NIPH
Norwegian Institute of Public Health

Situational awareness and forecasting for Norway

FHI COVID-19 modelling team

Week 1, 5 January 2022

Main results:

We note that the estimated reproduction numbers in this period are subject to considerable uncertainty due to the increasing dominance of the Omicron variant and the Christmas vacation period affecting the test activity and hospitalisation data. A description of the estimated increase of the Omicron variant, including the method we use, is provided in the COVID-19 Ukesrapport, week 52. The short-term projections do not account for an increasing incidence of Omicron cases in the following weeks, and hospitalisation probabilities are based on the Delta variant. We are currently working to update the model to account for a turnover from Delta to Omicron.

- **National epidemiological situation:**

  The most recent reproduction numbers:

Model	Median	5%	95%	Prob>1	period/day	More info
Changepoint	0.79	0.59	1.02	0.4	Since 13. Dec	Table 1
SMC	0.96	0.77	1.22	0.35	28 Dec	Fig. 4
EpiEstim	1.08	1.06	1.1		28 Dec	Table 17, Fig. 28

- **National forecasting:**

  One-week-ahead national forecasts from changepoint model:

Indicator	Median/Mean 95% PI	day	Info 2-3 weeks forecasts
Hospital beds	349/333 (217-569)	2 Jan	Table 2
Ventilator beds	91/90 (62-126)	2 Jan	Table 2

  * Age-specific hospital prevalence predictions are provided in Figures 6 and 7.

- **Regional epidemiological situation:**

  The newest regional reproduction numbers for Oslo:

Model	Median	5%	95%	Prob>1	period/day	Info other counties
SMC	1.47	0.82	2.18	0.91	15 Dec - 22 Dec	Fig. 4
EpiEstim	0.84	0.81	0.86		20 Dec	Table 17, Fig. 28

- **Telenor mobility data and the number of foreign visitors:** The most recent mobility development is found in Figures 22 and 23 for the largest municipality in each county and for each county, respectively. Figure 24 shows the total number of roamers per day per county.

1 Estimated national reproduction numbers

Calibration of our national changepoint model to hospitalisation incidence data leads to the following estimates provided in table 1. Figure 2 shows the estimated daily number of COVID-19 patients admitted to hospital (1), with blue medians and interquantile bands, which are compared to the actual true data, provided in red. The uncertainty captures the uncertainty in the calibrated parameters in addition to the stochastic elements of our model and the variability of other model parameters.

Table 1: Calibration results

Reff	Period
2.31/2.32(1.86-2.86)	From Feb 17 to Mar 14
0.55/0.55(0.46-0.66)	From Mar 15 to Apr 19
0.86/0.83(0.12-1.43)	From Apr 20 to May 10
0.51/0.54(0.06-1.12)	From May 11 to Jun 30
1.12/1.04(0.12-1.76)	From Jul 01 to Jul 31
0.89/0.9(0.5-1.31)	From Aug 01 to Aug 31
0.94/0.94(0.67-1.26)	From Sep 01 to Sep 30
1.21/1.21(0.9-1.47)	From Oct 01 to Oct 25
1.17/1.18(0.76-1.65)	From Oct 26 to Nov 04
0.86/0.86(0.74-0.99)	From Nov 05 to Nov 30
1.02/1.01(0.91-1.12)	From Dec 01 to Jan 03
0.68/0.69(0.5-0.93)	From Jan 04 to Jan 21
0.82/0.82(0.58-1.05)	From Jan 22 to Feb 07
1.32/1.33(1.14-1.55)	From Feb 08 to Mar 01
1.07/1.07(0.95-1.18)	From Mar 02 to Mar 24
0.86/0.86(0.72-0.99)	From Mar 25 to Apr 12
0.76/0.76(0.61-0.93)	From Apr 13 to May 05
0.99/1(0.7-1.3)	From May 06 to May 26
0.81/0.8(0.54-1.08)	From May 27 to Jun 20
0.98/0.97(0.82-1.11)	From Jun 21 to Aug 04
1.14/1.14(0.98-1.33)	From Aug 05 to Aug 31
0.8/0.8(0.69-0.9)	From Sep 01 to Sep 24
1.08/1.07(1.03-1.11)	From Sep 25 to Dec 12
0.79/0.79(0.59-1.02)	From Dec 13

Median/Mean (95% credible intervals)

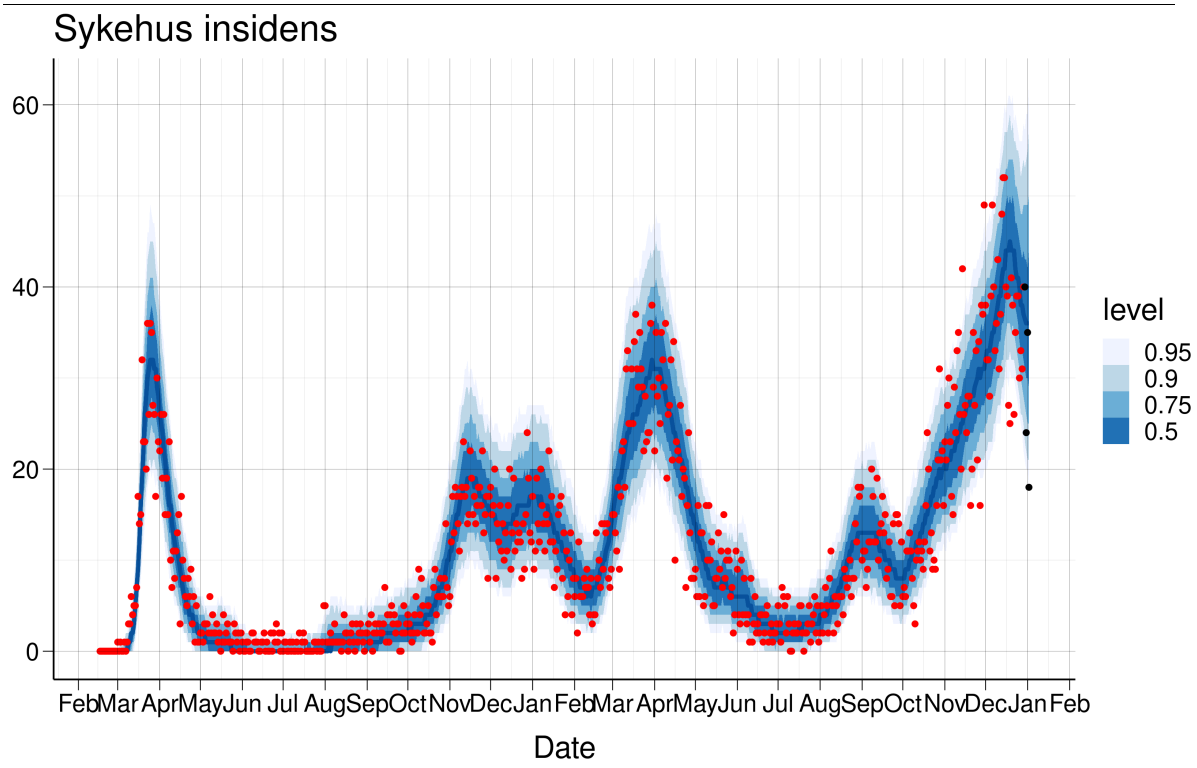
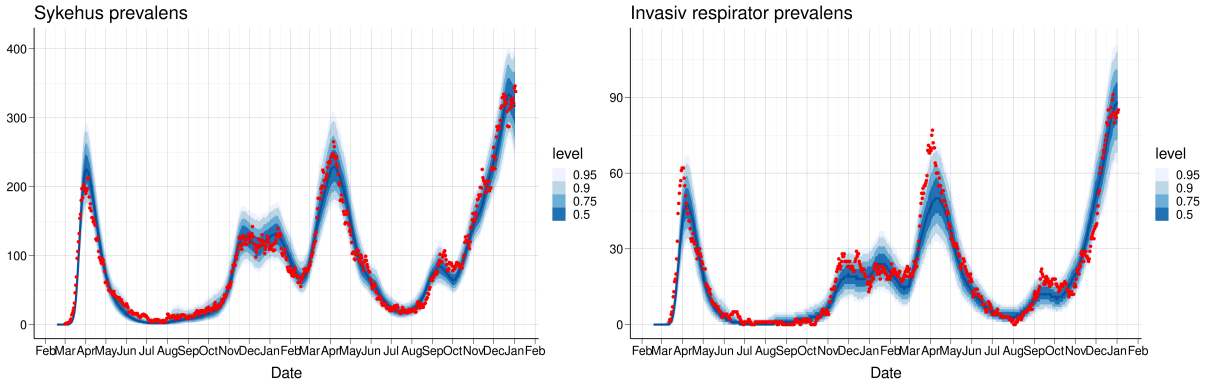


Figure 1: Hospital admissions

Figure 2: A comparison of true data (red) and predicted values (blue) for hospital admissions. The last four data points (black) are assumed to be affected by reporting delay. The uncertainty captures the uncertainty in the calibrated parameters, in addition to the stochastic elements of our model and the variability of other model parameters.

In figure 3, we show how our national model fits the national hospital prevalence data (3a) and the daily number of patients receiving ventilator treatment (3b). Those data sources are not used to estimate the parameters, and can therefore be seen as a validation of the model assumptions.



(a) Hospital prevalence

(b) Ventilator prevalence

Figure 3: A comparison of true data (red) and predicted values (blue) for hospital and respirator prevalence. Prevalence data is based on NIPaR and may be different to the data from Helsedirektoratet.

1.1 National SMC-model: Estimated daily reproduction numbers

Figure 4 shows the SMC estimate of the 7-day-average daily reproduction number $R(t)$ from the start of the epidemic in Norway and until today. In the figure we plot the 95% credibility interval and quantiles of the estimated posterior distribution of $R(t)$.

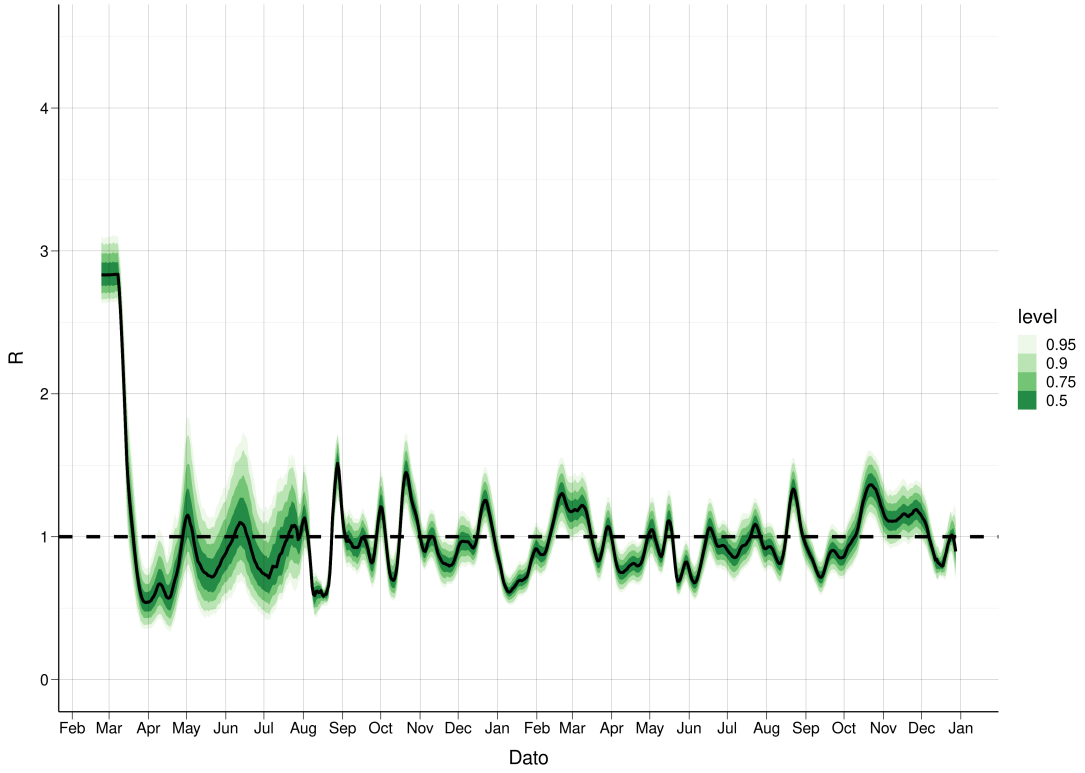


Figure 4: R(t) estimates using a Sequential Monte Carlo approach calibrated to hospitalisation incidence and test data. The large uncertainty during the last 7 days reflects the lack of available data due to the transmission delay, test delay, time between symptoms onset and hospitalisation. The green band shows the 95% posterior credibility interval. As we use test data only from 1 August, the credibility interval becomes more narrow thereafter.

2 National 3-week predictions: Hospital beds and Ventilator beds

The national changepoint model estimates the projected national prevalence of hospitalised patients (hospital beds) and prevalence of patients receiving ventilator treatment (ventilator beds). The projected epidemic and healthcare burden are illustrated in figure 5.

Table 2: Estimated national prevalence, incidence, hospital beds and ventilator beds. Median/Mean (CI)

	1 week prediction (Jan 09)	2 week prediction (Jan 16)	3 week prediction (Jan 23)
Prevalence	10540/9430 (3694-24879)	8406/6971 (2013-24529)	6810/5109 (1087-23723)
Daily incidence	2260/1978 (714-5673)	1809/1463 (392-5535)	1472/1069 (211-5435)
Hospital beds	326/318 (216-487)	306/291 (183-528)	282/258 (154-551)
Ventilator beds	95/95 (65-126)	89/88 (58-132)	84/80 (49-143)

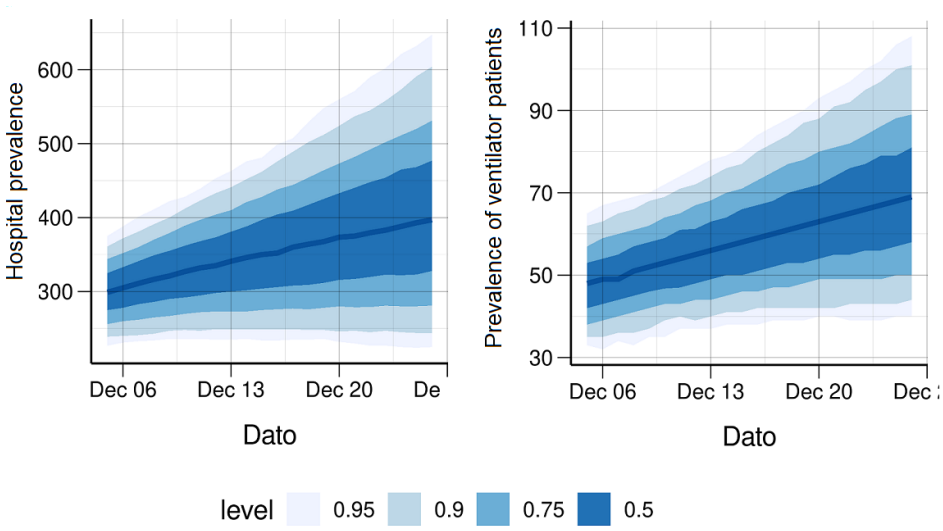


Figure 5: National 3 week predictions for hospital beds (left) and ventilator beds (right)

2.1 Hospital and Ventilator prevalence by age

In Figures 6 and 7 we show the hospital prevalence by age group obtained from the simulations of the national model, including a 3 week forecast period. The real number of patients in each age group is also included (black dots). In the forecast period, we assume that the age distribution of the cases in hospital and respirator beds will remain the same as today. Specific values for these projections are shown in table 3.

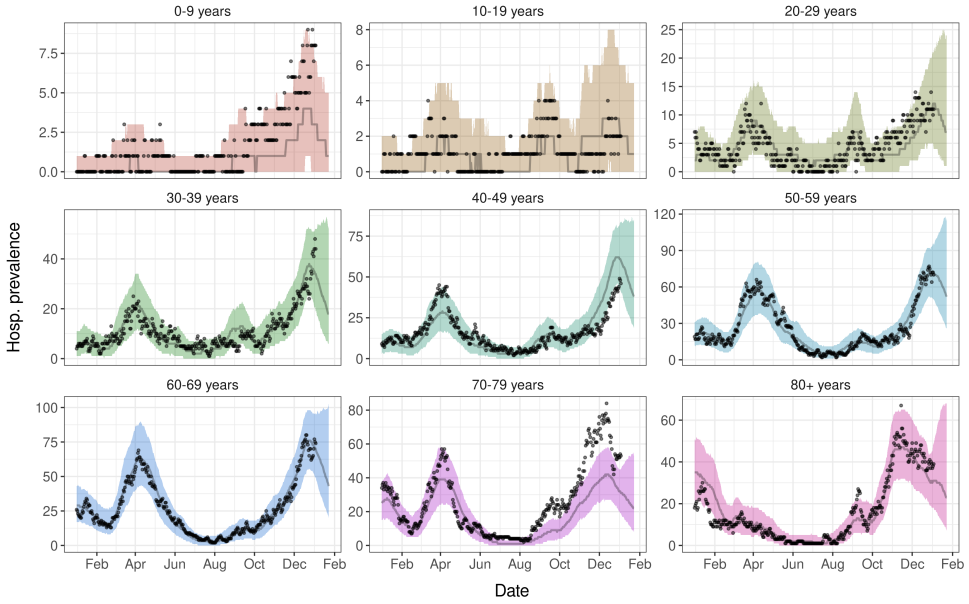


Figure 6: Simulated hospital prevalence by age group. Real data is shown as black dots

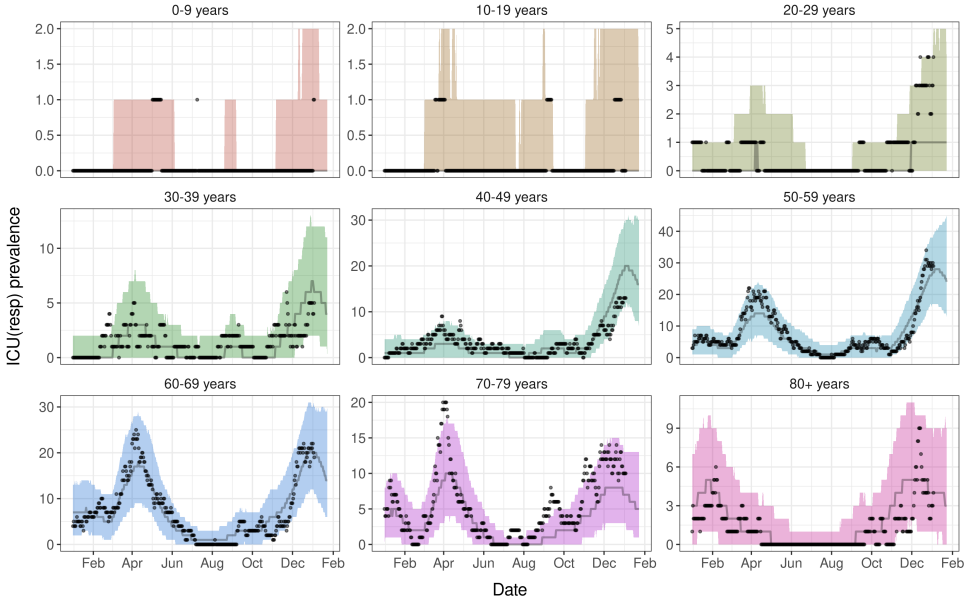


Figure 7: Simulated respirator prevalence by age group. Real data is shown as black dots

2.1 Hospital and Ventilator prevalence by age

Table 3: Hospital and Respirator prevalence per age group: 3 week prediction (2022-01-23). Mean and 95 perc. CI

Age group	Hosp	Resp
0-9 years	2 (0-6)	0 (0-1)
10-19 years	2 (0-5)	0 (0-2)
20-29 years	11 (3-27)	2 (0-5)
30-39 years	27 (10-60)	6 (1-12)
40-49 years	50 (25-95)	19 (8-33)
50-59 years	69 (38-125)	29 (15-48)
60-69 years	58 (29-108)	17 (7-32)
70-79 years	29 (12-60)	6 (2-14)
+80 years	34 (14-76)	5 (1-11)

3 Estimated regional reproduction numbers

Calibration of our regional SMC model to hospitalisation incidence data and test data leads to the following estimates for current regional reproduction numbers by county (Table **??**).
Below we show the estimated daily number of COVID-19 patients admitted to hospital and the estimated daily number of laboratory-confirmed SARS-CoV-2 cases for each county. Model estimates are shown with blue medians and interquantile bands, which are compared to the actual true data, provided in red. The blue bands describe the uncertainty in the calibrated parameters, in addition to the stochastic elements of our model. Last four data points are shown in black as they may be affected by reporting delay.

Table 4: Regional estimates, 15 Dec-22 Dec

County	Median	95CI	Prob>1
Oslo	1.47	0.82-2.18	0.91
Rogaland	0.99	0.61-1.47	0.48
Møre og Romsdal	0.87	0.52-1.36	0.26
Nordland	0.97	0.54-1.27	0.4
Viken	1.01	0.68-1.71	0.52
Innlandet	0.92	0.61-1.44	0.33
Vestfold og Telemark	0.87	0.52-1.47	0.27
Agder	0.81	0.62-1.09	0.11
Vestland	0.90	0.56-1.26	0.29
Trøndelag	0.98	0.64-1.46	0.44
Troms og Finnmark	0.76	0.54-0.95	0.01

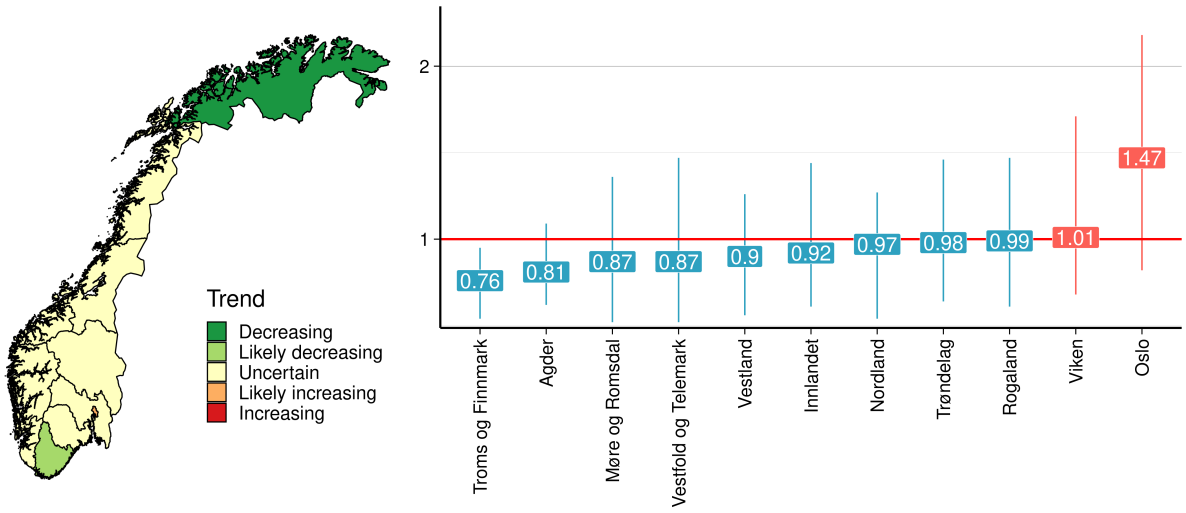
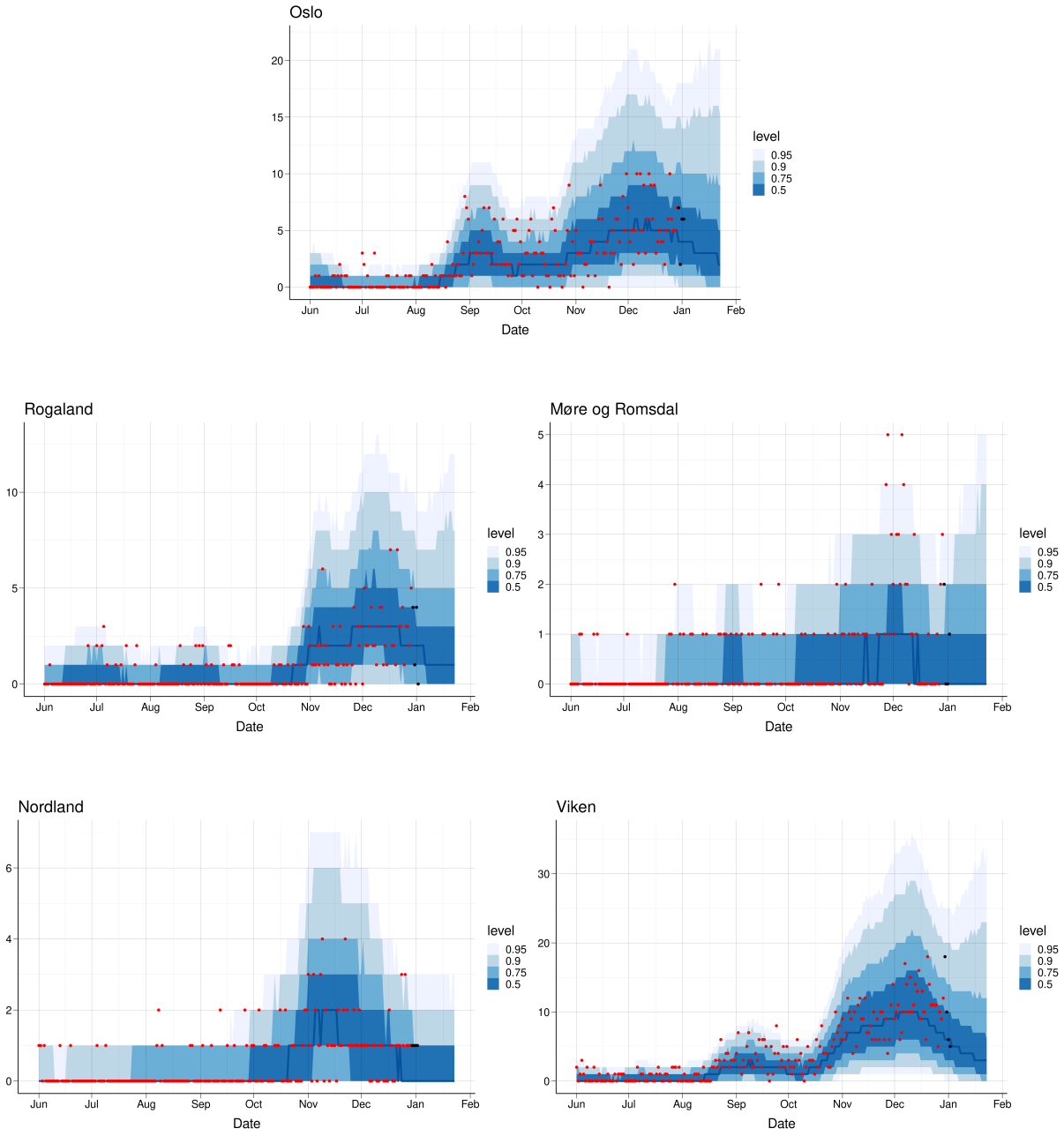
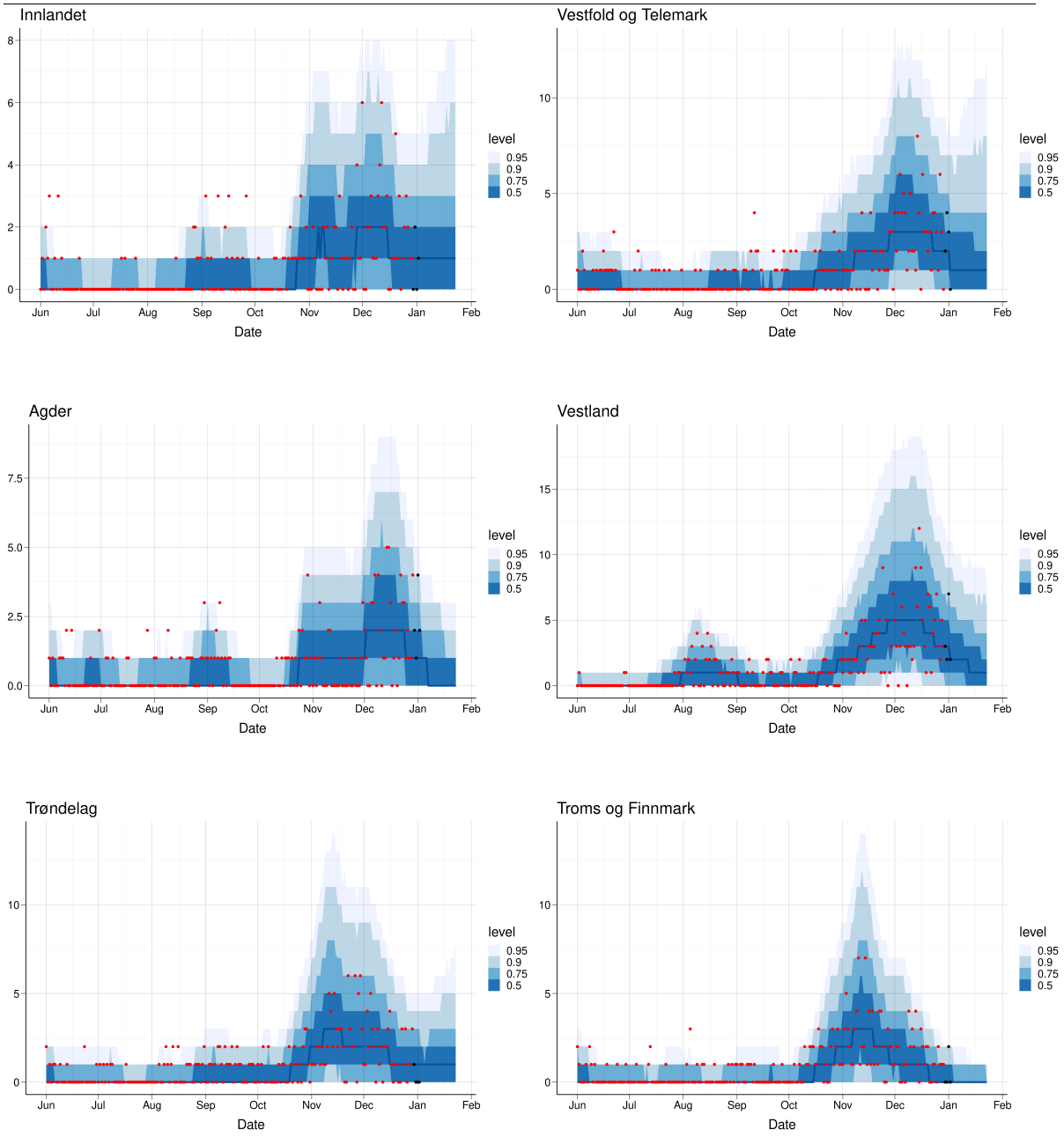


Figure 8: The map shows the direction of the trend in incidence in the counties based on the latest reproduction numbers shown in the other chart. The trend is increasing if the probability that the latest reproduction number is above one is above 95%, the trend is likely increasing if this probability is between 80% and 95%, the trend is uncertain if the probability is between 20% and 80%, the trend is likely decreasing if the probability is between 5% and 20% and is decreasing if the probability that the latest R is above one is less than 5%.

Estimated vs observed hospital incidence and 3 weeks forecast by county:

Forecasts are now based on the estimated reproduction numbers obtained by our regional SMC model, for each county. In the forecasted period of three weeks, we use the mean daily reproduction number during the period today - 21 days until today - 10 days.

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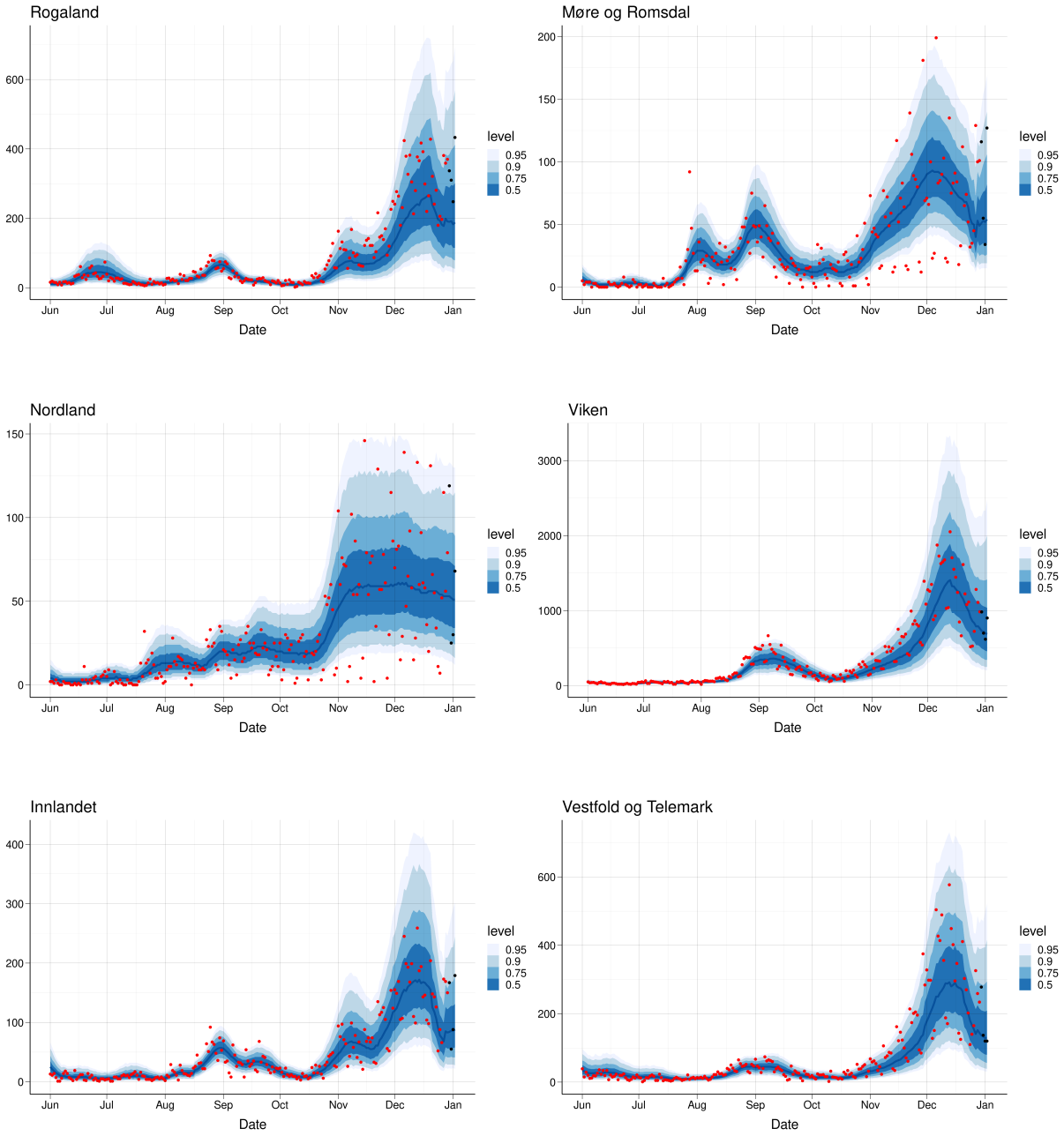
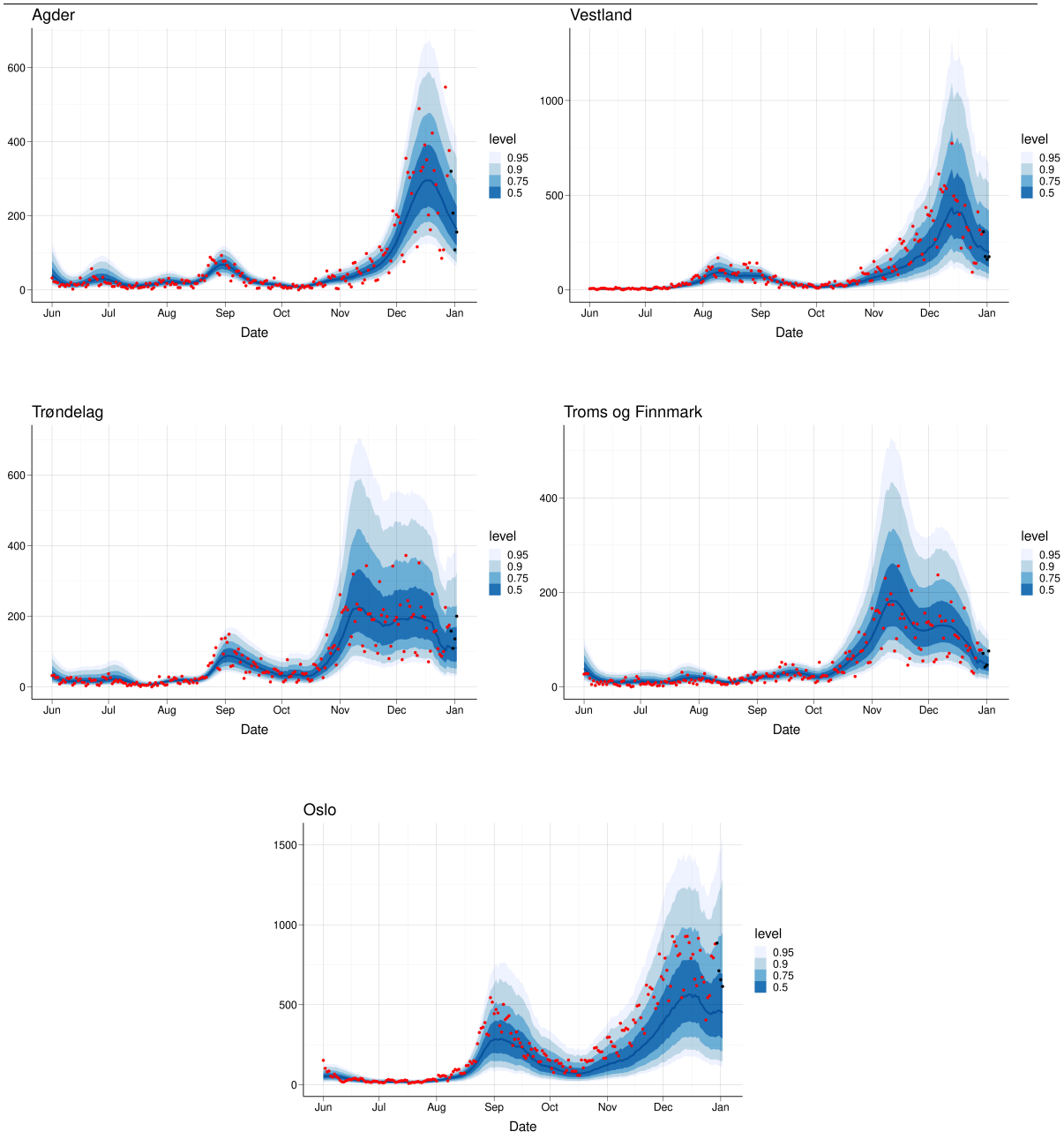
Estimated and observed lab-confirmed test data by county:

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4 Regional 3-week predictions: Cumulative (total) incidence and Prevalence

Below is shown the estimated short-term forecasting of total incidence of infected individuals since 1st of August (2021) (table 5), daily incidence (table 6) and prevalence (table 7) for each county.

Table 5: Estimated cumulative number of infections, 2022-01-02

Region	Total	No. confirmed	Fraction reported	Min. fraction
Oslo	97266 (53328; 162447)	54396	56%	33%
Rogaland	33720 (18689; 60410)	16936	50%	28%
Møre og Romsdal	8857 (5835; 13613)	6362	72%	47%
Nordland	9488 (5441; 15913)	5605	59%	35%
Viken	119511 (71405; 203591)	75764	63%	37%
Innlandet	15716 (9072; 27122)	9587	61%	35%
Vestfold og Telemark	28512 (16029; 50961)	15303	54%	30%
Agder	16295 (9640; 27812)	12794	79%	46%
Vestland	55713 (29488; 103465)	22689	41%	22%
Trøndelag	25430 (12249; 50929)	16396	64%	32%
Troms og Finnmark	14378 (6817; 28990)	9998	70%	34%

Fraction reported=Number confirmed/number predicted; Minimal fraction reported=number confirmed/upper CI

Table 6: Predicted incidence per day: Median/Mean (CI)

Region	1 week prediction (09 Jan)	2 weeks prediction (16 Jan)	3 weeks prediction (23 Jan)
Agder	105/132 (33-382)	78/108 (20-343)	61/92 (10-327)
Innlandet	177/255 (39-998)	158/272 (23-1309)	138/292 (14-1637)
Møre og Romsdal	102/137 (26-493)	89/143 (15-642)	75/151 (8-776)
Nordland	69/79 (9-212)	60/73 (6-220)	52/66 (4-228)
Oslo	828/1164 (194-4177)	677/1057 (111-4280)	549/942 (61-4091)
Rogaland	369/557 (52-2285)	308/547 (25-2709)	250/532 (13-2968)
Troms og Finnmark	36/40 (10-90)	28/31 (6-78)	21/25 (3-68)
Trøndelag	183/267 (48-1017)	164/286 (29-1344)	145/310 (18-1774)
Vestfold og Telemark	259/403 (46-1757)	217/397 (26-2001)	182/384 (14-2203)
Vestland	396/526 (74-1663)	290/437 (38-1641)	212/367 (20-1590)
Viken	820/1335 (208-5791)	649/1272 (121-6612)	515/1207 (68-7146)

Table 7: Predicted prevalence. Number of infectious individuals (asymptomatic plus pre-symptomatic plus symptomatic) per day. Median/Mean and 95 perc. CI for three weeks prediction.

Region	09 Jan	16 Jan	23 Jan	low CI, 23 Jan	high CI, 23 Jan
Agder	502/619	368/499	285/420	61	1450
Innlandet	796/1109	711/1181	628/1265	75	6919
Møre og Romsdal	483/620	407/624	344/654	48	3276
Nordland	316/354	273/326	235/298	20	1007
Oslo	3871/5247	3139/4759	2535/4262	327	18130
Rogaland	1719/2471	1412/2418	1154/2356	71	12933
Troms og Finnmark	173/190	131/146	100/115	19	303
Trøndelag	833/1171	739/1239	656/1339	94	7435
Vestfold og Telemark	1191/1780	1001/1754	843/1705	80	9552
Vestland	1894/2434	1390/2011	1013/1686	109	7055
Viken	3835/5974	3024/5659	2423/5379	363	31151

5 Regional 3-week predictions: Hospital beds and ventilator beds

Below is shown the estimated short-term forecasting of expected hospital prevalence (table 8) and patients on ventilator treatment for each county (table 9).

Table 8: Number of hospitalisation beds occupied by Covid-19 patients: Median/Mean (CI)

Region	1 week prediction (09 Jan)	2 weeks prediction (16 Jan)	3 weeks prediction (23 Jan)
Agder	10/11 (1-28)	7/9 (1-23)	6/7 (0-20)
Innlandet	11/12 (2-35)	10/13 (1-40)	9/13 (1-50)
Møre og Romsdal	5/6 (0-17)	5/7 (0-22)	5/7 (0-28)
Nordland	5/6 (0-16)	4/5 (0-15)	4/5 (0-14)
Oslo	38/44 (12-109)	34/42 (9-120)	29/39 (6-131)
Rogaland	19/23 (5-59)	17/21 (2-67)	14/20 (1-77)
Troms og Finnmark	4/5 (0-13)	3/3 (0-10)	2/2 (0-8)
Trøndelag	10/12 (1-33)	8/11 (1-36)	8/11 (1-44)
Vestfold og Telemark	18/21 (4-56)	15/19 (2-64)	13/18 (1-74)
Vestland	27/30 (8-70)	21/25 (5-66)	16/21 (3-61)
Viken	59/68 (21-174)	48/62 (15-196)	40/58 (10-229)

Table 9: Number of ICU beds occupied by Covid-19 patients: Median/Mean (CI)

Region	1 week prediction (09 Jan)	2 weeks prediction (16 Jan)	3 weeks prediction (23 Jan)
Agder	3/3 (0-9)	2/3 (0-7)	2/2 (0-6)
Innlandet	3/3 (0-9)	3/3 (0-9)	2/3 (0-10)
Møre og Romsdal	1/1 (0-4)	1/1 (0-5)	1/2 (0-6)
Nordland	1/2 (0-5)	1/1 (0-5)	1/1 (0-4)
Oslo	9/10 (3-22)	9/10 (2-23)	8/9 (2-26)
Rogaland	5/6 (1-14)	5/5 (0-15)	4/5 (0-16)
Troms og Finnmark	1/2 (0-5)	1/1 (0-4)	1/1 (0-3)
Trøndelag	3/3 (0-9)	2/3 (0-9)	2/3 (0-9)
Vestfold og Telemark	5/6 (1-14)	4/5 (0-14)	4/5 (0-15)
Vestland	8/9 (2-20)	6/7 (1-18)	5/6 (1-16)
Viken	17/18 (6-40)	14/16 (4-41)	12/15 (3-46)

6 14-day trend analysis of confirmed cases and hospitalisations by county

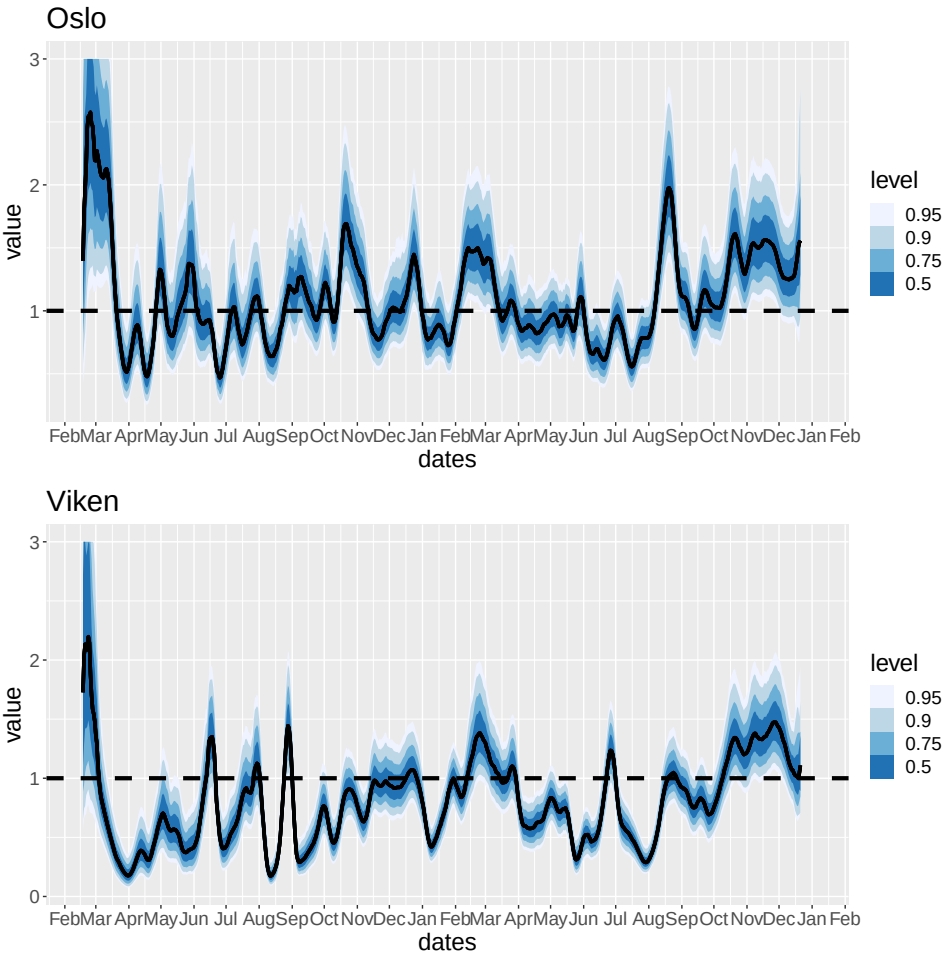
To estimate recent trends in hospitalisation and number of positive tests, we present results in table 10 based on a negative binomial regression where we account for weekend effects. We exclude the last three days to avoid problems of reporting delay and fit the model using data from 17 days to 3 days before the current date. We fit a separate trend model for confirmed cases and for hospital incidence. We only fit a trend model if there has been more than 5 cases or hospitalisations in the 14-day period.

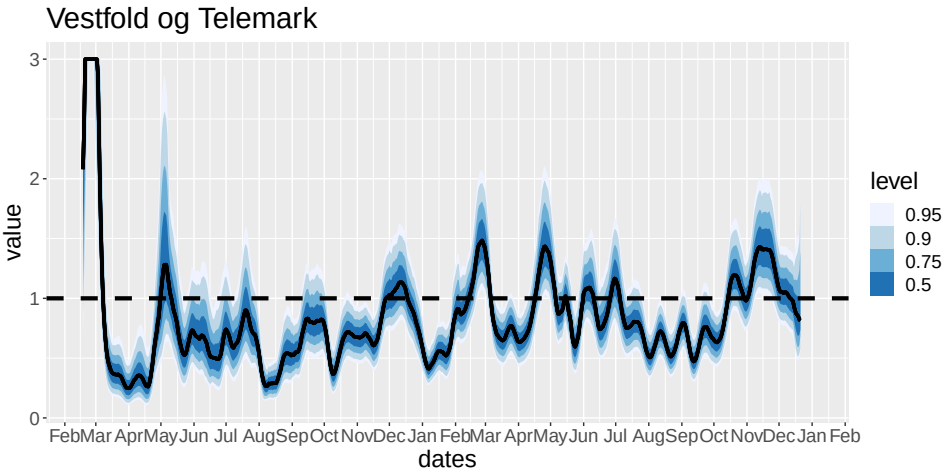
Table 10: Trend analysis for the last 14 days

	Average daily increase last 14 days		Doubling Time (days)	
County	Hospitalisations	Cases	Hospitalisations	Cases
Agder	4.4 (-6.4, 16.8) %	-0.9 (-5.4, 3.7) %	16.1 (-10.6, 4.5)	-73.5 (-12.6, 19.3)
Innlandet	-9.2 (-20.3, 2.4) %	-1.6 (-5.8, 2.9) %	-7.2 (-3.1, 29.7)	-44 (-11.6, 24.6)
Møre og Romsdal	Not enough data	1.7 (-2.7, 6.3) %	Not enough data	40.7 (-25.1, 11.3)
Nordland	1.2 (-11.7, 16.1) %	1.1 (-6.8, 9.5) %	59.1 (-5.6, 4.7)	65.7 (-9.8, 7.6)
Norge	-0.5 (-3.2, 2.3) %	-0.9 (-3.9, 2.1) %	-130.2 (-21, 31.1)	-73.9 (-17.4, 33.2)
Oslo	3.3 (-2.9, 10) %	0 (-2.3, 2.3) %	21.3 (-23.9, 7.3)	-1671.4 (-29.4, 30.5)
Rogaland	1 (-6.9, 9.7) %	0.2 (-2.3, 2.9) %	66.5 (-9.7, 7.5)	278.1 (-29.4, 24.3)
Troms og Finnmark	-6.6 (-21, 9) %	-3.8 (-7.8, 0.4) %	-10.1 (-2.9, 8)	-17.9 (-8.5, 189.9)
Trøndelag	3.9 (-10.2, 20.8) %	-0.1 (-3.6, 3.4) %	18.2 (-6.5, 3.7)	-543.4 (-19.1, 20.6)
Vestfold og Telemark	2 (-6.2, 11.1) %	-1.5 (-4.9, 2.1) %	34.5 (-10.9, 6.6)	-46.4 (-13.8, 34.1)
Vestland	-1.3 (-9.5, 7.5) %	-3 (-7, 1.3) %	-51.4 (-6.9, 9.6)	-22.9 (-9.5, 55.7)
Viken	-3.6 (-8, 1) %	-1.6 (-4.4, 1.4) %	-18.9 (-8.3, 71.3)	-44.2 (-15.3, 50.2)

7 Regional SMC-model: Estimated daily reproduction numbers

In the figures below we plot the 95% credibility interval and quantiles of the estimated posterior distribution of the regional, daily reproduction numbers. For some counties, uncertainty is large towards the most recent time, because there are very few data and possibly reporting delays which are different in each county.

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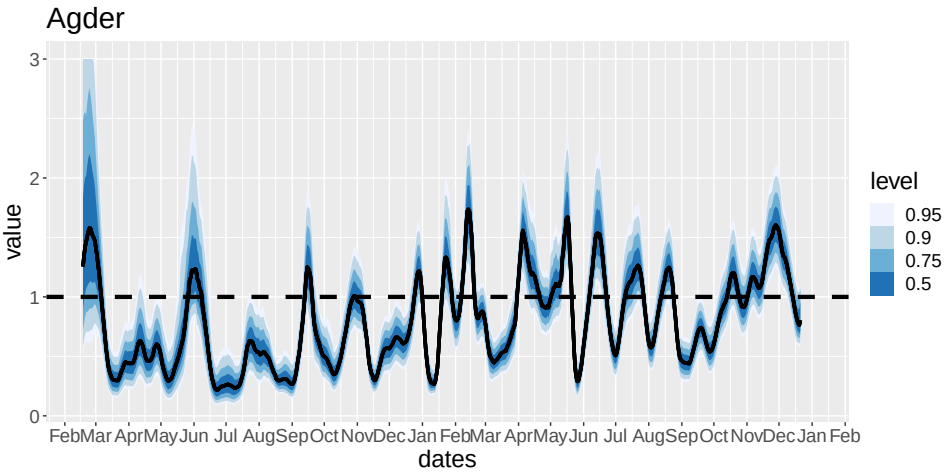
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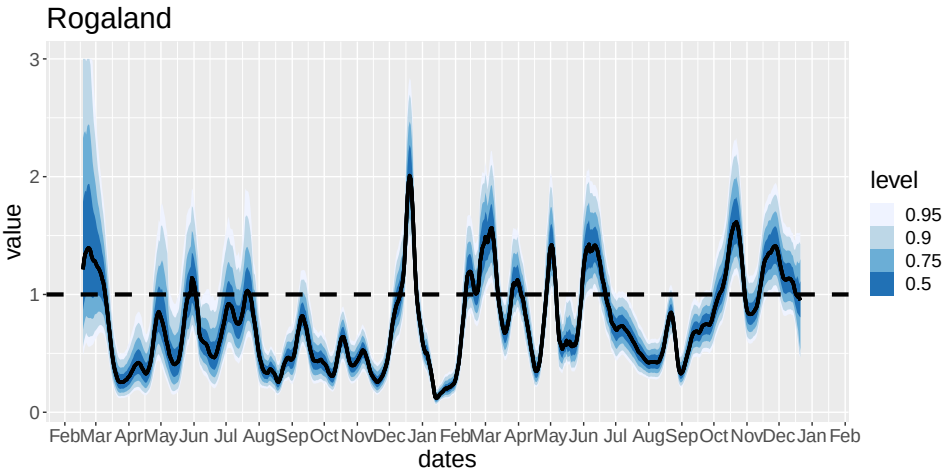
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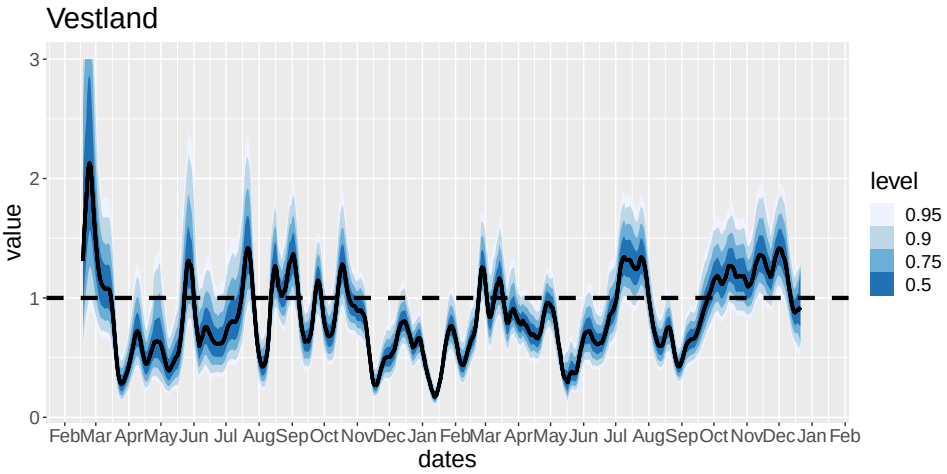
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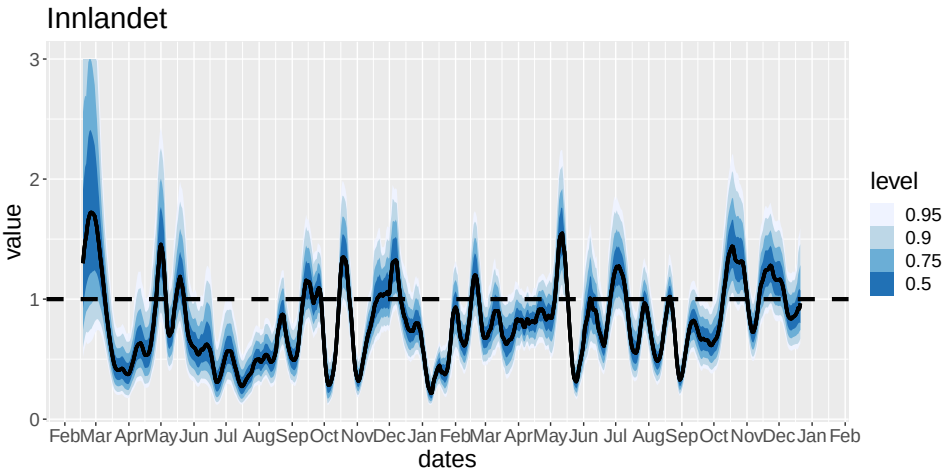
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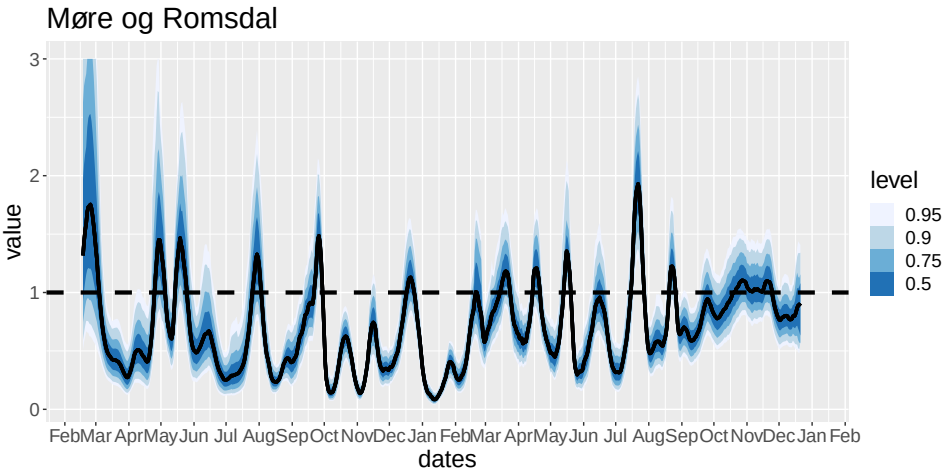
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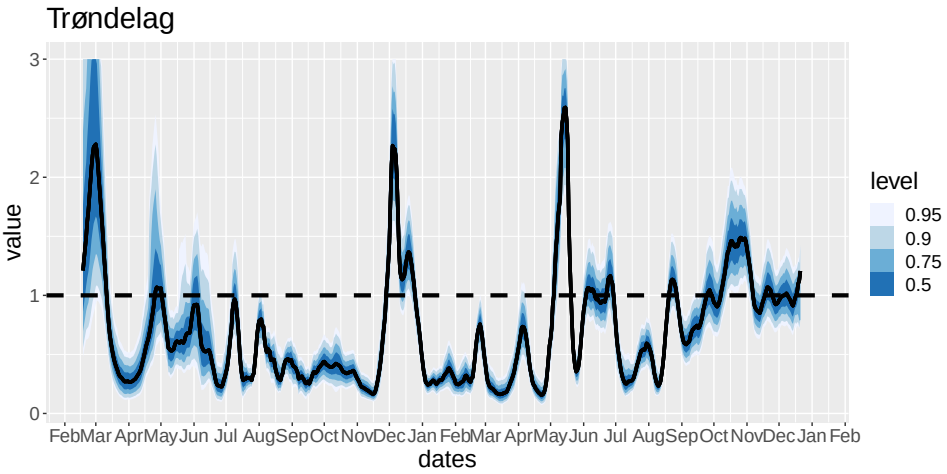
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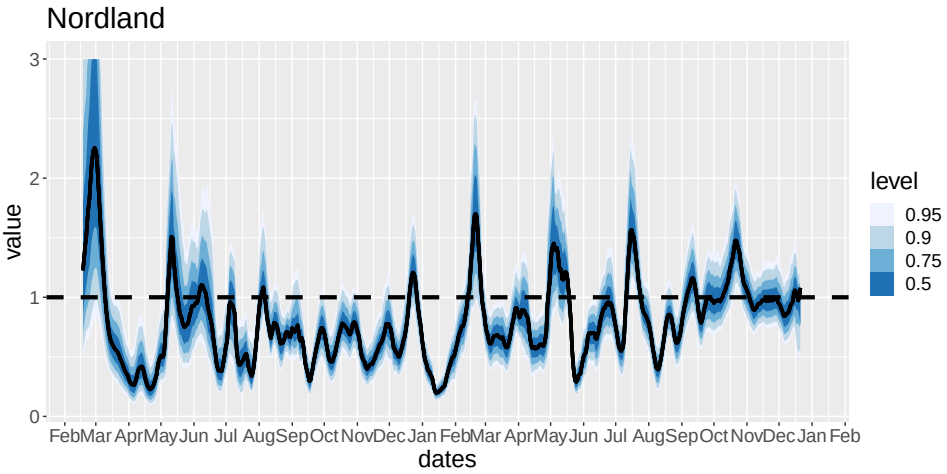
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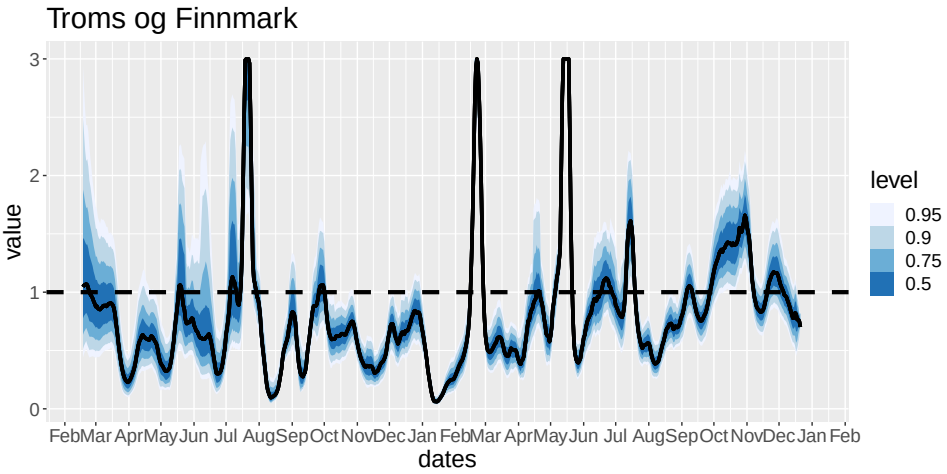
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8 Short-term predictions per health trust ("helseforetak"): number of occupied covid-19 beds and number of patients receiving ventilator treatment

In the table below we distribute our short-term predictions to the Norwegian health trusts ("helseforetak"), on the basis of their areas of responsibility.

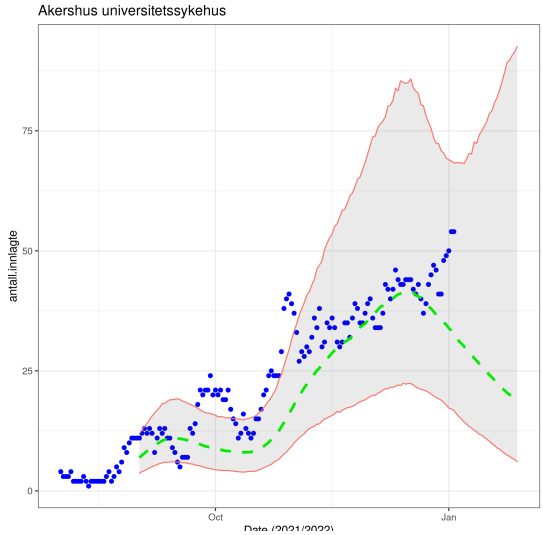
Table 11: Number of hospitalisation beds occupied by Covid-19 patients: Median/Mean (CI)

Helseforetak	1 week prediction (09 Jan)	2 weeks prediction (16 Jan)	3 weeks prediction (23 Jan)
Akershus universitetssykehus	29/32 (13-70)	25/30 (11-77)	21/28 (8-87)
Finnmarksykehuset	1/1 (0-3)	1/1 (0-3)	1/1 (0-2)
Helse Bergen	19/21 (6-49)	15/18 (4-45)	12/15 (3-42)
Helse Fonna	8/9 (4-18)	7/8 (3-18)	6/7 (2-21)
Helse Førde	5/5 (2-12)	4/4 (1-11)	3/3 (1-10)
Helse Møre og Romsdal	5/6 (1-15)	5/7 (1-21)	5/7 (0-27)
Helse Nord Trøndelag	3/4 (1-10)	3/4 (1-11)	3/4 (0-14)
Helse Stavanger	15/18 (5-44)	13/16 (3-51)	11/15 (2-58)
Nordlandssykehuset	3/3 (1-8)	3/3 (0-7)	2/3 (0-7)
Oslo universitetssykehus	32/37 (12-88)	28/35 (8-99)	24/33 (7-107)
St. Olavs hospital	7/8 (1-20)	6/8 (1-23)	5/8 (1-30)
Sykehuset Innlandet	10/12 (3-29)	9/12 (2-35)	9/12 (2-44)
Sykehuset Telemark	7/9 (2-22)	6/8 (2-26)	5/8 (1-30)
Sykehuset i Vestfold	11/12 (3-31)	9/11 (2-36)	7/11 (1-43)
Sykehuset Østfold	15/17 (6-44)	12/16 (5-49)	10/15 (3-58)
Sørlandet sykehus	10/11 (3-26)	8/9 (2-21)	6/7 (1-18)
Universitetssykehuset i Nord-Norge	3/4 (1-9)	3/3 (0-7)	2/2 (0-5)
Vestre Viken	23/27 (9-67)	19/25 (7-76)	16/23 (5-89)

Table 12: Number of respirator beds occupied by Covid-19 patients: Median/Mean (CI)

Helseforetak	1 week prediction (09 jan)	2 weeks prediction (16 jan)	3 weeks prediction (23 jan)
Akershus universitetssykehus	8/8 (3-16)	7/7 (3-17)	6/7 (2-18)
Finnmarksykehuset	0/1 (0-2)	0/0 (0-1)	0/0 (0-1)
Helgelandssykehuset	0/1 (0-2)	0/0 (0-2)	0/0 (0-1)
Helse Bergen	6/6 (1-14)	4/5 (1-13)	4/4 (1-11)
Helse Fonna	2/2 (1-5)	2/2 (1-5)	2/2 (0-5)
Helse Førde	1/1 (0-3)	1/1 (0-3)	1/1 (0-3)
Helse Møre og Romsdal	1/1 (0-4)	1/1 (0-5)	1/2 (0-6)
Helse Nord Trøndelag	1/1 (0-3)	1/1 (0-3)	1/1 (0-3)
Helse Stavanger	4/5 (1-11)	4/4 (0-12)	3/4 (0-12)
Nordlandssykehuset	1/1 (0-3)	1/1 (0-3)	1/1 (0-2)
Oslo universitetssykehus	8/8 (2-18)	8/8 (2-19)	7/8 (2-22)
St. Olavs hospital	2/2 (0-6)	1/2 (0-6)	1/2 (0-6)
Sykehuset Innlandet	3/3 (0-8)	3/3 (0-8)	2/3 (0-9)
Sykehuset Telemark	2/2 (0-6)	2/2 (0-6)	2/2 (0-6)
Sykehuset i Vestfold	3/3 (1-8)	2/3 (0-8)	2/3 (0-9)
Sykehuset Østfold	4/5 (2-10)	4/4 (1-10)	3/4 (1-12)
Sørlandet sykehus	3/3 (0-9)	2/3 (0-7)	2/2 (0-6)
Universitetssykehuset i Nord-Norge	1/1 (0-4)	1/1 (0-3)	1/1 (0-2)
Vestre Viken	7/7 (2-16)	6/6 (2-16)	5/6 (1-18)

In the figures below, we plot the 95% credibility interval and quantiles of the estimated posterior distribution of the daily number of occupied covid-19 beds and the number of patients receiving ventilator treatment for a few health trusts. The others are available on request. In blue are actual data, in green our median prediction and in gray the 95% credibility interval. For some counties, uncertainty is considerable towards the most recent time because there is little data and possibly reporting delays that are different in each county.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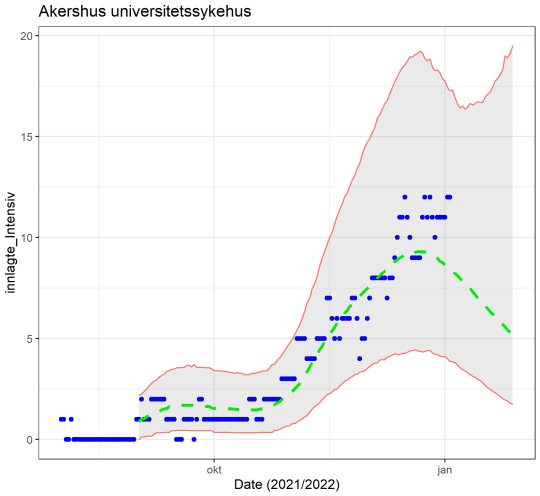
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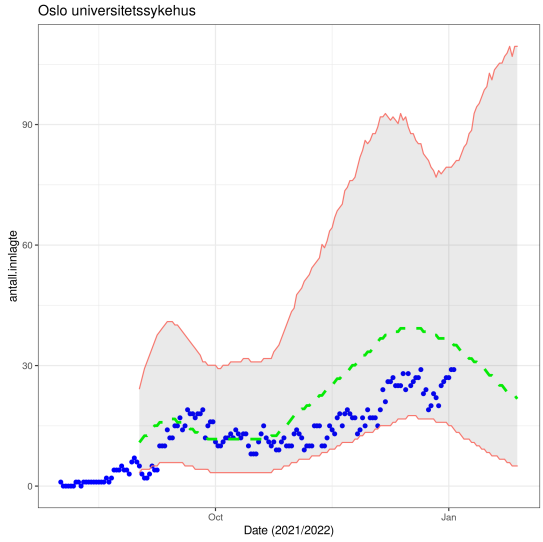
Date (2021/2022)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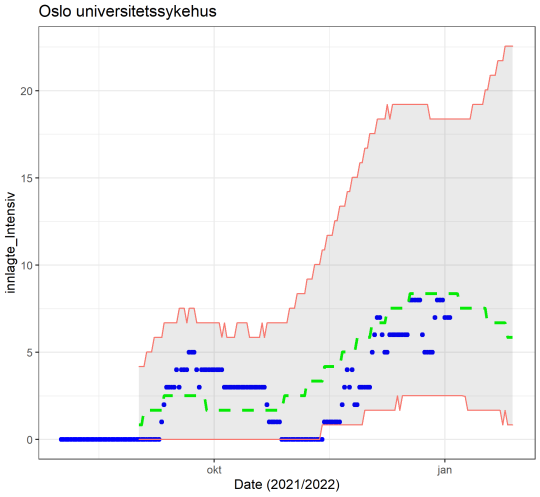
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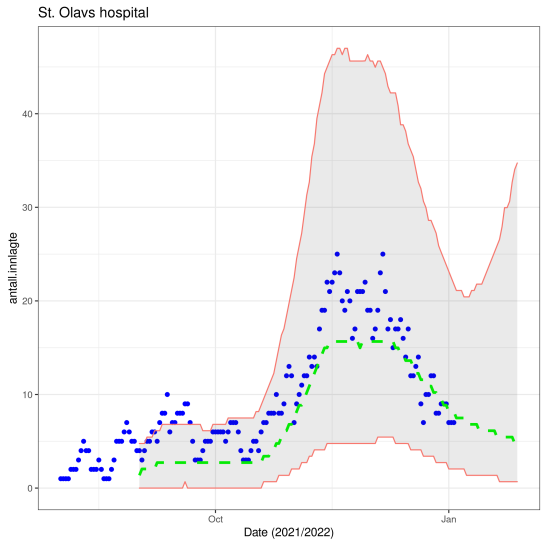
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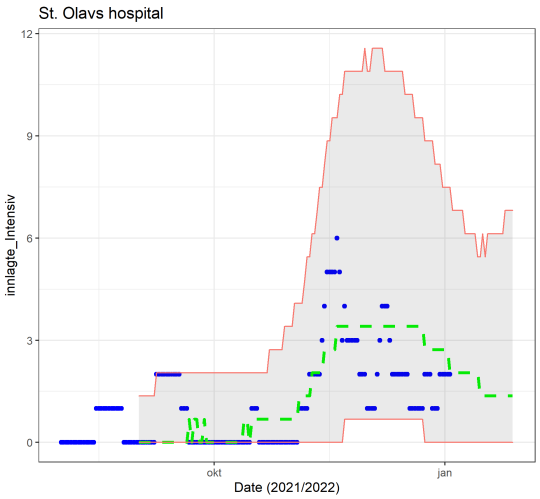
Date (2021/2022)


St. Olavs hospital
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Date (2021/2022)

9 Mobility

Number of trips out from each municipality during each day is based on Telenor mobility data. The reference level is set to 100 on March 2nd 2020 for all the figures in this section, and we plot the seven-day, moving average of the daily mobility. Figure 20 shows an overview of the mobility since March 2020 for the largest municipalities in each county, and Figure 21 shows the total mobility out from all municipalities in each county, including Oslo. Figure 22 and 23, zooms in on mobility from August 16 2021, for municipalities and counties, respectively.

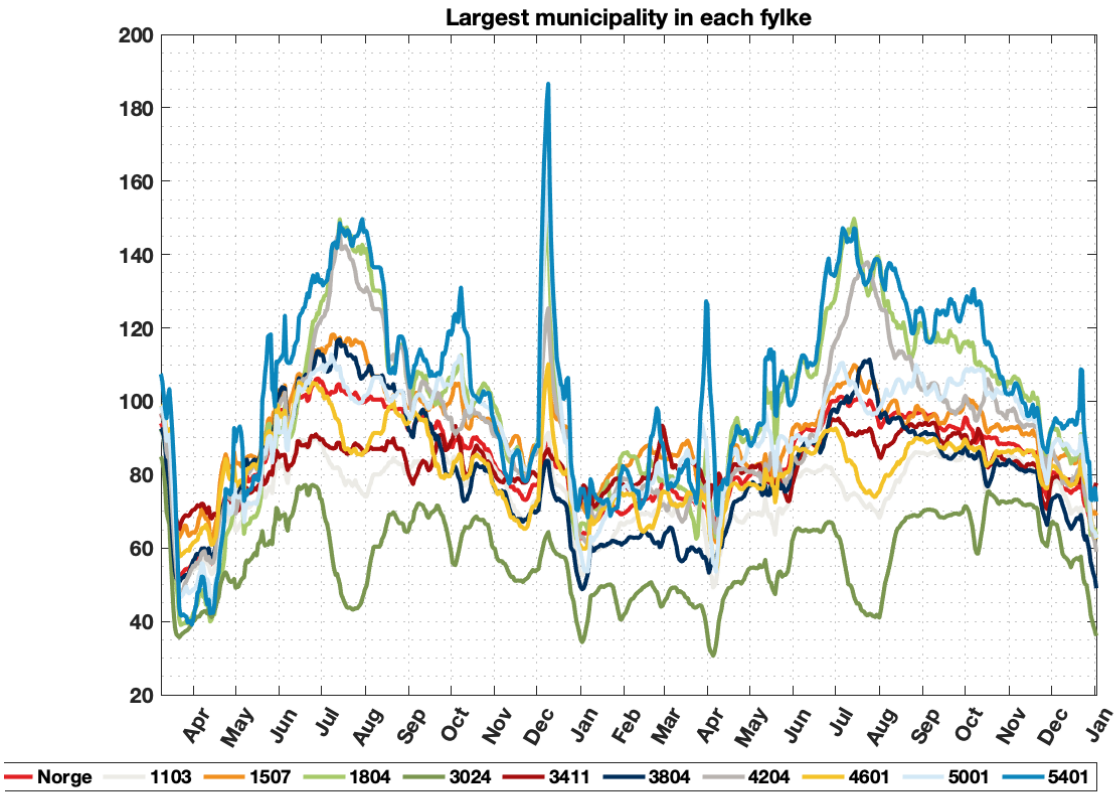


Figure 20: Mobility for selected municipalities since March 2020: Nationally (Norge), Stavanger (1103), Ålesund (1507), Bodø (1804), Bærum (3024), Ringsaker (3411), Sandefjord (3804), Kristiansand (4204), Bergen (4601), Trondheim (5001), Tromsø (5401).

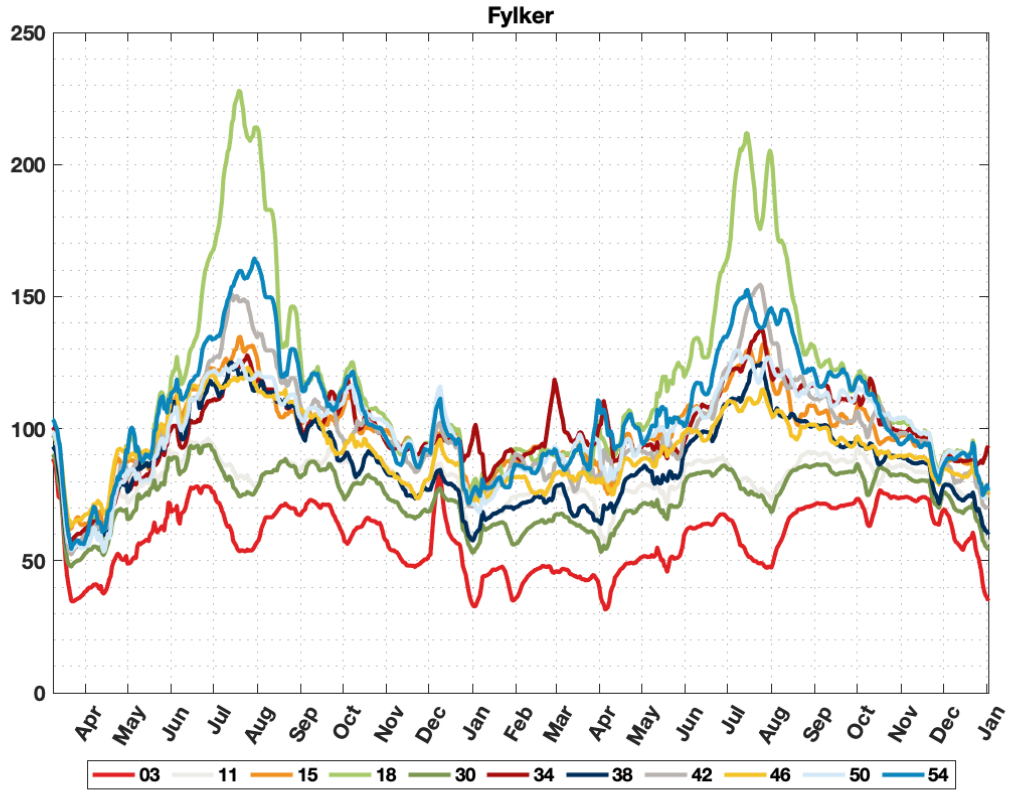


Figure 21: Mobility for fylker since March 2020: Oslo (03), Rogaland (11), Møre og Romsdal (15), Nordland (18), Viken (30), Innlandet (34), Vestfold og Telemark (38), Agder (42), Vestland (46), Trøndelag (50), Troms og Finmark (54).

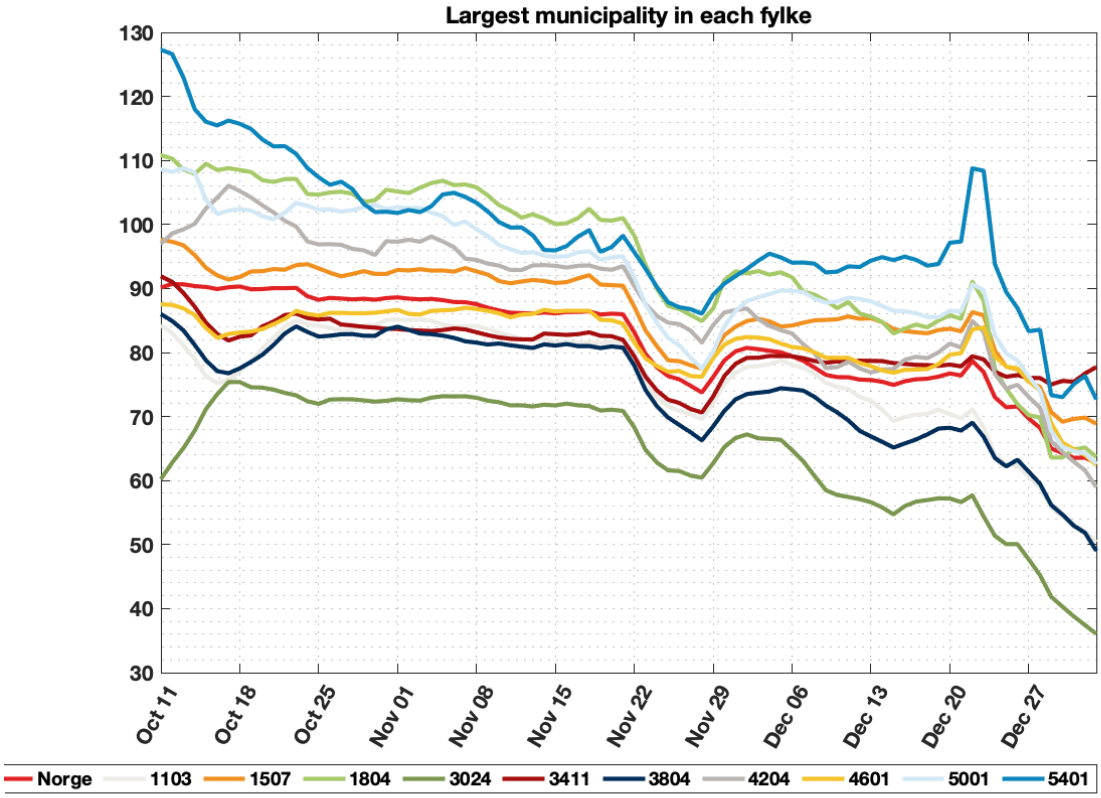


Figure 22: Zoom: Mobility from August 16, 2021 and onwards: Nationally (Norge), Stavanger (1103), Ålesund (1507), Bodø (1804), Bærum (3024), Ringsaker (3411), Sandefjord (3804), Kristiansand (4204), Bergen (4601), Trondheim (5001), Tromsø (5401).

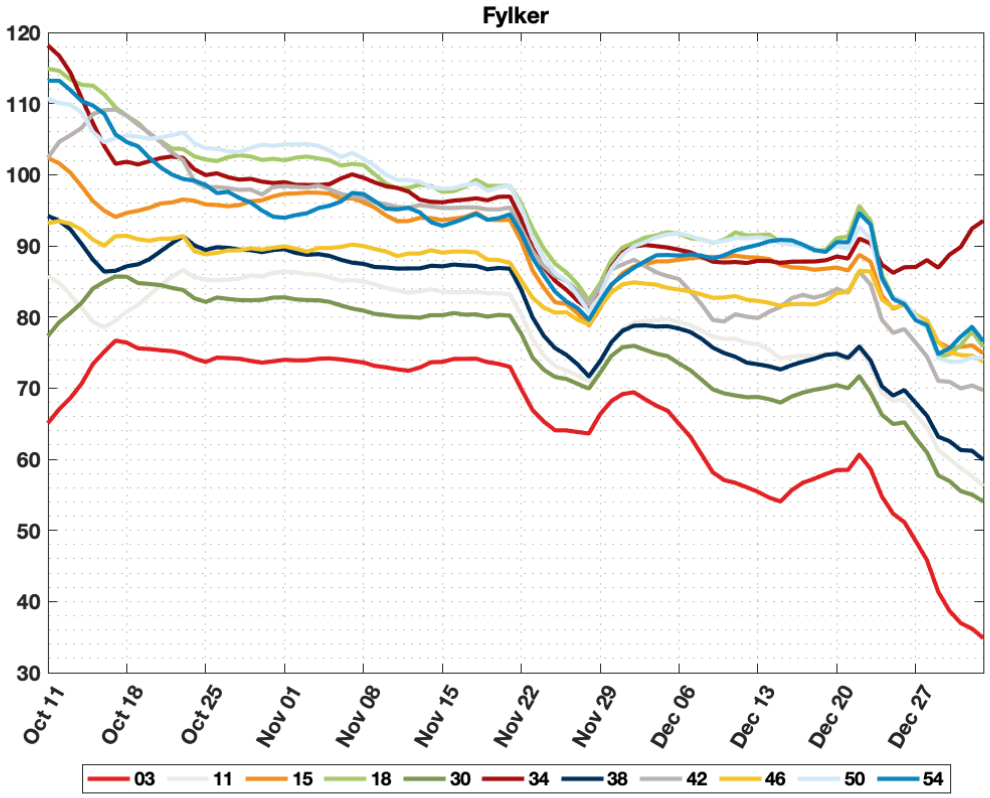


Figure 23: Zoom: Mobility from August 16, 2021 and onwards, per fylker: Oslo (03), Rogaland (11), Møre og Romsdal (15), Nordland (18), Viken (30), Innlandet (34), Vestfold og Telemark (38), Agder (42), Vestland (46), Trøndelag (50), Troms og Finnmark (54).

	49	50	51	52	53
Norge	76.2	79.4	75.7	76.7	69.7
Stavanger	72.1	78.1	72.5	70.4	60.6
Ålesund	80.0	84.2	85.3	83.7	75.4
Bodø	86.9	91.8	85.6	85.8	70.2
Bærum	62.7	64.8	56.6	57.2	47.7
Ringsaker	73.1	79.4	78.7	78.1	76.0
Sandefjord	68.5	74.3	66.9	68.2	61.4
Kristiansand	84.3	83.0	76.9	81.4	73.1
Bergen	79.1	80.9	77.9	79.7	75.5
Trondheim	80.1	89.6	88.0	86.5	76.3
Tromsø	89.0	94.0	94.3	97.2	83.3

Table 13: Municipalities

	49	50	51	52	53
Oslo	66.3	65.0	55.4	58.5	48.5
Rogaland	73.4	79.3	76.2	74.6	66.2
Møre og Romsdal	81.2	88.0	88.3	87.0	80.3
Nordland	84.7	91.7	91.5	91.1	79.6
Viken	72.2	73.5	68.8	70.4	62.9
Innlandet	83.7	89.4	87.9	88.5	87.0
Vestfold og Telemark	73.8	78.4	73.3	74.8	67.9
Agder	84.3	85.3	79.8	83.9	76.4
Vestlandet	81.4	83.8	82.2	83.3	80.3
Trøndelag	83.0	91.7	91.2	90.0	80.0
Troms og Finnmark	82.2	88.6	90.1	90.5	79.5

Table 14: Counties

Weekly mobility for Norway and selected municipalities is displayed in Table 13 and mobility for counties is displayed in Table 14. The percentages in the tables are to be interpreted towards the reference level of 100 for week 10 in March 2020. The color-coding encodes the following: 'Green' monotonic decrease in mobility, 'Yellow' almost monotonic decrease or flat mobility trend, 'Red' increasing mobility.

9.1 Foreign roamers on Telenor's network in Norway

An analysis of foreign roamers in Norway from January 2020 has been carried out, to better understand the potential virus importation. In Figure 24 the total number of roamers per day per county are displayed.

Figure 25 shows the levels of roamers from the following countries: Poland, Lithuania, Sweden, Netherlands, Denmark, Latvia, Germany, Spain, Finland and the rest of the world. These levels represent the total number of foreign, visiting roamers from each of the countries per day in Norway, since July 5 2021.

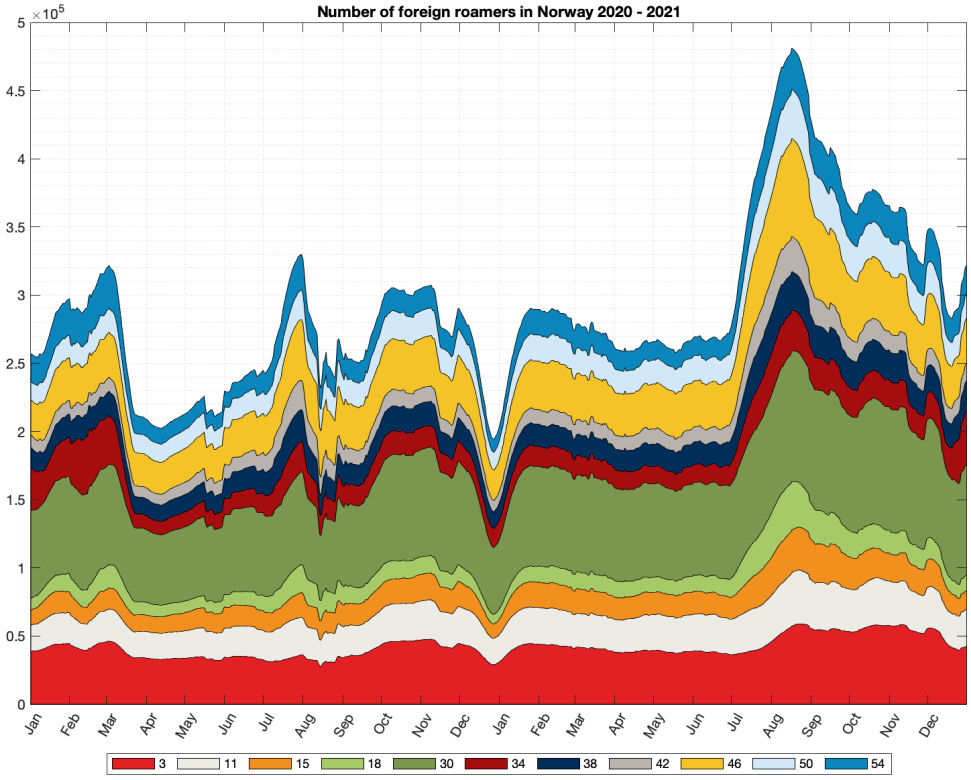


Figure 24: The total number of foreign roamers in Norway broken down on different fylker: Oslo (3), Rogaland (11), Møre og Romsdal (15), Nordland (18), Viken (30), Innlandet (34), Vestfold og Telemark (38), Agder (42), Vestland (46), Trøndelag (50), Troms og Finnmark (54).

9.1 Foreign roamers on Telenor's network in Norway

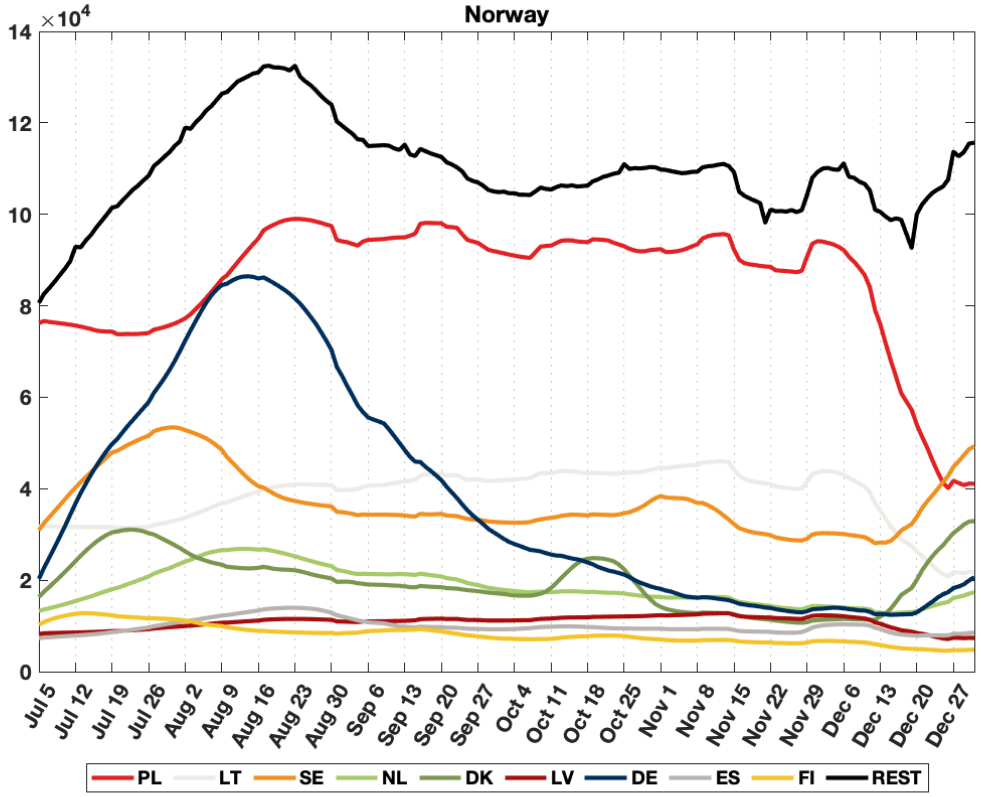
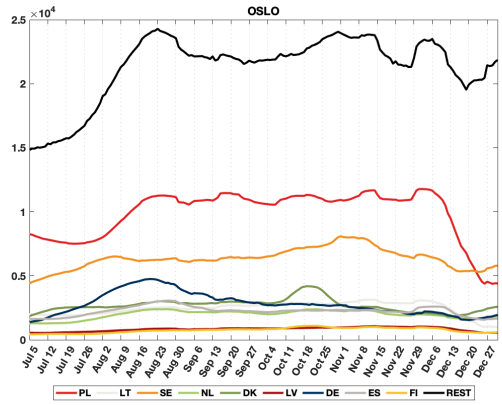
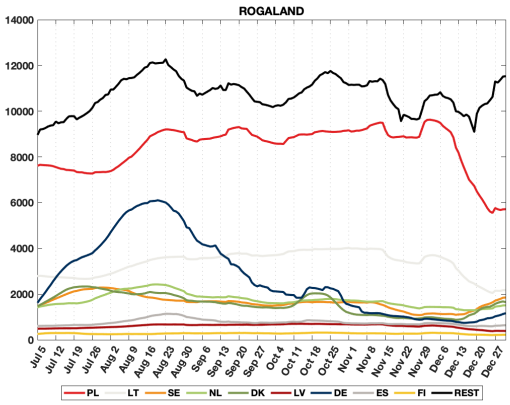
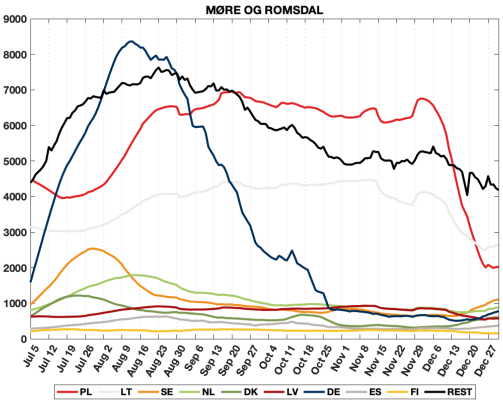


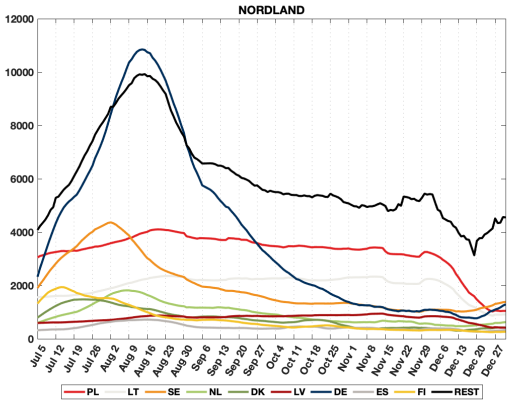
Figure 25: National overview of total number of foreign, visiting roamers from Poland, Lithuania, Sweden, Netherlands, Denmark, Latvia, Germany, Spain, Finland and the rest of the world.

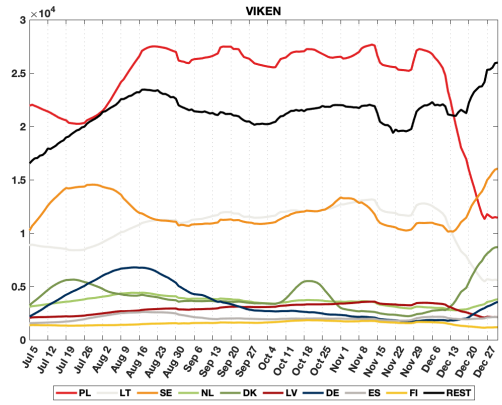
9.2 Foreign roamers per county (fylke) in Norway

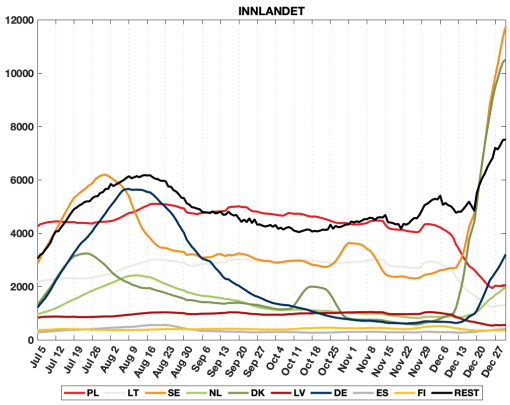




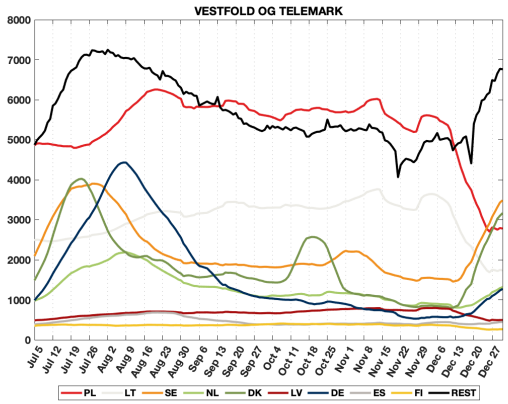


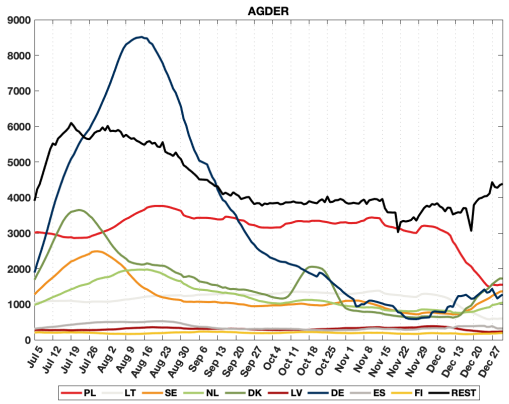


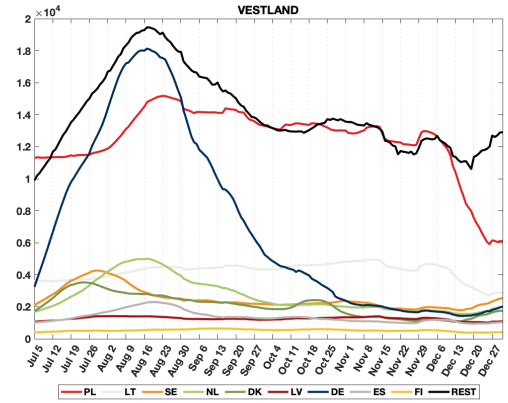


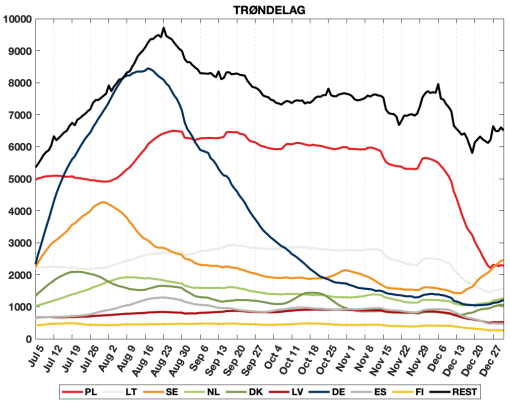


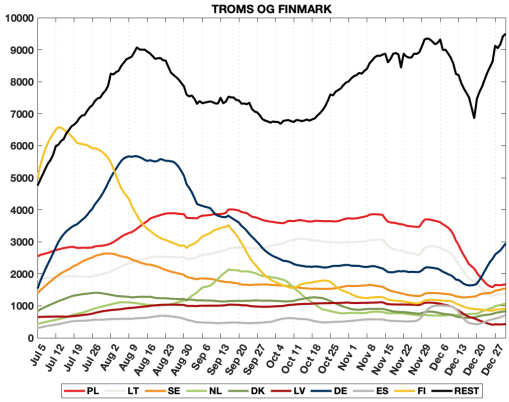
9.2 Foreign roamers per county (fylke) in Norway











10 Estimated parameters

Table 15: Estimated parameters

	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	Period
R0s	1.49	2.135	2.315	2.318	2.485	3.175	Until March 14
R1s	0.364	0.515	0.553	0.555	0.593	0.736	From 15 March to 19 April
R2s	0.006	0.596	0.858	0.829	1.074	1.671	From 20 April to 10 May
R3s	0.003	0.321	0.505	0.536	0.738	1.43	From 11 May to 30 June
R4s	0	0.707	1.12	1.038	1.389	2.046	From 01 July to 31 July
R5s	0.311	0.765	0.894	0.904	1.062	1.471	From 01 August to 31 August
R6s	0.527	0.839	0.94	0.943	1.034	1.456	From 01 September to 30 September
R7s	0.732	1.111	1.212	1.206	1.309	1.645	From 01 October to 25 October
R8s	0.528	1.026	1.172	1.18	1.328	1.863	From 26 October to 04 November
R9s	0.614	0.821	0.857	0.86	0.9	1.083	From 05 November to 30 November
R10s	0.876	0.979	1.015	1.013	1.046	1.175	From 01 December to 03 January
R11s	0.298	0.615	0.679	0.686	0.749	1.031	From 04 January to 21 January
R12s	0.432	0.733	0.821	0.818	0.901	1.216	From 22 January to 07 February
R13s	1.019	1.256	1.321	1.33	1.4	1.658	From 08 February to 01 March
R14s	0.885	1.021	1.067	1.066	1.108	1.256	From 02 March to 24 March
R15s	0.653	0.818	0.861	0.859	0.901	1.092	From 25 March to 12 April
R16s	0.502	0.707	0.762	0.763	0.817	1.02	From 13 April to 05 May
R17s	0.562	0.87	0.994	0.997	1.124	1.488	From 06 May to 26 May
R18s	0.392	0.7	0.811	0.804	0.911	1.311	From 27 May to 20 June
R19s	0.73	0.923	0.976	0.972	1.024	1.189	From 21 June to 04 August
R20s	0.91	1.077	1.139	1.143	1.204	1.481	From 05 August to 31 August
R21s	0.606	0.759	0.799	0.798	0.837	0.95	From 01 September to 24 September
R22s	1.006	1.062	1.076	1.075	1.089	1.138	From 25 September to 12 December
R23s	0.391	0.716	0.786	0.789	0.859	1.107	From 13 December

Table 16: Assumptions

Assumptions	Mean	Distribution	Reference
Mobile Mobility Data			
Telenor coverage	48%		https://ekomstatistikken.nkom.no/
Data updated	January 2nd		
Data used in the predictions	January 2nd	Fixed	Corrected to preserve population
Model parameters			
Exposed period ($1/\lambda_1$)	2 days	Exponential	changed from Feretti et al 2020
Pre-symptomatic period ($1/\lambda_2$)	2 days	Exponential	Feretti et al 2020
Symptomatic infectious period ($1/\gamma$)	3 days	Exponential	changed from Feretti et al 2020
Asymptomatic, infectious period ($1/\gamma$)	3 days	Exponential	changed from Feretti et al 2020
Infectiousness asympt. (r_{I_a})	0.1	Fixed	Feretti et al 2020
Infectiousness presymp (r_{E_2})	1.3	Fixed	guided by Feretti et al 2020
Prob. asymptomatic infection (p_a)	0.4		Feretti et al 2020
Healthcare			
Fraction asymptomatic infections	40%	Fixed	Mizumoto et al 2020 20% for the old population, Diamond Princess
% symptomatic and asymptomatic infections requiring hospitalization: 0-9 years 10 - 19 years 20 - 29 years 30 - 39 years 40 - 49 years 50 - 59 years 60 - 69 years 70 - 79 years 80+ years	 0.1% 0.1% 0.5% 1.1% 1.4% 2.9% 5.8% 9.3% 22.3%	Fixed	Saljie et al 2020 corrected for: % of elderly living in elderly homes in Norway (last two age groups) and corrected for presence among positive tested since May 1.
Probability that an admission has been reported on Monday From Sunday From Saturday From Friday From Thursday	 32% 49% 68% 86%	Fixed	Estimated from "Beredskapsregistret BeredtC19"
Probability that an admission has been reported From one day before From two days before From three days before From four days before	 53% 77% 82% 91%	Fixed	Estimated from "Beredskapsregistret BeredtC19"
Probability that a positive laboratory test has been reported From one day before From two days before From three days before From four days before	 6.7% 59% 90% 97%	Fixed	Estimated from MSIS
Probability that a negative laboratory test has been reported From one day before From two days before From three days before From four days before	 16% 74% 92% 98%	Fixed	Estimated from MSIS

Supplementary analysis: EpiEstim estimation of reproduction number based on laboratory-confirmed cases

To complement the results of the metapopulation model, we present estimates of the temporal evolution of the reproduction number in Norway based on an analysis of laboratory-confirmed cases. The primary purpose of this analysis is to provide a more comprehensive perspective on the epidemic situation, taking into account several data sources.

Table 17: Estimated reproduction numbers 7 days ago

Location	Reff
National	1.08(1.06 - 1.1)
Oslo	0.98(0.95 - 1.01)
Rogaland	1.08(1.03 - 1.13)
Møre og Romsdal	1.19(1.09 - 1.3)
Nordland	1.13(1.02 - 1.25)
Viken	0.89(0.87 - 0.92)
Innlandet	0.98(0.91 - 1.05)
Vestfold og Telemark	0.89(0.84 - 0.94)
Agder	1.01(0.96 - 1.06)
Vestland	0.9(0.85 - 0.95)
Trøndelag	1.02(0.96 - 1.09)
Troms og Finnmark	0.86(0.78 - 0.95)

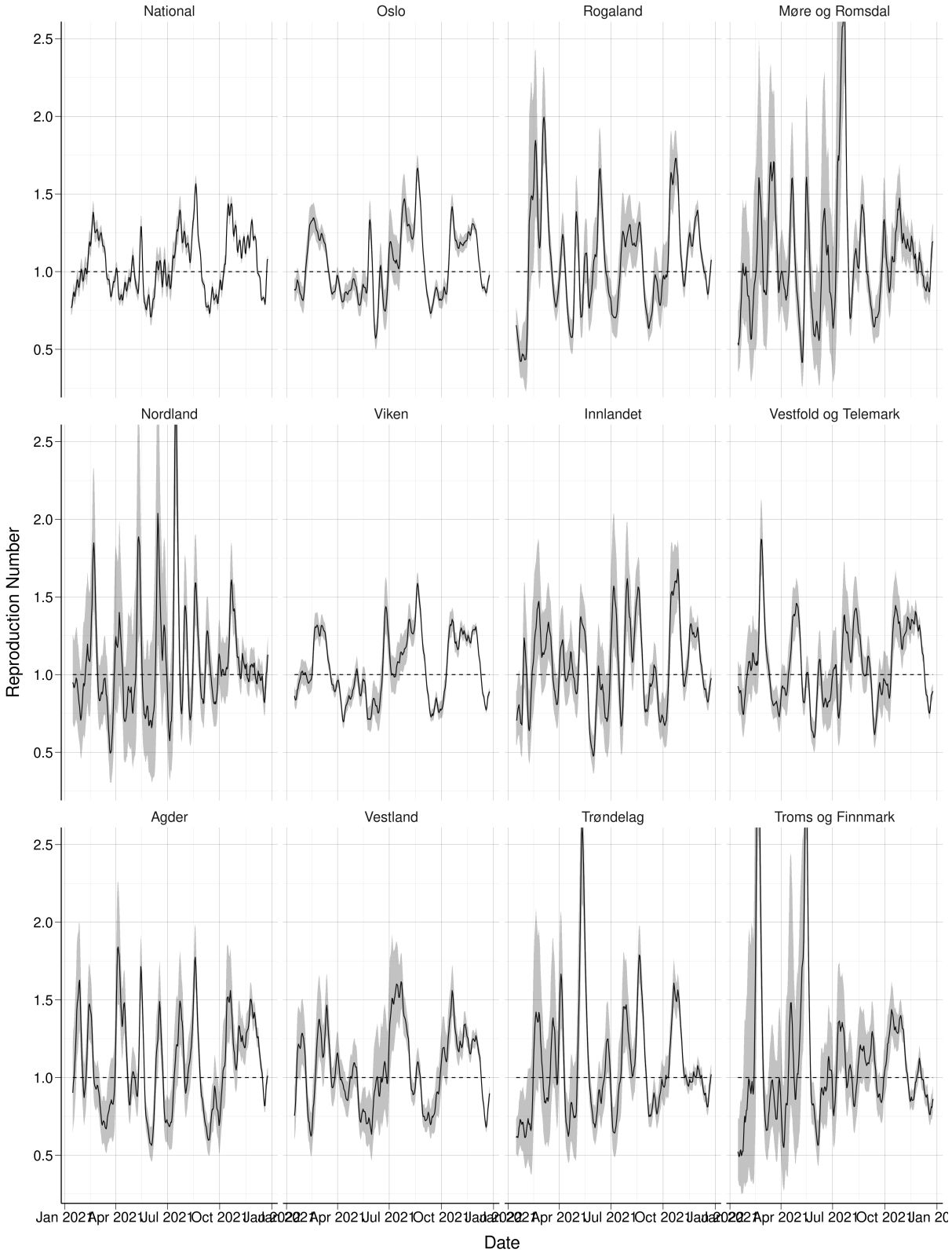


Figure 28: Reproduction number estimated using the R package EpiEstim.

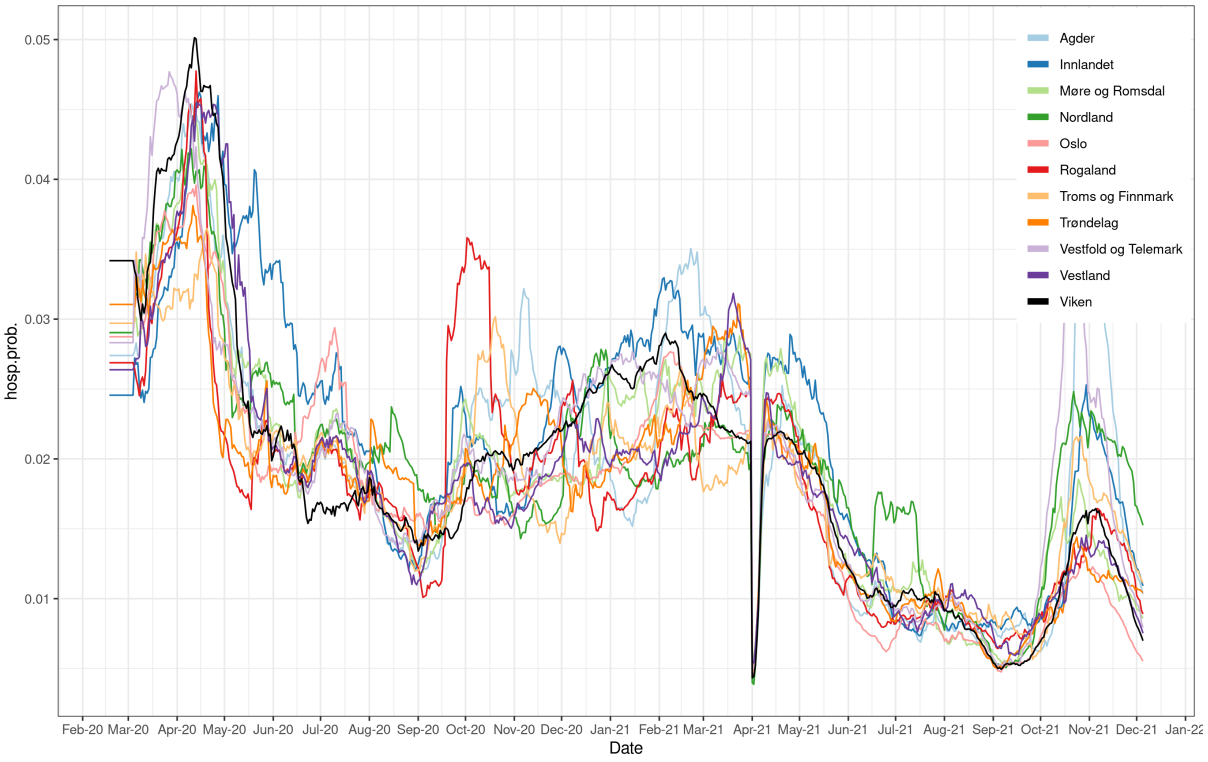


Figure 29: Regional hospitalisation probabilities per infection. The estimates are based on Salje et al., and regional data on the age distribution in the test data and the empirical case-hospitalisation rates.

Models and materials:

This report presents results based on a mathematical infectious disease model describing the geographical spread of COVID-19 in Norway. We use a metapopulation model for situational awareness and short-term forecasting and an individual-based model for long-term predictions. This report does not contain the long-term prediction results. Reproduction numbers of the metapopulation model are estimated in two ways: SMC-ABC is used to estimate a step-function in the transmissibility through prespecified changepoints, and SMC is used to estimate a daily varying reproduction number. We also provide estimates based on EpiEstim and a simple trend analysis. The models are described in previous reports and will not be explained here.

The metapopulation model takes daily varying Telenor mobility data as input. We also provide plots of the recent mobility for situational awareness.

How you should interpret the results: 3-week-ahead predictions and long-term scenarios
We provide both 3-week-ahead predictions and long-term scenarios. These are simulations of the disease spread into the future, under specific assumptions.

In the 3-week-ahead predictions, we assume that all parameters are as today, and simulate disease spread 3-weeks-ahead in time. Hence, these predictions are conditional on the current situation, and specifically on the most recently estimated reproduction number. The 3-week-ahead predictions thus do not take into account changes in transmissibility that are not yet captured by the available data, for example due to the delay between transmission and hospitalisation. Hence one of the conditions for the predictions to be valid is that the intervention policies do not change significantly in the next weeks. Hence, it does not make sense to evaluate or use the predictions if there are big changes in factors like

- new interventions
- relaxation of interventions
- a combination of new interventions and relaxations
- a significant change in vaccination coverage
- new variants with new properties
- a significant change in the contact behaviour of individuals.

As these factors are not likely to stay constant in the long-term future, we do not produce predictions for longer than three weeks ahead in time. Hence, our 3-week-ahead predictions are predictions of what may happen in the future, if there were no significant changes in the assumptions.

In addition to the short-term predictions, we also produce different long-term scenarios. Scenarios are not predictions of how we think the future pandemic will evolve. The scenarios are based on different hypothetical assumptions, and hence cannot be validated against what we later actually observe in the data. They are not meant to be, and hence should not be interpreted as, what we believe to be the most probable future outcome.

The purpose of the scenarios is manifold. Scenarios can contribute to situational awareness, and as information in decision making and future preparedness planning. Scenarios can be used to provide a better understanding of possible future disease spread, under specific assumptions. The assumptions of the scenarios may also sometimes be unrealistic. For example, scenarios can contribute in understanding the current situation, should we not change intervention policies in the future. This does however not mean that we believe that the intervention policies will stay constant. Scenarios can also be used to compare different intervention strategies, like comparing different vaccination strategies.

In this report, the term patient in ventilator treatment includes only those patients that require either invasive mechanical ventilation or ECMO (Extracorporeal membrane oxygenation).

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