	1.98.E-03	3.49.E+03	2.176091	0.176091	6.15.E+02	7.89.E+02	7.89.E-10					
225	1.49.E-03	8.90.E+03	2.352183	0.176091	1.57.E+03	2.36.E+03	2.36.E-09					
338	6.98.E-04	1.40.E+04	2.528274	0.176091	2.47.E+03	4.83.E+03	4.83.E-09					
506	2.02.E-04	1.37.E+04	2.704365	0.176091	2.41.E+03	7.24.E+03	7.24.E-09					
759	3.61.E-05	8.26.E+03	2.880456	0.176091	1.46.E+03	8.69.E+03	8.69.E-09					
1139	3.99.E-06	3.08.E+03	3.056548	0.176091	5.43.E+02	9.24.E+03	9.24.E-09	1.94.E-06				
1709	2.73.E-07	7.12.E+02	3.232639	0.176091	1.25.E+02	9.36.E+03	9.36.E-09					
2563	1.15.E-08	1.02.E+02	3.40873	0.176091	1.79.E+01	9.38.E+03	9.38.E-09	2.0.E-06	7.1.E+09			
3844	3.02.E-10	8.98.E+00	3.584821									



Johnson, Morawska et al. BLO tri-modal model, speaking
Volume concentration distribution of droplets



Johnson, Morawska et al. BLO tri-modal model, speaking
Number concentration of droplets

[22]

BLO tri-modal model:

$$\frac{dCn}{d\,\mathrm{Log}D} = \ln(10) \times \sum_{i=1}^{3}\left(\frac{Cn_i}{\sqrt{2\pi}\ln(GSD_i)}\right)\exp\left(-\frac{(\ln D - \ln CMD_i)^2}{2(\ln GSD_i)^2}\right), \quad 0.8\,\mu m \le D \le 1000\,\mu m \tag{1}$$

Table 2
Model parameters for aerosols produced by healthy volunteers during speaking and coughing. DF=APS sample dilution factor. EF=APS sample evaporative diameter shrinkage factor. SF=DDA droplet spread factor.

i	1		2		3	
	(B mode)		(L mode)		(O mode)	
	Mean	SE (%)	Mean	SE (%)	Mean	SE (%)
Speaking						
Cn_i (cm^{-3})	0.015 × DF	*16*	0.019 × DF	*15*	0.00126	*0.8*
CMD_i (µm)	0.807/EF	*0.45*	1.2/EF	*8.1*	217/SF	*0.5*
GSD_i	1.30	*1.3*	1.66	*3.1*	1.795	*0.5*
Coughing						
Cn_i (cm^{-3})	0.021 × DF	*9*	0.033 × DF	*8*	0.01596	*0.6*
CMD_i (µm)	0.784/EF	*0.61*	0.8/EF	*2.9*	185/SF	*0.4*
GSD_i	1.25	*0.8*	1.68	*1.5*	1.837	*0.4*

Table 3
Parameter correction factors: DF=APS sample dilution. EF=APS sample evaporative diameter shrinkage. SF=DDA droplet diameter spreading on slide surface.

Correction	Speaking	Coughing
DF (APS)	3.6	4.3
EF (APS)	0.5	0.5
SF (DDI)	1.5	1.5