Folkhälsomyndigheten

Scenarier för fortsatt spridning – delrapport 8

Delrapport inom regeringsuppdraget att löpande uppdatera scenarier för hur smittspridningen av det virus som orsakar sjukdomen covid-19 kan komma att utvecklas framöver

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About the publication

The Swedish Public Health Agency presents scenarios for continued spread of covid-19 during the period 20 February to 20 May 2022. The report is a partial report within government assignment S2021 / 05258 which replaces previous government assignments *to continuously update scenarios for how the spread of the virus that causes covid-19 can occur. to be developed in the future,* S2020 / 08831, and the government assignment *regarding infection control measures in society,* S2021 / 00001.

The work has been performed at the unit for analysis.

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Content

Summary

The report, which is a partial report on the government's assignment to continuously update scenarios for how the spread of the virus that causes covid-19 disease may develop in the future, S2020 / 0528, presents two scenarios for the spread of covid-19 until 20 May 2022.

In scenario 0, we assume that the omicron continues to circulate. In scenario 1, it is assumed that a new variant of the virus will be introduced on March 20 and that protection against the new variant, after vaccination or infection with omicron, will only last for three months. Results from scenario 0 show that the spread of infection decreases and is at very low levels after February 2022, while the results from scenario 1 with the introduction of a hypothetical new virus variant of particular importance show an increased spread of infection in the spring of 2022 with a peak in mid-May.

The new scenarios are more uncertain than those previously presented. One factor is that the dark figure in the spread of infection is now higher, due to changed recommendations for testing. In addition, scenario 1 is based on the assumption that an unknown and hypothetical virus variant would be introduced.

The Public Health Agency's assessment is that, based on the scenarios, there is no reason to introduce additional infection control measures at present or in the near future. Measures in health care and care for the elderly are still important in order to protect those at high risk of serious covid-19 disease. Good adherence to basic hygiene routines and other care hygiene routines is the basis for preventing the spread of infection. In addition to this, source control, symptom testing and infection tracking are important tools to protect those at greatest risk for serious consequences of the disease.

Businesses can also, if necessary, use screening for covid-19 to reduce the risk of introducing infection. The measures need to be adapted to regional and local conditions.

Epidemiological surveillance no longer focuses on monitoring the spread of infection in society, but the main purpose is to monitor trends and their most serious consequences. Monitoring continues on the basis of confirmed cases from testing of the groups in society that the Swedish Public Health Agency recommends, including sequencing of positive samples and external monitoring with special focus on new virus variants of particular importance. Beyond that is
monitoring with supplementary data sources, such as syndrome monitoring, prevalence studies and targeted studies, important for assessing the epidemiological situation.

Depending on the characteristics of a possible new variant, different infection control measures may be relevant (scenario 1). If it is a variant that does not cause more serious disease than the omicron variant and that the vaccine protection against serious disease persists, the need for additional infection control measures is considered to be very small. Is it, on the other hand, a variant that in addition to the ability to circumvent protection

from vaccination and previous infection also causes serious illness in more people, additional infection control measures may be necessary. In the first instance, targeted measures to identify suspected cases through extended testing to more groups in society than those currently recommended for testing should be introduced, as well as subsequent infection tracing to identify and break chains of infection at an early stage. At present, the risk of an introduction of such a variant is not considered likely.

Based on the extensive immunity obtained through vaccination in combination with a large number of individuals having a covid-19 infection during the

Recently, the risk that a new virus variant would cause serious illness in a significant part of the population is considered small. The need for general societal measures to generally reduce the contact intensity is therefore not considered to be relevant during the time period for which the simulation applies. On the other hand, it is likely that the spread of covid-19 in the longer term will give rise to the need for recurring vaccination measures for all or parts of the population, infection control measures in health care and care activities for the elderly in the coming winter seasons. It will therefore continue to be important to monitor the morbidity of covid-19 and that the vaccination effort continues.

The report shows graphs of simulated cases at national level. Detailed output for all scenarios is presented in a separate appendix. Scenario 1 is hypothetical and is based on assumptions about the introduction of a completely new virus variant of special significance, such a variant is currently not proven either in Sweden or globally.

The scenarios are designed to illustrate possible processes and should not be construed as forecasts. The purpose is to provide support for planning care resources.

Background

We have created scenarios for the spread of covid-19 until 20 May 2022. Modeling of the number of cases has been done nationally. The scenarios have been developed within the government assignment to continuously update scenarios for how the spread of the virus that causes covid-19 disease may develop in the future, S2020 / 0528. The modeling is updated continuously, with the next interim report on April 20, 2022.

Purpose

The purpose of these scenarios is to demonstrate a possible development of the spread of covid 19 over the next three months. The scenarios have been developed to form the basis for planning care resources. The work is a partial report of the government assignment to continuously update scenarios for how the spread of the virus that causes covid-19 disease may develop in the future, S2020 / 0528

Method

We have developed scenarios that illustrate a continued spread of covid-19 during the period 20 February to 20 May 2022. The modeling includes both reported cases and unconfirmed cases, of which the latter constitute the so-called dark number. Unconfirmed cases also contribute to the spread of infection but are not shown in the graphs. The Swedish Public Health Agency estimates that the number of deaths during the wave of infection spread caused by the omicron variant is higher than in 2021, which is why the uncertainty regarding the number of simulated cases is judged to be great.

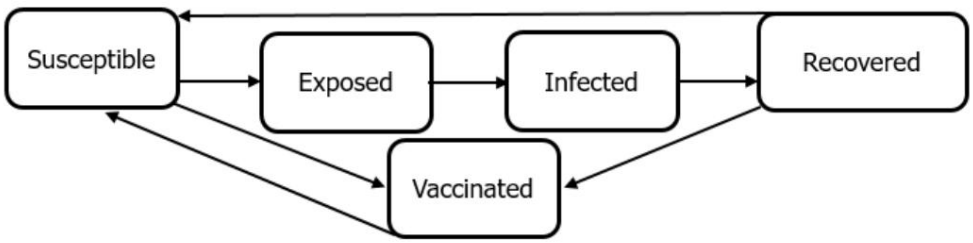
Model description

In the modeling, we use an epidemiological spread model called VirSim, which is a so-called trade model that divides the population into the trade unions Susceptible (susceptible), Exposed, Infected and Recovered; S, E, I, R. In this modeling, VirSim is age-divided into three groups, groups 0-19, 20-69 and 70 years and older. We use population data from Statistics Sweden (SCB 2019) and data on reported cases of covid-19 from SmiNet, which is the Swedish Public Health Agency's system for reporting cases of notifiable diseases from the health service.

The section Infected is divided into reported and unconfirmed cases. Reported cases correspond to the cases that have been confirmed via sampling and reported to the Swedish Public Health Agency via SmiNet. Unconfirmed cases correspond to cases that have not been reported in SmiNet and constitute the so-called dark number. A simplified description of the model can be found in Figure 1. The time horizon in the modeling is three months and the time step is one day. The part of the population that is not or has been ill with covid-19, or received and had the effect of vaccination, is in the compartment susceptible (Susceptible), and a subset is then moved each time step further according to the arrows in Figure 1. Over time, protection against infection from both infection and vaccination, this is illustrated in Figure 1 with arrows back to the compartment susceptible.

The generation time in the model, which consists of the incubation period and the infectious period, is set at approximately five plus five days for the original variant of the virus. For the alpha, delta and omicron variants, the generation time is set at three plus five days.

Figure 1. Simplified flow chart of the model



Immunity and vaccination in the model

In the modeling, we assume that all infected people, both reported cases and unconfirmed cases, receive immunity and that they thus have protection against infection for a period of time. The protection against infection with the original variant of the virus, or the alpha or delta variants, is set to one year after infection with the same variants.

The protection against infection with the omicron variant is set at 3 months after infection with the original, alpha or delta variant. In summary, we divide the virus variants into two groups, where group 1 consists of all variants before omicron and group 2 of omicron and any new virus variant of special importance. The person who is infected receives protection that lasts for one year against infection by the same virus variant
(same group) but only for three months against a new variant (different group). For example, a person infected with the alpha variant has protection against infection of the alpha or delta variant for one year, but only for three months against infection of the omicron variant.

People who have been infected by the omicron variant have protection against new infection of the omicron variant for one year, but should a new variant occur, we assume that the protection from the omicron variant only remains for 3 months against the new variant.

In all simulated scenarios, vaccination is included. The following paragraphs briefly explain the various assumptions made regarding vaccination in the model.

Assumptions for vaccination in the simulation

In the model, we assume that all people who are 12 years and older in Sweden have been offered vaccines at the start of the simulation. We also assume that certain age groups,
or proportions of age groups, have been offered dose three at the beginning of the simulation or are offered dose three during the time horizon of the simulation.

The following are further assumptions for vaccines in the model:

- Vaccination coverage for the first dose is assumed to be 95 percent for persons 70 years and older. The corresponding figure for people aged 16-69 is 85 percent and in the group of people 12-15 a vaccination coverage of 75 percent is assumed.

- All people who receive a first dose in the modeling also receive a second dose. We assume that 90 percent of people older than 70 years and healthcare professionals who have taken their second dose also take their third dose. Corresponding figure for the group 20-69 years is 75 percent.
- We assume that the vaccine effectiveness against infection caused by the omicron variant gradually decreases and that the protection against infection after three months has ceased.

Vaccination is assumed to protect against both infection and infectivity in the model, which means that the proportion of the vaccinated who are protected from infection does not infect others either.

- The proportion of those vaccinated who do not receive protection against infection, or have lost their protection, is assumed to be as contagious as those who have not been vaccinated if they become infected.

- Protection against the original variant and the alpha variant: In the model, we have assumed a 60 percent protective effect of AstraZeneca's vaccine Vaxzevria® and around 90 percent of the mRNA vaccines (Pfizers Comirnaty® and Moderna's vaccine) against the original virus variant and against the alpha variant. These figures come from the vaccine manufacturers' own pre-registration studies and refer to the effect against symptomatic covid-19. Follow-up studies have shown a similar, very good protective effect against severe disease for the three vaccines.

  Studies that in a good way compare the protective effect of all available vaccines, in the same population, in the same place and with the same circulating virus variants are currently to a very limited extent. It is therefore not possible to directly compare the measures of vaccine protection that form the basis for the model's assumptions.

- Protection against the omicron variant: The protective effect against infection with the omicron variant is assumed to be zero after the first dose and 20 percent after the second dose. The protective effect after a third dose is assumed to be 50 percent.
- Protection against the delta variant: The protective effect against infection with the delta variant after vaccination is 35 percent after the first dose and 70 percent after two and three doses in the model.

Note that the protective effect of the vaccines against severe disease is higher and lasts longer.

Vaccination logic

In the case of vaccination, a proportion of the population in the Susceptible, or Recovered, compartments is transferred to the Vaccinated compartment at the rate at which the vaccination is assumed to take place until the assumed coverage rate is reached (see Figure 1). A share, corresponding to (1-assumed vaccination effect) is moved to Exposed. The protection of the vaccine against infection with the omicron variant decreases with time and three months after dose three, protection against infection has ceased.

The alpha, delta and omikron variants

We assume that the Alpha variant is 50 percent more contagious than the original variant. Alfa was introduced in the model on December 4, 2020. The Delta variant is assumed in turn to be 70 percent more contagious than the alpha variant. The introduction of the delta took place on 5 May 2021 in the model. The number of cases and dates for introduction are obtained from optimization.

We assume that the omicron variant has a 25 percent higher infectivity than the delta variant. The omikron variant will be introduced in the model on November 25, 2021 and dominates completely after mid-January 2022.

Adaptation of the model

The model has been adapted to reported cases until 10 February 2022.
The adjustment is made through optimization. Slightly simplified, we let the model apply for it

value of the model parameters *infectivity, contact intensity* and *dark numbers* for each age group and time period, which causes the model to generate reported cases that follow the actual development as well as possible provided that certain conditions are met.

In the adaptation, the model's proportion of infected persons, with an ongoing infection, needs to correspond with the proportion of PCR-positive persons according to the Gloria surveys corresponding period of time, we start from the surveys Gloria 3, 4, 6, 7, 10, 15, 16 and 171 . Previously published report2 describes the method used in more detail. We assume that infected people in the exams on average get positive results in PCR tests for ten days. In the model, the compartment Recovered is divided into two parts: a part where previously infected individuals who have recovered, but who are still assumed to test positive on a PCR test, end up.
The person stays there for an average of five days and is then transferred to the second part of Recovered, where individuals are no longer assumed to test positive on a PCR test. This means that all cases in the Infected compartments, both reported and unconfirmed cases, and the first part of the Recovered compartment, must be accommodated within the confidence interval for the respective age group and time period (see Table 1). When this condition is met, together with other conditions, we get the proportion of unconfirmed cases for the age groups during the period, which gives the value the dark number.

Table 1. Total proportion of PCR-positive people in the population based on Gloria surveys.

Investigation	0-19 KI Lower (percent)	0-19 KI Upper (percent)	20-69 KI Lower (percent)	20-69 KI Upper (percent)	70 years and older KI Lower (process nt)	70 years and older KI Upper (process nt)
Gloria 3	0.1	1.7	0.4	1.4	0.0	0.2
Gloria 4	0.0	0.2	0.2	0.8	0.0	0.8
Gloria 6	0.0	0.8	0.0	0.2	0.0	0.6
Gloria 7	0.0	0.9	0.0	0.2	0.0	0.6
Gloria 10	1.0	5.2	0.2	1.0	0.1	2.4
Gloria 15	0.2	0.9	0.4	1.6	0	1
Gloria 16	0.1	1.6				
Gloria 17	0.4	6.1	0.0	0.4	0.0	1.8

Another condition determines how large a part of the model's population should have formed antibodies, either after vaccination or a previous infection. Not all individuals vaccinated in the model are assumed to form antibodies: 75 percent of those under 70 years of age and 70 percent of those over 70 years of age are assumed to form antibodies after a dose and 95 percent of those under the age of 70 and 90 percent of those over the age of 70 form antibodies after two doses. The proportion is based on our studies on the detection of antibodies to covid-19, by analysis of immunity levels in blood samples from outpatient care3 . Table 2 shows the values that the model must match. These antibody levels do not protect against infection.

Table 2. Proportion of immune in different age groups at different times 2020 and 2021.

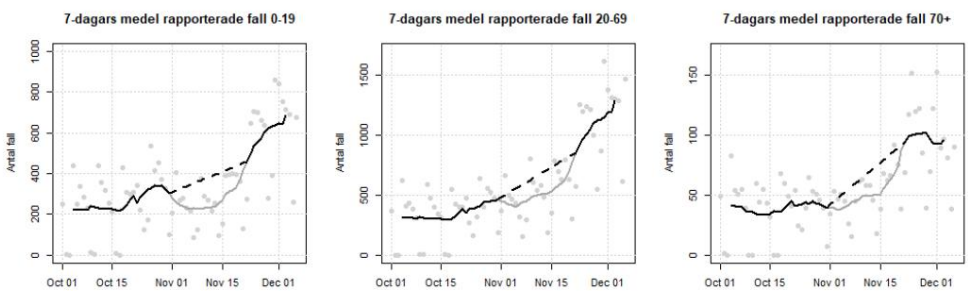
Survey 0-19 KI	Lower (percent)	0-19 KI Upper (percent)	20-69 KI Lower (percent)	20-69 KI Upper (percent)	70 years and older KI Lower (percent)	70 years and older KI Upper (percent)
2020 v 22	2.0	6.4	4.1	9.3	0.5	5.4
2020 v 42-43	4.4	7.1	6.0	8.8	0.9	2.7
2020 v 48-49	9.4	12.8	5.9	9.2	2.1	4.7
2021 v 9-10	21.0	25.1	19.2	23.0	12.4	17.4
2021 v 21-22	26.6	31.3	52.8	58.1	83.1	88.3
2021 v 38-39	39.3	44.9	84.0	88.6	85.6	90.7

The value of the contact intensity parameter has no explicit restrictions, it can vary in the range 0 to 1. The parameter describes the age group's relative decrease in the number of daily contacts compared to the time just before the pandemic, when contact intensity was 1. Other factors affecting the spread are included, such as weather. and whether the contacts take place indoors or outdoors. The initial number of contacts per day has been taken from the POLYMOD study4 .

During the period 1-21 November 2021, the sampling indication for covid-19 in Sweden was changed. To correct for any underreporting (larger dark numbers) as a result of reduced testing, we have assumed that the number of cases follows the trend of the seven-day average for 31 October 2021 and 22 November, see Figure 2 below.

The sampling indication was changed again on 20 January and 9 February in such a way that fewer tests are recommended, which results in higher dark numbers.
For these periods, we have no new Gloria or immunity studies to adapt the model to. We assume that changed testing leads to further higher dark numbers and have therefore added two periods when the dark number is gradually increased, an increase in the period November-December 2021 and a further increase in January 2022 and onwards.

Figure 2. Corrected number of cases used in the model during the period 30 October - 22 November 2021



Hospital admissions

The risk of need for inpatient care in the intensive care unit is based on data from the National Board of Health and Welfare for January 2022. The risk of need for inpatient care in the regular care ward is based on data from the National Board of Health and Welfare for December 2021 and January 2022. in a regular ward is age-dependent and is based on data on hospitalizations of patients with a primary diagnosis of covid-19. The risks used in the scenarios are presented in Table 3 below.

Due to data delays, the risks are always based on data that is one to three months old.

Table 3. Risk of need for hospital care per age group

Type of care	0-19 years (percent)	20-69 years (percent)	70 years and older (percent)
Risk of needing care in a regular ward (per cent)	0.29	0.49	8.69
Risk of need for intensive care (percent)	0.02	0.03	0.46

Scenarios

We have developed two scenarios for continued dissemination during February 20 to May 20, 2022 called scenario 0 and scenario 1. The scenarios illustrate a possible development of the spread of infection over the next three months, until 20 May 2022

In scenario 0, we assume that the omicron continues to circulate, while in scenario 1 we assume that a new variant of the virus is introduced on March 20 and that protection against the new variant, after infection with omicron, lasts only three months.

Results

Below, simulated results are presented nationally for scenarios 0 and 1. The models are simulated until 20 May 2022. For each scenario, we present two graphs of cases, a graph with all age groups and a graph with only the group 70 years and older. Then we show a graph of expected new hospital admissions for all ages for scenarios 0 and 1 based on each age group's risk of admission to a regular ward and intensive care unit, respectively.

Results from scenario 0 show that the spread of infection decreases and is at very low levels after February. The results from scenario 1 show an increased spread of infection in the spring of 2022 with a peak in mid-May. There is great uncertainty about the development in scenario 1. The scenario should therefore be interpreted as an illustration of a possible development if a new variant of the virus, with the ability to circumvent protection caused by both vaccination and infection, were introduced and taken over as the dominant variant. There is also uncertainty about the size of the dark figure as the sampling indication has changed in 2022 at the same time as no new prevalence measurements have been made. The care risks for inpatient care in a regular ward and IVA are based on historical data for December / January and January and will change over time, which is why they should be interpreted with caution. As before, there is additional uncertainty regarding the structure of the model - in this modeling homogeneous contacts are assumed, which underestimates the risk of cluster outbreaks, see separate analysis of the risk of cluster outbreaks5 .

Scenario 0

Figure 3. Kingdom: Number of reported and simulated cases according to scenario 0 in all age groups up to 20 May 2022 (actually reported cases up to 10 February).

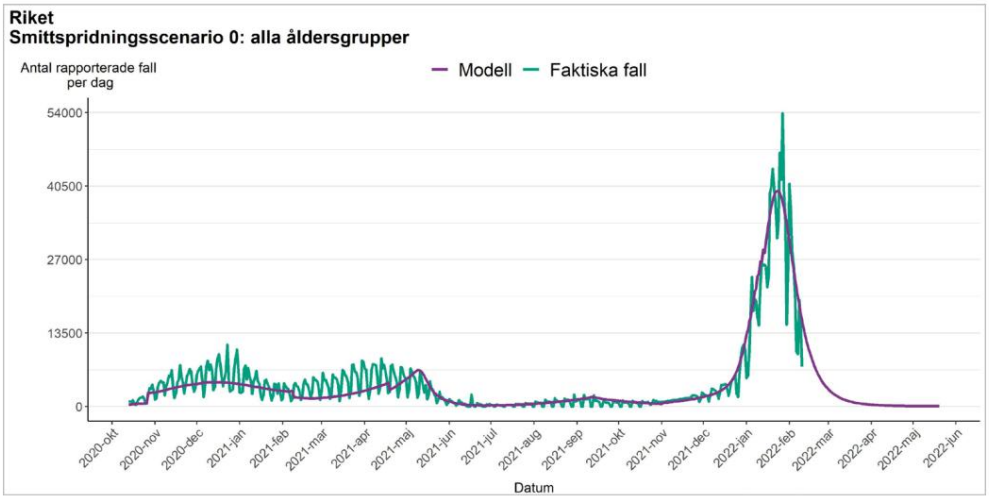
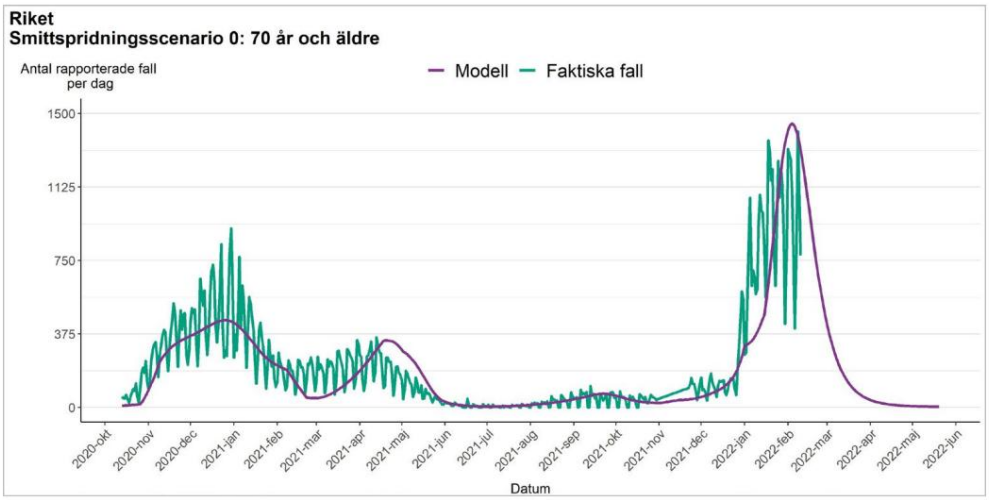


Figure 4. Kingdom: Number of reported and simulated cases according to scenario 0, age group 70 years and older: 13 October 2020 - 20 May 2022 (actually reported cases up to 10 February).



Scenario 1

Figure 5. Kingdom: Number of reported and simulated cases according to scenario 1 in all age groups up to 20 May 2022 (actually reported cases up to 10 February).

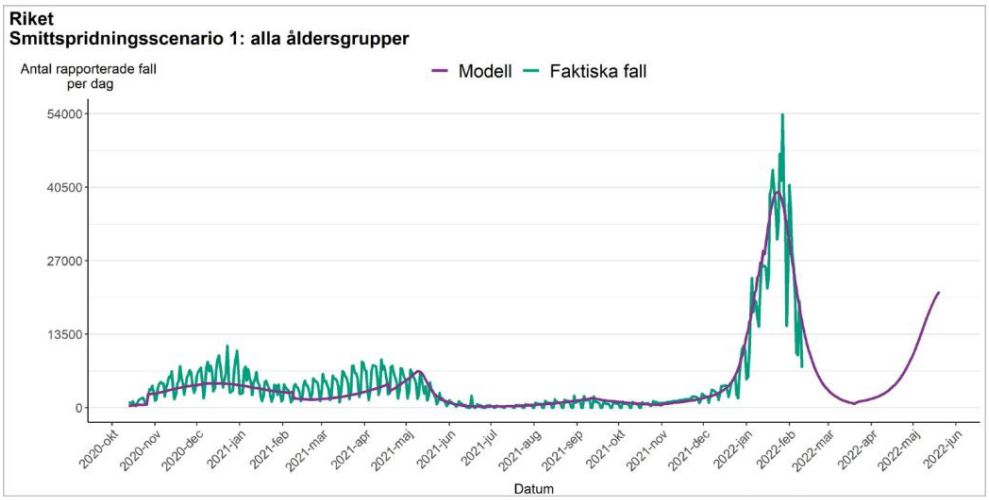


Figure 6. Kingdom: Number of reported and simulated cases according to scenario 1, age group 70 years and older: 13 October 2020 - 20 May 2022 (actually reported cases up to 10 February).

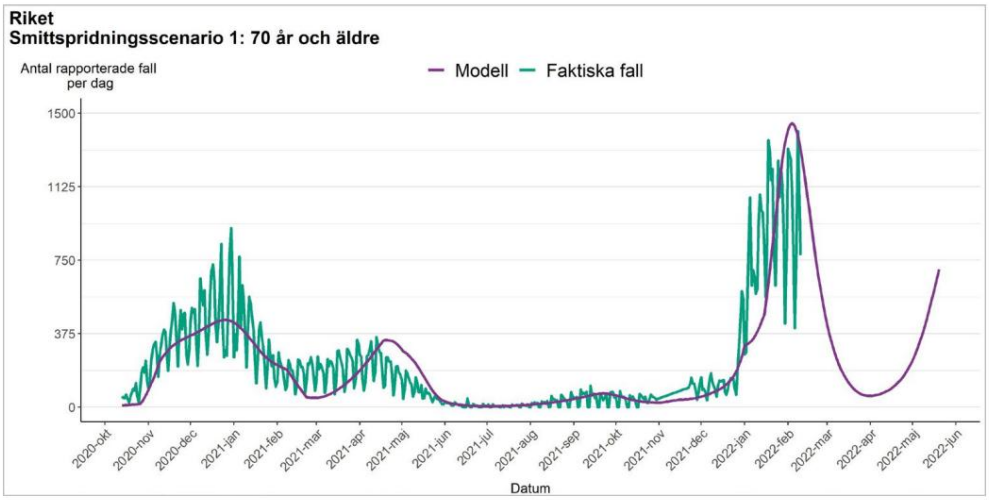
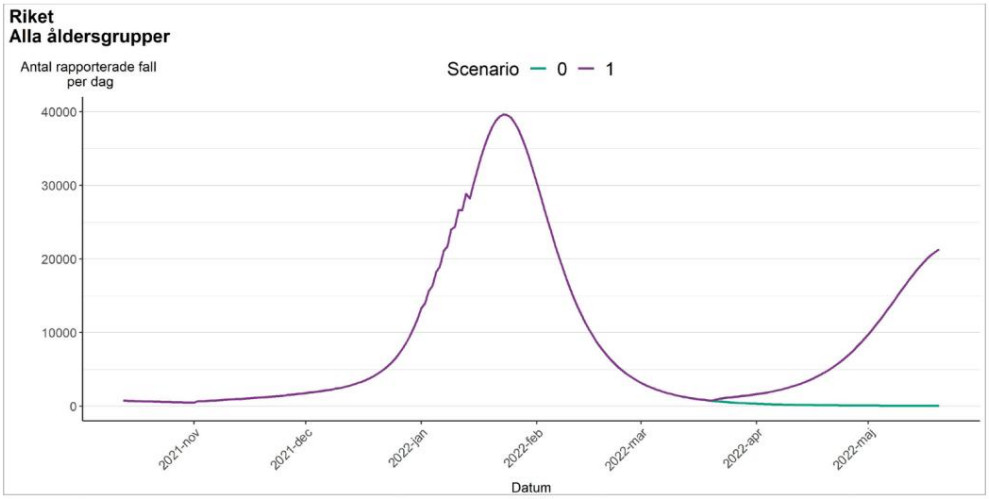
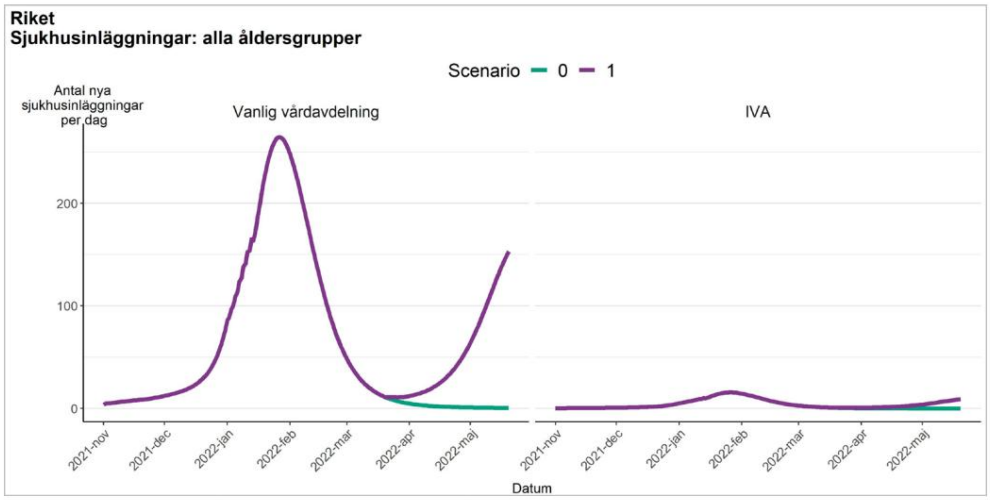


Figure 7. Kingdom: Number of simulated cases according to scenarios 0 and 1, all age groups up to it 20 May 2022.



Note that Figure 8 showing hospital admissions shows the number of new admissions per day.

Figure 8. The kingdom. Comparison of expected admissions to the regular ward (left) and IVA (right) according to scenarios 0 and 1, all age groups, until 20 May 2022.



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1. Information on the Public Health Agency's population surveys, see: Information on The Public Health Agency's population surveys

2. Modeling report: Modeling report

Detection of antibodies to SARS-CoV-2 in blood samples from outpatient care: Detection of antibodies to SARS-CoV-2 in blood samples from outpatient care

4. Mossong J, Hens N, Jit M, Beutels P, Auranen K, et al. (2008). Social Contacts and Mixing Patterns Relevant to the Spread of Infectious Diseases, PLOS Medicine 5 (3): e74.

5. Risk of increased spread of infection and national and regional cluster outbreaks: Risk of increased transmission and national and regional cluster outbreaks

The report presents scenarios for the continued spread of covid-19 until 20 May 2022.
The scenarios are designed to illustrate a possible process and should not be perceived as one forecast.

This report is a partial delivery of the government assignment that the Public Health Agency received from the Ministry of Social Affairs 26 November 2020 "Assignment to continuously update scenarios for how the spread of the virus that causes covid-19 disease may develop in the future".

The report's scenarios form the basis for planning for SKR, the county administrative boards, MSB and the National Board of Health and Welfare in their respective assignments within the same government assignment.

The Swedish Public Health Agency is a national knowledge agency that works for better public health. The authority does this by developing and supporting society's work to promote health, prevent ill health and protect against health threats. Our vision is a public health that strengthens the development of society.

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