NIPH
Norwegian Institute of Public Health

# Situational awareness and forecasting

FHI COVID-19 modelling team

**21 April 2020**

## What this report contains:

This report presents results based on a mathematical model describing the geographical spread of COVID-19 in Norway. The model consists of three layers:

- Population structure in each municipality
- Mobility data for inter-municipality movements (Telenor mobile phone data)
- Infection transmission model

The model produces estimates of the current epidemiological situation at the municipality, county (fylke) and national levels, a forecast of the situation for the next three weeks and a long term prediction.

How we calibrate the model:

The model is fitted to Norwegian COVID-19 hospitalization prevalence data since March 10 until today. We seed new infections into the model using imported COVID-19 cases in Norway from February 26 until March 18.

How you should interpret the results:

The model is stochastic (random). To predict the probability of various outcomes, we run the model many times. We present the results in terms of mean values, 95% confidence intervals, median and interquartile ranges. We underline that the confidence bands presented might be broader: First, there are uncertainties related to the natural history of SARS-CoV-2, including the importance of asymptomatic and presymptomatic infection. Second, there are uncertainties related to the timing of hospitalization relative to symptom onset, the severity of the COVID-19 infections by age, and the duration of hospitalization and ventilator treatment in ICU. These uncertainties are not fully explored in the present results. We will update the model parameters in accordance with new evidence and local data as they becomes available and results can change also significantly. See more details at the end of this report.

The mobility data is updated until April 20. It accounts for the changes in the movement patterns between municipalities that have occurred since start of the epidemics.

In the forecasting, we use the reproduction numbers that fit the hospitalization data best. The basic reproductive number, $R_0$, is used until March 14. A new effective reproductive number,$R_{eff}$, acts from March 15 until today, and in the future when we predict. $R_0$ and $R_{eff}$ are calibrated to hospitalization data (number of occupied beds) until today. Estimates of $R_0$ and $R_{eff}$ are uncertain, and we use their distribution to guarantee appropriate uncertainty of their estimates of our predictions. However, uncertainties related to the model parameters, as well as the transient period in week 11 and week 17, imply that reported effective reproductive values should be interpreted with caution. We will update the parameters related to permanence in hospital and ICU as soon as NPR data will be linked with MSIS.

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

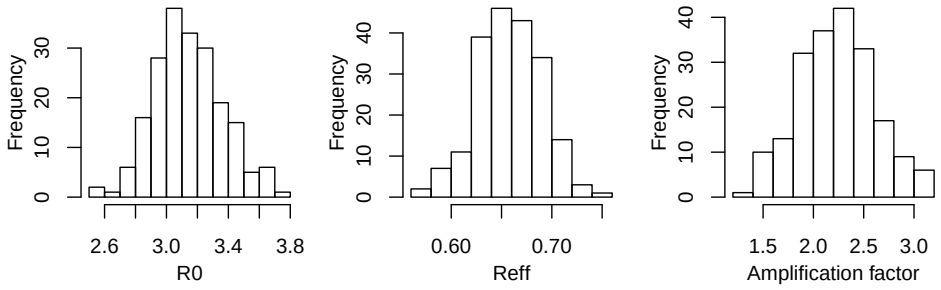
# 1 Estimated Reproductive Numbers

Calibration of our model with hospitalisation data leads to the following estimates:

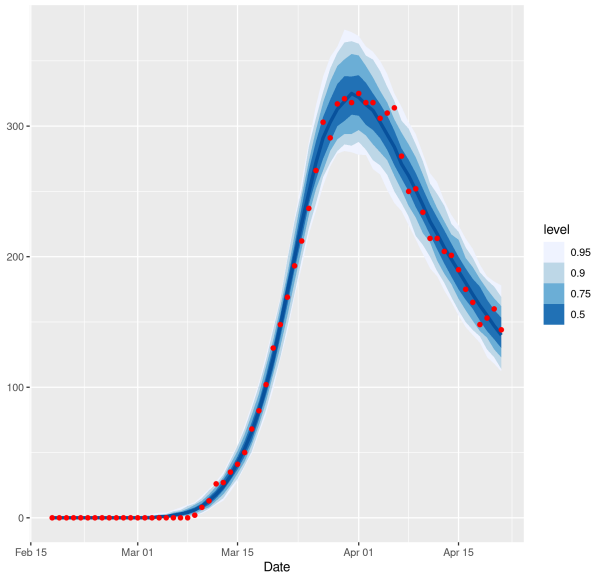
Table 1: Calibration results

| Parameter | Mean | Median | Confidence interval (95 %) |
|---|---|---|---|
| Amplification factor | 2.23 | 2.24 | (1.54-3.01) |
| Ro | 3.15 | 3.14 | (2.77-3.62) |
| Reff | 0.66 | 0.66 | (0.59-0.71) |

Estimated densities of these three parameters are plotted below:




Our model estimates the number of hospitalised Covid-19 patients, plotted below with blue median and interquartile bands, which are compared with the actual hospitalisation data, in red. The uncertainty captures the uncertainty in the calibrated parameters in addition to the stochastic elements of our model.




True total number of hospitalisations (red) and predicted values (blue)

## 2 Estimated cumulative number of infected individuals

Table 2: Estimated cumulative number of infections, 2020-04-21

| Region | Total | Symptomatic | No. confirmed | Fraction reported | Min. fraction |
|---|---|---|---|---|---|
| Norway | 47362 (43861; 51803) | 29016 (26769; 31624) | 7166 | 15% | 14% |
| Agder | 2909 (2152; 3848) | 1776 (1305; 2323) | 294 | 10% | 8% |
| Innlandet | 2475 (1721; 3353) | 1502 (1036; 2025) | 414 | 17% | 12% |
| Møre og Romsdal | 925 (573; 1321) | 573 (357; 803) | 118 | 13% | 9% |
| Nordland | 773 (451; 1189) | 475 (269; 714) | 110 | 14% | 9% |
| Oslo | 10865 (9719; 12132) | 6619 (5869; 7428) | 2177 | 20% | 18% |
| Rogaland | 6298 (5062; 7676) | 3857 (3109; 4688) | 393 | 6% | 5% |
| Troms og Finnmark | 1346 (811; 2330) | 819 (478; 1372) | 225 | 17% | 10% |
| Trøndelag | 2160 (1535; 2837) | 1325 (938; 1755) | 422 | 20% | 15% |
| Vestfold og Telemark | 3887 (2898; 5286) | 2372 (1750; 3204) | 263 | 7% | 5% |
| Vestland | 5135 (3984; 6619) | 3135 (2436; 4011) | 807 | 16% | 12% |
| Viken | 10589 (9171; 11943) | 6564 (5663; 7457) | 1940 | 18% | 16% |

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

# 3 Predicted incidence of infected individuals, next three weeks

Predicted incidence (asymptomatic and symptomatic) for Norway per day, with confidence intervals.

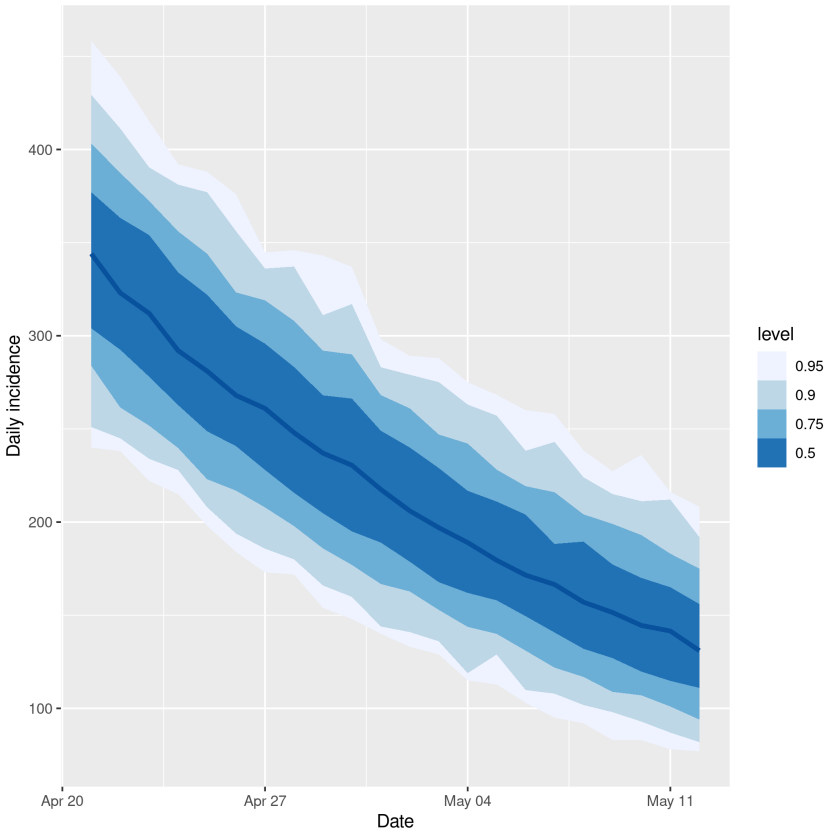



Table 3: Predicted incidence per day.

| Region | 1 week prediction (28 April) | 2 weeks prediction (05 May) | 3 weeks prediction (12 May) |
|---|---|---|---|
| Norway | 250 (166-346) | 184 (105-268) | 134 (77-208) |
| Agder | 16 (7-29) | 12 (5-23) | 9 (2-18) |
| Innlandet | 18 (8-31) | 13 (5-25) | 10 (3-20) |
| Møre og Romsdal | 6 (1-14) | 5 (0-10) | 3 (0-8) |
| Nordland | 5 (0-12) | 4 (0-9) | 3 (0-7) |
| Oslo | 40 (22-58) | 31 (15-50) | 22 (9-39) |
| Rogaland | 32 (17-52) | 23 (9-39) | 17 (6-32) |
| Troms og Finnmark | 7 (1-16) | 5 (1-13) | 4 (0-10) |
| Trøndelag | 13 (5-23) | 9 (3-19) | 7 (2-16) |
| Vestfold og Telemark | 21 (9-35) | 15 (5-29) | 11 (4-21) |
| Vestland | 28 (14-45) | 21 (7-37) | 15 (5-29) |
| Viken | 69 (39-99) | 50 (25-78) | 37 (17-62) |

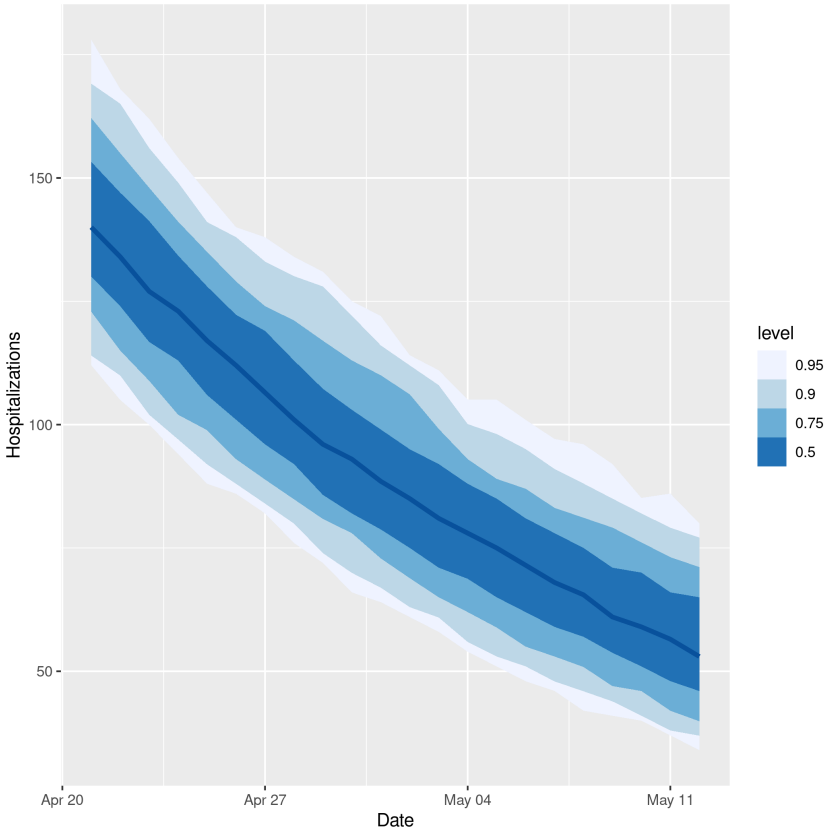
# 4 Predicted hospitalisation, next three weeks, including patients in ventilator treatment

Table 4: Number of hospitalisation beds occupied by Covid-19 patients.

| Region | 1 week prediction (28 April) | 2 weeks prediction (05 May) | 3 weeks prediction (12 May) |
|---|---|---|---|
| Norge | 102 (70-141) | 75 (47-108) | 55 (30-87) |
| Agder | 6 (0-13) | 5 (0-12) | 3 (0-10) |
| Innlandet | 7 (1-16) | 5 (0-12) | 5 (0-12) |
| Møre og Romsdal | 2 (0-8) | 2 (0-7) | 1 (0-5) |
| Nordland | 2 (0-7) | 1 (0-5) | 1 (0-5) |
| Oslo | 19 (9-32) | 13 (4-24) | 8 (1-15) |
| Rogaland | 13 (4-24) | 9 (2-19) | 6 (0-15) |
| Troms og Finnmark | 3 (0-9) | 2 (0-7) | 2 (0-7) |
| Trøndelag | 5 (0-12) | 4 (0-10) | 3 (0-7) |
| Vestfold og Telemark | 10 (1-20) | 7 (1-16) | 5 (0-12) |
| Vestland | 12 (3-23) | 8 (1-17) | 6 (0-14) |
| Viken | 24 (10-41) | 19 (7-32) | 15 (4-28) |

Yesterday's real value for Norway: 144

Predicted daily number of COVID-19 patients in hospital in Norway (95% confidence intervals and interquartile range), next three weeks, including patients ventilator treatment.




Similar table and figure for each county (fylke) available on request.

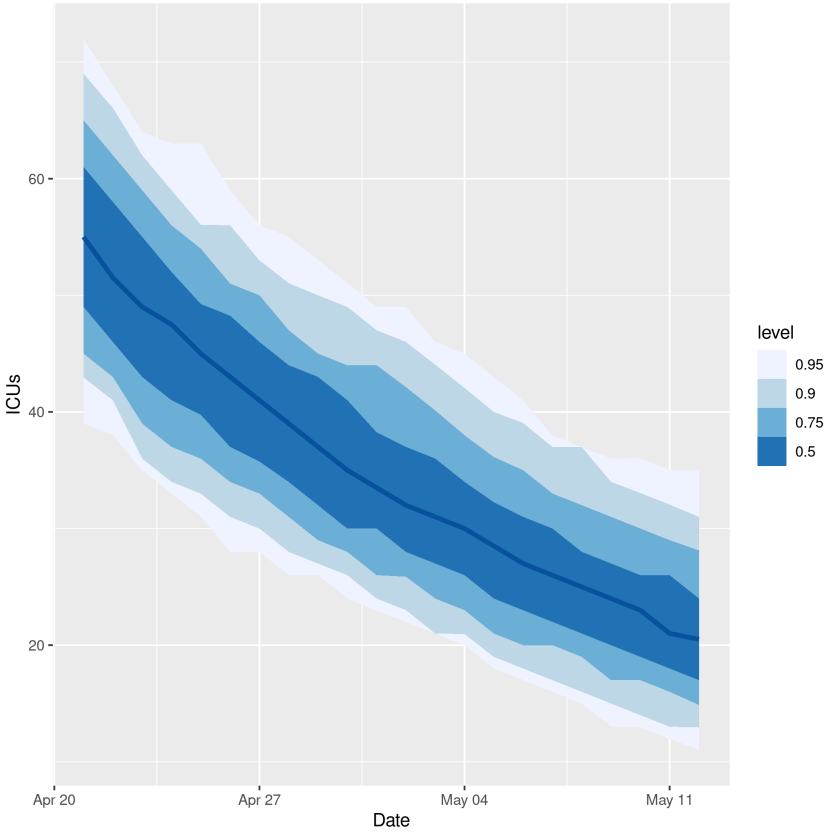
# 5 Predictive number of patients in ventilator treatment: next three weeks

Table 5: Number of ICU beds occupied by Covid-19 patients.

| Region | 1 week prediction (28 April) | 2 weeks prediction (05 May) | 3 weeks prediction (12 May) |
|---|---|---|---|
| Norge | 39 (26-55) | 29 (18-43) | 21 (11-35) |
| Agder | 3 (0-6) | 2 (0-5) | 1 (0-4) |
| Innlandet | 3 (0-7) | 2 (0-5) | 2 (0-5) |
| Møre og Romsdal | 1 (0-3) | 1 (0-3) | 0 (0-2) |
| Nordland | 1 (0-3) | 1 (0-2) | 0 (0-2) |
| Oslo | 7 (3-13) | 5 (1-10) | 3 (0-6) |
| Rogaland | 5 (1-10) | 3 (1-8) | 2 (0-6) |
| Troms og Finnmark | 1 (0-4) | 1 (0-3) | 1 (0-3) |
| Trøndelag | 2 (0-5) | 1 (0-4) | 1 (0-3) |
| Vestfold og Telemark | 4 (0-8) | 3 (0-7) | 2 (0-5) |
| Vestland | 4 (1-9) | 3 (0-7) | 2 (0-6) |
| Viken | 9 (3-17) | 7 (2-13) | 6 (1-12) |

Yesterday's real value for Norway: 40

Predicted daily number of COVID-19 patients in ventilator treatment in Norway (95% confidence intervals and interquartile range), next three weeks.




Similar table and figure for each county (fylke) available on request.

# 6 Predicted prevalence of infectious individuals, next three weeks:

Predicted daily prevalence of asymptomatic, presymptomatic and symptomatic individuals, aggregated, whole Norway, (95% confidence interval).

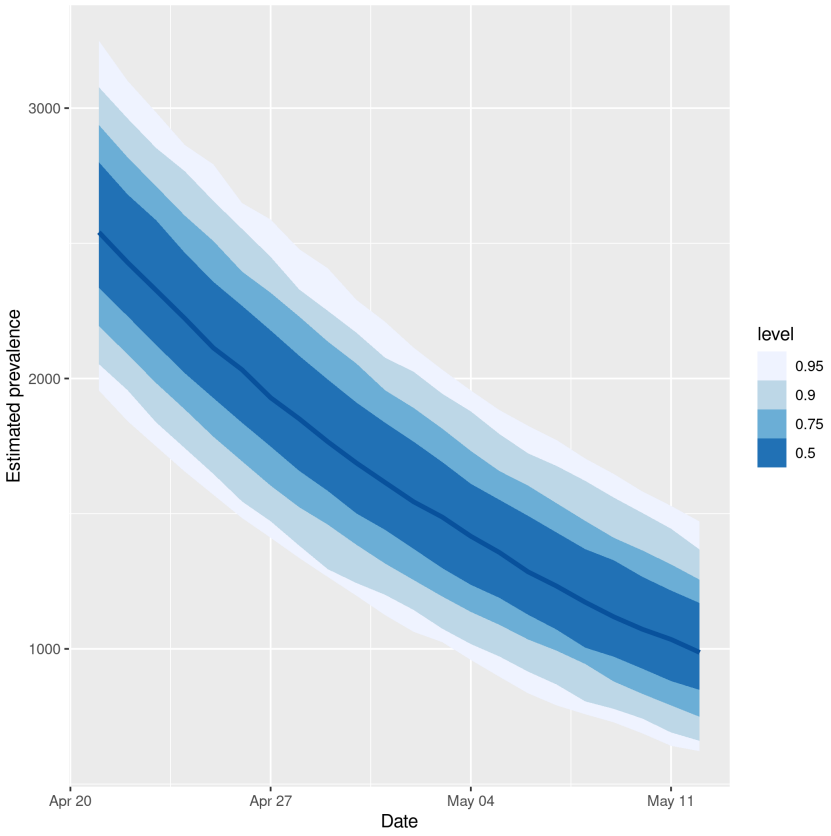
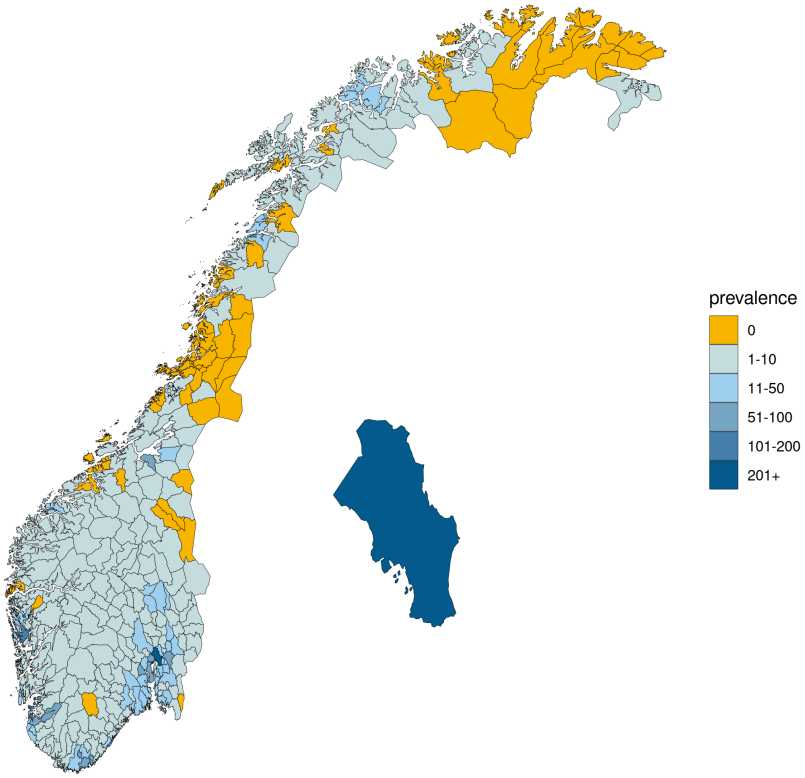



Table 6: Predicted prevalence. Number of infectious individuals (asymptomatic plus pre-symptomatic plus symptomatic) per day. Means and 95 perc. CI for three weeks prediction.

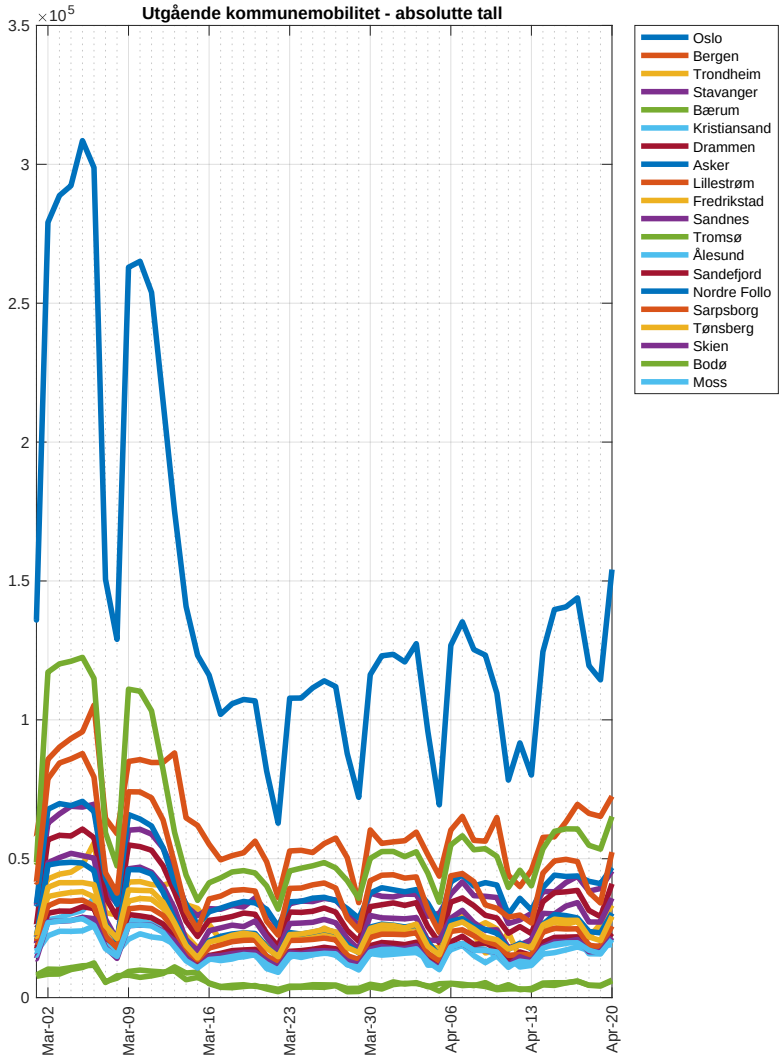
| Region | Mean, 28 April | Mean, 05 May | Mean, 12 May | low CI, 12 May | high CI, 12 May |
|---|---|---|---|---|---|
| Norway | 1865 | 1366 | 1002 | 565 | 1471 |
| Agder | 116 | 85 | 64 | 32 | 106 |
| Innlandet | 129 | 96 | 71 | 35 | 117 |
| Møre og Romsdal | 42 | 31 | 24 | 7 | 50 |
| Nordland | 33 | 25 | 19 | 5 | 42 |
| Oslo | 300 | 219 | 161 | 84 | 242 |
| Rogaland | 234 | 171 | 124 | 66 | 189 |
| Troms og Finnmark | 51 | 38 | 28 | 10 | 59 |
| Trøndelag | 94 | 68 | 51 | 18 | 94 |
| Vestfold og Telemark | 152 | 111 | 82 | 37 | 132 |
| Vestland | 205 | 152 | 111 | 54 | 185 |
| Viken | 513 | 374 | 273 | 145 | 417 |

Map of predicted prevalence. Number of infectious individuals (asymptomatic plus presymptomatic plus symptomatic) today in each municipality.



# 7 Mobility between municipalities

Number of trips out from each municipality during each day, based on Telenor mobility data. We have observed a large reduction in inter-municipality mobility in week 11 (around March 11), with a minimum reached on Tuesday 17 March. The reduction with respect to the weeks before (for example week 10) is on average 50%. Thereafter, we observe a slight increasing trend: in Oslo, for example, out-mobility has increased of roughly 2% per day in the last three weeks. Weekends still have a lower mobility, indicating that there is still some commuting-to-job during weekdays. On Tuesday April 14th, mobility was only reduced by 38% compared to before restrictions. On Monday April 20th, when kindergarten have started to re-open, the reduction was only 23%.



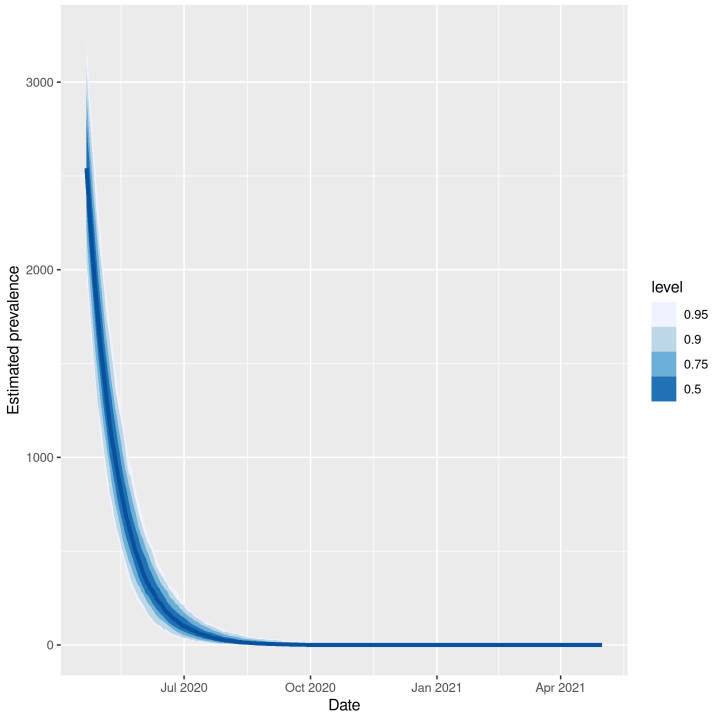
Percentage reduction in total mobility out from each municipality: Monday April 13th is compared to Monday March 2nd (last Monday before restrictions); Tuesday April 14 is compared to Tuesday March 3, etc. until Monday April 20th is compared to Monday March 2nd.

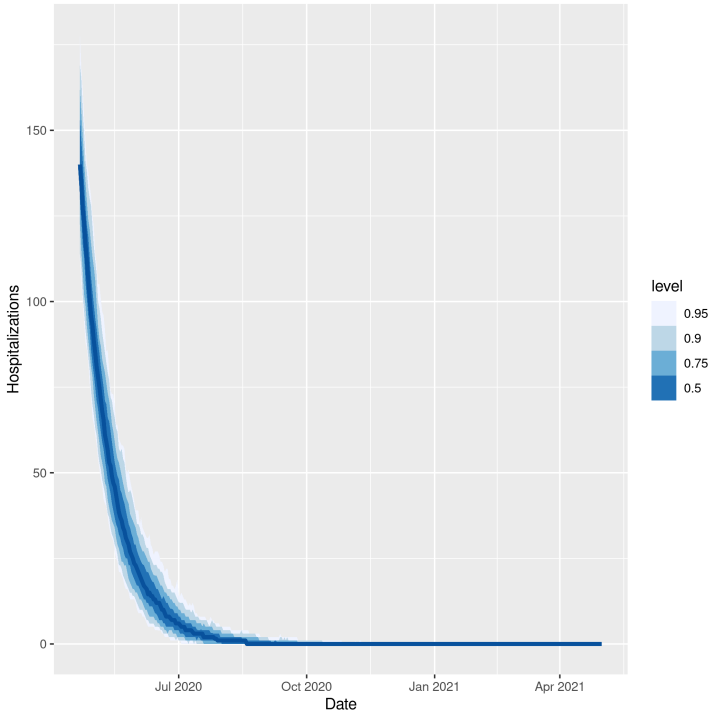
| | Man_13 | Tirs_14 | Ons_15 | Tors_16 | Fre_17 | Mon_20 |
|---|---|---|---|---|---|---|
| Hele Norge | 52% | 38% | 35% | 35% | 33% | 23% |
| Oslo | 71% | 57% | 52% | 54% | 52% | 45% |
| Bergen | 47% | 36% | 38% | 34% | 34% | 15% |
| Trondheim | 68% | 45% | 45% | 45% | 51% | 22% |
| Stavanger | 52% | 42% | 45% | 40% | 37% | 27% |
| Bærum | 66% | 55% | 51% | 50% | 47% | 44% |
| Kristiansand | 44% | 36% | 38% | 38% | 41% | 23% |
| Drammen | 59% | 41% | 35% | 37% | 33% | 28% |
| Asker | 54% | 43% | 36% | 38% | 35% | 31% |
| Lillestrøm | 66% | 47% | 43% | 43% | 38% | 33% |
| Fredrikstad | 47% | 31% | 28% | 28% | 23% | 20% |
| Sandnes | 57% | 40% | 42% | 35% | 32% | 26% |
| Tromsø | 67% | 46% | 57% | 51% | 53% | 29% |
| Ålesund | 48% | 34% | 32% | 29% | 29% | 14% |
| Sandefjord | 50% | 36% | 30% | 33% | 32% | 24% |
| Nordre Follo | 63% | 46% | 39% | 39% | 37% | 36% |
| Sarpsborg | 54% | 32% | 28% | 30% | 25% | 22% |
| Tønsberg | 55% | 37% | 32% | 33% | 32% | 26% |
| Skien | 52% | 33% | 27% | 30% | 26% | 21% |
| Bodø | 68% | 48% | 50% | 53% | 49% | 39% |
| Moss | 53% | 36% | 31% | 31% | 24% | 23% |

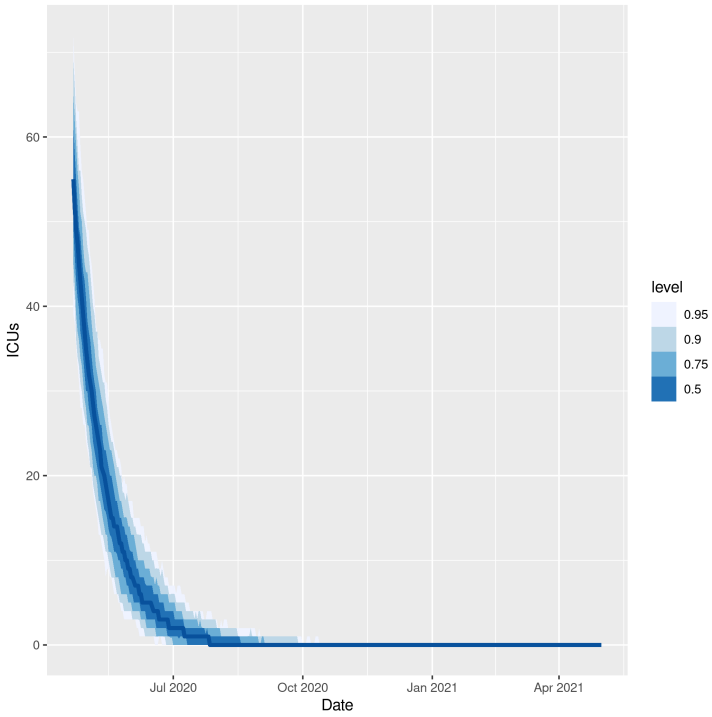
# 8 Long-term prediction results

Predicted daily number of COVID-19 patients in hospital and receiving ventilator treatment in Norway until the end April, 2021, in addition to prevalence. The figures are made using 1 runs of each of the 200 candidate models, where the $R_{eff}$ is varying accordingly.

The confidence intervals reflected on the plots are two tailed around the median, and therefore the upper 95 % level shows the 97.5 % boundary.

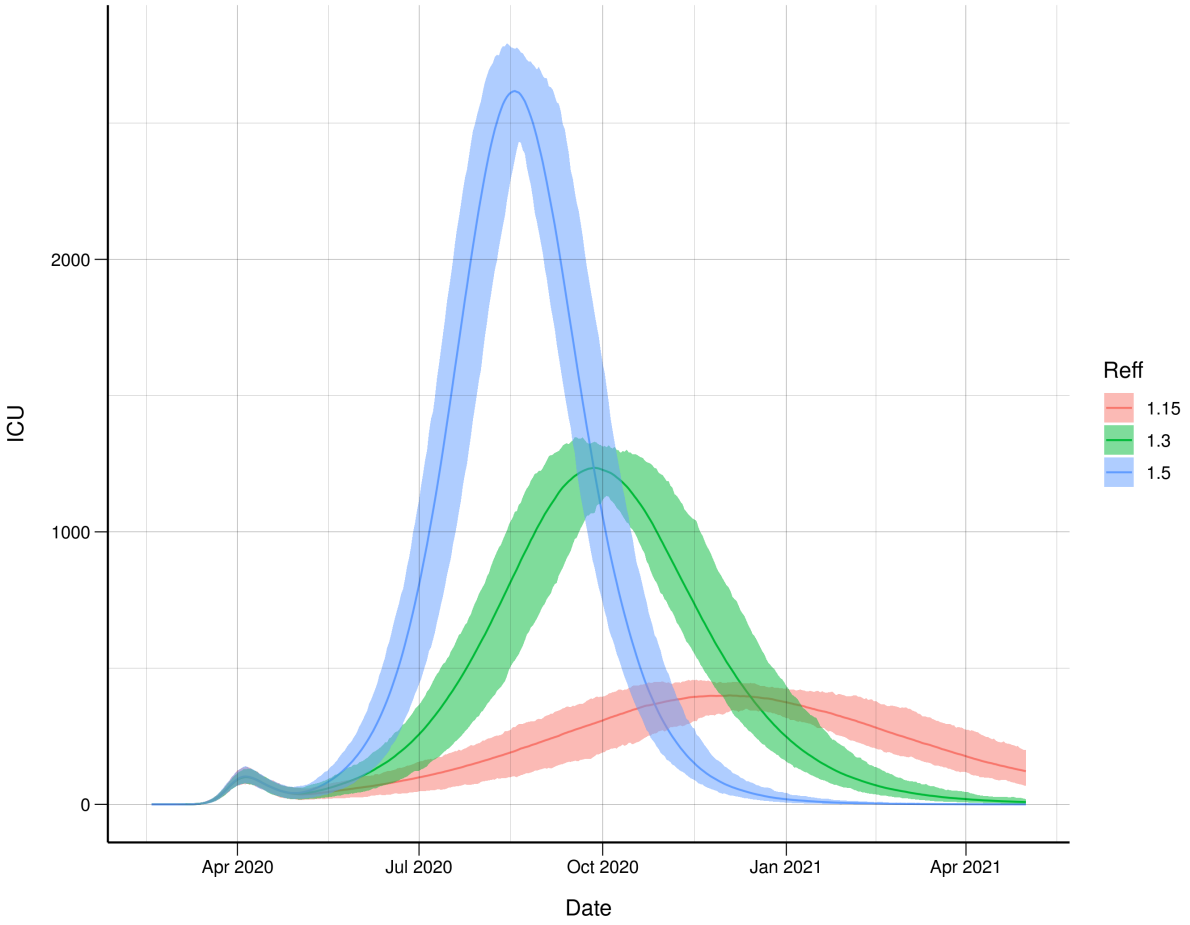



Hospitalizations
150
100
50
0
Jul 2020
Oct 2020
Jan 2021
Apr 2021
Date
level
0.95
0.9
0.75
0.5


ICUs
60
40
20
0
Jul 2020
Oct 2020
Jan 2021
Apr 2021
Date
level
0.95
0.9
0.75
0.5

# 9 Long-term scenario results

Here we show how the epidemics will develop, from April $13^{th}$ if the reproductive number would increase to 1.15, 1.3 and 1.5 respectively. We show the daily number of covid-19 patients with ventilator treatment.

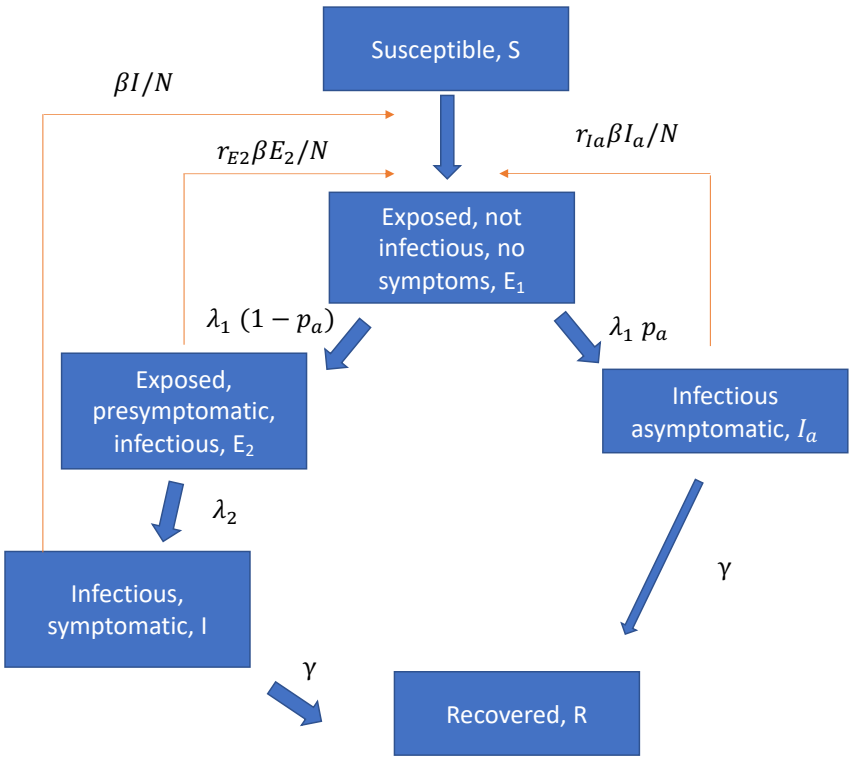


# Model

We use a metapopulation model to simulate the spread of COVID-19 in Norway in space and time. The model consists of three layers: the population structure in each municipality, information about how people move between different municipalities, and local transmission within each municipality. In this way, the model can simulate the spread of COVID-19 within each municipality, and how the virus is transported around in Norway.

## Transmission model

We use an SEIR (Susceptible-Exposed-Infected-Recovered) model without age structure to simulate the local transmission within each area. Mixing between individuals is assumed random. Demographic changes due to births, immigration, emigration and deaths are not considered. The model distinguishes between asymptomatic and symptomatic infection, and we consider presymptomatic infectiousness among those who develop symptomatic infection. In total, the model consists of 6 disease states: Susceptibles (S), Exposed, infected, but not infectious (E), Presymptomatic infected (E2), Symptomatic infected (I), Asymptomatic infected (Ia), and Recovered, either immune or dead (R). A schematic overview of the model is shown below:




## Movements between municipalities:

We use 6-hourly mobility matrices from Telenor to capture the movements between municipalities. The matrices are scaled according to the overall Telenor market share in Norway, estimated at 48%. Since week 8, we use the actual daily mobility matrices to simulate the past. In this way, alterations in the mobility pattern will be incorporated in our model predictions. To predict future movements, we use the latest weekday measured by Telenor. We follow closely the development in the mobility matrices, and weekend patterns will be introduced if needed.

## Healthcare utilization

Based on the estimated daily incidence data from the model and the population age structure in each municipality, we calculated the hospitalization using a weighted average. The hospitalization is assumed delayed relative to symptom onset. We calculate the number of patients admitted to ventilator treatment from the patients in hospital using age adjusted probabilities and an assumed delay.

## Seeding

At the start of each simulation, we locate 5.367.580 people in the municipalities of Norway according to data from SSB per January 1. 2020. All confirmed Norwegian imported cases with information about residence municipality and test dates are used to seed the model, until 18th March. For each case, we add an additional random number of infectious individuals, in the same area and on the same day, to account for asymptomatic imported cases who were not tested or others missed. This is called amplification factor.

## Reproduction number and calibration

We assume a reproduction number $R_0$ until March 14 and a new effective reproduction number $R_{eff}$ active from March 15 until today, and in the future when we predict. We estimate the reproduction numbers $R_0$ and $R_{eff}$ so that the predicted number of hospitalized individuals is closest to the true number of hospitalized individuals, from March 10 until today. Restrictions introduced on March 12 require a change in the effective reproduction number. We use a method called sequential ABC which tests thousands of combinations of $R_0, R_{eff}$ and the amplification factor, to determine the 200 ones that lead to the best fits of hospitalisations. Then we run 1 simulation of the future for each of these 200 best parameters.

## Update notes: what is new in this report.

Here we list aspects of the model or of the input parameters which have changed compared to previous reports, and we explain the reason for these changes. Some changes will have big effects on some of our estimates.

– 14 April: **Hospitalisation risk:** Our model requires the specification of the proportion of symptomatic and asymptomatic patients requiring hospitalisation. Previously we used estimates from Verity et al. (2020) based on Chinese data, adapted to the Norwegian demography, and to the reduced mobility of elderly patients living in elderly homes. We summarised this proportion to be 5.6%. Under these assumptions, our model estimates a cumulative number of infected individuals of ca. 14.000. As we have had ca 135 confirmed deaths in Norway, this corresponds to an Infection Fatality Ratio (IFT) of roughly 1%. However, international studies indicate that the IFT should be around 0.3% (https://www.cebm.net/covid-19/global-covid-19-case-fatality-rates/). We therefore calibrate our model to this IFT (in addition to calibrate the model to the hospitalisation data), by adjusting the hospitalisation risk in our model, reducing it by a third, to 1.85%. The effect of this change is visible on the estimated cumulative number of infected individuals, which is now approximately 45.000. A further effect of this change is that the reproductive numbers are different, with $R_0$ larger and $R_{eff}$ smaller than before, when we had a higher hospitalisation risk.

– 14 April: **Change point for the reproductive number:** On March 12, a number of contact restrictions were implemented. During that week 11, mobility was reduced significantly, and appears to stabilize on Monday March 16th. Between the 11th and 16th of March we expect a reduction of the reproduction rate. We model this change as a sudden jump from a first reproduction rate $R_0$ to a second and lower reproduction rate $R_{eff}$, through a change in the model parameter $\beta$. We have chosen Monday March 15 as the changepoint for the reproductive number because it gives the best fit to the hospitalisation data. If we move the changepoint to March 14, or assume a

continuous linear reduction during week 11, the fit deteriorates. We also notice that the best changepoint depends on the assumed time between symptoms appearance and hospitalisation, which is assumed to have mean 8 days in this report. The optimal changepoint also depends on the assumed hospitalisation risk.

– 20 April: **Change in parameter estimation method:** We use sequential ABC instead of iterative parameter calibration. Estimation of the reproduction numbers and of the amplification factor in the seeding of the epidemic at the start is done using Approximate Bayesian Computation (ABC), as described in Engebretsen et al. (2020): https://www.medrxiv.org/content/10.1101/2020.03.11.20033555v1. Sequential ABC avoids to calibrate $R_0$ first on part of the data and then, given the best values of such $R_0$, to find the best fitting $R_{eff}$, which might not lead to optimal estimation and is based on more ad-hoc choices. We also do not weigh the last part of the data more than the rest. Sequential ABC takes more time to run: therefore the daily report might use only the hospitalisation until yesterday.

# Parameters used today

Table 7: Assumptions I

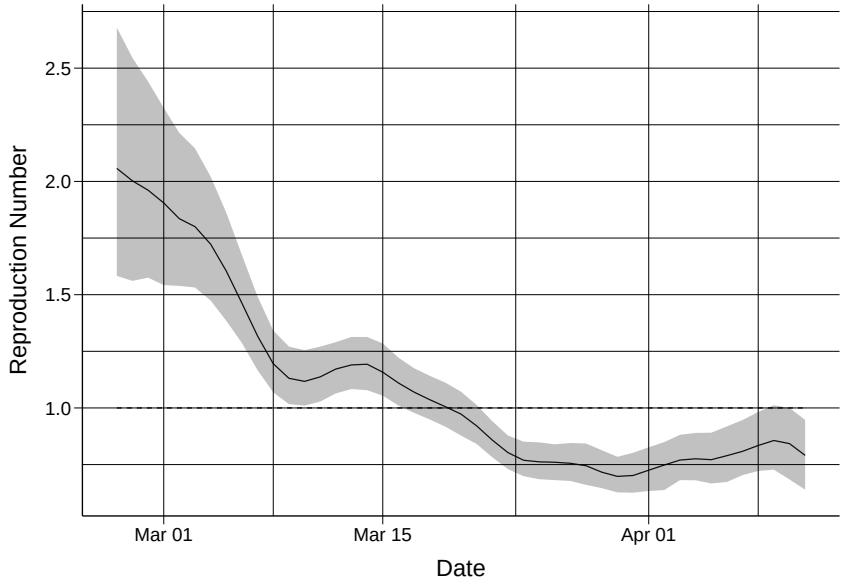
| Assumptions | Mean | Distribution | Reference |
|---|---|---|---|
| **Seeding** | | | |
| Scaling factor on imported cases | Min. 1.38<br>1st Qu. 1.97<br>Median 2.24<br>Mean 2.23<br>3rd Qu. 2.48<br>Max. 3.17 | random | Calibrated to hospitalizations |
| Telenor coverage | 48% | | https://ekomstatistikken.nkom.no/ |
| **Model parameters** | | | |
| Exposed period ($1/\lambda_1$) | 3 days | Exponential | Fraser et al. Not published |
| Pre-symptomatic period ($1/\lambda_2$) | 2 days | Exponential | Fraser et al. Not published |
| Symptomatic infectious period ($1/\mu$) | 5 days | Exponential | Fraser et al. Not published |
| Asymptomatic, infectious period ($1/\mu$) | 5 days | Exponential | Fraser et al. Not published |
| Infectiousness asympt. ($r_{I_a}$) | 0.1 | Fixed | Fraser et al. Not published |
| Infectiousness presymp ($r_{E_2}$) | 1.25 | Fixed | Fraser et al. Not published |
| Prob. asymptomatic infection ($p_a$) | 0.4 | | Fraser et al. Not published |
| $R_0$ (until March 14) | Min. 2.58<br>1st Qu. 2.99<br>Median 3.14<br>Mean 3.14<br>3rd Qu. 3.29<br>Max. 3.73 | random | Calibrated to hospitalizations |
| $R_{eff}$, from 15 March until today | Min. 0.58<br>1st Qu. 0.64<br>Median 0.66<br>Mean 0.66<br>3rd Qu. 0.68<br>Max. 0.75 | random | Calibrated to hospitalizations |

Table 8: Assumptions II

| Assumptions | Mean | Distribution | Reference |
|---|---|---|---|
| **Healthcare** | | | |
| Time sympt. onset to hospitalisation | 8 days | Poisson | |
| Fraction asymptomatic infections | 40% | Fixed | Mizumoto et al 2020<br>20% for the old population, Diamond Princess |
| % symptomatic and asymptomatic infections requiring hospitalization:<br>0-9 years<br>10 - 19 years<br>20 - 29 years<br>30 - 39 years<br>40 - 49 years<br>50 - 59 years<br>60 - 69 years<br>70 - 79 years<br>80+ years | <br><br>0.00%<br>0.013%<br>0.37%<br>1.13%<br>1.43%<br>2.73%<br>3.93%<br>5.53%<br>5.33% | Fixed | Verity et al 2020<br>corrected for: % of elderly living in of elderly living in Norway (last two age groups).<br>Also corrected by 1/3 to account for severity in comparison with the expected fatality rate. |
| % hospitalized patients requiring ICU<br>0-9 years<br>10 - 19 years<br>20 - 29 years<br>30 - 39 years<br>40 - 49 years<br>50 - 59 years<br>60 - 69 years<br>70 - 79 years<br>80+ years | <br>5%<br>5%<br>5%<br>5%<br>6.3%<br>12.2%<br>27.4%<br>43.2%<br>70.9% | Fixed | Verity et al 2020 |
| Overall hospitalization risk | 1.9% | Fixed | Verity et al 2020<br>(adapted to Norwegian population) |
| Normal hospitalization length | 8 days | Poisson | Ferguson et al 2020 |
| Time in hospital before ICU | 4 days | Poisson | Ferguson et al 2020, Expert opinion |
| Time in ICU | 12 days | Poisson | Ferguson et al 2020, Expert opinion |
| **Mobile phone mobility** | | | |
| Until April 20 | Measured Telenor mobility | | |
| Data used in the predictions | April 20 | Fixed | Corrected to preserve population |

## Supplementary analysis: Instantaneous Reproduction Number based on lab-confirmed cases only, EpiEstim

These following results are based on confirmed cases and should be interpreted very carefully due to the multiple changes in testing criteria during this period. During the early part of the period, testing was mainly based on travel to areas with an ongoing outbreak, while the last two weeks have changed to testing people with an acute respiratory infection. The fact that the reproduction number is close to or bellow one corresponds to the break in the exponential growth in confirmed cases. The last two weeks have seen a fairly constant rate of new confirmed cases.
Using the date of onset of the confirmed cases from the outbreak registry we estimate the instantaneous reproduction number using the procedure outlined in Thompson et Al (2019). This method, implemented in the EpiEstim R-package uses a Bayesian method to estimate the instantaneous reproduction number smoothed over a sliding window of 7 days. For data without onset date, we estimate an onset date by subtracting 7 days, which is the mean delay between the date of onset and reporting date in the data, from the reporting date. The serial interval was assumed at 5 days with uncertainty; the serial interval refers to the time between symptom onset between successive cases in a chain of transmission (see https://www.medrxiv.org/content/10.1101/2020.02.03.20019497v2). To account for censoring of observations with onset dates in the last few days we correct the observed data by the mean of a negative binomial distribution with observation probability given by the empirical cumulative distribution of the onset to reporting date distributions. Due to this correction, the results from the last few days should be interpreted with caution. These dates are indicated by the weaker colours.



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