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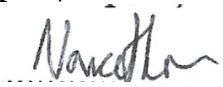

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SUMMARY

The covid-19 pandemic has made a significant impact all over the world since it was first discovered in December 2019. Reducing the threats associated with the virus quickly became top priority for policymakers. This thesis aims to look into the governmental pandemic risk management in Norway, focusing particularly on the Norwegian Institute of Public Health and their covid-19 risk assessments. The thesis presents an evaluation of the Norwegian Institute of Public Health's (NIPH) covid-19 risk assessments from a risk science point of view. The evaluation allows for the observation of risk science trends and degree of adherence to contemporary risk science in the risk assessment. It presents main actors within the governmental pandemic risk management in Norway and reflects on how NIPH's role influence the decision-making. The main risk science concepts that are discussed in this thesis is the risk concept, uncertainties, knowledge and strength of knowledge, risk assessments, the balance of different concerns and risk communication.

The work finds that NIPH's covid-19 risk assessments comply with contemporary risk science to some degree, however there are also areas for improvement. One of the main findings is that the NIPH definition of risk is not in line with current risk science as it does not sufficiently reflect uncertainties and knowledge. The way risk is defined and characterized can largely impact the risk assessment and the following decision-making, and because NIPH have an advisory role in the governmental risk management in Norway it will be beneficial for them to adopt a broader risk definition that reflects uncertainties and knowledge. This will allow the Norwegian Directorate of Health (HDIR) and the Norwegian Ministry of Health and Care Services (HOD) to make appropriate decisions as they are aware of all important aspects of risk, not just the probabilities and consequences.

As the epidemic develops NIPH are able to gather more knowledge and data, and this is reflected in their risk assessments. The thesis discusses the trends related to the dynamics of the pandemic and attempts create an overall understanding of how risk science can support covid-19 risk assessments and management.

PREFACE

This master thesis marks the end of my master's degree in Risk Analysis and Governance at the University of Stavanger. The last two years have been challenging but very rewarding.

I would like to thank my supervisor Roger Flage for providing me with guidance, feedback, and motivation during the writing of this thesis.

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1. INTRODUCTION

1.1 Background

The Covid-19 pandemic rapidly spread worldwide after the first outbreak in China in December 2019. The pandemic has made a significant impact and has led to economic and health crisis all over the world. Reducing the threats associated with the virus quickly became top priority for policymakers. Borders were closed, schools and businesses were forced to shut down, and people were told to stay at home. Several infection control measures were put in place, some of which are still effective to this date as new strains of the virus keeps emerging. The virus was first confirmed to have spread to Norway in February 2020, and on 12 March the same year the Norwegian government introduced the strictest and most comprehensive measures since World War 2.

Humans have had to make decisions based on uncertainties and risks ever since the start of their existence. The ones who managed to use their minds and experience to gather food, warmth and protection were favored by evolution, and humanity survived by developing a defense against the inevitable existence of risks and uncertainties (Kloman, 2010). The actual concepts of risk and risk assessments can be traced back to thousands of years ago, when the Athenians used their skills and resources to assess risk before making decisions (Bernstein, 1996). The first scientific publications and conferences concerning fundamental concepts, ideas, and principles on how to assess and manage risk were however not established until around 40 years ago (Aven, 2016). The concepts of risk, and the methodologies for assessing and managing risk have been largely developed throughout the years and the risk science, although a young science, can provide valuable guidance for risk assessments and risk management.

The Norwegian Institute of Public Health (NIPH) plays an important part in providing knowledge about infection control, and throughout the covid-19 pandemic they have continuously established several risk assessments and response reports. There has been a lot of discussion regarding the preparedness for this pandemic, and if the restrictive actions taken has been necessary and warranted. Even though the coronavirus is still spreading in our communities we are seeing strict restrictions lifting and turning into lighter recommendations. As we move towards the end of the pandemic and are slowly easing in to our ‘normal’ pre-covid lives, it is important to look back at and evaluate what have been done during the last

two years. The risk science has over the last decades generated a lot of knowledge regarding risk management and risk assessments, and this knowledge is a valuable tool for every risk situation. For example can the way risk is described and understood largely influence the risk assessment, and therefore also have big implications for the decision-making and risk management (Aven, 2016, Aven & Bouder, 2020). This thesis aims to evaluate NIPH's risk assessments to see how and if they adhere to contemporary risk science.

1.2 Purpose of thesis

The purpose of this thesis is to evaluate and discuss the Covid-19 risk assessments by the Norwegian Institute of Public Health (NIPH) from a risk science point of view, and by doing so answer the following research questions:

- Does the Covid-19 risk assessments by NIPH comply with contemporary risk science?
- How do NIPH's Covid-19 risk assessments develop throughout the pandemic?
- How does NIPH's role during the pandemic influence the governmental risk management and decision-making?

The evaluation and discussion of NIPH's Covid-19 risk assessments from a risk science point of view will provide a better understanding of NIPH's role during the pandemic. The thesis will address this role and explore how their role might have affected the risk assessments and the decision making. A theoretical foundation based on literature research will be presented as a basis for the empirical work, and central risk science elements will be established and used a guide for the evaluation. The thesis will evaluate if NIPH's risk assessments are in line with contemporary risk science, if suitable risk science methods and principles have been used, and present potential areas for improvement. This will in turn generate a better understanding of NIPH's risk assessment methods and contribute to the development of better risk assessment techniques in the future. It will also generate a better understanding of NIPH's pandemic preparedness and reflect on how risk science can support the risks management related to future pandemics.

1.3 Scope and limitations

This work evaluates and discuss 36 publicly available risk assessments and reports gathered from NIPH's web page. NIPH have several other publications regarding the covid-19 available online, such as weekly updates and other covid-19 related articles. These might consist of relevant information related to the covid-19 risk assessments, however, none of these have been examined as part of the evaluation because of the time constraints of this work. Risk science consists of several more concepts and ideas that are not mentioned in this study. The scope is limited to the concepts and ideas that seem most relevant in the pursuit of answer the research questions.

1.4 Thesis structure

The first chapter presents an introduction to the thesis and includes the background and purpose of thesis (including research questions) and then introduce the scope and limitations of the work.

The second chapter presents the theoretical basis that is relevant for the rest of the work. This includes epidemiology theory and risk science theory.

The third chapter reviews the governmental pandemic risk management in Norway and discuss the different management roles. It also aims to explain how risk assessments are used in pandemic risk management.

In chapter four the methods for collecting and evaluating the data are presented. All used data material is also listed.

Chapter five presents the evaluation and the results, whereas chapter six discusses the findings in relation to the theory presented in chapter two.

The seventh and final chapter presents a conclusion of the work.

2. THEORY

This first part of this chapter aims to present and discuss central theoretical knowledge regarding epidemiology. It provides a general review of epidemiology as a medical science and presents central themes and terms within the field. A section on epidemiology in connection to the covid-19 pandemic is also provided. The second part of the chapter presents key parts of risk science. It discusses the concept of risk, presents main characteristics of high-quality risk assessments, and discuss the important role of risk communication. The theoretical review is essential to understand the full context of the evaluation, presentation of results and subsequent discussion.

2.1 Epidemiology and public health

Public health concerns the community effort to protect, maintain and improve a population's health through education, preventive actions, and other organized interventions (Rothman, 2012). Epidemiology is a fundamental medical science that plays an essential role in improving public health. One of the top priorities for improving population health is control of transmissible diseases, and epidemiology is a valuable tool for this cause. We can trace epidemiology all the way back to the later decade of the fifth century BC and to the Greek physician Hippocrates who had great influence on medicine practices and public health. Sickness and diseases were at this time believed to be caused by divine power, however Hippocrates turned the attention to environmental factors. He believed that earthly causes in different communities could affect locally occurring diseases (Rothman, 2012). Moving forward in history, the control of transmissible diseases can be traced all the way back to the mid-14th century when the black death swept through Europe. In the medieval populations epidemics were still normally seen as acts of divine power and wrath, but it was also recognized that the black death plague was transmissible and that measures could be put in place as an attempt to control the spreading of the disease. To control the transmission certain entry points for foreigners were restricted, and sick patients and their close contacts were isolated (Rothman, 2012). This procedure, that we today call quarantine, plays an important part in the control of transmissible diseases. Although we can trace the efforts of trying to understand and control disease back to Hippocrates over 2000 years ago, epidemiology was not recognized as a scientific discipline until the nineteenth century when the measure of distribution of disease in specific human population groups became a common practice

(Bonita et al., 2006). Modern epidemiology makes major contributions to public health by identifying and mapping diseases. Epidemiologists studies, describes, quantifies, and presumes causal mechanisms for illness in populations (Friis & Sellers, 2020). The description and data analysis of a disease and its related factors can lead to an explanation of its occurrence which in turn can be used for prevention and predictions (Diekmann & Heesterbeek, 2000).

When it comes to infectious disease epidemiology, professionals within the field attempt to create an understanding of where the disease is coming from, who it might affect and how, and then use this information to control or reduce the transmission of the disease and other negative consequences related to the disease. A variety of quantitative measures are used to create an understanding of the occurrence of disease. Two central measures are prevalence and incidence. Both these measures provide estimates of the burden of disease in a specific population, however, the interpretations of the measures differ (Nelson & Williams, 2014). Prevalence represents the frequency of *existing* cases in a specific population at a particular time, while incidence is the number of *new* cases in a specific population at a particular time, in other words the rate of occurrence. The incidence data can provide useful information in an epidemic situation and is sometimes referred to as "attack rate" during epidemics (Bonita et al., 2006).

Another measure commonly used for infectious diseases is the basic reproduction number R_0 which refers to number of secondary cases produced by one case. The basic reproduction number depend on three factors: duration of infected period, frequency of contact between infectious and susceptible people and level of infectiousness and the likeliness of infection being transmitted in contact situations (infectiousness) (FHI, 2020). R_0 for an infectious disease are normally reported as a numeric value and interpreted very straightforward; if the value of R_0 is higher than 1, the outbreak is expected to continue and if the value of R_0 is lower than 1 the outbreak will eventually die out. The total proportion of infected individuals in a population (attack rate) will increase when the R_0 increases. Information regarding the basic reproduction number is especially important in the early stages of an epidemic. This is because the R_0 value informs decision makers about how comprehensive infection control measures needs to be in order to control the epidemic (Kristiansen et al., 2020). The value of R_0 can differ between communities due to changes in population density. R_0 is a valuable concept, but the R_0 estimates is usually derived from complex mathematical models that uses

various assumptions and inputs. This can sometimes lead to misrepresentation, misinterpretation, and misapplication of the R_0 value (Delamater et al., 2019).

Case fatality risk (CFR) is another common measure that describes the severity of the disease by defining the proportion of infected cases who die. The case fatality risk might not always provide an accurate representation of fatality, especially in the start of an epidemic. For example, the fatality might be underestimated if the patients are not followed up until they are completely healthy again, and it might be overestimated if individuals with mild symptoms are not detected (Battegay et al., 2020). The measures presented above are some central measures used to understand central epidemiological conditions related to infectious diseases. Epidemiologists often also use data that are already available to investigate health and diseases (Bonita et al., 2006).

2.2 The epidemiology of Covid-19

The role of epidemiology has become significantly preeminent in the last two years while the world has been dealing with the coronavirus disease. We have become aware of the importance of epidemiology in public health policy when facing emerging infectious diseases (Edwards & Lessler, 2021). In December 2019 health authorities in Wuhan, China discovered a cluster of patients with symptoms of pneumonia. All the patients had a connection to a live-animal market, and in January 2020 Chinese authorities reported on a newly discovered coronavirus related to the sick individuals. The virus is related to SARS-CoV and betacoronavirus found in bats (FHI, 2020). Epidemiologists and virologists acted quickly by using preliminary data to estimate certain epidemiological conditions related to the new virus. Some of the important conditions that were attempted to establish from the start are listed below (Edwards & Lessler, 2021; Battegay et al., 2020):

- How many individuals one infected individual was likely to infect (estimates of the reproduction number R_0)
- How long it took an individual to develop symptoms and become contagious after being infected
- The proportion of infected cases who died (case fatality risk)
- The likeliness of transmission from asymptomatic persons

These estimates have been updated continuously throughout the pandemic as more data become available. As the epidemic progressed the epidemiologists also gave more attention to infection prevention strategies and more clinical studies of the disease (Edwards & Lessler, 2021). Estimating and predicting the characteristics and epidemiologic factors of Covid-19 have proved to be challenging. A high flow of information and new data, together with continuous updates online by informal platforms and through media, allowed for an almost real-time description of the emerging epidemic (Battegay et al., 2020). A lot of this information can be perceived as contradictory as it is hard to achieve 'scientific consensus' (Aven & Bouder, 2020).

Early epidemiological analyses used preliminary data from Wuhan and small numbers of identified transmission pairs together with knowledge of similar infectious diseases to estimate the basic reproduction number. The very first estimates of R_0 ranged between 1,5 and 4. Mass screening of passengers on cruise ships and flights in February and March 2020 provided estimated the proportion of infected individuals that were asymptomatic to be 18-31%, and tracing studies showed that individuals were highly infectious as presymptomatic and mildly symptomatic (Koelle et al., 2022). Mathematical models were used to present potential scenarios of the development of the virus and led governments all around the world to impose strict restrictions to deal with the spread. New waves of the pandemic also saw changes in the virus characteristics as virus adaptation occurred and new variants started to spread. The hopes of herd immunity faded as evidence for repeated infections were found. However, the vaccine rollout reestablished the hope of one day going back to life pre-covid (Koelle et al., 2022).

2.2.1 Covid-19 modeling

One commonly used epidemic model during covid-19 is the SEIR model. S, E, I and R represent the fraction of the population that are susceptible, exposed, infectious, and recovered. Based on the basic reproduction number and several other parameters researchers can estimate the number of asymptomatic, number of infected cases, number of hospital admissions and number of dead. A central element in the SEIR model is data regarding how the different groups of society interact with each other and within their group. NIPH did a study in 2017 where 4300 Norwegians were randomly picked and asked to track their daily contacts. This data provides insights into how people interact with each other and was useful

when modeling covid-19 as it represents the potential of transmission in society (Kristiansen et al., 2020). During Covid-19 NIPH have also worked together with Telenor and the University of Oslo to collect phone data that shows how people interact with each other. In infection studies, the probability of events changes over time and from place to place. Infection models must therefore be dynamic, and this makes the modeling and the predictions more challenging (Kristiansen et al., 2020)

Many modeling efforts have been made to increase the understanding of the virus and its development, and mathematical simulation models have played an important role in doing so. The scientific community had to react fast in order to support public health preparedness and response efforts, and their predictions were based on both mathematical and epidemiological assumptions. Data and information were limited at the start of the pandemic and involved large uncertainties. It normally takes months or year to develop research questions into publications, but the rapid development of Covid-19 required policy decisions to be made fast. The quality of the epidemiologists' advice depends on the data input they use in the models as well as the health authorities and governments understanding of the representativeness and quality of the data sources (Dimitris et al., 2022). For all simulation models, it is important to keep in mind that the results are not more reliable than the data input, and their predictions and potential scenarios therefore needs to be interpreted cautiously (Saldãna & Velasco-Hernàndez, 2022; Kristiansen et al., 2020). Despite this uncertainty, models can provide valuable and useful insights, including insights into what data is required to gain a better understanding and more reliable predictions.
The models used during the pandemic are helpful to keep track of many individual factors that affect the course of infection. However, models will only ever be a simplification of reality (Kristiansen et al., 2020). Figure 1 below is a simplified infection model that shows number of infected with and without control measures, in relation to the health services' capacity. The model represents how the population is more susceptible early in the epidemic, and number of infected therefore increases rapidly without preventative actions.

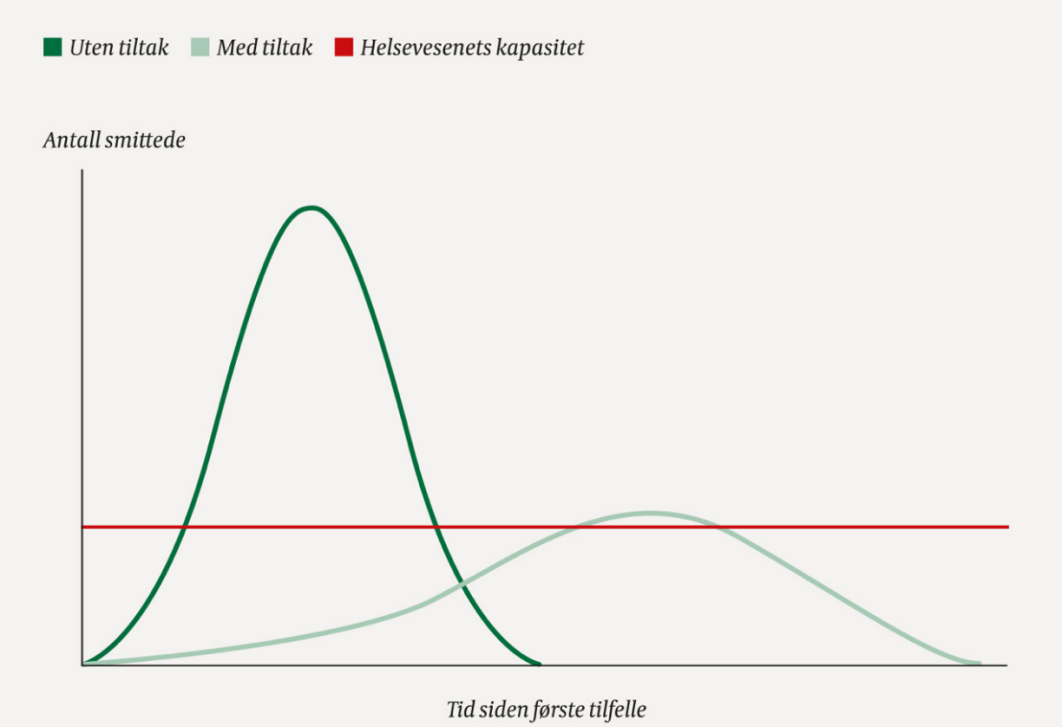

Figure 1: Number of infected with and without preventative action during an epidemic (Kristiansen et al., 2020)

2.2.2 Communicating uncertainty in public health emergencies

Communicating uncertainty during a pandemic can prove to be challenging, especially in the early stages of a pandemic when information is scarce, and uncertainties are large. Decision-makers may require guidance based on evidence, and the public seeks accurate explanations during all stages of the emergency. When effectively communicating uncertainty, epidemiologists and other professionals have to acknowledge that the decision-makers and the public might not be used to public disagreement or evolving perspectives. They may therefore benefit from clearly communicated guidance from trusted sources (Dimitris et al., 2022). For effective pandemic response skills like trust building, collaboration, teamwork, and kindness are critical. Not having these skills can lead to confusing or even harmful information sharing that in turn may lead to an erosion of public trust, and this trust can be hard to rebuild. Everyone who is involved in information sharing must therefore engage with each other and work together in order to build or maintain trust by communicating effectively (Dimitris et al., 2022).

2.2.3 Moving forward

The work faced by epidemiologists now and in the future will change. At the start of the pandemic, it was all about gathering insights about the virus, identifying transmission patterns, and understanding how prevention control would affect the development by modeling incidence of various scenarios. Epidemiologists will continue to research Covid-19 and other infectious diseases, however other health issues have become preeminent as a result of the pandemic. Long-term effects, effects of multiple exposures, implications for other infectious and chronic diseases, and improving the long-term response of Covid-19 are some of the issues epidemiologists are now facing. These are so called ripple effects that will affect the work of epidemiologists for many years to come (Edwards & Lessler, 2021).

2.3 Risk Science

A science is a knowledge discipline that provides us with the most warranted statements (also referred to as most justified beliefs), that can be made at the time being on issues or matters related to the relevant knowledge field (Aven, 2019; Hansson, 2013). A science can always self-improve, and its basic commitment is therefore to do research, find and produce the most reliable knowledge available at the time. Because a science provides us with the best justified representation of current matters within the relevant field, risk science can offer valuable guidance on all matters related to the risk field. Risk science is useful when attempting to understand, assess, communicate, and manage risk. It provides knowledge about principles, concepts, models, and methods and can guide us in the right direction when handling risk in real-life situations. Risk science consists of two main components: applied (A) and generic (B). Applied risk science (A) supports knowledge generation for specific risk activities, while generic risk science (B), involves the development of the generic concepts, approaches, methods, and principles that in turn can support applied risk science (A). A risk assessment for example, is a method used to produce knowledge related to type A, where the focus is on a specific activity (e.g., understanding climate change). If one were to research possible improvements in the risk assessment method however (e.g., how to present uncertainty) this would be related to type B risk science. From this we see that risk science can support other sciences in specific risk situations (Aven, 2020). For example, risk science can support epidemiologists when they research the covid-19 pandemic.

2.3.1 The concept of risk

Many people might have an idea of what risk is, but struggle to come up with a clear definition. It might be easy to think of risk as only some unwanted consequences related to an activity. But imagine a monetary investment. The investment can lead to loss of money, but there is also a potential of the investment making you rich. We can link the term 'potential' to the uncertainties involved - we cannot know exactly what the consequences will be until the activity is realized. Risk therefore concerns both undesirable and desired consequences of an event and the related uncertainties to what these consequences will be (Aven & Thekdi, 2021).

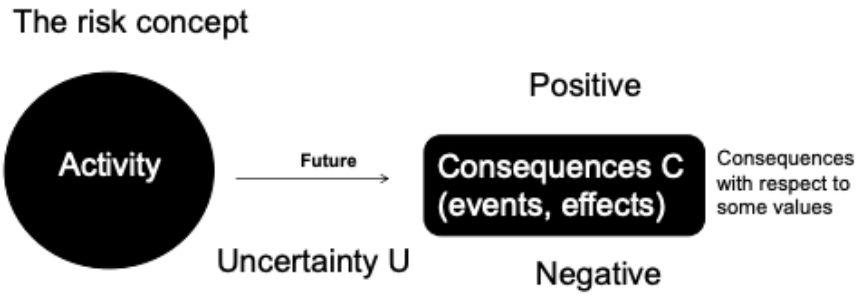

Figure 2: Basic features of the risk concept (Aven & Thekdi, 2021).

There are several different interpretations of the term 'risk', and the definition of risk varies even among risk experts. ISO (2018) defines risk simply as "the effect of uncertainty on objectives". This definition can be linked to some of the Society for Risk Analysis' (SRA) qualitative definitions such as "risk is the consequences of the activity and associated uncertainties" or "risk is the deviation from a reference value and associated uncertainties". Both the SRA and ISO (2018) definitions emphasizes uncertainties as a key aspect of the risk concept. Renn (2008) and Terje Aven (2019) defines a general form of risk as consequences of an activity (that can influence something of human value), and the associated uncertainties related to these consequences.

Work has been done to try to establish a universal risk definition, but because the suitability of the definition can depend on the risk situation this is not an easy task. According to Kaplan (1997) authors should be able to define risk the way they find most suitable, whilst also recognizing the importance of including an explanation of the chosen definition and

interpretation. This is important because the way risk is defined and interpreted can influence the risk handling (Aven & Bouder, 2020).

2.3.2 Risk description (A', C', Q, K)

Building on the SRA definition "risk is the consequences of the activity and associated uncertainties" we can describe risk as (A', C', Q, K). Aven & Thekdi (2021) suggest the use of this these risk characterizations when describing risk:

A' is the specified event or risk activity
C' represents some specified consequences
Q represents a measure or description of uncertainty related to the consequences, and
K represents the background knowledge supporting Q and (A', C').

It is also important to note that for the uncertainty description (Q) it is very normal to use probability (P). However, according to contemporary risk science, probabilities alone are not enough to get a proper understanding of risk. Q should therefore also include a judgement of the strength of the background knowledge (SoK) supporting these probabilities (Aven & Thekdi, 2021). According to Aven and Flage (2018) there are some elements or criteria that should be considered when judging the strength of knowledge:

- How reasonable are the assumptions?
- Is the information/data reliable and are there enough information/data available?
- To what degree is there agreement among experts?
- To what degree is the phenomena understood, and are there accurate prediction models available?
- Has the knowledge (K) been examined well enough?

It is hard to transform strength of knowledge judgments into descriptive quantities, and nominal scales are better for this purpose. Based on the criteria above one can for example describe the strength of knowledge by using a scale of weak, medium, or strong (Aven & Thekdi, 2021). In some situations where the strength of knowledge is weak, the knowledge might be assessed and then the analysts leave it up to others to decide if the event will occur

or not. In most cases, there will be enough data to allow for broad judgements of the probability (e.g., unlikely, low probability etc.). These types of judgements should be accompanied with a presentation of the background knowledge and a judgment of the strength of this knowledge. As new information and data becomes available, it can make the SoK stronger (Aven & Thekdi, 2021). Uncertainty and lack of or weak knowledge can create major challenges when doing a risk assessment. The way risk is described can influence the risk assessment, the decision making and the risk management in general. The role of uncertainty and knowledge should therefore not be undermined (Aven & Bouder, 2020).

2.3.3 Risk assessments

Risk assessment is a systematic process where risk is identified, explored, expressed, and evaluated. A risk assessment identifies risk sources, threats, hazards, and opportunities; help us understand the risk event and the related consequences while representing and expressing uncertainties and risk (Aven, 2019). Risk assessments aims to identify both potential scenarios related to a risk and the likelihood of these scenarios happening. Risk assessments are a valuable tool used to support decision making and risk management (Renn, 2008). As mentioned in the risk concept section above, risk should be understood and described as more than just probabilities and consequences. Risk assessments should, according to contemporary risk science, be placed in a broad risk framework where attention is brought to uncertainties and knowledge. Historical data and probabilities are helpful aspects to include and consider in any risk assessment but basing the assessments on these aspects alone does not allow for proper judgements of uncertainties (Aven & Bouder, 2020). Using broad risk perspectives when conducting risk assessments is especially important when studying risk in the case of large uncertainties.

2.3.4 Stages of the risk assessment

The main stages of a risk assessment consist of planning, the risk analysis, a risk evaluation and then the use of the risk assessment. In the planning stage the issue is clarified and objectives for the assessment are set. Moving on to the risk analysis stage where the identification of events (A') happens. It is important to not overlook any events as the risk relating to these events cannot be assessed further. A study of how these events occur and what influences this occurrence (risk factors, risk sources) is then performed. This is often

referred to as a cause analysis (Aven & Thekdi, 2021). Below is a figure 3 of a simple bow-tie diagram often used to visualize the causes of the risk event and its related consequences. We see the risk event A' in the middle and on the left side the causes and preventive barriers are presented. On the right side we see the consequences C' related to event A' and the mitigation barriers. The *cause analysis* often reflects on the quality of the barriers preventing A'. A *consequence analysis* addresses the consequences C' of event A' and the barriers that can prevent A' to result in serious consequences.

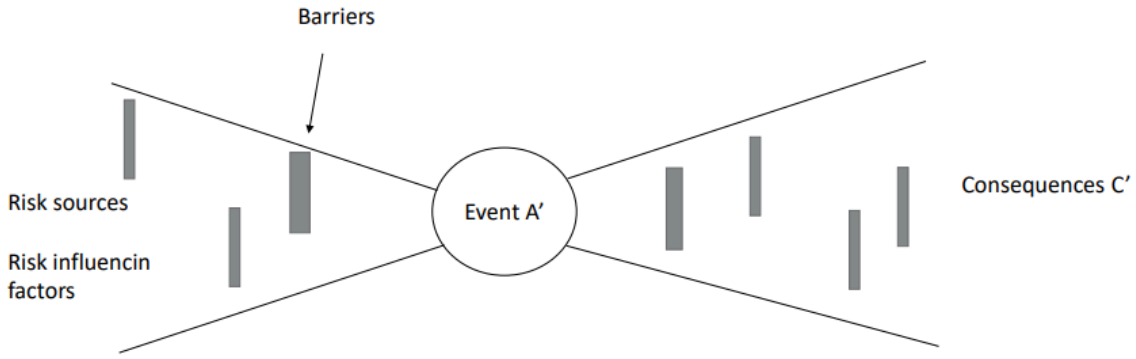

Figure 3: A simplified bow-tie example (Aven &Thekdi, 2021).

The overall risk picture is presented and often the consequences are introduced together with the use of uncertainty measures (e.g., probabilities). The background knowledge and a judgment of the strength of the knowledge supporting these measures should be included.
An important part of the risk analysis is the risk characterization, where the aim is to describe the risk. The way risk is defined and described can affect the overall risk picture. For example, if risk is simply considered as a product of probabilities and consequences it can influence the decision-makers to make unsuccessful decisions as they are not aware of the uncertainties and strength of knowledge.
Once the risk analysis part is done, the risk evaluation process is next. The results of the risk analysis are measured against criteria to judge the significance of the risk and acceptability of risk (Aven, 2019). The risk assessment is only a tool used to inform decision makers and does not provide a clear answer about what to do (Aven & Thekdi, 2021).

2.3.5 High quality risk assessments

Risk assessment is a useful tool in risk management but judging the scientific quality of a risk assessment is also important in order to understand if the assessment properly characterize the risk (Aven, 2019). Below are some basic criteria a risk assessment will meet if it is of high scientific quality according to the SRA (2018) and Aven (2019):

- *The work is solid.* The work is in compliance with rules and assumptions and limitations or constraints are introduced. The work is also clear and logical, and one can easily understand the judgements and choices that are presented. Finally, the models, methods and approaches used are systematic, comprehensible, and properly justified.

- *The analysis is relevant and useful.* It contributes to development and produces scientific risk knowledge, and/or provides help towards the problem it is concerned with.

- *The assessment and results are reliable and valid.* There is consistency in the measuring instruments used such as the experts used, and the methods and procedures (reliability). The measurements are also measuring what they are supposed to measures (validity). In relation to validity the degree of knowledge or lack of knowledge should also be addressed.

- *The decision-makers confidence in the assessments with its results and findings.* This can depend on the decision-makers understanding of the risk assessment, and the judgement of the competence of the analysts and scientists. It can also depend on if the decision-maker is aware of the background knowledge that the assessment is based on (remember the background knowledge can be more or less strong).

2.3.6 Balancing different concerns

The management of risk is mostly about finding a balance between development and protection. Development strategies are normally not as influenced by uncertainties and risk and often include tools that are only value based, while protection strategies aim to improve robustness and resilience often by using cautionary and precautionary principles. Risk assessments can be helpful when deciding on the balance between the two concerns. In the face of scientific uncertainties cost-benefit analysis and quantitative risk analysis are not able to accurately describe the best risk management policy (Aven, 2019).

In cases of scientific uncertainties, the precautionary principle is often invoked. SRA (2018a) provides two interpretations:

- It is an ethical principle that implies that when serious consequences are at stake, and these consequences are subject to scientific uncertainties, precautionary measures should be put in place, or the activity should not be carried out.

- The principle expresses that in situations where potentially hazardous agents might induce great harm on the environment or to humans, regulatory actions can be taken even when conclusive evidence about the potential harmful effects are not ready yet.

One problem with the principle is that it does not provide any guidance as to when it should be applied. This is because a judgement of what is scientific uncertainty is subject to value judgements (Aven, 2019). Another dilemma is that to be 'better safe than sorry' can be costly and counterproductive for other important aspects such as for example society. What seems like a precautionary measure can end up doing more harm than good (Ricci & Sheng, 2013). In situations with large uncertainties there are no principle that can prescribe exactly what to do, but they can provide valuable guidance for decision-making. Uncertainties are always present in risk situations, and there is no correct and objective way to handle these uncertainties. When contemplating whether to use the precautionary principle or not, it is important to clarify if the uncertainties are in fact scientific. Being aware of scientific uncertainties can lead to a search for more knowledge to reduce the uncertainties and in turn gain a better understanding of the risk issues (Aven, 2019).

2.3.7 Risk communication

To successfully assess and manage risk, effective communication is an important element. Risk communication involves the sharing and exchange of risk-related information, data, and knowledge between different target groups. This can be regulators, decision-makers, media, the general public etc. Today, risk professionals must recognize that the information they want to convey is likely to compete with several conflicting messages from unofficial sources (Aven, 2019).

According to Renn (2008), there are four essential principles of good risk communication:

The **first** principle relates to how a risk analyst should critically review his or her own performance. An evaluation of the performance can answer questions such as 'is the level of performance good enough to justify the public's trust?' or 'is the communication work understandable, honest, and timely?'

The **second** principle of good risk communication is to implement a communication and risk management program that supports continuous effective communication with stakeholders, decision-makers, and the public. Many risk managers believe that communication is mainly important after the management process is over. However, risk communication is important in the overall process and in all stages of risk assessment and management.

The **third** principle refers to how communication must be adapted to the different needs of the different target audience. The messages should match public expectations.

The **fourth** principle of good risk communication refers to how good communication practice allows for the collection of feedback, and acknowledgements of changes in preferences and values. The communication practice can then be modified and adjusted according to this.

Successful risk communication must be seen in relation to the scientific quality of the risk assessment and the risk description. The risk professionals might be confident in their use of methods and approaches, but a risk communication based on, for example, a simple likelihood judgement alone can confuse the public. This is because a simple likelihood judgment does not really include a judgement of the strength of the knowledge supporting it,

and the characterization of risk and the risk level might not be clear. The public may therefore have difficulties in understanding what the likelihood judgement really expresses (Aven, 2019). A high-quality scientific risk analysis is essential for good risk communication, as well as an understanding of the target group's risk perceptions.

Risk professionals should aim to have a transparent and timely risk communication strategy. This demonstrates respect and openness for the audience and makes sure not only that the audience have the information they need to follow risk reduction measures, but it also helps towards increasing or maintaining the risk professional's legitimacy and trustworthiness. Building trust and credibility is a key element in risk communication (Aven, 2019). The challenge for authorities when communicating risk, especially to the public, is to make the communication work effective. Scientific reports can be hard to understand for the general layperson, so the language and terminology used have to be adapted in order to be engaging. Public authorities also need to understand the importance of having a leading role and of not hiding or filtering their knowledge (Aven, 2019).

3. GOVERNMENTAL PANDEMIC RISK MANAGEMENT IN NORWAY

The Infectious Disease Control Act (1995) aims to protect the population against contagious diseases by averting them and preventing them from being transmitted within the population. It also aims to prevent contagious diseases from being imported to Norway or exported from Norway to other countries. The Act ensures that health authorities and other authorities work together to coordinate infection control activities, and that they implement the necessary infection control measures. The Infectious Disease Control Act includes regulations on so called *allmennfarlige* contagious infectious diseases. The word *allmennfarlig* is hard to translate directly to English, but in general it means something that is hazardous to public health or safety. According to The Infectious Disease Control Act section 1-3, certain criteria must be met in order to consider a contagious infectious disease as particularly hazardous to public health or safety. The disease must be very contagious, or occur particularly often, or have a high mortality rate, or cause serious or permanent damage, and; usually lead to the need for long-term treatment (often hospitalized treatment) or long-term sick leave; or the disease spreads widely and becomes a significant burden for public health; or it leads to a

significant burden because no effective preventative measures exist (The Infectious Disease Control Act, 1995, §1-3).

3.1 Risk management roles

The National Health Preparedness Plan (NHPP, 2018) produced by The Norwegian Ministry of Health and Care Services (HOD) explains the roles and responsibilities of all actors involved in health preparedness and related health crisis management. The three main actors in charge of health preparedness on a governmental level, and in the case of a pandemic outbreak, are HOD, The Norwegian Directorate of Health (Hdir) and NIPH. The regional health authorities and municipalities are also important players. According to the Infection Control Act (1995, §7-1, 7-3) the regional health authorities are responsible for necessary health care from specialist health services. During a pandemic regional health authorities must ensure that the population are still receiving adequate health care regardless of if the illness is related to the pandemic or if its due to other conditions that require treatment. It is also their duty to make sure the population within their region have access to necessary examinations, hospital treatments, isolation in hospital and other specialist health services regarding the infectious disease.

Many municipal functions will be affected in the case of a pandemic. Each municipality are responsible for the prevention and delaying of infection and is expected to guide the public and provide them with updated advice. At the same time, the municipality must ensure that other tasks and services are performed. If the health authorities describe the pandemic as a contagious infectious disease that is particularly hazardous to public health or safety the municipalities are given broad powers to implement infection control measures (Infection Control Act, 1995, §7-1).

According to NHPP (2018), it is HOD that have the main responsibility for national health preparedness. In the face of a pandemic, HOD will cooperate with other underlying agencies and the healthcare sector. The role of Hdir supports this responsibility by providing advice, implementing policies and by managing regulations. Another important role of Hdir is to provide guidance to the municipalities through the state governor and facilitate training and measures of competence. When a crisis is unfolding HOD can delegate the responsibility for national coordination of health care sectors and implementation of necessary control

measures to the directorate. If the situation calls for it, Hdir can implement these coordination efforts without consulting HOD first.
Hdir may decide that municipalities, county municipalities or state institutions shall organize or perform more specific services or measures, co-operate, or follow more specific guidelines when necessary to ensure effective and sound infection control (Infection Control Act, 1995, §7-10).

NIPH is the state's infection control institute and a national knowledge institution that provides knowledge for the entire health sector. NIPH's role is to assist Hdir by providing professional advice when required. Following The Infection Control Act (1995, §7-9), NIPH's role in the face of a communicable disease is to monitor Norway's epidemiological situation as well as the international epidemiological situation. To do so they conduct research and health analyzes and ensure necessary vaccine supply and preparedness. NIPH are allowed to process personal- and health information and data when that is necessary to perform their role. NIPH provides professional advice, assistance, guidance and information to municipal and state institutions, health personnel and the population in general regarding infectious diseases, infection control and the chosen infection control measures.

HOD has developed a separate national preparedness plan for outbreaks of serious infectious diseases (2019). The purpose of this plan is to secure a common national preparedness plan for outbreaks of severe contagious diseases. The municipalities are responsible for assessing the situation and to implement necessary measures, and NIPH gives professional advice to the municipalities regarding this. In some cases, the management of the disease needs to be coordinated from a national perspective. The municipalities will then become part of the national effort to control the disease. As described in the NHPP (2018), HOD might delegate the responsibility for national coordination to Hdir. NIPH perform professional risk assessments and present advice to Hdir, and the Hdir provide an overview of these and other recommendations and assessments to HOD.

4. METHODS AND DATA

The purpose of this chapter is to explain and justify the chosen research methodology and steps taken in order to be able to answer the research questions. The thesis is built on relevant literature and observations of existing risk assessments. The communication purpose of the thesis is to inform and to provide clarity on the topic of risk science related to the Covid-19 risk assessments by NIPH.

4.1 Literature review

When conducting research different methods are used as tools to answer problem statements or research questions. Literature review is a qualitative research method that includes the study of articles, journals, and other written material. A literature review aims to capture useful information and material from existing research contributions and use this to create new research. This thesis uses literature review to describe existing work in a critical way by providing an interpretation of the research and provide appropriate summaries of it. A literature review helps provide a fresh perspective (Jesson et al., 2011), and allows for a more detailed understanding of a certain selected theme. This can be done by for example looking into how the theme have evolved over time (Ringdal, 2018).

When studying the NIPH risk assessments and their potential compliance with risk science a literature review can provide a useful overview. The literature review applied in this thesis will be used to identify key risk science themes in the existing literature and in the risk assessments and will allow for the detection of potential improvements.

4.2 Conceptual research

The conceptual research evolves from the literature review as it aims to generate knowledge regarding how the risk science concepts identified are presented, described, and used in the risk assessments. Aven (2018) argues that conceptual knowledge generation and research is an important element in risk analysis. Evaluation research is a combination of empirical and conceptual research as it investigates how central concepts work in relation to their purpose, explores what challenges can arise, and identifies areas of improvement.

This thesis compares the concepts and methods used in NIPH's risk assessments with those presented in the theory chapter. This allows the work to point out strengths and weaknesses in the risk assessments. The conceptual research identifies important elements in the risk assessments, such as for example the risk definition, risk characterization and the way NIPH deals with uncertainties. Evaluating NIPH's risk assessments from a risk science perspective can be linked to both applied risk science knowledge (A) and generic risk knowledge (B). The focus is how NIPH uses risk concepts to assess the risks related to covid-19, so a specific risk activity (A). The basis for the evaluation is however the generic risk science (B), and the research will argue that B knowledge can improve the applied risk knowledge (A). Conceptual research can be helpful when attempting to generate knowledge of how to deal with risk problems (Aven, 2018).

4.3 Risk assessments

The risk assessments collected for the evaluation are publicly available at https://www.fhi.no/publ/2020/covid-19-epidemien-risikovurdering/. 36 reports have been published between 28.january 2020 and 9.february 2022. The reports include NIPH's assessment of the status of the Covid-19 situation and their related risk assessments. The risk assessments are used as a basis for the advice NIPH provide for the Norwegian Health Directorate (Hdir), which in turn is used to support the Ministry of Health and Care Services' (HOD) decision making. Initially, a quick exploratory reading of all the published notes and reports was done to get an overview over the data. From this quick overview it became apparent that four of the published files were duplicates and therefore not necessary to include when moving forward with the evaluation. These are:

- *24.03.2020: Presentasjon Covid-19 vedlegg til notat 24.03.2020.* This presentation is already included as an attachment in the main report published 24.march 2020.
- *24.03.2020: Risiko, prognose og respons i Norge etter uke 12.* The same report has been published with the relevant attachments and so the bigger report with attachments will be more beneficial for the evaluation.
- *27.12.2020: Nye varianter av SARA-CoV-2: kunnskap, risiko og respons.* The same report is published twice.
- *17.11.2020: Risiko ved covid-19-epidemien i Norge.* The same report is published twice.

One report, published on the 1st of April 2020, considers the testing, tracking and isolation strategy for covid-19 and was not included in the evaluation. Overall, 31 out of 36 risk reports published between 28th of January 2020 and 9th of February 2022 were used for the evaluation.

Most of the reports have separate chapters titled "risk assessment", however the evaluation considers the risk reports as a whole. This is logical because risk is discussed and assessed in general throughout all parts of the report and issues raised and discussed in other sections are relevant to the overall risk assessment.

As the Covid-19 situation is still ongoing it is likely that more relevant data (risk assessments) will be published during the execution of this work. However, because of the time constraints of this work, the cut-off date for the data collection was set to 9th of February 2022. No new or updated risk assessments past this date have been considered in the evaluation. The risk assessments in table 1 below were collected and evaluated more thoroughly.

Date published	**Title**
28.01.2020	Risikovurdering av og respons på 2019-nCoV-infeksjon i Norge
25.02.2020	Risikovurdering og respons i Norge – andre versjon
12.03.2020	Risikovurdering og respons i Norge – tredje versjon
24.03.2020	Risiko, prognose og respons i Norge etter uke 12. Med vedlegg
05.04.2020	Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 14
21.04.2020	Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 16
05.05.2020	Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 18
19.05.2020	Risiko, prognose og respons i Norge
11.06.2020	Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 23

Date published	Title
01.07.2020	Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 26
11.09.2020	Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 37
09.10.2020	Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 41
05.11.2020	Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 45
30.11.2020	Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 48
21.12.2020	Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 51
27.12.2020	Nye varianter av SARS-CoV-2: kunnskap, risiko og respons
13.01.2021	Nye varianter av SARS-CoV-2: Kunnskap, risiko og respons. Første oppdatering
22.01.2021	Utvidet varsel, Nordre Follo
27.01.2021	Nye varianter av SARS-CoV-2: kunnskap, risiko og respons. Andre oppdatering
28.05.2021	Risiko ved variant B.1.617.2
16.06.2021	Risiko ved Delta-varianten av SARS-CoV-2 – første oppdatering
03.07.2021	Risiko ved Delta-varianten av SARS-CoV-2 – andre oppdatering
26.07.2021	Risiko ved Covid-19-epidemien i Norge i lys av framveksten av Delta-varianten av SARS-CoV-2
17.11.2021	Risiko ved Covid-19-epidemien i Norge
28.11.2021	Risiko ved omikron-varianten av SARS-CoV-2 i Norge
07.12.2021	Risiko ved covid-19-epidemien og ved omikronvarianten i Norge
13.12.2021	Risiko ved covid-19-epidemien og ved omikronvarianten i Norge

Date published	Title
22.12.2021	Risiko ved covid-19-epidemien og ved omikronvarianten i Norge
12.01.2022	Risiko ved covid-19-epidemien og ved omikronvarianten i Norge
26.01.2022	Risiko ved covid-19-epidemien og ved omikronvarianten i Norge
09.02.2022	Risiko ved covid-19-epidemien i Norge – en oppdatering

Table 1: Overview of the collected data material.

The risk assessments were qualitatively evaluated and described by looking closer into the following predetermined parts reflecting key concepts presented in the theory chapter:

1. **Risk definition.** This considers the terminology used in the risk assessments and is only focused on clear quotations of the risk definition.

2. **Risk description.** This is used to evaluate the general description of risk and observe if this description has connection to the risk definition. The aim was also to observe any changes in the general risk description as the epidemic develops.

3. **Risk events (A') and consequences (C').** This was used to evaluate how the risk events and consequences were presented, discussed, and assessed throughout the epidemic.

4. **Uncertainty description (Q=P).** The measure of uncertainty is described as probability in the risk assessments. This point was used to evaluate how probabilities were categorized and presented.

5. **Background knowledge (K).** The background knowledge is important for the overall risk picture and indicates the foundation for the conclusions in the risk assessments. This evaluation investigates how the background knowledge is presented and specified and addresses how the knowledge basis change as the epidemic develops.

6. **Strength of knowledge (SoK).** The knowledge supporting the risk assessments can be more or less strong, and a judgement of the strength of knowledge is, according to risk science, beneficial to gain a better description of uncertainties. The evaluation addresses if any judgement of the strength of knowledge are present in the risk assessments.

7. **Links to risk science.** The evaluation aims to address the general risk management and find links to risk science. This involves observing the risk management strategies, approaches and concepts, risk communication etc.

5. RESULTS

The results of the evaluation are presented in this chapter. The findings were first plotted into an evaluation table, but to make the findings more readable and understandable these findings are presented and explained further in the separate sections of this chapter. The evaluation summary table that provides the basis for this chapter is included in appendix B. The overall evaluation and findings are presented in chapter 5.1 and 5.2.

5.1 Trends

To create an overview of how the risk assessments develop throughout the pandemic, and how they comply with risk science the observation of trends was considered to be fruitful.

5.1.1 Risk definition

The risk definition is close to constant throughout the pandemic with only minor differences in wording. Risk is simply defined as a product of probabilities (P) and consequences (C'). Out of the 31 risk reports evaluated, more than half (58%) do not provide a clear definition. However, it is clear from the risk descriptions in the reports without a clear definition that risk is considered as an expected value based on probabilities (P) and consequences (C'). The findings from the evaluation show four different wordings of the risk definition. These are presented below in order of how many times they were used:

1. Risk is the product of probability and consequence: **7**
2. Risk is the probability that an event (of an assessed magnitude) occurs multiplied by the magnitude of the consequences: **3**
3. Risk is defined as the product of probability of an event and the consequences of said event: **2**
4. Risk is considered by assessing the probability of a certain development and the consequences of this development: **1**

5.1.2 Risk events (A') and consequences (C')

In the early phase of the pandemic risk of import to Norway and proliferation within Norway are the main risk events considered in the risk assessments. All the risk assessments published in 2020 address these risk events. The report published 25th of February 2020 also considers the risks of lack of elimination in China, export to other countries and uncontrolled proliferation in other countries. The report on the 19th of May 2020 considers risk of import to Norway and risk of proliferation in Norway as well as three more risk events: risk of lack of compliance with measures, risk of serious illness within the population, and risk of serious illness for people with risk factors. The risk reports published from 1st of July 2020 until 21st of December 2020 assess the risk of increase in import to Norway and splits the risk of proliferation in Norway into three separate risk events: risk of local proliferation, risk of regional proliferation, and risk of national proliferation. The report published on 27th of December is the first of ten reports to present the risk events as risk questions. Most of the reports published in 2021 assess the risks related to the new variants of the virus. The risk questions (risk events) relate to infectiousness risks of new variants, risks of change in immunity, risk of more severe illness, risk of lower test sensitivity, risk of change in vaccine effects and risk of the new variants spreading to and within Norway. From the report published on 13th of December 2021 until the last report on 9th of February 2022 the main risk events considered is the risk of a new wave and the risk of a growing epidemic.

Descriptive consequences for the risk events mentioned above are not listed in a systematic way in the published risk reports. The connections between a *specific* risk event presented in the risk assessment and its related consequences are a little unclear. Rather consequences are mainly mentioned and discussed in separate sections throughout the reports and consequences are only roughly categorized on a scale from low to very high for each specific

risk event. However, large parts of the reports are dedicated to the level of severity of the disease and how this together with the proliferation of the virus effects the disease burden and the risk reduction measures. The consequences are linked to how the virus develops and how it spreads to and within the country. The recurring consequences in most of the reports are:

- Continuous proliferation and uncontrolled proliferation
- Higher disease burden (including significant burden on health services: increased number of sick and hospitalized etc.)
- Socio-economic consequences
- Public health consequences
- Need for stronger reinforced infection control measures (and negative repercussions regarding this)

Towards the later phase of the epidemic NIPH presents more detailed scenarios/consequences related to the risk of a new wave. This includes theoretical numbers of daily new hospital admissions as well as a potential daily number of patients already in hospital care needing respiratory treatment. Overall, NIPH creates a relatively good understanding of the main consequences related to the epidemic.

5.1.3 Uncertainty description (Q=P)

From the very first report published on the 28th of January 2020 NIPH presents the SEIR model and explains that this model is used to calculate probabilities for ongoing transmission (proliferation). The SEIR model is used throughout the pandemic to provide estimates of the current situation and prognosis for coming weeks. NIPH makes it clear that the data input for the model involves large uncertainties, and sensitivity analyzes are used to gain insights into how the uncertain data affects the simulated results. The predictions made by NIPH are informed by their own modelling as well as international modelling and research. NIPH presents the probabilities both qualitative and quantitative. For example, in the first report the probability for ongoing transmission is considered for the reproduction number being 1,4 and 2,5. For *one* imported case the probability for ongoing transmission after six weeks is considered to be 37% if R=1,4 and 64% if R=2,5. In the report from 7th of April scenarios for the reproduction number being 1,15 and 0,70 are presented. NIPH illustrate the uncertainty by showing how small changes in the reproduction number (input in model) can lead to

significant changes in the estimates. In the report from 21st of April, scenarios for the reproduction number being 1,15, 1,30 or 1,50 are represented in a simple figure showing patients in intensive care for each scenario.

As mentioned above, the development of the epidemic is modelled using several different models, however the main one used is the stochastic SEIR model. The mathematical models are used, among other things, to present estimates of number of infected and sick people where the proportion of hospitalized is a decisive parameter. The estimates produced by the models involve large uncertainties and some of NIPH's predictions are therefore presented with uncertainty intervals.

From the report published on 25th of February until and including the report published on 13th of December 2021 the probabilities are roughly categorized into low, moderate (medium), high, and very high in the main part of the risk assessments. These categories of probability are the ones that are used together with consequences (C') when NIPH concludes about the level of risk. In the reports published between 27th of December 2020 and 7th of December 2021, NIPH includes a judgement of the strength of the knowledge backing the risk assessment. The reports published on 27th of December 2020 and 13th and 27th of January 2021 include risk events where the probabilities for these risk events happening cannot be established as the knowledge is too weak.

5.1.4 Background knowledge (K)

The three initial risk assessments are mainly based on limited available knowledge from preliminary international research as well as data from the Chinese Center for Disease Control and Prevention (CDC) and the World Health Organization (WHO). Available knowledge about other similar diseases is also presented and used in these risk assessments. The second (25. February 2020) and third (12. March 2020) reports are updated versions of the first published report from 28. January 2020. The second and third version includes a separate section that presents a more systematic overview of the information used as a basis for the risk assessment. All information sources are included as references in the three initial reports.

From late March 2020, and in the fourth published report, NIPH were able to use national hospital admission numbers in their mathematical models for the first time since the start of the pandemic. As the epidemic grows and spreads within Norway NIPH gathers more data regarding diagnosis and hospital admissions, testing, medical consultations, vaccination coverage etc. Their monitoring of the Covid-19 situation in Norway provides valuable input for the risk assessments.
NIPH also creates rapid knowledge summaries based on existing knowledge about epidemics as well as newer covid-19 specific research (e.g. reports from the European Centre for Disease Prevention and Control (ECDC)).

The basis for the risk assessments is, from March 2020 and onwards, both international and national monitoring, knowledge, and modeling of the epidemic. From July 2020 until December 2020 there is a separate section in the reports dedicated to new knowledge. This knowledge comes from NIPH's own research and monitoring of the Covid-19 situation as well as international published literature and knowledge summaries from WHO, ECDC and sister institutes. Throughout the rest of the pandemic the risk assessments are mainly based on knowledge gathered through NIPH's own monitoring of the epidemic and the virus, risk assessments from WHO and ECDC and oral communication with European and Nordic colleagues. In May 2021 the risk of the new Delta-variant is assessed, and in the four following reports risk assessments from Public Health England are also referred to together with the risk assessments from WHO and ECDC.

The reader of the risk assessments is also referred to earlier reports for more background knowledge, and several of the reports mentions the importance of reading the assessments in conjunction with each other.

5.1.5 Strength of knowledge (SoK)

There is a consistent openness regarding lack of knowledge and limited knowledge throughout all the risk assessments. However, there are no systematic judgement of the strength of knowledge in the early reports. A somewhat systematic judgment of the strength of knowledge is first made in the report published 7th of April 2020. In this report NIPH refers to several studies and publications and explains the method used to gather the data. For several of the studies and publications they mention they include a short evaluation regarding

their confidence in the data collection. For example, NIPH refers to a study in Japan concerning quarantine for close contacts. They judge this study to have several weaknesses that give reason to doubt the results. They then compare this study to non-controlled studies regarding the same theme, and conclude that even with weak documentation, quarantine for close contacts seem to reduce spread of infection. An overview of the risk of airborne infection is also presented in the same report. The overview is based on swift searches performed by one single scientist in a database called PubMed. The data is presented together with an immediate judgment of the strength of this knowledge: the data contains methodological uncertainties and the procedure for the data collection might have led to important documentation being overlooked and misinterpreted.

Besides the report from 7th of April that contains a somewhat systematic evaluation of the strength of knowledge it is not until the last report in 2020 a proper systematic judgement of the strength of the knowledge is introduced. In the risk assessment published on 27th of December 2020 NIPH first introduce different levels of confidence in the knowledge base for the assessment. Here they explain that when the confidence in the knowledge base is minimal, they will not draw any conclusions about the risk. The knowledge confidence level is systematically presented together with the level of probability, level of severity of consequences and level of risk. Below is a concrete example of how the strength of knowledge judgement is presented. Table 2 presents a summary of the risk assessment published on 27th of December 2020. As one can see, the reader is referred to the relevant chapter for each risk event. Chapter 5 and 6 in this case explains how there is limited data available, and the current knowledge basis is too weak to conclude on the probability of the event and therefore they cannot make conclusions about the risk.

Risikospørsmål	Sann-synlighet	Konsekvens	Risiko	Tiltro	Kap.
1. Hva er risikoen for at det skal oppstå varianter av SARS-CoV-2 med endrete egenskaper innen smittsomhet, virulens eller immunitet?	Høy	Moderat / stor	Moderat / høy	Moderat	2.1, 2.1, 2.3
2. Hva er risikoen for at den engelske og den sør-afrikanske varianten er mer smittsomme?	Høy	Moderat / stor	Moderat / høy	Moderat	2.1, 2.2, 2.4
3. Hva er risikoen for at den engelske og den sør-afrikanske varianten skal spre seg *til Norge*?	Høy	Moderat / stor	Moderat / høy	Stor	2.1, 2,2, 2.5
4. Hva er risikoen for at den engelske og den sør-afrikanske varianten skal spre seg *i Norge*?	Høy	Moderat / stor	Moderat / høy	Moderat	2.1, 2.2, 2.6
5. Hva er risikoen for at den engelske og den sør-afrikanske varianten gir mer alvorlig sykdom?	Lav	Stor	Moderat	Moderat	3
6. Hva er risikoen for at testene som benyttes i Norge har lavere sensitivitet for den engelske og den sør-afrikanske varianten?	Lav	Moderat	Lav	Stor	4
7. Hva er risikoen for at gjennomgått SARS-CoV-2-infeksjon gir lavere immunitet mot den engelske og den sør-afrikanske varianten?	Kan ikke konkludere ennå	Moderat	Kan ikke konkludere ennå, se tekst	Liten	5
8. Hva er risikoen for at vaksinene som benyttes eller skal benyttes i Norge gir lavere immunitet mot den engelske og den sør-afrikanske varianten?	Kan ikke konkludere ennå	Stor	Kan ikke konkludere ennå, se tekst	Liten	6

Table 2: A summary of the risk assessment published on 27th of December 2020 (NIPH).

As more data and knowledge is gathered NIPH updates the risk assessments and their judgements of the strength of knowledge. As their confidence in the knowledge base increases, they can make more conclusions regarding the risk. Below is the summary risk assessment from 27th of January 2021. This shows that between 27th of December 2020 and 27th of January 2021, NIPH have gathered the sufficient data to make conclusions about the two risk events that they could not make conclusions about a month prior. It is also clear by looking at the summary of these risk assessments that knowledge regarding the English variant have increased, however more knowledge is required to make conclusions about the South African variant. The green and orange writing represents changes in the assessments compared to the one published on 13th of January 2021. Green means the assessment of probability, consequences, risk or confidence in the knowledge base have decreased, whereas orange represents increased.

Risikospørsmål om den engelske (E), sør-afrikanske (SA) og brasilianske (B) varianten	Sann-synlighet	Konsekvens	Risiko	Tiltro til vurderingen	Kap.
1. Hva er risikoen for at det skal oppstå varianter av SARS-CoV-2 med endrete egenskaper innen smittsomhet, virulens eller immunitet?	Høy	Moderat / stor	Moderat / høy	Stor	3.1, 3.1, 3.3
2. Hva er risikoen for at variantene er mer smittsomme?	Høy	Stor	Høy	Stor	3.1, 3.2, 3.4
3. Hva er risikoen for at variantene vil fortsette å spre seg *til Norge*?	Høy	Stor	Høy	Stor	3.1, 3,2, 3.5
4. Hva er risikoen for at variantene skal spre seg *i Norge*?	Høy	Stor	Høy	Moderat	3.1, 3.2, 3.6
5E. Hva er risikoen for at den engelske varianten gir mer alvorlig sykdom?	Moderat	Stor	Moderat	Moderat	4
5SA og 5B: Hva er risikoen for at den sør-afrikanske og brasilianske varianten gir mer alvorlig sykdom?	Kan ikke konkludere ennå	Stor	Kan ikke konkludere ennå	Liten	4
6. Hva er risikoen for at testene som benyttes i Norge har lavere sensitivitet for variantene?	Lav	Liten	Lav	Stor	5
7E. Hva er risikoen for at gjennomgått SARS-CoV-2-infeksjon gir lavere immunitet mot den engelske varianten?	Lav	Liten	Lav	Moderat	6
7SA og 7B: Hva er risikoen for at gjennomgått SARS-CoV-2-infeksjon gir lavere immunitet mot den sør-afrikanske og brasilianske varianten?	Lav / moderat	Liten	Moderat	Moderat	6
8E. Hva er risikoen for at vaksinasjon med vaksinene som benyttes* eller skal benyttes i Norge gir lavere immunitet mot den engelske varianten? (Vurderingen gjelder bare mRNA-vaksiner.)	Lav	Stor	Moderat	Liten / moderat	7
8SA og 8B. Hva er risikoen for at vaksinasjon med vaksinene som benyttes eller skal benyttes i Norge gir lavere immunitet mot den sør-afrikanske og brasilianske varianten?	Kan ikke konkludere ennå	Stor	Kan ikke konkludere ennå	Liten	7

Table 3: A summary of the risk assessment published on 27th of January 2021 (NIPH)

The evaluation of the strength of knowledge backing the risk assessment is included in 10 risk assessments between 27th of December 2020 and 7th of December 2021. The only report between these dates that do not include a systematic evaluation of the strength of knowledge is the one from 22nd of January 2021 (Utvidet varsel, Nordre Follo). The five reports between the 7th of December 2021 and 9th of February 2022 does not include a systematic judgement of the strength of knowledge.

5.1.6 Summary risk description (C', Q, K)

A comparison between the risk definitions in the risk reports and the way NIPH describe the risk show a clear connection. From the second report published in February 2020 until and including the report published on 13th of December 2021 risk is described mainly as the combination of probability (P) and the severity of consequences (C'). NIPH moves slightly away from this formal definition when they consider their confidence in the knowledge base before they conclude about risk. They acknowledge the uncertainty, and state that, where the knowledge is weak, they cannot describe risk properly.
The first risk assessment published in January 2020 simply just describes the risk of import to Norway as low, and the risk of proliferation within Norway as moderate. The reports published from and including 25th of February 2020 until and including 11th of June 2020 includes a section for each risk event and a conclusion on risk for each risk event. Below is an example of how risk is described for 'risk of import to Norway'. This is taken from the risk assessment published 12th of March 2020:

"Conclusion on current risk for import to Norway:

- The probability for import to Norway is considered to be **very high**
- The consequences of import to Norway are considered to be **large**
- The risk of import to Norway is therefore considered to be **very high.**"

The six risk assessments from and including 1st of July 2020 until and including 21st of December 2020 also presents sections for each risk event and a conclusion like the ones above, but in addition to that these risk assessments also include a table that presents the overall risk assessment in a more systematic way. See example below:

Risiko		Vurdering		Risiko	Begrunnelse
		Sannsynlighet	Konsekvens		
Import til Norge		Høy	Liten / moderat	Moderat	Se 11.1
Oppblussing i Norge	Lokalt	Høy	Liten	Moderat	Se 11.2
	Nasjonalt	Lav	Moderat	Lav	Se 11.2

Tabell 3. Overordnet risikovurdering for ukene 27 – 30.

Table 4: A summary risk assessment for weeks 27-30 (NIPH, 2020)

10 risk assessments published from and including the 27th of December 2020 until and including the 7th of December 2021 presents a systematic overview of the risk assessment. They include tables that displays the risk questions (A'), probabilities (P), consequences (C'), risk (PxC') and confidence (in the knowledge base). Like all the reports published before these ones also includes separate systematic sections where the assessed risk is described closer, and the level of assessed risk is justified.

Towards the later phase of the epidemic (after 7th of December 2021) risk is mainly just described and discussed in general for the development of the epidemic. The earlier risk assessments are more event focused whereas the later ones are more focused on the consequences of a growing pandemic and a potential new wave. The risk is not described in a systematic way or a table in these risk assessments, and no conclusion is made on level of risk unlike the earlier risk assessments.

5.1.7 Risk communication trend

The report published 7th of April 2020 is the first one to mention the importance of risk communication. In this report NIPH recommends strengthening the risk communication to prepare the population for the oncoming epidemic. This report also considers the public's risk perception and how the infection control measures have had a significant frightening effect where the signal has been a zero vision: no contagious situations and no new cases. This means that even when the strict infection control measures are lifted, the public is likely to still see covid-19 as a big threat and it can be challenging for individuals to move away from the through restrictions. Majority of the reports published after 7th April 2020 up until 9th of February 2020 includes information and advice on risk communication. In some of these

reports it is only briefly mentioned while other reports include whole sections or paragraphs dedicated to risk communication.

Transparency

In the report from 5th of May 2020 NIPH states that it is important to have a good dialogue with the population to make them understand that a zero vision is not realistic. The public must be prepared for the epidemic to last several years. The importance of having a good dialogue with the population is repeated in several reports. From November 2020 and onwards the importance of openness between the authorities and the population is highlighted. Transparency regarding the basis for decision-making and openness regarding uncertainties are key points NIPH refer to when giving advice on successful risk communication. To update and inform the whole population as quick as possible, and to keep the communication simple and clear are also takeaways from several of the reports. The report published on 5th of November 2020 have a separate section dedicated to vaccine communication. NIPH wants to be open about uncertainties and professional disagreements, be clear about the knowledge basis backing the vaccine recommendations and correct incorrect statements and rumors about covid-19 and the vaccine. Clear answers and information without concepts that can create misunderstandings is also important in the communication work. In the report published on 3rd of July 2021, NIPH presents new labels created by WHO for the different variants to avoid stigmatizing and misleading geographical indications. NIPH decides to use these new labels in publications that are intended for the general public. This is an example of how NIPH is adhering to clear and simple communication to avoid misunderstandings. The report from 21st of December 2020 underline the importance of facing questions and worries from the population with openness and respect.

Alternative risk communication strategies for different groups

Adapting the risk communication to different groups in society is also a recurring theme in many of the reports. One example is the communication with vulnerable groups in society such as homeless people, sex workers and drug addicts. The communication must be adapted to these groups so that they can receive adequate information regarding infection control measures, symptoms of covid-19 as well as how and when to contact health services for help. Several alternative communication strategies for the vulnerable groups are mentioned such as

more focus on outreaching contact, using illustrative information material, and conveying the information through the most suitable channels (e.g., through institutions or volunteer organizations). NIPH recognizes that advice must be altered depending on the target group. The report published on 5th of November 2020 discuss how well adapted information measures should be translated to several languages to communicate with immigrant groups. For example, linguistic nuances might be hard to interpret for some immigration groups. Qualified interpreters and people who have the appropriate language and cultural competence could get involved to make the communication clearer. NIPH also suggest, in the report from 21st of December 2020 that using spokespersons with different backgrounds and language (who are not the authorities) to convey experiences and information to selected groups can be beneficial for risk communication. Another example is how NIPH uses social media to share information, answer questions and communicate with different groups of society. By using platforms such as Instagram they can more easily connect with for example younger people.

Media

The report published on 5th of May 2020 include a separate section for information sharing with media, and NIPH highlights that the goal is to answer the media as quick and correct as possible. They admit that, because of a lack of capacity, there have been times during 2020 where the communication with the media has been slower than envisioned. Inquiries from media are channeled through the communication staff and the requests from media should be answered by professionals within the field so that the information shared with the public is valid and accurate. NIPH also use social media such as Facebook, Instagram, and Twitter to share advice, answer questions, gain valuable input from and communicate with different groups of society.

Risk perception

The report from 11th of September 2020 presents challenges with getting individuals to comply with infection control measures. NIPH are aware that challenges arise as the population's risk perception changes. As people grow tired of the restrictions and perceive the risk of covid-19 to be lower than before (based on less hospital admissions and deaths) it is harder to keep up their compliance with risk reduction measures. NIPH recommends the authorities to be open and honest with the population and to justify the infection control measures. The Norwegian population have general high trust in the authorities, and for the

legitimacy and success of the infection control measures to be maintained it is important to build on this trust. NIPH also emphasize that voluntary choice of correct behavior is important and that unnecessary threats of punishment for not complying with the measures will not be fruitful. NIPH strives to deliver rapid and transparent information to the population and this communication aims to contribute to trust in the health advisers which again can and should lead to better compliance from the public. In December 2020 NIPH states that the public needs to be prepared, trough good risk communication, for stronger measures to be implemented as the epidemic worsens again. As mentioned earlier NIPH found it challenging that some measures had a frightening effect on the population. In January 2021 when a new variant of the virus was emerging and new restrictions followed, NIPH recognized the importance of balancing the 'frightening effect' with the compliance of measures. It must be made clear to the population that efforts are made to stop the local outbreak, but people also need to be reassured that the new variant does not appear to cause more serious illness than the other variants.

Overall trend in risk communication

The focus on openness in the risk communication is constant throughout the pandemic. Because of the large uncertainties NIPH aim to keep the public informed about these uncertainties and give them rapid updates on the situation and present new knowledge as well as be open about ethical challenges related to the risk and the risk reducing measures. However, there are slight changes in the risk communication as the epidemic unfolds. Towards the end of 2020, there is more focus on working closely together with all municipalities so that the public communication is more uniform throughout the country. The important role of the municipalities in risk communication is highlighted in several reports from November 2020 and onwards. In the report published 22nd of January 2021 NIPH state that they will contact the municipality's communication staff to support and coordinate their risk communication. In November 2020 it also becomes clear that NIPH aim to use risk communication to correct incorrect statements that are made, especially in media and social media. This focus continues as NIPH intend to make sure the public understand that the epidemic's disease burden and related challenges must be considered with a holistic approach. For example, the media will report on number of cases every day, however this might not provide an accurate presentation of how severe the risk situation actually is. Towards the end of 2021 and beginning of 2022 NIPH recognize that good risk

communication is required to get across to the public that everyone is responsible to help curb the spread of infection and to protect themselves and others. As Norway got closer to get rid of all restrictions the individual risk was by many perceived as small as many people were vaccinated and tended to not get severe illness. NIPH made a point of saying that less measures and more personal responsibility still required good risk communication.

5.1.8 Dynamic risk management

Already in the second report published in February 2020 NIPH acknowledges that the risk cannot be eliminated and that the risk management strategy requires a risk mitigation focus. From the very first report published in January 2020 they also state that the benefits of risk reduction measures must be weighed against costs and potential negative side effects. From the third report (12th of March 2020) this is referred to as a trade-off between burden of measures versus burden of disease. There are consistent clarifications throughout the pandemic that highlights the fact that reducing risk can create other negative repercussions. The five reports published from September 2020 until 21st of December 2020 includes an evaluation of all infection control measures (risk mitigation measures). Here, the infection control measures are listed, challenges related to the measures are presented, and adjustments of the measures are recommended based on NIPH's experience of their effect and negative side effects.

The importance of a dynamic risk management strategy is also recognized from the start. Because the epidemic is very volatile, the strategy must be able to be adjusted as the epidemic evolves and more knowledge is generated. The need for the dynamic risk management to consider a wide range of aspects such as health, society and economic is also recognized as early as June 2020. As the epidemic evolves, more knowledge is generated and risk mitigation measures are adjusted, any negative consequences that affects vulnerable groups and society as a whole needs to be taken into consideration and evaluated.

5.1.9 Recommended measures based on (lack) of knowledge and overall strategy

Already in the first report the preliminary strategy is to delay the onset of domestic proliferation, and then reduce it when it is no longer possible to delay. The measures recommended in the first report reflects the lack of knowledge about the virus. For example, screening at airports and quarantine of close contacts are not recommended as they seem to be too resource intensive. NIPH acknowledge that these conclusions might change and that certain measures that are recommended now (testing, isolation of infected individuals, symptom monitoring and hand hygiene) might be unreasonable when more knowledge is available or if the epidemic situation changes. Already in the second report a more thorough review of measures is presented where NIPH advise that voluntary 'at home' quarantine for close contacts is now beneficial.

Three strategies are presented in the report published on 24th of March 2020: release, brake and suppress. The burden of disease and burden of measures differ between the strategies. The release strategy is not compatible with the goal of protecting society and minimizing the burden on health services and is therefore not discussed any further. NIPH suggest in the same report to delay the decision on which strategy to choose for another 1-3 weeks while more knowledge (consequences and negative repercussions) about the current measures is gathered and analyzed. Because of large uncertainties NIPH also acknowledges that the strategies put in place will basically be experiments. It is highlighted that NIPH are following the development of the epidemic and are carrying out analyzes and assessments to be able to advise on which measures are most feasible at the current time. It becomes clearer in the next few reports that the two strategies of brake and suppress are used in conjunction as a part of an overall dynamic strategy.

The report published on 27th of December 2020 addresses the new variants of the virus, and NIPH suggest that the dynamic strategy is still valid for this new situation. Their advice is to attempt to delay the introduction and proliferation of new variants by introducing new measures and that these measures need to be reviewed frequently.

The measures put in place at the moment might be able to keep the current epidemic under control, but new, more contagious variants might challenge this control. NIPH's advice is to

implement more measures to limit the risk of the new variants until more knowledge is generated. By stating this NIPH are implicitly referring to the precautionary principle. The precautionary principle is implicitly referred to like this in 4 of the reports (27th Dec 2020, 13th Jan 2021, 27th Jan 2021 and 28th Nov 2021). The precautionary principle is referred to **explicitly** in 4 reports (17th Nov 2021, 7th Dec 2021, 12th Dec 2021 and 22nd Dec 2021).

The first explicit mention of the precautionary principle emerges in the report published 17th of November 2021. Here, it is stated that there is less basis for reducing the proliferation based on a precautionary basis now compared to nine months ago. This is due to more knowledge and less uncertainty. The risk of an uncontrolled epidemic situation with severe consequences affecting lives and health is less, and there is less fundamental uncertainty at this point. NIPH refers to the Norwegian Government Agency for Financial Management (DFØ) and their guide for situations in which the use of the precautionary principle should be considered. According to DFØ, four points should be met in order to consider the use of the precautionary principle. These four points are listed below together with NIPHs own assessment of the current situation and its affiliation to these points.

- There is great uncertainty that cannot be quantified in monetary value, related to the future consequences. The damage scenarios are complex, and the connection between measures and the probabilities for damage in the future is not known. ***NIPH*** *states that the uncertainties are significantly less, and model simulations have been developed to forecast possible future scenarios. The established knowledge basis for the infection control measures and their negative side effects are bigger, and the epidemic situation is now understood better.*

- The damages can be severe, either for the current population or future generations. ***NIPH*** *states that the risk is significantly lower now and that successful control of previous outbreaks indicate that severe consequences can be avoided in the future.*

- If the damages occur, they will be irreversible. ***NIPH*** *states that severe infection can be irreversible for certain individuals, but there is an overall low risk for severe infection as most of the population have been vaccinated. The consequences of*

measures can, on the other hand, be irreversible (e.g. children's learning is affected by closed schools).

- There is not enough time to evaluate the development and gather more knowledge before risk reducing measures are implemented. ***NIPH*** *states that in a vaccinated population there is more reason to spend time evaluating the situation and, in that way, gather information and knowledge regarding both disease burden and burden of measures.*

NIPH conclude that there is less basis to introduce measures based on the precautionary approach to avoid potential health losses. They clarify that this does not mean measures should not be implemented, but that the implementation of new measures should be based on other justified decisions.

The importance of the dynamic risk management strategy becomes obvious in the report published only 11 days after NIPH concludes that the precautionary approach is not justified any longer. In the report published on 28th of November 2021 which addresses the new omicron variant the precautionary principle is implicitly referred to again. New measures now need to be put in place while more knowledge is gathered, however there are no link to the DFØ's criteria. In the next report from 7th December 2021, it is stated that the new omicron variant has led to increased uncertainties regarding the epidemic's development, and NIPH assess the new situation in relation to DFØ's criteria for using the precautionary principle. They conclude that there is a certain basis for applying a precautionary approach as the burden on health services is increasing and there is not enough capacity for a new wave of infection. Applying the precautionary principle will help buy more time to gather knowledge, review the hospitals contingency plans and vaccinate more people. The reports from 13th and 22nd of December 2021 refers to the report published on the 7th of December stating that the criteria for using a precautionary approach is still fulfilled.

The report from 27th January 2021 includes a systematic overview presenting four alternative strategy goals for the current situation. This overview shows how the recommended risk reduction measures change depending on the strategy goal. For example, if the goal of the strategy is to keep the epidemic under control the infection control measures must be varying and dynamic and might last several months. If the goal of the strategy is to establish an

overview of the current situation the infection control measures need to be very strong over a short period of time (one week).

The report published on 17th of November presents the governments goals for the work against the covid-19-epidemic: "The government inform that the management of the pandemic will safeguard health, reduce disturbances in society and protect the economy, like WHO are also doing. In normal everyday life with increased preparedness, the government's strategy is to prevent the covid-19 pandemic to lead to a significant disease burden and prevent strain on the municipal health service capacity and hospital capacity, let the population experience a normal everyday life, let public services be soundly provided and protect the economy. The infection control against covid-19 must be incorporated into the ordinary infection control system."

The reports from 17th of November 2021 to 26th of January 2022 all encourages the need to build robustness and acknowledges the need for new cost-benefit analyses and a more long-term strategy. The report published on 12th of January introduces factors that will be important for this long-term strategy, one of these being the need to define what is the best balance between disease burden and burden of measures. Better preparedness and better monitoring of the development of the epidemic are key factors that need to be in place to be able to protect the public health and the health services from unacceptable effects from the virus while also introducing measures with small negative repercussions.

5.2 Compliance with risk science terminology

The Society for Risk Analysis Glossary (2018) provide an overview over central terms within risk assessment and management. It has already been established that the risk definition adopted by NIPH does not comply with contemporary risk science terminology. According to contemporary risk science, risk concerns undesirable and undesirable consequences of an activity *and* the related uncertainties (Aven & Thekdi, 2021). Emphasis on uncertainties is common in many risk definitions, especially when facing large uncertainties. The covid-19 pandemic is certainly a risk situation involving large uncertainties. The risk definitions presented in all NIPH's covid-19 risk assessments do therefore *not* comply with risk science. Risk is simply defined only as a product of probability and consequence. According to current risk science this is not sufficient as it does not clarify the role of uncertainty.

Below are some other comparisons of NIPH's terminology in the risk assessments and the SRA terminology:

Terminology	SRA Glossary	NIPH
Qualitative uncertainty definition	"For a person or a group of persons, not knowing the true value of a quantity or the future consequences of an activity" "Imperfect or incomplete information/knowledge about a hypothesis, a quantity, or the occurrence of an event"	No formal qualitative uncertainty definition found in any of the assessments. Uncertainty is however referred to in all the reports when discussing or acknowledging both not knowing the true value of the model outputs, and when data/knowledge are limited or non-existent. This is in line with the definition of SRA.
Knowledge	"Knowledge is gained through, for example scientific methodology and peer-review, experience and testing"	Knowledge and knowledge development are central in all NIPH's risk assessments. No definition of knowledge is given. But the knowledge referred to in the assessments are based on professional research, epidemiologic research, published literature, modeling, and knowledge summaries from WHO, ECDC etc. When the knowledge is weaker, for example the use of a non-peer reviewed study NIPH recognize it, makes the reader aware of it and provide a justification for why that particular research can still be useful. This thesis concludes that NIPH's perception of what knowledge is, is in line with the SRA terminology.
Model	"A model of an object (e.g., activity, system) is a simplified representation of this object"	No clear definition. NIPH states that the model used is a simplified

Terminology	SRA Glossary	NIPH
		representation of reality. This is in line with the SRA terminology.
Robustness	"The antonym of vulnerability" "A system is robust to uncertainty if specified goals are achieved despite large info-gaps"	No definition. Health care services are considered robust if they are able to handle periods of increased health care burden. No reference to uncertainty.
Threat	"Risk source, commonly used in relation to security applications (but also in relation to other applications, for example the threat of an earthquake)"	No clear definition of threat, but the word "threat" is used in a way that complies with the SRA definition. E.g.: "the threat of the pandemic".
Vulnerability	"The degree to which a system is affected by a risk source or agent" "The degree to which a system is able to withstand specific loads" "Vulnerability is risk conditional on the occurrence of risk source/agent"	No definition of vulnerability. However, vulnerability is referred to when discussing part of the population who are more at risk of infection. This complies with the SRA terminology.
Model uncertainty	"Uncertainty about the model error, i.e., about the difference between the model output and the true value being modeled"	NIPH describe that the results from the models involve uncertainties because the inputs involve uncertain data. The model is built on assumptions and the model does not represent true values. This complies with the SRA terminology.
Precautionary principle	See section 2.3.6	See section 5.1.9 SRA's description of application of the precautionary principle is somewhat different to the criteria NIPH have used for their consideration of applying the precautionary principle, however the main ideas are similar.

Terminology	SRA Glossary	NIPH
Risk assessment	"Systematic process to comprehend the nature of risk, express and evaluate risk, with the available knowledge"	In NIPH's handbook for detection, assessment, and management of covid-19-outbreaks in municipalities (FHI, 2022), risk assessment is explained as the process of assessing the likelihood of the outbreak growing and worsening, and the consequences related to this. This terminology is more limited than the SRA definition. It does not include an expression of risk evaluation and knowledge relating to the assessment.
Risk communication	"Exchange or sharing of risk-related data, information, and knowledge between and among different target groups (such as regulators, stakeholders, consumers, media, general public)."	No clear definition of what risk communication is, but risk communication is referred to when sharing information about the risk situation with media and with the public.
Risk management	"Activities to handle risk such as prevention, mitigation, adaption or sharing." "It often includes trade-offs between costs and benefits of risk reduction and choice of level of tolerable risk"	No clear definition, however, NIPH constantly refer to prevention and mitigation efforts as well as trade-offs between costs and benefits in relation to risk management.

Table 5: A comparison of terminology between SRA Glossary (2018) and FHI (2020-2022).

NIPH does not provide many formal definitions of terms used in the risk assessments. However, when discussing and expressing risk and risk situations NIPH uses a lot of the terms presented in the glossary. It is also clear from the use of the terms, that NIPH to some degree follow the same terminology. One of the important findings is that NIPH's definitions of risk does not comply with risk science.

6. DISCUSSION

6.1 Possible explanations of the observed trends

As the epidemic situation developed NIPH presented updated risk assessments and new knowledge and advice regarding the current covid-19 situation. In the early stages of the pandemic the focus was mainly on the potential degree of import of the virus to Norway, and the following proliferation within the country. NIPH attempted to understand the epidemiological factors related to the virus and the extent of the potential epidemic situation Norway was facing. As the epidemic evolved and grew NIPH started to present more specific and detailed scenarios. At the start NIPH could only use covid-19 affected numbers and data from overseas, whereas the middle and later stages of the epidemic allowed them to use national data. This can explain why the presented scenarios became more specific as the epidemic evolved and more data became available.

Even though the risk definition stays close to constant throughout the whole pandemic, the risk characterization changes slightly. From assessing risk based on probabilities and consequence NIPH adds another element: confidence in the knowledge base. They explain that where the confidence in the knowledge base is weak, they cannot conclude about risk. Here, NIPH adds the element of uncertainty into the risk description instead of just talking about uncertainty and lack of knowledge throughout the reports. However, after the risk assessment published on 7th of December 2021 this element is removed again. NIPH does not provide any explanation as to why these systematic evaluations of their confidence in the knowledge base suddenly disappear. However, the end of the systematic evalutions of strength of knowledge is seen in relation to when NIPH, after the report published on 7th of December 2021, also starts discussing and describing risk more generally and less systematic. From presenting clear systematic summary tables of the assessed risk, NIPH discuss risk in general and presents more specific conclusions about risk. NIPH uses statements like *the omicron variant **will** give rise to a significant wave* or *it is **expected** that the epidemic will grow for a while, and then reach a low level in end of March.* The possible explanation for this less systematic description of risk and the disappearance of the knowledge confidence evaluations can be that NIPH at this point have gathered so much information and knowledge regarding the virus that they see these systematic presentations as less necessary.

In the very early stages of the epidemic and at the start of the implementation of restrictions, NIPH were unaware of how the public would react to the infection control measures. The report from 7th of April is the first one to recognize that the way risk has been communicated have influenced the public's risk perception. NIPH, from that report and onwards, refer to how good risk communication can increase the public's understanding of the risk. Being open and honest about uncertainties are and adapting the risk communication to different target groups are key reoccurring points in the risk assessments. In May 2020, NIPH addresses risk communication with media. As the epidemic have developed so has the media coverage, and so NIPH highlights that media inquiries need to be met quick and correct information must be communicated. This is a smart tactic to avoid media amplification. Two-way communication between NIPH and the public is also presented. This is a valuable tool for NIPH as feedback and questions from the public can represent the public's risk perception and give NIPH a clearer idea of what risk communication strategies to follow. As the epidemic develops so do the risk communication.

6.2 Ways to improve compliance with risk science

This work has established that risk science provides the most updated and justified knowledge regarding risk concepts and that these concepts are valuable for all risk situations, including when facing a pandemic.

As mentioned in the theory chapter, most individuals and groups have a perceived idea of what risk *is*, however the definition of risk is not always clear. NIPH's risk definitions and risk descriptions reflects the likelihood of something happening and the severity of the consequences if it happens. For the readers of the risk assessments, and for the public when presented with the NIPH risk assessments this message is quite clear. For example, the probability of covid-19 import to Norway is considered **high**, but the consequences are considered **low.** The risk is therefore considered **moderate.** This risk description is quite clear and simple; however, the question becomes *what does this really tell the decision-makers and the public?* Contemporary risk science argues that this presentation of risk used by NIPH is not satisfactory. Referring to the theory chapter regarding risk description it is stated that the way risk is defined and described can influence the risk assessment and the overall risk handling. According to risk science, uncertainties and knowledge play essential roles in the risk description and risk understanding. The way NIPH describe risk is important

for how HOD perceives the risk and conclude about what to do. Therefore, it would be beneficial for NIPH to adopt a definition and characterization of risk that gives more weight to uncertainties and in turn a better understanding of the risk. Compliance with risk science when defining and characterizing risk can prove to be fruitful for future risk assessments.

During the pandemic the uncertainties have been so large that making accurate predictions have not been possible. NIPH states in their risk reports that the estimates and predictions presented are based on limited knowledge and uncertain data input for the prediction models. However, NIPH still use these predictions to present potential scenarios to HDIR and HOD and make them available for the public. If the risk characterization behind these scenarios does not give sufficient weight to the strength of knowledge and uncertainties, HOD and the public might interpret these scenarios to be more realistic than what they are.

NIPH do however present a consistent openness regarding how the model assumptions involve large uncertainties, and how there are also significant uncertainties relating to the epidemic's development. NIPH points out shortcomings in the knowledge base and are clear regarding lack of knowledge and limited knowledge throughout all their risk assessments. Their risk assessments are built on current available data and information and are updated as more scientific knowledge becomes available. To express uncertainties, NIPH use uncertainty intervals and categorize probabilities into low, medium, and high. According to fundamental risk science, a judgement of the strength of the knowledge backing the risk assessment should be included. A more systematic judgement of the strength of the knowledge included in the risk characterization would, according to risk science, be more beneficial as it can benefit the risk communication and the overall understanding of each risk event. Even though NIPH is open about lack of knowledge and uncertain data a majority of the report includes no explicit judgement of the strength of the knowledge. A systematic evaluation of the strength of the knowledge is only included in 10 of NIPH's risk assessments. To reach a higher degree of compliance with risk science, this systematic evaluation should have been included in all the risk assessments.

6.3 The importance of balancing different concerns

According to risk science, the precautionary measure can be applied to the covid-19 risk handling. This is because the consequences of the covid-19 risks can be severe, and there are scientific uncertainties involved (Aven & Bouder, 2020). NIPH refers to the precautionary measure several times throughout the pandemic. They argue for applying the precautionary principle when the risk involves a potential uncontrolled epidemic situation with severe consequences for lives and health and when there are large uncertainties. They also refer to DFØ and their guide for use of the precautionary principle. This work concludes that NIPH's application of the precautionary principle is in line with what risk science recommended use of the principle.

A well-known principle of risk management is the need to balance different concerns. As mentioned in earlier parts of the work, NIPH is only an advisory institute and their risk reports and risk assessments form parts of the basis for the decision-makers risk management strategy. The decision-makers must consider other input as well, such as issues, assessments, and perspectives from other sciences such as for example economics, social sciences etc. Broad deliberations have to be made in order to arrive at the best possible risk management strategy. Referring back to the precautionary principle, Aven & Bouder (2020) argue that the principles need to be used with care and as a stimulation and justification of gathering more scientific information and data. Therefore, when NIPH introduce the precautionary principle and argues that its application is necessary while new knowledge is gathered this is in line with the current risk science view – that there should not exist a conflict between the precautionary principle and science.

6.4 Links to high quality risk assessments

This work argues that NIPH's risk assessments overall meets the general criteria for high-quality risk assessments as presented by SRA (2018) and Aven (2019):

1. *The work is solid.* The risk assessments published by NIPH are easy to understand and are clear and logical. Limitations and constraints are introduced although not always in line with risk science thinking. Models and methods used are introduced and explained.

2. *The analysis is relevant and useful.* NIPH's covid-19 risk assessments contributes to the understanding of the risks of covid-19 and provides guidance for decision-makers.
3. *The assessment and results are reliable and valid.* NIPH's covid-19 assessments are based on appropriate methods and models, and the models are measuring what they are supposed to. The knowledge and lack of knowledge backing the models and methods are states, although not always systematic in line with risk science.
4. *The decision-makers have confidence in the assessments and its results and findings.* After two years of experience with the covid-19 pandemic it has been made clear that the governmental pandemic risk management in Norway have benefited greatly from the NIPH's risk assessments.

As mentioned earlier in this work, the author has decided to look at the overall risk reports produced by NIPH, not only the sections that are named "risk assessment". This is because the NIPH reports as a whole provide a much better understanding of the risk and the following risk assessment. Because the risk assessments are published within the risk reports it signals that NIPH expects the reader to consider all information in the risk reports together with the chapter on risk assessment. The chapter on risk assessment and conclusions drawn about risk is influenced by the information presented in the other chapters of the reports.

6.5 Reliability and validity of the findings

Like evaluating the quality of a risk assessment by checking its reliability and validity, the same goes for other types of research. The reliability and validity of the research demonstrates the strength of the research process and the trustworthiness of the findings (Roberts & Priest, 2006). Reliability refers to how consistent the research measuring instrument is. If the same results can be achieved when repeating the measuring method, the research is reliable. Reliability in qualitative studies is mostly concerned with creating an understanding of the research quality. A good quality study helps to create an understanding of the situation or problem that would otherwise be confusing (Golafshani, 2003). Validity refers to if the measurements measure what they are supposed to.

To establish reliability of this work a description of the method for the data collection and the evaluation was presented. Chapter 4 also introduced an overview of the collected data, the

reasonings for why the data was chosen, explanations for the cut-off date and introduced the elements that form the basis for the evaluation.

To ensure validity this work aimed to use the methods presented in chapter 4 the way they were set out to be used. The elements that form the basis for the evaluation were based on risk science theory, and chapter 4 explained how this work intended to look for how these central risk science elements were presented in the risk assessments. The thesis refers to these elements throughout the whole work to attempt to establish validity.

Some additional measures could have been taken to achieve even more valid and reliable results. The evaluation, findings and discussion could have been enhanced by for example including NIPH's explanation for the observed trends or including their reasoning for removing the systematic evaluations of the strength of the knowledge in the risk assessments. Looking retrospectively, NIPH could have been contacted to gain a better understanding and explanations of the certain trends and elements found through the evaluation. A more thorough investigation into how Hdir and HOD have interpreted and made use of the NIPH's risk assessments could have also provided more insights. It could also have been fruitful to examine if the differences in the risk characterization (with more or less weight given to uncertainties and knowledge) have actually affected the decision making in real life.

7. CONCLUSION

This work has evaluated and discussed NIPH's covid-19 risk assessments from a risk science point of view. The work has presented relevant theory and the methods used for the data collection and the evaluation. The objective was to explore if the covid-19 risk assessments by NIPH complied with contemporary risk science, how they developed throughout the pandemic and to create an understanding of how NIPH's role influence the governmental risk management and the decision-making. Following conclusions have been made:

The work has established that the NIPH risk assessments comply with contemporary risk science to a certain degree, but there are areas for improvement. Some terminology and descriptions of key risk terms in the risk assessments reflects fundamental risk science terminology and principles. Some examples are the use of the precautionary principle and when managing risk communication.

One of the main findings was however that the way NIPH define and describe risk does not consistently comply with current risk science. The NIPH's risk definitions reflects risk as a product of probabilities and consequences. According to current risk science this definition is not sufficient as it does not reflect uncertainties and knowledge. The way NIPH describe risk reflect the risk definition through parts of the pandemic. However, 10 of the risk assessments include a judgement of the strength of the knowledge supporting the assessment. To reach a higher degree of compliance with risk science the judgements of the strength of knowledge should always be included when characterizing risk.

The work also concludes that because NIPH has an advisory role to HDIR and HOD, it would be beneficial for them to adopt a risk characterization that is more in line with contemporary risk science. This is because the way risk is characterized affects the overall risk picture and in turn the governmental decision making and risk management. If proper weight is not given to uncertainties and strength of knowledge in the risk description HDIR and HOD might make unsuccessful decisions as they are not aware of the relevant uncertainties.

The explanations for possible trends are related to the dynamics of the pandemic. As the epidemic develops so does the risk description, risk communication and risk management strategies. As more knowledge and data are gathered the risk assessments are updated to create a better understanding of the covid-19 risks.

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APPENDIX A.

Overview of all NIPH's covid 19 risk reports considered for the thesis.

	Date published	Title and source
1	28.01.2020	Risikovurdering av og respons på 2019-nCoV-infeksjon i Norge. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/risikovurdering-av-og-respons-pa-2019-ncov-infeksjon-i-norge-28.01.2020.pdf
2	25.02.2020	Risikovurdering og respons i Norge – andre versjon. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/notat-om-risiko-og-respons-2020-02-25.pdf
3	12.03.2020	Risikovurdering og respons i Norge – tredje versjon. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/notat-om-risiko-og-respons-2020-03-12.pdf
4	24.03.2020	Risiko, prognose og respons i Norge etter uke 12. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/covid-19-epidemien-risiko-prognose-og-respons-i-norge-etter-uke-12.--24.mars-2020.pdf
5	24.03.2020	Presentasjon av Covid-19. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/presentasjon-covid-19-vedlegg-til-notat-24.-mars-2020_oppdatert.pdf
6	24.03.2020	Risiko, prognose og respons i Norge etter uke 12. Med vedlegg. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/covid-19-epidemien-risiko-prognose-og-respons-i-norge-etter-uke-12.--med-vedlegg.-24.mars-2020.pdf
7	05.04.2020	Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 14. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/notat-om-risiko-og-respons-2020-04-05.pdf
8	01.04.2020	Vurdering av test-, sporings- og isoleringsstrategi. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/vurdering-av-test-sporing-isoleringsstrategi_01-04-2020.pdf
9	21.04.2020	Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 16. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/notat-om-risiko-og-respons-21.04.2020.pdf

10	05.05.2020	Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 18. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/notat-om-risiko-og-respons-2020-05-05.pdf
11	19.05.2020	Risiko, prognose og respons i Norge. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/2020.05.19-notat-om-risiko-og-respons.pdf
12	11.06.2020	Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 23. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/notat-om-risiko-og-respons-2020-06-11.pdf
13	01.07.2020	Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 26. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/covid-19-epidemien---kunnskap-situasjon-prognose-risiko-og-respons-i-norge-etter-uke-26-01.07.2020.pdf
14	11.09.2020	Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 37. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/covid-19-epidemien---notat-om-risiko-og-respons-11.9.2020.pdf
15	09.10.2020	Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 41. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/2020-10-09-notat-om-risiko-og-respons.pdf
16	05.11.2020	Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 45. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/2020-11-05-notat-om-risiko-og-respons.pdf
17	30.11.2020	Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 48. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/covid-19-epidemien---kunnskap-situasjon-prognose-risiko-og-respons-i-norge-etter-uke-48-publisert-30.11.2020.pdf
18	21.12.2020	Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 51. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/covid-19-epidemien-kunnskap-situasjon-prognose-risiko-og-respons-i-norge-etter-uke-51-publisert-21.12.2020.pdf
19	27.12.2020	Nye varianter av SARS-CoV-2: kunnskap, risiko og respons. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803

		bd0/vedlegg/nye-varianter-av-sars-cov-2-kunnskap-risiko-og-respons-rapport-27.12.2020.pdf
20	27.12.2020	Nye varianter av SARS-CoV-2: kunnskap, risiko og respons. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/nye-varianter-av-sars-cov-2-kunnskap-risiko-og-respons-27.12.2020.pdf
21	13.01.2021	Nye varianter av SARS-CoV-2: Kunnskap, risiko og respons. Første oppdatering. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/nye-varianter-av-sars-cov-2-kunnskap-risiko-og-respons-forste-oppdatering-13.01.2021.pdf
22	22.01.2021	Utvidet varsel, Nordre Follo. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/utvidet-varsel-nordre-follo-2021-01-22-sladdet.pdf
23	27.01.2021	Nye varianter av SARS-CoV-2: kunnskap, risiko og respons. Andre oppdatering. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/nye-varianter-av-sars-cov-2-kunnskap-risiko-og-respons-andre-oppdatering-27-januar-2021.pdf
24	28.05.2021	Risiko ved variant B.1.617.2. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/2021-05-28-notat-om-risiko-ved-variant-b.1.617.2.pdf
25	16.06.2021	Risiko ved Delta-varianten av SARS-CoV-2 – første oppdatering. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/2021-06-16-notat-om-risiko-ved-variant-b.1.617.2.pdf
26	03.07.2021	Risiko ved Delta-varianten av SARS-CoV-2 – andre oppdatering. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/notat-om-risiko-ved-variant-b.1.617.2-andre-oppdatering-2021-07-03.pdf
27	26.07.2021	Risiko ved Covid-19-epidemien i Norge i lys av framveksten av Delta-varianten av SARS-CoV-2. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/2021-07-26-risiko-ved-covid-19-epidemien-i-norge-i-lys-av-framveksten-av-delta-varianten-av-sars-cov-2-.pdf
28	17.11.2021	Risiko ved Covid-19-epidemien i Norge. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/notat-om-risiko-ved-covid-19-2021-11-17.pdf
29	17.11.2021	Risiko ved Covid-19-epidemien i Norge. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803

		bd0/vedlegg/notat-om-risiko-ved-covid-19-2021-11-17-rev-kl.1805.pdf
30	28.11.2021	Risiko ved omikron-varianten av SARS-CoV-2 i Norge. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/2021-11-28-notat-om-risiko-ved-omikronvarianten.pdf
31	07.12.2021	Risiko ved covid-19-epidemien og ved omikronvarianten i Norge. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/notat-om-risiko-ved-covid-19-2021-12-07.pdf
32	13.12.2021	Risiko ved covid-19-epidemien og ved omikronvarianten i Norge. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/risikovurdering-2021-12-13.pdf
33	22.12.2021	Risiko ved covid-19-epidemien og ved omikronvarianten i Norge. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/risikovurdering-2021-12-22.pdf
34	12.01.2022	Risiko ved covid-19-epidemien og ved omikronvarianten i Norge. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/risikovurdering-12-01-2022.pdf
35	26.01.2022	Risiko ved covid-19-epidemien og ved omikronvarianten i Norge. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/risikovurdering-260122.pdf
36	09.02.2022	Risiko ved covid-19-epidemien i Norge – en oppdatering. https://www.fhi.no/contentassets/c9e459cd7cc24991810a0d28d7803bd0/vedlegg/risikovurdering-2022-02-09.pdf

APPENDIX B

Evaluation summary of NIPH’s covid-19 risk assessments.

Date	Title	Risk definition	Risk description	Risk description: A', C'	Risk description: Q	Risk description: K	Links to risk science
28.01.2020	**Risikovurdering av og respons på 2019-nCoV-infeksjon i Norge**	No clear definition	Import to Norway: **Low** risk. Spreading in Norway: **Moderate** risk	Risk of import and risk of spreading within Norway. Potential proliferation is explained by using the basic reproduction number *R*. The higher this number is the harder it will be to control the spreading. Also mentioned is the severity (consequences) of being infected split into 5 levels: asymptomatic, sickness, hospital, intensive care, and death.	Two disease pyramids are used to represent different levels of severity of infection. A stochastic SEIR model is used to calculate probabiliities for ongoing transmission. Sensitivity analyzes are performed to gain insights into how the uncertain data affects the simulated results.	The assessment is supported by preliminary available knowledge concerning the coronavirus. Available knowledge from other similar diseases are also used. Sources used are referenced in the assessment. The strenght of the knowledge behind the models are considered to be rather weak, and the assessment states that it needs to be interpreted with this in mind. However, there are **no systematic evaluation** of the strenght of the knowledge.	Risk-risk trade-offs. The expected benefits of potential infection control measures (risk mitigation) must be weighed against their costs and negative side effects. Reducing one risk can create other negative reprecussions. The risk management strategy must be dynamic
25.02.2020	**Risikovurdering og respons i Norge -andre versjon**	Risk is defined as the product of the probability of an event and the consequences of said event	Risk is described as the combination of probability (P) and severity of consequences (C). Lack of elimination in China: P=**high**, C=**large**. Risk is therefore considered to be **high.** Export to other countries: P= **high**, C=very **large**. Risk is therefore considered to be **high.** Uncontrolled proliferation in other countries: P=**very high**, C=**very large**. Risk is therefore considered to be very **high.** Import to Norway: P=**high**, C=**moderate**. Risk is therefore considered to be **high**, and is expected to get very **high.** Proliferation in Norway: P=**moderate**, C=**very large.** Risk is therefore considered to be moderate, but is expected to get very **high.**	Consequences and mitigation measures are considered for each event: lack of elimination in China, export to other countries, uncontrolled proliferation in other countries, import to Norway and proliferation in Norway. Some consequences mentioned are: continuous proliferation between countries, negative effects on economic activity, local uncontrolled proliferation and significant burden on health services.	A stochastic SEIR model is used to calculate probabilities for ongoing transmission within Norway. Sensitivity analyzes are performed to gain insights into how the uncertain data affects the simulated results. For the other consequences the probability is only mentioned as being between moderate and very high.	NIPH have collected the limited knowledge and data that is available and provides and overview of what information the risk assessment is based on in a separate section. The knowledge stems from several peer-reviewed articles, data from the Chinese Center for Disease Control and Prevention (CDC) and data from the World Health Organization (WHO). All sources are included as references. It is made clear that the knowledge is weak and more data is needed, however there are **no systematic evaluation** of the strenght of the knowledge.	The risk management strategy should not be to eliminate risk as this is not possible. Focus is on mitigating risk while comparing advantages of potential mitigation measures with their disadvantages
12.03.2020	**Risikovurdering og respons i Norge - tredje versjon**	Risk is defined as the product of the probability of an event and the consequences of said event	Risk is described as the combination of probability (P) and severity of consequences (C). Import to Norway: P=**very high**, C= **large**. Risk is therefore considered to be **very high.** Proliferation in Norway: P=**high and will become very high**. C=**very large**. Risk is therefore considered to be **very high.**	The two events are: import to Norway and proliferation in Norway. Consequences mentioned are: unidentified imported cases, local spreading, start of an epidemic and significant burden on the health services. The spreading of the epidemic is split into 5 phases.	Probabilities are only mentioned as being very high for both events and are based on the mathematical stochastic SEIR model.	An overview of the basis for the risk assessmemnt is provided as an attachment. The assessment is based on the currently available knowledge gathered from articles, journals, modeling studies, CDC and WHO. All sources are included as references. The reader is made aware of uncertain data and limitation of knowledge. However, there are **no systematic evaluation** of the strenght of the knowledge.	Focus is on mitigating risk while comparing advantages of potential mitigation measures with their disadvantages. Risk-risk trade-offs: burden of measures vs burden of disease. In this assessment the populations risk perception is considered as well as ethical challenges that might arise when developing risk mitigation measures

Date	Title	Risk definition	Risk description	Risk description: A', C'	Risk description: Q	Risk description: K	Links to risk science
24.03.2020	**Risiko, prognose og respons i Norge etter uke 12. Med vedlegg**	No clear definition	Risk is described as the combination of probability (P) and severity of consequences (C). Import to Norway: P=**low,** C=**small.** Risk is therefore considered to be **low.** Proliferation in Norway: P=**high**, C=**large**. Risk is therefore considered to be **high.**	The two events are: import to Norway and proliferation in Norway. Consequences mentioned are: local spreading and significant burden on health services. Three different strategies for how to deal with covid-19 in Norway are also presented and so are the related consequences. The consequences for the different strategies are categorized into catastrophic, significant and small.	Mathematical stochastic SEIR model is used to present estimates of the current situation and prognosis for the next two weeks. Sensitivity analyzes are performed to gain insights into how the uncertain data affects the simulated results. Uncertainty intervals are presented to describe the uncertainties related to the consequences for each strategy.	It is clearly stated that the data presented in the assessment involves large uncertainties that can extend beyond the specified uncertainty intervals. For the first time since the start of the epidemic, NIPH are able to use available hospital admission numbers in their mathematical models. Most of this report is based on the information and knowledge NIPH has gathered so far about the covid-19 situation in Norway. The reader is made aware of uncertain data and limitation of knowledge. However, there are **no systematic evaluation** of the strenght of knowledge.	Risk-risk trade-offs. The expected benefits of potential infection control measures (risk mitigation) must be weighed against their costs and negative side effects. Reducing one risk can create other negative reprecussions.
07.04.2020	**Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 14**	No clear definition	Risk is described as the combination of probability (P) and severity of consequences (C). Import to Norway: P= **moderate**, C= **small.** Risk is therefore considered to be **low.** Proliferation in Norway: P= **high,** C= **large.** Risk is therefore considered to be **high.**	The two events are: import to Norway and proliferation in Norway. Consequences mentioned are: increased number of sick and hospitalised people and burden on the health services. Consequences of the infection control measures effects on public health are also presented.	Mathematical stochastic SEIR model is used to present estimates of the current situation and prognosis for the next three weeks. Uncertainty intervals are presented to describe the uncertainty in the estimates. Scenarios for the reproduction number being 1,15 and 0,70 are presented. They illustrate the uncertainty by showing how small changes in the reproduction number (input in model) can lead to significant changes in the estimates.	This report presents all data input for the model in a separate attachement created by NIPH's modelling team. Separate section dedicated to knowledge updates. This includes NIPH's own hasty knowledge summaries that are based on existing knowledge about epidemics as well as newer covid-19 spesific research (e.g report from ECDC). A description of method for how the knowledge is gathered is presented as well as a judgement on the strenght of this knowledge. This is presented **somewhat systematic.**	Dynamic risk management. The public's risk perception and advice regarding risk communication is included. Bayesian networks used by the modelling team.

Date	Title	Risk definition	Risk description	Risk description: A', C'	Risk description: Q	Risk description: K	Links to risk science
21.04.2020	**Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 16**	No clear definition	Risk is described as the combination of probability (P) and severity of consequences (C). Import to Norway: P= **moderate**, C=**small.** Risk is therefore considered to be **low**. Proliferation in Norway: P= **high**, C=**large.** Risk is therefore considered to be **high.**	Socio-economic and public health consequences related to infection control measures.	Mathematical stochastic SEIR model is used to present estimates of the current situation and prognosis for the next three weeks. Uncertainty intervals are presented to describe the uncertainty in the estimates. Scenarios for the reproduction number being 1,15, 1,30 or 1,50 are represented in a simple figure showing patients in intensive care for each scenario.	Separate section dedicated to knowledge updates. All rapid knowledge reviews performed by NIPH are referenced to in this section. A reseach map have been developed by NIPH that entails relevant categorized scientific publications. **No systematic evaluation** of the strenght of knowledge included. However it is mentioned that the advice presented by NIPH should, as far as this is possible, be based on a systematic assessment of the validity of the available knowledge. A systematic list of knowledge gaps are included. The report entails a list of knowledge gaps and description of uncertainty regarding several aspects of the epidemic and the infection control measures.	Risk-risk trade-offs: burden of risk mitigation actions vs burden of disease. Dynamic risk management: the strategy chosen must be dynamic so that it can be adjusted once the epidemic evolves and more knowledge is generated. Links to risk perception and risk communication
05.05.2020	**Kunnskap, situasjon, risiko og respons i Norge etter uke 18**	No clear definition	Risk is described as the combination of probability (P) and severity of consequences (C). Import to Norway: P=**moderate**, C=**moderate**. Risk is therefore considered to be **moderate.** Proliferation in Norway: P= **moderate**, C= **moderate**. Risk is therefore considered to be **moderate.**	Socio-economic and public health consequences related to infection control measures. Consequences are listed for each measure and categorized into: small, moderate, varying, large, very large	Mathematical stochastic SEIR model is used to present estimates of the current situation and prognosis for the next three weeks. Uncertainty intervals are presented to describe the uncertainty in the estimates. Scenarios for the reproduction number being 1,1, 1,2 or 1,3 are represented in a simple figure showing patients in intensive care for each scenario.	Background knowledge and data sources are referenced in the report. The report entails a list of knowledge gaps and description of uncertainty regarding several aspects of the epidemic and the infection control measures. It is made clear that more knowledge is needed to reduce the uncertainty. There is **no systematic evaluation** of the strenght of the knowledge. NIPH have been asked to establish a national program for production of knowledge that includes assessments of this knowledge	Risk communication: separate section for how to deal with media. Dynamic risk management
19.05.2020	**Risiko, prognose og respons i Norge**	No clear definition	Risk is described as the combination of probability (P) and severity of consequences (C). Import to Norway: P=**low**, C=**moderate.** Risk is therefore considered to be **moderate.** Proliferation in Norway: P= **moderate,** C=**moderate**. Risk is therefore considered to be **moderate**. Lack of compliance with measures: P=**moderate**, C=**moderate**. Risk is therefore considered to be **moderate.** Serious illness within population: **low** risk. Serious illness for people with risk factors: **moderate** risk.	Only mentioned that there are socio-economic and public health consequences related to infection control measures.	Probabilities are only mentioned as moderate and low in this report. These are based on the models and data that have been presented in earlier reports.	The background information in this report stems from NIPH's current knowledge about the epidemic and modelling of the proliferation. The previous reports are refered to as they provide a better understanding of the basis for this report. **No systematic evaluation** of the strenght of the knowledge is included.	Risk perception and risk communication. Seperate section for risk-communication.

Date	Title	Risk definition	Risk description	Risk description: A', C'	Risk description: Q	Risk description: K	Links to risk science
11.06.2020	**Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 23**	No clear definition	Risk is described as the combination of probability (P) and severity of consequences (c). Import to Norway: P=**low**, C=**moderate.** Risk is therefore considered **moderate.** Proliferation in Norway: P=**moderate,** C=**moderate.** Risk is therefore considered to be **moderate.**	Consequences of non-compliance of infection control measures are briefly mentioned. Consequences of imported cases are mentioned: they will vary in severity depending on if they give rise to local proliferation or not.	Probabilities are only mentioned as low and moderate. They are based on models and data that have been presented in earlier reports	The background information in this report stems from current knowledge about the epidemic and modelling of the proliferation. A section on knowledge gaps is included. **No systematic evaluation** of the strenght of knowledge.	Behavioural adaptation: some of the control measures can give a false sense of security which can again lead to lack of compliance with other measures. Need dynamic risk management that consider all health, society and economic aspects.
01.07.2020	**Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 26**	No clear definition	Risk is described as the combination of probability (P) and severity of consequences (C). Import to Norway: P=**high**, C= **small/moderate**. Risk is therefore considered to be **moderate.** Local proliferation: P=**high**, C=**small.** Risk is therefore considered to be **moderate.** National proliferation: P= **low,** C=**moderate.** Risk is considered to be **low**.	Consequences of imported cases are mentioned: they will vary in severity depending on if they give rise to local proliferation or not. Consequences of proliferation in Norway: depends how quick proliferation is discovered and controlled (locally, regional and national), on the capacity of health services and the age groups affected.	The development of the epidemic is modelled using several different models. This report mentions the Sequential Monte Carlo model (SMC), but with no reference or explanation of how it works other than saying it provides estimates for the daily effective reproduction number	New knowledge is presented in a separate section with references. It is mentioned that some international literature have been summarized in a systematic way, but it is presented in separate notes (not in this report). GRADE-tool: a standard method for assessing the credibility of existing documentation. This tool have not been used by NIPH during the pandemic, but they are now considering using it. **No systematic evalution** of the strenght of the knowledge is included in the report.	Sequential Monte Carlo model is used to estimate the effective reproduction number. Need dynamic risk management that consider all health, society and economic aspects. Risk communication.
11.09.2020	**Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 37**	No clear definition	Risk is described as the combination of probability (P) and severity of consequence (C). Increase in import of cases: P= **low**, C= **small/moderate**. Risk is therefore considered **low** (if current infection control measures are continued). Local proliferation: P=**high,** C=**moderate/large**. Risk is considered **high.** Regional proliferation: P=**moderate,** C=**moderate.** Risk is considered to be **moderate.** National proliferation: P= **low,** C= **moderate/large.** Risk is considered **low.**	Consequences of imported cases are mentioned: the consequences will vary in severity depending on number of imported cases and if they give rise to local proliferation or not. Consequences of proliferation in Norway: depends how quick proliferation is discovered and controlled (locally, regional and national), on the capacity of health services and the age groups affected.	The development of the epidemic is modelled using several different models. The SMC model is mentioned as well as another method called EpiStim.	The risk assessment builds on NIPH's covid-19 surveillance, modelling of the epidemics' proliferation, current knowledge about the virus and professional infection control knowledge and experience. The sources are referenced and the reader is also referred to earlier reports. New knowledge is presented in a seperate section. A brief judgement of the strenght of the knowledge is included, but **not in a systematic way.** The GRADE-tool for credibility of documentation have been used for new information regarding medical treatment of covid-19.	Importance of risk communication and risk perception. How to get individuals to comply with infection control measures. Need dynamic risk management that consider all health, society and economic aspects. An evaluation of all infection control measures (risk mitigation measures) is included in the risk assessment.

Date	Title	Risk definition	Risk description	Risk description: A', C'	Risk description: Q	Risk description: K	Links to risk science
09.10.2020	**Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 41**	No clear definition	Risk is described as the combination of probability (P) and severity of consequences (C). Increase in import: P=**low**, C=**small/moderate.** Risk is therefore considered to be **low.** Local proliferation: P=**high**, C= **moderate**. Risk is therefore considered to be **high**. Regional proliferation: P=**moderate**, C=**moderate/large.** Risk is therefore considered to be **moderate.** National proliferation: P=**low,** C=**large.** Risk is therefore considered to be **moderate.**	Consequences of imported cases are mentioned: the consequences will vary in severity depending on number of imported cases, if they give rise to local proliferation and the potential size of this proliferation compared to the already established epidemic within the country. The proliferation within the country is explained by using the basic reproduction number R and the risk assessment presents conditions that work for and against increased proliferation. Consequences of proliferation in Norway: depends how quick proliferation is discovered and controlled (locally, regional and national), on the capacity of health services and the age groups affected.	The development of the epidemic is modelled using several different models. The SMC model is mentioned as well as another method called EpiStim. These models estimates the effective reproduction number R.	The risk assessment builds on NIPH's covid-19 surveillance, modelling of the epidemics' proliferation, current knowledge about the virus and professional infection control knowledge and experience. The sources are referenced and the reader is also referred to earlier reports. New knowledge is presented in a seperate section. **No systematic evaluation** of the strenght of the knowledge.	Risk communication. Need dynamic risk management that consider all health, society and economic aspects. An evaluation of all infection control measures (risk mitigation measures) is included in the risk assessment.

Date	Title	Risk definition	Risk description	Risk description: A', C'	Risk description: Q	Risk description: K	Links to risk science
05.11.2020	**Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 45**	No clear definition	Risk is described as the combination of probability (P) and severity of consequences (C). Increase in import: P=**high,** C=**moderate**. Risk is therefore considered to be **moderate.** Local proliferation: P=**high,** C=**moderate.** Risk is therefore considered to be **high.** Regional proliferation: P=**high,** C=**large/moderate.** Risk is therefore considered to be **high.** National proliferation: P=**moderate,** C=**large.** Risk is therefore considered to be **high**.	Consequences of imported cases are mentioned: the consequences will vary in severity depending on number of imported cases, if they give rise to local proliferation and the potential size of this proliferation compared to the already established epidemic within the country. The proliferation within the country is explained by using the basic reproduction number R and the risk assessment presents conditions that work for and against increased proliferation. Consequences of proliferation in Norway: depends how quick proliferation is discovered and controlled (locally, regional and national), on the capacity of health services and the age groups affected. Consequences of being infected are also presented. They are split into: infected, sick, diagnosed, hospital admission, intensive care and death.	The development of the epidemic is modelled using several different models. Number of infected and sick are estimated through mathematical models where the proportion of hospitalized is an decisive parameter. The estimates produced by the models involve large uncertainties.	The risk assessment builds on NIPH's covid-19 surveillance, modelling of the epidemics' proliferation, current knowledge about the virus and professional infection control knowledge and experience. The sources are referenced and the reader is also referred to earlier reports. New knowledge is presented in a seperate section. **No systematic evaluation** of the strenght of the knowledge.	Dynamic risk management. Risk perception and risk communication. An evaluation of all infection control measures (risk mitigation measures) is included in the risk assessment.

Date	Title	Risk definition	Risk description	Risk description: A', C'	Risk description: Q	Risk description: K	Links to risk science
30.11.2020	**Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 48**	No clear definition	Risk is described as the combination of probability (P) and severity of consequences (C). Increase in import: P=**moderate,** C=**moderate.** Risk is therefore considered to be **moderate.** Local proliferation: P=**high**, C=**moderate**. Risk is therefore considered to be **high**. Regional proliferation: P=**high**, C=**large/moderate.** Risk is therefore considered to be **high.** National proliferation: P=**moderate**, C=**large.** Risk is therefore considered to be **moderate.**	Consequences of imported cases are mentioned: the consequences will vary in severity depending on number of imported cases, if they give rise to local proliferation and the potential size of this proliferation compared to the already established epidemic within the country. The proliferation within the country is explained by using the basic reproduction number R and the risk assessment presents conditions that work for and against increased proliferation. Consequences of proliferation in Norway: depends how quick proliferation is discovered and controlled (locally, regional and national), on the capacity of health services and the age groups affected. Consequences of being infected are also presented. They are split into: infected, sick, diagnosed, hospital admission, intensive care and death. In this assessment these consequences are also considered for different age groups.	The number of people that have been infected, diagnosed, admitted to hospital, needed intensive care or died are estimated to illustrate the burden of disease. The development of the epidemic is modelled using several different models, thei main one being the stochastic SEIR model. Number of infected and sick are estimated through mathematical models where the proportion of hospitalized is a decisive parameter. The estimates produced by the models involve large uncertainties.	The risk assessment builds on NIPH's covid-19 surveillance, modelling of the epidemics' proliferation, current knowledge about the virus and professional infection control knowledge and experience. The sources are referenced and the reader is also referred to earlier reports. New knowledge is presented in a seperate section. **No systematic evaluation** of the strenght of the knowledge.	Dynamic risk management. Risk perception and risk communication. E.g: open communication with the public, health services, professional environments and across sectors. Justifications for the risk mitigation measures and openness regarding uncertainties. An evaluation of all infection control measures (risk mitigation measures) is included in the risk assessment.
21.12.2020	**Kunnskap, situasjon, prognose, risiko og respons i Norge etter uke 51**	For the covid-19 pandemic risk is considered by assessing the proability of a certain development and the consequences of this development	Risk is described as the combination of probability (P) and severity of consequences (C). Increase in import: P=**moderate,** C=**moderate.** Risk is therefore considered to be **moderate**. Local proliferation: P=**high,** C=**moderate.** Risk is therefore considered to be **high.** Regional proliferation: P=**high,** C=**large/moderate**. Risk is therefore considered to be **high.** National proliferation: P=**small,** C=**large**. Risk is therefore considered to be **moderate.**	The consquences are number of people infected (disease burden) and the negative reprecussions from the infection control measures. The negative reprecussions from the infection control measures are categorized into small, moderate, large, very large and varying.	The number of people that have been infected, diagnosed, admitted to hospital, needed intensive care or died are estimated to illustrate the burden of disease. Number of people infected are unknown and the development of the epidemicis therfore estimated from the mathematical models. The proportion of hospitalized is a decisive parameter in the modelling.	The risk assessment builds on NIPH's covid-19 surveillance, modelling of the epidemics' proliferation, current knowledge about the virus and professional infection control knowledge and experience. The sources are referenced and the reader is also referred to earlier reports. New knowledge is presented in a seperate section. The knowledge backing the effect and/or potential negative reprecussions of the risk mitigation measures are said to be too poor. However, **no systematic evaluation** of the strenght of the knowledge is presented.	Dynamic risk management. Risk perception and risk communication. E.g: open communication with the public, health services, professional environments and across sectors. Justifications for the risk mitigation measures and openness regarding uncertainties. An evaluation of all infection control measures (risk mitigation measures) is included in the risk assessment.

Date	Title	Risk definition	Risk description	Risk description: A', C'	Risk description: Q	Risk description: K	Links to risk science
27.12.2020	**Nye varianter av SARS-CoV-2: kunnskap, risiko og respons**	Risk is the product of probability and consequence	Risk is described as the combination of probability (P) and severity of consequences (C). Confidence in the knowledge base for the assessment (a judgement of strenght of knowledge) is also added as an importent element in the risk description. If the knowledge is weak, risk cannot be described properly.	Eight risk events are considered in this risk assessment. Consequences for each event are categorized into small, moderate and large. Consequences mentioned are: higher disease burden and the need for stronger reinforced infection control measures.	Probabilities for each risk event happening is categorized into low, moderate and high. NIPH does not conclude about the probability of two of the events because the knowledge is too weak.	It is stated that this report must be read in conjunction with the previous reports. New information is referenced. The infectioness of the new variant has been modelled in a preliminary study from the UK (not peer reviewed). For each risk event presented there is a reference to a section of the report that provides more information regarding that specific event. **A systematic evaluation** of the strenght of the knowledge is introduced. When the confidence in the knowledge base is minimal (weak strenght of knowledge), NIPH will not draw conclusions about the risk.	Precautionary principle: more measures should be implemented until more knowledge is generated.
13.01.2021	**Nye varianter av SARS-CoV-2: Kunnskap, risiko og respons. Første oppdatering**	Risk is the product of probability and consequence	Risk is described as the combination of probability (P) and severity of consequences (C). Confidence in the knowledge base for the assessment (a judgement of strenght of knowledge) is also added as an importent element in the risk description. If the knowledge is weak, risk cannot be described properly.	Eight risk events are considered in this risk assessment. Consequences for each event are categorized into small, moderate and large. Consequences mentioned are: higher disease burden, more efficient and comprehensive testing required, poor disease protection, high infectivity and the need for stronger reinforced infection control measures.	Probabilities for each risk event happening is categorized into low, moderate and high. NIPH does not conclude about the probability of two of the events because the knowledge is too weak.	It is stated that this report must be read in conjunction with the previous reports. New information about different SARS-CoV-2 variants are presented with references. For each risk event presented there is a reference to a section of the report that provides more information regarding that specific event. **A systematic evaluation** of the strenght of the knowledge is introduced. When the confidence in the knowledge base is minimal (weak strenght of knowledge), NIPH will not draw conclusions about the risk.	Precautionary principle: more measures should be implemented until more knowledge is generated.
22.01.2021	**Utvidet varsel, Nordre Follo**	No clear definition	Risk is described as the combination of probability (P) and the severity of consequences (C).	The risk event considered is the spreading of this outbreak. Consequences if this happens are considered very large: it will be hard to eliminate the variant from Norway, will be hard to keep the epidemic under control, there will be spreading to other parts of the country, the disease burden will increase	The probability for this outbreak spreading is considered to be high.	This report refers to the report from 13.01.2021 for more detailed information about the english variant. This hasty risk assessment is based on that report together with data from NIPH and Nordre Follo municipality. **No systematic evaluation** of the strenght of knowledge is presented for the risk event.	Risk communication: NIPH will contact the municipality's communication staff to support and coordinate their risk communication. Must be made clear to the population that efforts are made to stop the local outbreak, but also reassure people that this variant does not appear to cause more serious illness than the other variants.

Date	Title	Risk definition	Risk description	Risk description: A', C'	Risk description: Q	Risk description: K	Links to risk science
27.01.2021	**Nye varianter av SARS-CoV-2: kunnskap, risiko og respons. Andre oppdatering**	Risk is the product of probability and consequence	Risk is described as the combination of probability (P) and the severity of consequences (C). Confidence in the knowledge base for the assessment (a judgement of strenght of knowledge) is also added as an importent element in the risk description. If the knowledge is weak, risk cannot be described properly.	Ten risk events are considered in the risk assessment. Consequences for each event are categorized into small, moderate and large. The main consequences for all risk events relate to higher disease burden and stronger reinforced infection control measures. Consequences will also depend on how contagious the new variants are.	Probabilities for each risk event happening is categorized into low, moderate and high. NIPH does not conclude about the probability of two of the events because the knowledge is too weak.	The assessment is based on NIPH's monitoring of the epidemic and the virus, available knowledge and experience of the virus, the disease and infection control, as well as ECDC's risk assessments (referenced on same page). The report must be read in conjunction with the report from 13.01. For each risk event presented there is a reference to a section of the report that provides more information regarding that specific event. **A systematic evaluation** of the strenght of the knowledge is introduced. When the confidence in the knowledge base is minimal (weak strenght of knowledge), NIPH will not draw conclusions about the risk.	Precautionary principle: more measures should be implemented until more knowledge is generated. Risk communication: strenghten communication work to increase the publics understanding of the importance of the entry quarantine.
28.05.2021	**Risiko ved variant B.1.617.2**	Risk is the probability that an event (of an assessed magnitude) occurs multiplied by the magnitude of the consequences	Risk is described as the combination of probability (P) and the severity of consequences (C). Confidence in the knowledge base for the assessment (a judgement of strenght of knowledge) is also added as an importent element in the risk description. If the knowledge is weak, risk cannot be described properly.	Six risk events are considered in the risk assessment. Consequences for each event are categorized into small, medium and large. Consequences mentioned are greater risk of proliferation, higher disease burden and stronger reinforced infection control measures.	The probability for each risk event happening is categorized into low, medium and high.	The assessment is based on NIPH's monitoring of the epidemic and the virus, available knowledge and experience of the virus, the disease and infection control, oral communication with british and nordic colleagues as well as risk assessments from WHO, ECDC and Public Health England (not listed in references). **A systematic evaluation** of the strenght of the knowledge is introduced. When the confidence in the knowledge base is minimal (weak strenght of knowledge), NIPH will not draw conclusions about the risk.	"Try to delay the introduction and spread of the variant in Norway with proportionate measures"
16.06.2021	**Risiko ved Delta-varianten av SARS-CoV-2 - første oppdatering**	Risk is the probability that an event (of an assessed magnitude) occurs multiplied by the magnitude of the consequences	Risk is described as the combination of probability (P) and the severity of consequences (C). Confidence in the knowledge base for the assessment (a judgement of strenght of knowledge) is also added as an importent element in the risk description. If the knowledge is weak, risk cannot be described properly.	Six risk events are considered in the risk assessment. Consequences for each event are categorized into small, medium and large. Consequences mentioned are greater risk of proliferation, higher disease burden and stronger reinforced infection control measures. Consequences will depend on the vaccination's degree of protection against infection and serious illness.	The probability for each risk event happening is categorized into low, medium and high.	The assessment is based on NIPH's monitoring of the epidemic and the virus, available knowledge and experience of the virus, the disease and infection control, oral communication with british and nordic colleagues as well as risk assessments from WHO, ECDC and Public Health England (referenced on the same page). **A systematic evaluation** of the strenght of the knowledge is introduced. When the confidence in the knowledge base is minimal (weak strenght of knowledge), NIPH will not draw conclusions about the risk.	"Try to delay the introduction and spread of the variant in Norway with proportionate measures"

Date	Title	Risk definition	Risk description	Risk description: A', C'	Risk description: Q	Risk description: K	Links to risk science
03.07.2021	**Risiko ved Delta-varianten av SARS-CoV-2 - andre oppdatering**	Risk is the probability that an event (of an assessed magnitude) occurs multiplied by the magnitude of the consequences	Risk is described as the combination of probability (P) and the severity of consequences (C). Confidence in the knowledge base for the assessment (a judgement of strenght of knowledge) is also added as an importent element in the risk description. If the knowledge is weak, risk cannot be described properly.	Six risk events are considered in the risk assessment. Consequences for each event are categorized into small, medium and large. Consequences mentioned are greater risk of proliferation, higher disease burden, changes in population immunity and stronger reinforced infection control measures. Consequences will depend on the vaccination's degree of protection against infection and serious illness.	The probability for each risk event happening is categorized into low, medium and high.	The assessment is based on NIPH's monitoring of the epidemic and the virus, available knowledge and experience of the virus, the disease and infection control, oral communication with british and nordic colleagues as well as risk assessments from WHO, ECDC and Public Health England (referenced on the same page). **A systematic evaluation** of the strenght of the knowledge is introduced. When the confidence in the knowledge base is minimal (weak strenght of knowledge), NIPH will not draw conclusions about the risk.	Risk communication: WHO have introduced new labels on the variants to avoid stigmatizing and misleading geographical indications. NIPH will use these labels in publications that are intended for the general public.
26.07.2021	**Risiko ved Covid-19-epidemien i Norge i lys av framveksten av Delta-varianten av SARS-CoV-2**	Risk is the product of probability and consequence	Risk is described as the combination of probability (P) and the severity of consequences (C). Confidence in the knowledge base for the assessment (a judgement of strenght of knowledge) is also added as an importent element in the risk description. If the knowledge is weak, risk cannot be described properly.	Four risk events are considered in the main risk assessment. A risk assessment that considers the development of the epidemic for August - September is also included. Consequences for each event are categorized into small, medium and large. Consequences mentioned are higher disease burden, changes in population immunity and stronger reinforced control measures. Consequences will depend on the vaccination's degree of protection against infection and serious illness.	The probability for each risk event happening is categorized into low, medium and high	The assessment is based on NIPH's monitoring of the epidemic and the virus, available knowledge and experience of the virus, the disease and infection control, oral communication with british and nordic colleagues as well as risk assessments from WHO, ECDC and Public Health England (referenced on the same page). **A systematic evaluation** of the strenght of the knowledge is introduced. When the confidence in the knowledge base is minimal (weak strenght of knowledge), NIPH will not draw conclusions about the risk.	Risk perception: People are tired of the infection control measures
17.11.2021	**Risiko ved Covid-19-epidemien i Norge**	Risk is the product of probability and consequence	Risk is described as the combination of probability (P) and the severity of consequences (C). Confidence in the knowledge base for the assessment (a judgement of strenght of knowledge) is also added as an importent element in the risk description. If the knowledge is weak, risk cannot be described properly.	The risk related to new unknown variants of the virus is assessed. Five risk events connected to the AY.4.2 variant (subgroup Delta) is also considered. A risk assessment that considers the development of the epidemic for November - December is also included. Consequences are categorized into small, medoum and large for each risk event/risk assessment	The probability for each risk event happening is categorized into low, medium and high.	The assessment is based on NIPH's monitoring of the epidemic and the virus, available knowledge and experience of the virus and related disease as well as oral communication with british, nordic and other european colleagues. **A systematic evaluation** of the strenght of the knowledge is introduced. When the confidence in the knowledge base is minimal (weak strenght of knowledge), NIPH will not draw conclusions about the risk.	The risk cannot be eliminated, the focus needs to be on robustness and resilience. There is a need for new cost-benefit analyzes of the infection control measures. The precautionary principle: there is significantly less basis for reducing the proliferation based on a precautionary approach now compared to nine months ago. This is due to more knowledge and less uncertainty. Risk communication.

Date	Title	Risk definition	Risk description	Risk description: A', C'	Risk description: Q	Risk description: K	Links to risk science
28.11.2021	**Risiko ved omikron-varianten av SARS-CoV-2 i Norge**	Risk is the product of probability and consequence	Risk is described as the combination of probability (P) and the severity of consequences (C). Confidence in the knowledge base for the assessment (a judgement of strenght of knowledge) is also added as an importent element in the risk description. If the knowledge is weak, risk cannot be described properly.	Seven risk events are considered. Consequences for each event are categorized into small, medium and large. Consequences mentioned are higher disease burden, changes in population immunity, stronger reinforced control measures and less effective rapid tests. Consequences will also depend on the vaccination's degree of protection against infection and serious illness.	The probability for each risk event happening is categorized into low, medium and high	This report is based on international reports concerning the new variant, knowledge and experience about the virus, the disease, infection control and virology, as well as oral communication between european colleagues and WHO's and ECDC's assessments (these are referenced on the same page). **A systematic evaluation** of the strenght of the knowledge is introduced. When the confidence in the knowledge base is minimal (weak strenght of knowledge), NIPH will not draw conclusions about the risk.	Precautionary principle: Infection control measures are put in place while more knowledge is gathered.
07.12.2021	**Risiko ved Covid-19-epidemien og ved omikronvarianten i Norge**	Risk is the product of probability and consequence	Risk is described as the combination of probability (P) and the severity of consequences (C). Confidence in the knowledge base for the assessment (a judgement of strenght of knowledge) is also added as an importent element in the risk description. If the knowledge is weak, risk cannot be described properly.	For risk events related to the omicronvariant are considered as well as an overall risk assessment of the epidemic's development. Consequences mentioned are higher disease burden, changes in population immunity, increased burden on local municipalities, increased burden on health services, stronger reinforced control measures and less effective rapid tests. Consequences will also depend on the vaccination's degree of protection against infection and serious illness.	The probability for each risk event happening is categorized into low, medium and high	The assessment is an update based on the assessments from 17th november and 28th november. It is also based on NIPH's monitoring of the epidemic and the virus, available knowledge and experience of the virus and related disease as well as oral communication with british, nordic and other european colleagues. **A systematic evaluation** of the strenght of the knowledge is introduced. When the confidence in the knowledge base is minimal (weak strenght of knowledge), NIPH will not draw conclusions about the risk. This report also includes a section regarding knowledge production that presents spesific aspects about the virus that need more knowledge	The disease burden has to be balanced against the burden of infection control measures. An assessment of the use of precautionary approach is presented. The conclusion is that there is a basis to use precautionary measures to "buy more time" while more knowledge is gathered. A long-term strategy is needed, and this needs to include an assessment of cost and benefit.
13.12.2021	**Risiko ved Covid-19-epidemien og ved omikronvarianten i Norge**	No clear definition	Risk is described as the combination of probability (P) and the severity of consequences (C). Growing epidemic: P=**large,** C=**large**. Risk is therefore considered to be **big.**	This report addresses the risk related to the epidemic growing in December 2021 and January 2022. Consequences for a growing epidemic is considered large on a national scale.	The probability for a growing epidemic is considered to be large.	This report refers to the report from 7th December. There is **no systematic evaluation** of the strenght of the knowledge included in this report.	The criteria for using a precautionary approach is still fullfiled (refers to the previous report). Still a need to develop a long-term strategy (refers to the previous report). Risk communication: it is important the the population is aware and gains an understanding of the situation and the risk of further development. Transparancy regarding uncertainties is necessary.

Date	Title	Risk definition	Risk description	Risk description: A', C'	Risk description: Q	Risk description: K	Links to risk science
22.12.2021	**Risiko ved Covid-19-epidemien og ved omikronvarianten i Norge**	No clear definition	Risk is just described and discussed in general with no systematic set up of probabilities and consequences.	This report addresses the risk related to the epidemic growing in December 2021 and January 2022. It also assess the risk related to influenza and the RS virus. The consequences of a new wave is considered: higher burden on health services, but also rest of the society because more people will get sick and require sick leave. This will in turn affect the education sector, the business community and important societal functions.	The assessment concludes that it is **likely** the omicronvariant will give rise to a new epidemic wave in January. The consequences and the size of the wave do however still involve uncertainties.	This report refers to the report from 7th and 13th of December. General information about the covid-19 epidemic in Norway and information about the omicronvariant is presented with references. The report highlights that there are still large uncertainties involved. There is **no systematic** evaluation of the strenght of the knowledge.	The criteria for using a precautionary approach is still fullfiled and there is still a need to develop a long-term strategy (refers to the report from 7th December). Risk communication: it is important the the population is aware and gains an understanding of the situation and the risk of further development. Transparancy regarding uncertainties is necessary.
12.01.2022	**Risiko ved Covid-19-epidemien og ved omikronvarianten i Norge**	No clear definition	Risk is just described and discussed in general for the development of the epidemic between Januray and March.	Consequences of a new wave between January and March are mentioned: higher disease burden, increased sick-leave in society and increased burden on health services. For the individual person the consequences of this wave can be that an infection will happen earlier, but the risk of serious illness is low. The report also assess the risk related to influenza and the RS virus.	The assessment concludes that the omicronvariant **will** give rise to a significant wave of the epidemic in January-March. The consequences and the size of the wave do however still involve uncertainties.	The report refers to the risk assessments from 7th, 13th and 22nd December 2021. General information about the covid-19 epidemic in Norway and information about the omicronvariant is presented with references. The report highlights that there are still large uncertainties involved. There is **no systematic evaluation** of the strenght of the knowledge.	Still important to assess and balance the burden versus the benefit of the infection control measures. Risk communication: the rational behind the measures must be explained properly to the public. There is also still a need for a long-term strategy and factors that will be important for this strategy are presented.
26.01.2022	**Risiko ved Covid-19-epidemien og ved omikronvarianten i Norge**	No clear definition	Risk is just described and discussed in general for the development of the epidemic between Januray and March.	Consequences of a new wave between January and March are mentioned: higher disease burden, increased sick-leave in society and increased burden on health services. For the individual person the consequences of this wave can be that an infection will happen earlier, but the risk of serious illness is low. The report also assess the risk related to influenza and the RS virus.	The assessment concludes that the omicronvariant **will** give rise to a significant wave of the epidemic in January-March. The consequences and the size of the wave do however still involve uncertainties.	The report refers to the risk assessments from 7th, 13th and 22nd December 2021 as well as the previous report from 12th January. General information about the covid-19 epidemic in Norway and information about the omicronvariant is presented with references. Separate attachements are included that presents the knowledge base for the omicron variant's spreadability and the omicron variant's severity. The report highlights that there are still large uncertainties involved. There is **no systematic evaluation** of the strenght of the knowledge.	Risk perception: The individual risk is by many perceived as small now as the vaccinated people tend to not get severe illness. This can affect the public's compliance with infection control measures. Still important to assess and balance the burden versus the benefit of the infection control measures. Risk communication: less measures and more personal responsibility requries good communication.

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09.02.2022	**Risiko ved covid-19-epidemien i Norge - en oppdatering**	No clear definition	Risk is just described and discussed in general for the development of the epidemic.	Consequences of the current wave are mentioned: higher burden on the health services, but also rest of society as more sick-leave will be needed. For the individual person the consequence is that they will get infected earlier. The report also assess the risk related to influenza and the RS virus.	NIPH expects the epidemic to grow for a while, and then reach a low level at the end of March. Any uncertainties are only related to how far the current wave have developed.	The report refers to the risk assessments from 7th, 13th and 22nd December 2021 as well as the reports from 12th and 26th of January. The knowledge base from the 26th January report is described more detailed in this report. NIPH state that new research, experience from other countries and developments in Norway have made them more confident in their assessments. There are **no systematic evaluation** of the strenght of the knowledge included in the assessment	