Additional file 1

Tables S1 – S6, Figures S1 – S4

Unveiling Pandemic Patterns: A Detailed Analysis of Transmission and Severity Parameters Across Four COVID-19 Waves in Bogotá, Colombia

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Table S1. Overview of confirmed cases, hospitalisations, ICUs, deaths, and maximum instantaneous reproduction number R(t) in each wave.

Wave	Start	End	Confirmed	Hospital	ICU	Deaths	R(t) (95% BCI)
1	26 Feb 2020	25 Sep, 2020	270,929	30,161	10,808	7,296	2.44 (2.12 - 2.86)
2	01 Nov, 2020	01 Mar, 2021	331,060	24,564	8,476	6,068	1.22 (1.21 - 1.23)
3	01 Mar, 2021	14 Sept, 2021	781,860	42,516	15,667	13,195	1.46 (1.44 - 1.47)
4	20 Nov, 2021	24 Mar, 2022	305,481	8,590	1,362	1,715	2.27 (2.25 - 2.28)

Table S2. Relative transmission advantage between Alpha, Delta, Gamma, Mu, and Omicron (95% BCI). The pivot variant corresponds to the denominator in the logarithm of the definition: $T_{w,v} = \frac{T_{w,0}}{T_{v,0}}$. Thus, the variants in the columns are n times more transmissible than the pivot variant of each row.

Pivot variant	Alpha	Delta	Gamma	Mu	Omicron
Alpha	1	1.84 (1.63 - 2.13)	1.35 (1.19 - 1.56)	1.45 (1.28 - 1.68)	3.92 (3.35 - 4.61)
Delta	0.55 (0.47 - 0.61)	1	0.73 (0.72 - 0.75)	0.79 (0.78 - 0.8)	2.13 (1.95 - 2.33)
Gamma	0.75 (0.64 - 0.84)	1.37 (1.33 - 1.4)	1	1.08 (1.06 - 1.09)	2.91 (2.65 - 3.2)
Mu	0.69 (0.6 - 0.78)	1.27 (1.24 - 1.29)	0.93 (0.91 - 0.94)	1	2.7 (2.46 - 2.96)
Omicron	0.26 (0.22 - 0.3)	0.47 (0.43 - 0.51)	0.34 (0.31 - 0.38)	0.37 (0.34 - 0.41)	1

Table S3. Probability density functions for the estimation of epidemiological distributions. The parameter S of the Gen. Log-normal distribution is defined as the following infinite sum: $S = \sum_{j=1}^{\infty} (r\sigma)^j [1 + (-1)^j] 2^{j/g} \Gamma((j+1)/s)/\Gamma(j+1)$, where $r = 1$ for the mean, and $r = 2$ for the variance[1]. The abbreviations LN and GLN stand for Log-normal and Generalized Log-normal, respectively.

PDF$(y\|\{q_i\})$	**Mean**	**Variance**
Exponential$(y\|\{\beta\}) = \exp(-\beta y)$	β	β^2
Gamma$(y\|\{\alpha, \beta\}) = \frac{\beta^\alpha}{\Gamma(\alpha)} y^{\alpha-1} \exp(-\beta y)$	α/β	α/β^2
Weibull$(y\|\{\alpha, \sigma\}) = \frac{\alpha}{\sigma}\left(\frac{y}{\sigma}\right)^{\alpha-1} \exp\left(-\left(\frac{y}{\sigma}\right)^\alpha\right)$	$\sigma\Gamma(1 + 1/\alpha)$	$\sigma^2\left(\Gamma(1 + 2/\alpha) - \Gamma(1 + 1/\alpha)^2\right)$
LN$(y\|\{\mu, \sigma\}) = \frac{1}{\sqrt{2\pi}\sigma}\frac{1}{y}\exp\left(-\frac{1}{2}\left(\frac{\log y - \mu}{\sigma}\right)^2\right)$	$\exp\left(\mu + \frac{\sigma^2}{2}\right)$	$\left[\exp\left(\sigma^2\right) - 1\right]\exp\left(2\mu + \sigma^2\right)$
GLN$(y\|\{\mu, \sigma, g\}) = \frac{1}{y}\frac{g}{2^{(g+1)/g}\sigma\Gamma(1/g)}\exp\left(-\frac{1}{2}\left\|\frac{\log y - \mu}{\sigma}\right\|^g\right)$	$\exp(\mu)\left[1 + \frac{S}{2\Gamma(1/g)}\right]$	$\exp(2\mu)\left[1 + \frac{S}{2\Gamma(1/g)}\right] - mean^2$

Table S4. Bayes factors $2\log(B_{ij})$ for the models fitted to the epidemiological distributions.

Delay time	Gamma	LN	Weibull	Exponential	GLN
ICU stay	603.17	55.64	1766.67	4610.71	0
Hosp. stay	13804.41	120.81	17491.57	20120.17	0
Onset to ICU	2143.06	384.24	3365.65	11152.66	0
Onset to hosp.	3320.67	549.26	9623.35	36426.87	0
Onset to death	0	658.86	1390.76	6954.73	366.58

Rows contain the comparison of the models specified in each column with respect to the best model. Notice that, in every case with found strong evidence in favor of the Gen. Log-normal. In most of the cases we found evidence in favor of the Generalized Log-Normal distribution as the best model, except for the onset-to-death distributions, for which the best model is the Gamma. Notice that, we used the representation $2\log(B_{ij})$ for reporting the Bayes factor, following the usual notation[2],[3]. Thus, the null cells of the table correspond to the best model, and the non-null cells contain the Bayes factors between the best model and the rest of them.

Table S5. Mean and variance of the epidemiological distributions estimated from the best model (95% BCI).

Wave	Delay time	Mean (days)	Var (days²)
1	Onset to hosp	7.41 (7.35 - 7.48)	83.48 (82.57 - 84.63)
2	Onset to hosp	7.95 (7.87 - 8.04)	94.88 (93.56 - 96.35)
3	Onset to hosp	7.77 (7.72 - 7.82)	83.12 (82.44 - 83.89)
4	Onset to hosp	5.54 (5.49 - 5.57)	75.56 (67.94 - 78.13)
1	Onset to ICU	12.31 (12.22 - 12.38)	491.76 (436.25 - 583.12)
2	Onset to ICU	10.83 (10.68 - 11.01)	260.29 (257.33 - 267.71)
3	Onset to ICU	9.17 (9.07 - 9.27)	120.46 (118.84 - 122.45)
4	Onset to ICU	7.84 (7.55 - 8.17)	102.49 (102.18 - 107.22)
1	Onset to death	17.42 (17.33 - 17.5)	148.85 (143.75 - 154.93)
2	Onset to death	18.75 (18.66 - 18.84)	169.87 (163.41 - 176.47)
3	Onset to death	17.47 (17.42 - 17.51)	143.98 (139.88 - 148.02)
4	Onset to death	14.87 (14.65 - 15.03)	109.71 (102.19 - 118.85)
1	Hosp. stay	10.84 (10.72 - 10.98)	275.48 (275.43 - 277.16)
2	Hosp. stay	8.83 (8.74 - 8.93)	151.97 (151.59 - 152.91)
3	Hosp. stay	8.77 (8.69 - 8.86)	139.85 (138.83 - 141.26)
4	Hosp. stay	7.85 (7.7 - 8.01)	99.6 (96.47 - 103.35)
1	ICU stay	16.2 (15.91 - 16.52)	648.86 (638.93 - 668.89)
2	ICU stay	15.4 (15.16 - 15.67)	546.75 (538.2 - 563.37)
3	ICU stay	14.41 (14.25 - 14.61)	424.59 (426.1 - 428.93)
4	ICU stay	12.4 (11.9 - 13.11)	272.68 (272.31 - 294.95)

Table S6. Hospitalisation Case Ratio (HCR), ICU Case Ratio (ICU-CR), Case Fatality Ratio (CFR), Hospitalisation Fatality Ratio (HFR), ICU Fatality Ratio (ICU-FR), Hospitalisation percentage (HOSP-%), ICU admission percentage (ICU-%) and Death percentage (DEATH-%) by age-group for each wave (95% CI).

Age group	Wave	HCR	ICU-CR	CFR	HFR	ICU-FR	HOSP-%	ICU-%	DEATH-%
0-9	1	0.071 (0.066, 0.076)	0.012 (0.01, 0.014)	0.001 (0.0, 0.001)	0.01 (0.003, 0.017)	0.042 (0.009, 0.075)	2.702 (2.696, 2.708)	1.323 (1.316, 1.33)	0.11 (0.107, 0.112)
0-9	2	0.048 (0.044, 0.052)	0.009 (0.007, 0.011)	0.0 (0.0, 0.001)	0.008 (0.0, 0.016)	0.021 (0.0, 0.05)	2.064 (2.058, 2.07)	1.109 (1.102, 1.116)	0.066 (0.064, 0.068)
0-9	3	0.029 (0.027, 0.03)	0.004 (0.004, 0.005)	0.0 (0.0, 0.001)	0.017 (0.008, 0.026)	0.067 (0.025, 0.109)	2.063 (2.058, 2.067)	0.862 (0.857, 0.866)	0.121 (0.119, 0.123)
0-9	4	0.089 (0.084, 0.093)	0.009 (0.007, 0.01)	0.0 (0.0, 0.001)	0.004 (0.001, 0.008)	0.014 (0.0, 0.034)	16.17 (16.145, 16.195)	10.206 (10.154, 10.257)	0.35 (0.341, 0.359)
10-19	1	0.022 (0.02, 0.024)	0.008 (0.007, 0.009)	0.0 (0.0, 0.001)	0.014 (0.003, 0.025)	0.02 (0.0, 0.042)	1.426 (1.421, 1.43)	1.397 (1.39, 1.404)	0.082 (0.08, 0.084)
10-19	2	0.012 (0.011, 0.013)	0.002 (0.002, 0.003)	0.0 (0.0, 0.0)	0.014 (0.0, 0.028)	0.036 (0.0, 0.084)	1.168 (1.164, 1.173)	0.661 (0.655, 0.666)	0.066 (0.064, 0.068)
10-19	3	0.005 (0.005, 0.006)	0.001 (0.001, 0.001)	0.0 (0.0, 0.0)	0.041 (0.021, 0.062)	0.101 (0.03, 0.173)	0.854 (0.851, 0.857)	0.44 (0.437, 0.444)	0.114 (0.112, 0.116)
10-19	4	0.011 (0.009, 0.012)	0.001 (0.0, 0.001)	0.0 (0.0, 0.0)	0.019 (0.001, 0.037)	0.0 (0.0, 0.0)	2.468 (2.457, 2.478)	1.322 (1.302, 1.341)	0.233 (0.226, 0.241)
20-29	1	0.027 (0.025, 0.028)	0.009 (0.008, 0.01)	0.001 (0.001, 0.001)	0.041 (0.032, 0.051)	0.082 (0.058, 0.105)	5.291 (5.283, 5.3)	4.987 (4.973, 5.0)	0.905 (0.898, 0.912)
20-29	2	0.013 (0.012, 0.014)	0.002 (0.002, 0.003)	0.0 (0.0, 0.001)	0.034 (0.023, 0.046)	0.136 (0.085, 0.186)	3.908 (3.9, 3.916)	2.088 (2.079, 2.098)	0.544 (0.538, 0.55)
20-29	3	0.009 (0.009, 0.01)	0.002 (0.002, 0.002)	0.001 (0.001, 0.001)	0.088 (0.074, 0.102)	0.195 (0.156, 0.234)	3.824 (3.819, 3.83)	2.489 (2.482, 2.497)	1.084 (1.078, 1.089)
20-29	4	0.006 (0.005, 0.006)	0.001 (0.0, 0.001)	0.0 (0.0, 0.0)	0.032 (0.014, 0.051)	0.057 (0.0, 0.134)	3.946 (3.933, 3.96)	2.57 (2.543, 2.597)	0.641 (0.629, 0.653)
30-39	1	0.05 (0.048, 0.051)	0.017 (0.016, 0.018)	0.003 (0.003, 0.004)	0.064 (0.055, 0.072)	0.117 (0.098, 0.137)	9.916 (9.906, 9.927)	9.455 (9.437, 9.473)	2.604 (2.592, 2.616)
30-39	2	0.025 (0.024, 0.026)	0.006 (0.005, 0.006)	0.001 (0.001, 0.002)	0.052 (0.042, 0.062)	0.146 (0.113, 0.18)	7.487 (7.476, 7.497)	5.002 (4.988, 5.017)	1.648 (1.638, 1.658)
30-39	3	0.024 (0.023, 0.024)	0.008 (0.007, 0.008)	0.003 (0.003, 0.004)	0.14 (0.13, 0.151)	0.266 (0.242, 0.29)	9.603 (9.594, 9.612)	8.266 (8.252, 8.28)	4.343 (4.331, 4.354)
30-39	4	0.006 (0.005, 0.006)	0.001 (0.0, 0.001)	0.0 (0.0, 0.0)	0.044 (0.024, 0.065)	0.146 (0.038, 0.254)	4.482 (4.468, 4.496)	3.01 (2.981, 3.039)	0.991 (0.976, 1.006)
40-49	1	0.089 (0.086, 0.092)	0.032 (0.03, 0.033)	0.01 (0.009, 0.011)	0.112 (0.102, 0.121)	0.213 (0.191, 0.234)	13.05 (13.037, 13.062)	12.906 (12.886, 12.926)	6.058 (6.041, 6.076)
40-49	2	0.05 (0.048, 0.051)	0.015 (0.014, 0.016)	0.005 (0.004, 0.005)	0.093 (0.082, 0.104)	0.221 (0.192, 0.249)	10.849 (10.837, 10.862)	9.568 (9.548, 9.588)	4.153 (4.137, 4.169)
40-49	3	0.051 (0.049, 0.052)	0.02 (0.019, 0.021)	0.01 (0.01, 0.011)	0.199 (0.189, 0.208)	0.316 (0.299, 0.334)	16.126 (16.115, 16.137)	17.189 (17.17, 17.208)	10.33 (10.313, 10.346)
40-49	4	0.008 (0.008, 0.009)	0.001 (0.001, 0.001)	0.001 (0.0, 0.001)	0.08 (0.054, 0.105)	0.155 (0.062, 0.248)	5.111 (5.096, 5.125)	4.258 (4.224, 4.293)	2.099 (2.077, 2.121)
50-59	1	0.163 (0.159,	0.059 (0.057,	0.028 (0.026,	0.168 (0.159,	0.307 (0.287,	20.294	20.52 (20.496,	14.227

		0.167)	0.062)	0.029)	0.178)	0.326)	(20.279, 20.308)	20.544)	(14.201, 14.253)
50-59	2	0.099 (0.096, 0.102)	0.035 (0.034, 0.037)	0.015 (0.014, 0.016)	0.144 (0.134, 0.154)	0.294 (0.272, 0.316)	19.142 (19.126, 19.158)	19.844 (19.817, 19.871)	11.388 (11.362, 11.413)
50-59	3	0.092 (0.091, 0.094)	0.038 (0.037, 0.04)	0.024 (0.023, 0.025)	0.26 (0.251, 0.268)	0.4 (0.385, 0.415)	23.02 (23.007, 23.032)	26.068 (26.046, 26.09)	19.303 (19.281, 19.324)
50-59	4	0.019 (0.018, 0.021)	0.004 (0.003, 0.004)	0.002 (0.002, 0.003)	0.124 (0.099, 0.148)	0.215 (0.145, 0.286)	8.196 (8.177, 8.214)	9.545 (9.495, 9.595)	5.423 (5.388, 5.457)
60-69	1	0.29 (0.284, 0.296)	0.12 (0.116, 0.124)	0.08 (0.076, 0.084)	0.273 (0.262, 0.284)	0.426 (0.406, 0.445)	20.523 (20.508, 20.537)	23.712 (23.686, 23.737)	23.41 (23.379, 23.441)
60-69	2	0.19 (0.186, 0.195)	0.079 (0.076, 0.082)	0.049 (0.046, 0.051)	0.254 (0.242, 0.265)	0.434 (0.414, 0.454)	22.411 (22.394, 22.428)	27.006 (26.975, 27.036)	23.171 (23.137, 23.205)
60-69	3	0.156 (0.153, 0.159)	0.067 (0.065, 0.069)	0.056 (0.054, 0.058)	0.359 (0.349, 0.369)	0.51 (0.494, 0.526)	21.126 (21.114, 21.139)	24.708 (24.686, 24.73)	24.456 (24.433, 24.48)
60-69	4	0.042 (0.039, 0.044)	0.01 (0.009, 0.011)	0.008 (0.007, 0.009)	0.176 (0.154, 0.197)	0.333 (0.28, 0.387)	14.063 (14.039, 14.086)	21.806 (21.736, 21.876)	13.061 (13.01, 13.112)
70-79	1	0.433 (0.424, 0.442)	0.176 (0.169, 0.184)	0.174 (0.167, 0.181)	0.398 (0.384, 0.412)	0.591 (0.569, 0.613)	15.231 (15.218, 15.244)	17.31 (17.287, 17.332)	25.302 (25.27, 25.333)
70-79	2	0.332 (0.324, 0.339)	0.147 (0.141, 0.153)	0.127 (0.121, 0.132)	0.378 (0.364, 0.392)	0.566 (0.544, 0.587)	18.657 (18.642, 18.673)	23.997 (23.968, 24.026)	28.922 (28.886, 28.959)
70-79	3	0.25 (0.245, 0.256)	0.098 (0.094, 0.101)	0.12 (0.116, 0.124)	0.477 (0.464, 0.49)	0.634 (0.615, 0.654)	13.574 (13.563, 13.584)	14.355 (14.337, 14.373)	20.902 (20.88, 20.924)
70-79	4	0.115 (0.11, 0.12)	0.023 (0.02, 0.025)	0.027 (0.024, 0.03)	0.224 (0.204, 0.244)	0.403 (0.35, 0.456)	19.523 (19.496, 19.55)	24.229 (24.156, 24.302)	23.09 (23.027, 23.154)
80+	1	0.548 (0.536, 0.56)	0.142 (0.134, 0.151)	0.313 (0.302, 0.324)	0.562 (0.545, 0.578)	0.674 (0.643, 0.704)	11.568 (11.556, 11.579)	8.391 (8.374, 8.408)	27.303 (27.27, 27.335)
80+	2	0.468 (0.457, 0.479)	0.121 (0.114, 0.128)	0.243 (0.233, 0.252)	0.509 (0.493, 0.526)	0.671 (0.64, 0.702)	14.314 (14.3, 14.328)	10.724 (10.703, 10.745)	30.043 (30.006, 30.08)
80+	3	0.387 (0.378, 0.396)	0.082 (0.077, 0.087)	0.237 (0.229, 0.245)	0.61 (0.596, 0.625)	0.717 (0.688, 0.747)	9.81 (9.801, 9.819)	5.623 (5.612, 5.635)	19.348 (19.327, 19.37)
80+	4	0.261 (0.252, 0.271)	0.037 (0.033, 0.041)	0.108 (0.102, 0.115)	0.391 (0.37, 0.411)	0.576 (0.522, 0.631)	26.042 (26.012, 26.072)	23.054 (22.983, 23.126)	54.111 (54.035, 54.186)
all	1	0.111 (0.11, 0.112)	0.04 (0.039, 0.041)	0.027 (0.026, 0.028)	0.239 (0.235, 0.244)	0.366 (0.357, 0.375)	-	-	-
all	2	0.074 (0.073, 0.075)	0.026 (0.025, 0.026)	0.018 (0.018, 0.019)	0.243 (0.238, 0.249)	0.415 (0.404, 0.425)	-	-	-
all	3	0.054 (0.054, 0.055)	0.02 (0.02, 0.02)	0.017 (0.017, 0.017)	0.31 (0.305, 0.314)	0.444 (0.436, 0.452)	-	-	-
all	4	0.028 (0.028, 0.029)	0.004 (0.004, 0.005)	0.006 (0.005, 0.006)	0.189 (0.18, 0.197)	0.338 (0.313, 0.363)	-	-	-

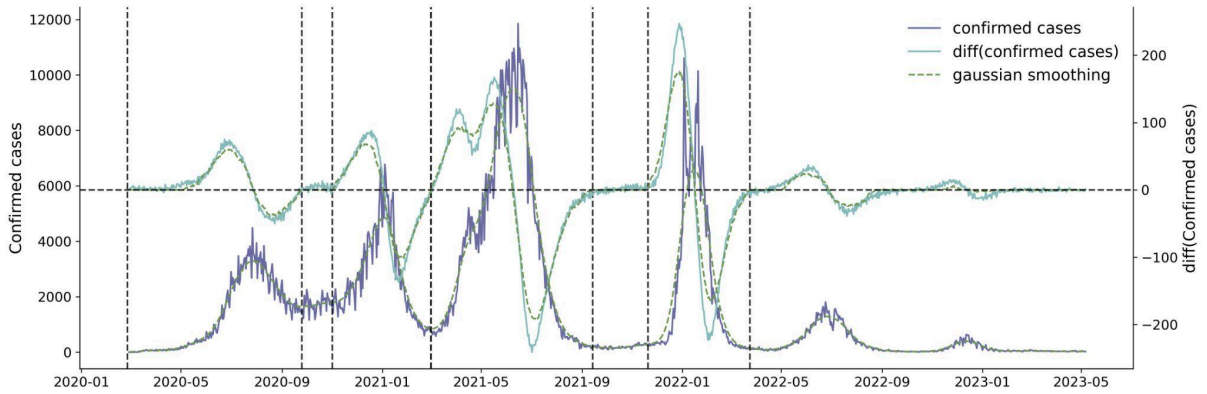

Fig. S1. New daily confirmed cases (left axis) and daily difference (right axis). In both cases, a Gaussian smoothing method was performed to avoid multiple roots around close dates. The roots selected as start and end dates of each waves are represented using black dashed lines.

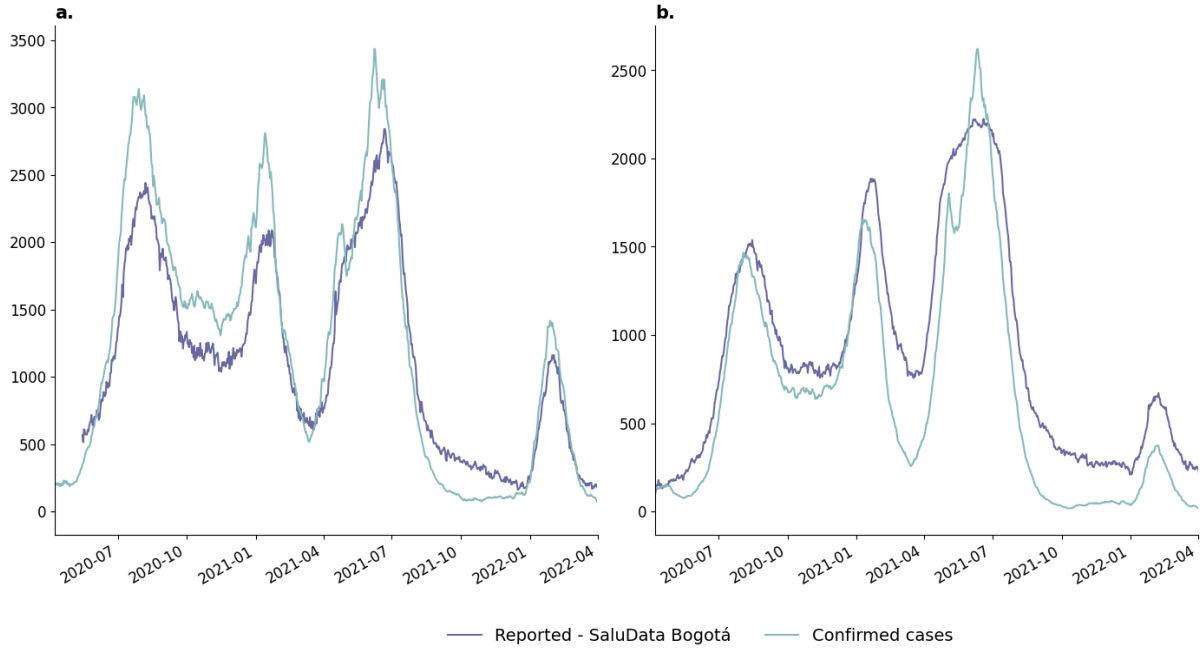

Fig. S2. Comparison between daily occupancies reported by Saludata Bogotá[4, 5] and reconstruction made using Confirmed cases dataset a) General hospital bed occupancy. b) ICU occupancy.

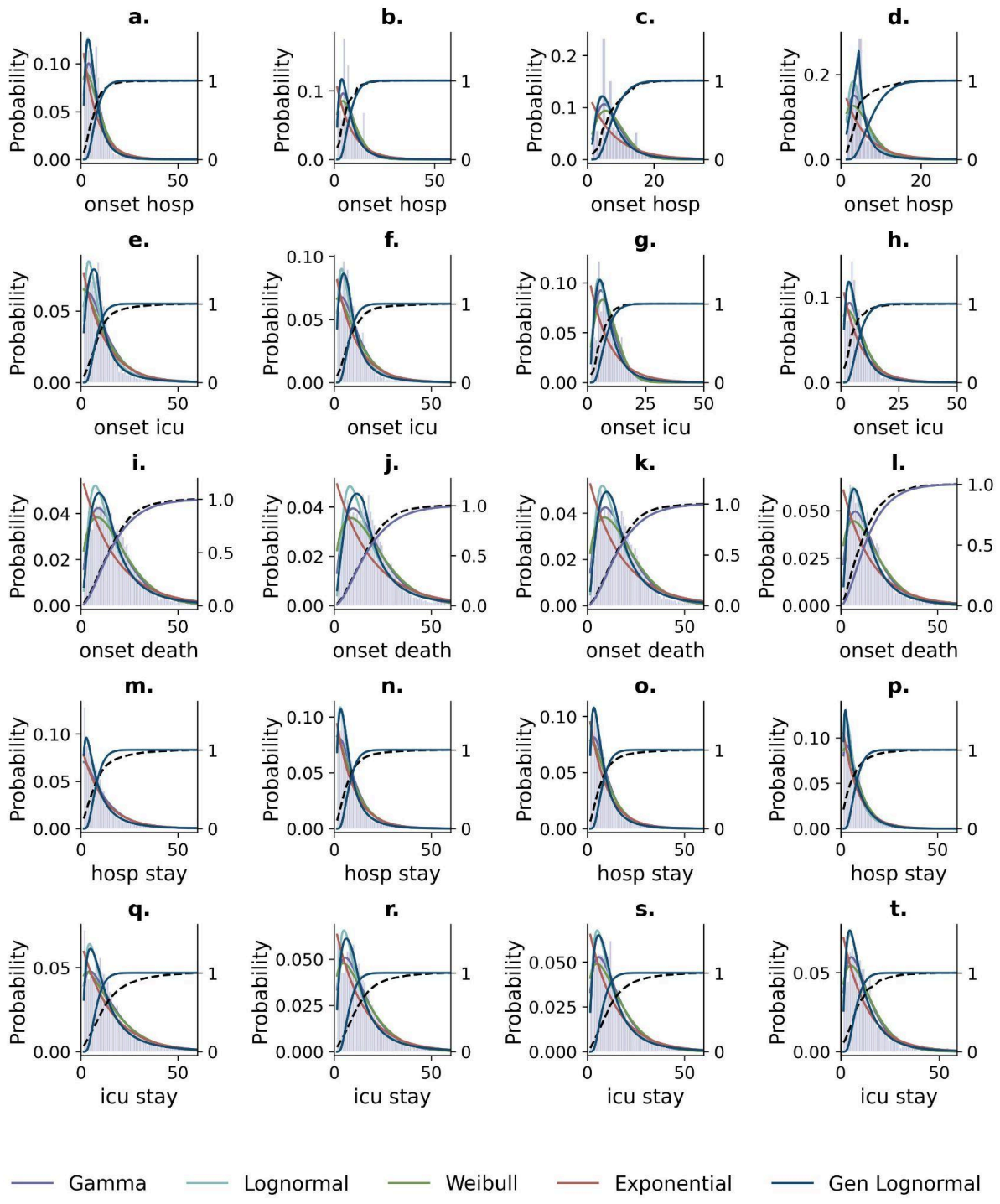

Fig. S3. Observed delay times fitted to different probability density functions. a-d) Onset to hospitalisation, e-h) Onset to ICU, i-l) Onset to death, m-p) Stay at the general hospital, q-t) ICU stay. In every case, the cumulative distribution of the data compared to the best distribution, according to the BF, is shown on the left axis. The left axis gives the probability of occurrence of each event, while the right axis shows the cumulative probability of the best model.

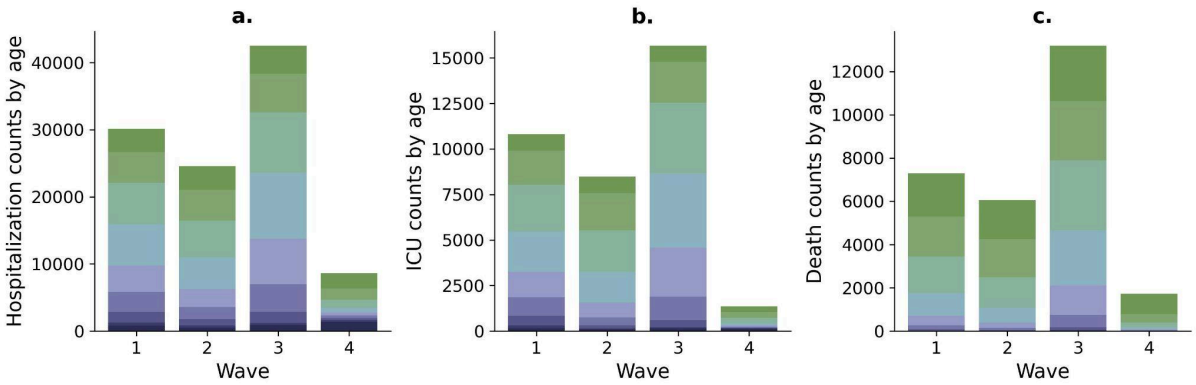

Fig. S4. Population counts for severe outcomes, disaggregated by age. a) Hospitalisations, b) ICU, c) Deaths.

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