Pathogen risks due to climate change:
Review of the health and policy context and legal basis for the introduction of mandatory vaccination in The Netherlands

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Abstract

The Earth's climate is changing rapidly, and as a result, pathogenic diseases will spread across the globe. This thesis aims to give a global view on these potential environmental impacts of climate change, in relation to (spreading) pathogenic diseases, and how these can cause big health risks for both humans and animals. By using different case studies, examples from different countries and existing literature, this thesis will give an evaluation of the importance of vaccination against these (uprising) pathogenic diseases for protecting global health.

This literature-based thesis shows not only that the (positive) effects of vaccination against pathogenic diseases but also that amongst the Dutch population there is more hesitancy to get vaccinated. One of the findings in the thesis is that due to vaccination hesitancy the demand is now almost insufficient to obtain herd immunity, thus becoming a real health risk of the Dutch population. Therefore, this thesis discusses a legal solution for the decreasing heard immunity level amongst the Dutch population. Mainly by looking at what the possibilities are within the Dutch laws, the following research question for this thesis study was formed: '*Would it be legally possible to make vaccination mandatory within the Dutch laws and regulations?*'.

The key findings in this literature-based thesis are, that the future arrival of pathogens due to climate change, will be a real scenario with major consequences for both human and animal health. In addition, available literature and studies show that vaccination will be the best (prevention) medicine for pathogenic risks. Thirdly, in order to combat the declining vaccination rate in the Netherlands, the Dutch government has legal starting points to make (types of) vaccinations mandatory. The last key finding is that, even though this thesis has shown that it is legally possible to make vaccinations mandatory, a larger study should be done into the ethical, operational and negative sides of making vaccinations (legally) mandatory.

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1 Introduction

The climate is changing. This is a fact. The effects of the changing climate are more and more visible each day. In the Russian city of Yakutsk for instance, it has always been cold (normally -53.4 degrees Celsius) but the mercury in 2023 has dropped to -62.7 degrees Celsius (Born, 2023). On the other side of the spectrum Death Valley. The hottest place on earth (normally 49 degrees Celsius) the temperature has risen in 2023 to 54 degrees Celsius (National Park Service, 2023). The more the climate of the earth will change, the more effects of it will become visible. But there is another effect of climate change, that we cannot see with the naked eye: the spreading of pathogens.

Scientists have long predicted the (re)emerge of pathogens, due to the effects of climate change. The March 2022 report, from the *Intergovernmental Panel on Climate Change* (IPCC), warned that, without swift climate action we will see an escalation of infectious diseases around the globe (Nicholas, 2022). Since pathogens can form a serious health risk for both humans and animals, and because we do not (and cannot) know all the pathogens that will (re)emerge due to climate change, there are two main ways to combat the risk of these pathogens: 1) humans stop the climate change by taking serious action now, or 2) we vaccinate everybody to (hopefully) prevent a pandemic. Unfortunately, climate change is still happening to this day, with no end in sight. Therefore, this thesis focusses on vaccination as a source or remedy against the possible climate change pathogenic risks.

Vaccinations are to this day the best (prevention) medicine against pathogens (UNICEF, 2022). As seen with *SARS-CoV-2* (also known as Coronavirus or COVID-19) as soon as people got vaccinated, the spread of the virus slimmed. This showed the significant importance of vaccinations. Due to the positive results of vaccinations, it may be our best (or even only) solution in the fight against the pathogenic (re)emergence. But we can only combat pathogens if people are getting vaccinated. There is a decreasing level in people wanting to get vaccinated in the Netherlands. More and more people are hesitant, and this is creating a problem for the herd immunity[1]. The question now rises, how can we protect the health and welfare of people, if other people are not willing to get vaccinated and thus endanger herd immunity?

[1] Group immunity (also known as herd immunity or population immunity) is the indirect protection from an infectious disease that happens when a population is immune either through vaccination or immunity developed through previous infection.

1.1 Research question

Climate change forces us to adapt. There are multiple visible effects that climate change can and already is causing, but we should not forget about the 'invisible' effects of climate change: (re)emergence of (dangerous/contagious) pathogens. Concerning the rising health risk of (new) pathogens due to climate change and the decreasing level of herd immunity due to vaccination hesitancy, it is believed that preventive vaccination will become important to our 'survival'. But since people in the Netherlands are more hesitant to get vaccinated, a possible solution for this problem could be to make vaccinations legally mandatory. Therefore, this thesis aims to answer the following research question:

Would it be legally possible to make vaccination mandatory within the Dutch laws and regulations?

1.2 Research Objectives

Vaccination is not only our best medicine against pathogenic diseases, but it has also become one of our overall protection instruments for the health of people. Different vaccinations are implemented in the Dutch Policy plan 'Immunization Program', which protects children at the start of their life. Due to this immunization program some diseases are even eradicated. But when people are hesitant to get their children vaccinated, this can cause serious health problems. Not only heard immunity cannot be achieved, but diseases could make a comeback. A study about the importance of vaccination, especially in relation to the upcoming pathogenic risk due to climate change, may reveal that implementing mandatory vaccination in the Dutch Health Policy program, can be seen as a main protection mechanism for the health and welfare of people.

Therefore, to answer the research question, the secondary objectives of the thesis are:

I) To review the different pathogens and infections/contagious diseases.

II) To map vaccinations and the effects of mutations and epidemics/pandemic.

III) To identify the different pathogenic risks that will arise due to climate change.

IV) To review how the Dutch Vaccination Policy and the Dutch Immunization Program are implemented.

V) To identify the reasons for the decline of the national vaccination rate.

VI) To investigate which measures can be taken to increase the national vaccination rate.

VII) To identify which mandatory characters there are for making vaccinations mandatory

VIII) To investigate the legal position of mandatory vaccination

IX) To discuss the implementation of mandatory vaccination in ethical dimensions

1.3 Research Aims

The previous explained objectives of this thesis study are to help answer the main research question. The topics climate change, pathogens and (mandatory) vaccination are the biggest part for this thesis. Since these topics are very large and could have a thesis study of their own, it is necessary to determine what the specific aims of this thesis are. Therefore, this thesis has the following two main aims:

1. Investigate how, due to climate change, pathogens could form a threat to the health and welfare of humans.
2. Investigate if making vaccinations mandatory is possible within the Dutch law.

1. Climate change and pathogens

Overall, climate change describes global warming—the ongoing increase in global average temperature—and its effects on Earth's climate system. Climate change creates a chain reaction: with rising temperatures some places will be met with extreme drought, causing deserts to expand, which can lead to more common heat waves and wildfires. Another example of this 'chain' due to the rising temperatures is: glaciers and other ice parts will start to melt, causing the sea-level to rise, which can create flooding's and possible even land disappearance. These 'chain-events' will threaten the lives and health of people in many different aspects: people need to flee from the drought or overflooding lands, food and water will become scares, there will be smaller liveable surfaces for too many people and animals and there will be an uprising of more (new) pathogen threats. The latter is where this thesis will focus on when talking about climate change effects.

2. Legal mandatory vaccination

Vaccinations have literally transformed public health, and the World Health Organization (WHO, 2020) estimates that 2–3 million lives are saved each year by current immunization programs. But due to the increase of vaccine hesitancy in the Netherlands, the group immunity in The Netherlands is at risk. When group immunity cannot be achieved, due to the

lack of people getting vaccinated, the government can no longer properly protect its citizens against pathogens. Making vaccinations mandatory could then be a way for the government to protect the group immunity. In order for this thesis to not get too broad, this thesis will focus on the possibilities within the Dutch legislation for mandatory vaccinations.

1.4 Outline

Chapter 2 presents the literature review of this thesis. This chapter also presents the methodology, the methods that are used for data collection and ends with the limitations of the thesis study.

Chapter 3 of the thesis presents information about pathogens and vaccination in general.

Chapter 4 specifies the different effects that will occur due to climate change, that are in relation to (re)emergence of pathogens.

Chapter 5 presents and explains the Dutch vaccination policy and Dutch immunization program and how these are implemented.

Chapter 6 presents the findings of legal laws and legislation that come to play when making vaccination mandatory in The Netherlands.

Chapter 7 summarizes and concludes the findings in this thesis with recommendations to policy makers and researchers.

2. Reviewed literature

This chapter present the literature that was used for this thesis study. This chapter will review the strategy for this thesis and explain the methods and used data. This chapter will end with the reflections on the difficulties I encountered while conducting my research.

2.1 Research strategy

The research strategy for this thesis is a literature-based research. There are a few reasons why I decided to approach this topic by using existing literature and source research as a method for this thesis.

First, I initially had the idea to also do an interview-based thesis. I wanted to conduct interviews amongst the Dutch population and see what their opinion would be on mandatory vaccination. However, my final goal of this thesis was to map out which climate change effects would cause pathogen risks and how this can be translated into legal mandatory vaccination, not what the opinion of people would be on the subject.

Secondly, there is already a lot of existing and useful research done on the subject of climate change and pathogenic risks. Therefore, doing a literature and source-based research thesis offered the best outcome. By reading many studies I was able to put all the useful information together and which laid down the basis of my thesis. After that I could fully focus on finding out the part for which there was no answer yet: is mandatory vaccination possible?

Lastly, since I have a Dutch bachelor's degree in law it was easier for me to find research and documents in relation to the Dutch legislation. This was also part of the reason I choose The Netherlands as country for my thesis instead of another country.

2.2 Methods of data collection

After determining the research strategy, the method for collecting data for this thesis had to be chosen. There are two types of data collecting: primary and secondary data (Saunders et al., 2000). Since this thesis is using existing data for answering the objectives and research question, the method 'secondary data' collecting was chosen. The information generated for this thesis included: reports, articles, books and case studies. These were found by using academic electronic databases, official websites of relevant organizations and articles provided by the supervisor for this thesis. The databases used for finding relevant research information, were mainly Google Scholar, websites of organizations such as the WHO and the Rijksoverheid [Dutch government website] and the Social Sciences Citation Index. However, most of the data has been collected by using the reference lists of already existing studies and articles.

During the search for data, it became clear that there was a lot of useful information and data. Because it was a lot of data that was collected, a system had to be formed in order to divide the information for further use in this thesis-paper. This system was created by using the some of the six step of Braun & Clarke (2006) for transcription: step 1) familiarizing yourself with data, step 3) searching for themes and step 5) defining and naming themes.

During step 5 the following four themes had been created for dividing the collected data:

1. Climate change effects in relation to pathogenic risk
2. Pathogens, viruses and bacteria
3. Vaccination (effects)
4. Legal Mandatory Vaccinations

2.2 Main sources of data

This thesis collected a lot of data and ended up with 8 pages of references. Due to the large amount of collected data a full report of all the data cannot be done. Instead, in this chapter part the main used data per theme will be elaborated.

1. Climate change effects in relation to pathogenic risk

- Report of the Intergovernmental Panel on Climate Change (March 2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability.*

This large report is a kind of comprehensive summary of all that is known about the drivers of climate change, its impacts and future risk. This report lists all pathogen-related hazards that could pose a threat to human and animal health due to the impact of climate change.
This document was one of the main sources of this thesis. This report proved many important information that was used for writing this thesis. Without this document the thesis could not have contained all the information that was required to in the end answer the research question.

Quality of this document:

Credibility: The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing all the science, related to climate change. The IPCC was created in 1988 by the World Meteorological Organizations (WMO) and the United Nations Environment Program (UNEP), for the purpose to provide governments at all levels with scientific information that they can use to develop climate policies.

Strength: The UN explains that thousands of people and scientist all over the world contribute to the work of IPCC. Meaning that many people of different background and studies are interpreting the data before a report is published. Another reason for the strength of this report, is the fact that this report is created by assessing a vast amount of published scientific papers on climate change and put them together.

Weaknesses: The only weakness for this report would be the size of the rapport (more that 3000 pages). This makes it harder for people to read this document.

Bias: There is no real reason that I could find for the IPCC to be bias. The IPCC does not conduct its own research, thus they do not promote something or their own agenda. The only bias thing I could think of was that this report is written as a summary for policy makers, meaning that the written information is meant to show that policy change is needed and that the writers want this to happen.

2. Pathogens, viruses and bacteria

- Article Woolhouse etal. (2012) Disease invasion; impacts on biodiversity and human health Chapter: *Human viruses; discovery and emergence.*

This document was the first document I found on pathogens, viruses and bacteria. The document consists of a clear explanation of what exactly pathogens, viruses and

bacteria are, and how it works anatomically and medically (becoming ill, transferring, contamination, etc.). This article has helped me to better understand the pathogen's part and thus to be able to convey this well in my chapters.

Quality of this document:

Credibility: This research article is indexed in the National Library of Medicine (National Centre of Biotechnology Information), which is an official website of the United States government,

Strength: The information in this article is written by five different scientists and there is a comprehensive review done of the peer reviewed literature in this article.

Weaknesses: The study takes mainly an ecological approach to studying the diversity of human viruses.

Bias: There could be a slight possibility be for bias, since this study was partly supported by the USAID PREDICT program led by Peter Daszak of the Wildlife Trust.

3. Vaccination (effects)

- Rijksvaccinatieprogramma.nl
  Dutch National Immunisation Programme.

This website is what the government uses to relay information about vaccinations to the Dutch citizens. For me it was also a great source of data, because it showed me all I need to about vaccinations.

Quality of this document:

Credibility: The data from this website is credible because it is from an official website of the Dutch government and meant to provide information for the Dutch citizens about vaccinations.

Strength: I can find all the data I need on this website. It tells me not only about what a vaccine is but also what kind of literature and resources they have used, and they are transparent about the risks of vaccination.

Weaknesses: Websites are normally not seen as good resources. And another weakness could maybe be that the website only shows what the Dutch government wants to show the citizens.

Bias: The national vaccination program was created by the Dutch government to get people vaccinated. The government therefore does benefit from this website because it may persuade / reassure people to get vaccinated.

4. Legal Mandatory Vaccination

Article Bozzola et al. (2018) *Mandatory vaccinations in European countries, undocumented information, false news and the impact on vaccination uptake: the position of the Italian pediatric society.*

This document gave more insight into the character mandatory vaccination and how it can be unfolded in a positive and negative way.

Quality of this document:

Credibility: This research article is indexed in the National Library of Medicine (National Centre of Biotechnology Information), which is an official website of the United States government. The research article is also published in an official Italian Journal (journal of Italian Paediatrics).

Strength: The information in this article is written by six different scientists, thus being peer reviewed. Besides from discussing the medical side, the study also looks into what is going on in the society for the decreasing level of the national vaccination rate.

Weaknesses: The aim of this study is confronting vaccination policies for only children under 18 months against, and also for only European countries. But with climate change the whole world and every age will have the same pathogenic risks.

Bias: The discussion of the document is mainly based for the Italian government, which could look like a study that is specifically done for policy change in the Italian government.

2.3 Concluding reflections

Since my thesis approach started with reading as many useful data as I could find, I noticed that I was gathering a lot of information and data (maybe even too much). I then had to figure out how to use all the data within the page limits of the thesis. During this process I started feeling that I might have taken the harder variant of doing research after all. When you do interviews, this is your data, and you can draw a conclusion from it. But to be able to answer my research question, I had to read so many studies, articles, and legislation that I sometimes regretted that I hadn't just done a study with interviews (about what the Dutch population would think if the government made vaccinations mandatory). Another reason why I found this way of research and literature-based thesis writing hard, was because I felt I had a responsibility of making my thesis very clear and understandable for anyone that might read my thesis. Not only because I am talking about some climate change effects that might be very risky for people's health, but mainly because I am looking at a possibility for a government to make vaccinations mandatory. Making something mandatory, especially when it comes to the human body, often evokes resistance. Therefore, I felt I was obliged to show the reader, not only what the possibilities would be, but especially what the other side would be of mandatory vaccination and whether we should even want this possibility in the future.

Also, during my thesis I learned not only to better understand scientific publications, but especially that I had to look for the opposite side of my findings. I learned so much more by understand all the side of mandatory vaccination, then when I was only looking at the possible ways of making vaccination legally mandatory.

3. Pathogens and vaccination

Before getting into why climate change causes (new) pathogens to (re-)emerge and if mandatory vaccination can be used as a tool to combat pathogenic risk, it is important to define some terms and processed such as: pathogens, infection, vaccination and pandemic/ epidemic.

3.1 Pathogens

The body of humans and animals are naturally full of microbes[2] (microorganisms make up about 1 to 3 percent of the body's mass), being bacteria, viruses and fungi. When these microbes are present in a healthy balance, they cannot do harm. In fact, they can even help the body in multiple daily processes (e.g digestion), but also in counteracting possible diseases.

However, if the equilibrium of microbes are disturbed, overgrowth can occur. In that case a microbe can become a *pathogen* (Balloux & Van Dorp, 2017). Pathogens can also enter the body from outside, resulting in an infection since the bodies' immune system is not (yet) familiar with this pathogen. A pathogen is a kind of (micro)organism that causes disease upon entering the body: all a pathogen needs to thrive and survive is a host. Once the pathogen sets itself up in a host's body, it needs to avoid the body's immune responses[3] and use the body's resources to replicate, before exiting and spreading to a new host. Pathogens can be transmitted a few ways depending on the type. Among other, they can be spread through skin contact, bodily fluids, airborne particles, contact with feces and touching a surface touched by an infected person (Santos-Longhurst, 2019).

3.1.1 Bacteria/Virus/Parasite

There are different types of pathogens, but this thesis will be focussing on the three most common types: viruses, bacteria and parasites.

[2] Microbes are tiny living things (also called microorganisms). They live in water, soil, and in the air. The human body is home to millions of these microbes too. Some microbes make us sick. Others are important for our health.
[3] The immune response is how your body recognizes and defends itself against pathogens and substances that appear foreign and harmful.

- **Viruses**

Viruses are one of the smallest known pathogens to cause infectious diseases. Viruses are different from all other infectious microorganisms because they are the only group of microorganisms that are entirely reliant on the cells of their host (human, animal or even plant) for replication (Woolhouse et al., 2012). Viruses are known to infect nearly every type of organism on earth. Some viruses, called bacteriophages, even infect bacteria (Vivotesting.com, *Introduction to Bacteria, Viruses, Fungi, and Parasites*).

Examples of pathogens viruses are: Corona (COVID-19), Ebola, Hepatitis-B, HIV, measles, smallpox, polio and Zika.

- **Bacteria**

Bacteria are generally 10 to 100 times larger than viruses (still only visible through a microscope). Bacteria are single-celled microorganisms (but still very complex). They can survive on its own, inside or outside a host. There are many different types of bacteria, and they are everywhere, in your intestines for one. Bacteria can enter the body through an opening in your skin, such as a cut or a surgical wound, or through your airway and cause infections like bacterial pneumonia (Doron & Gorbach, 2008). Some bacteria might double in number every fifteen minutes, while others take weeks or months to multiply.

Examples of bacteria that cause diseases include Cholera, Plague, Scarlet fever and Tuberculosis.

- **Parasites**

Parasites are usually larger than bacteria. Parasites are different from bacteria and viruses because their cells share many features with human cells, including a defined nucleus. A parasite is an organism that lives on or with another organism (host). The parasite uses a host to stay alive and multiply. Parasites can be microscopic-small or large enough to see with the naked eye. Parasitic infections can be spread in several ways. For example, protozoa and helminths[4] can be spread through contaminated water, food, waste, soil and blood (Rush, 2022). Some parasites are spread by insects that act as a carrier, or so-called vector, of the disease. For example, malaria is caused by parasitic protozoa that are transmitted by mosquitos when they feed on humans (Vonfield et al., 2022).

[4] Kind of bacterium

3.1.2 Infection disease

Infection means *the invasion and growth of pathogens in the body that can cause fever and other health problems* (depending on where it occurs in the body). Infection occurs as soon as the pathogen enters a living organism (human or animals) and starts multiplying (Drexler, 2010). But infection by a pathogen does not necessarily lead to a disease[5]: a disease can occur when the cells in your body become damaged (as a result of the infection) and signs and symptoms of an illness appear. When a body is you infected, the immune system of that body will start to activate and will try to eliminate the invader from the body. Many infections occur without symptoms of illness because the immune system responds so efficiently that the invading microorganism do not stand a chance. For example, viruses and bacteria can make us very sick because they kill 'good' cells and therefore disrupt the cell function. With COVID-19, it disrupted the lung cells, and (many) infected got trouble with breathing (Rarani et al., 2022), or with the variola virus (smallpox (skin)), where you will get red spots all over the body (CDC.gov, 2016). The difference between a 'normal' infection and infectious disease is that infection implies the presence of a pathogen, whereas infectious disease relates to the occurrence of cases and outbreaks caused by a pathogen in a population (Burrell, 2017). Infectious diseases are transmissible from human to human, or from animal to animal and sometimes even from animal to humans. Infectious diseases that spread from host to host are what we call to be *contagious*.

3.1.3 Contagious disease

Contagious diseases (such as the flu, colds, or strep throat) can be spread from person to person in several ways. One way is through direct physical contact, like touching or kissing (a person who has the infection). Another way is when an infectious microbe travels through the air after someone nearby sneezes or coughs (COVID-19 for example). Some infections spread to people from an animal or insect but are not contagious for another human (findlater & Bogoch, 2018). Lyme disease (when you get bitten by an infected tick) is such an example. You cannot catch it from someone when you touch or kiss them. Luckily, not all contagious pathogens are dangerous or harmful. Since pathogens can cause a variety of different diseases, some can be more severe than others. Because the human body's immune system

[5] A disease is a particular abnormal condition that negatively affects the structure or function of all or part of an organism, and that is not immediately due to any external injury.

acts as a defence against pathogens, the body can easily fight off some of these pathogens. Therefore, some infections may be mild, while others can be life threatening. For example, the common cold is a mild viral infection compared with the lethal Ebola virus disease (Bell, 2020).

The tricky part of a contagious pathogen is how the immune system of the host is able to handle the infection of a pathogen. Some people that got COVID-19 (even in the 'first round') only had symptoms of 'a normal flu'. But even a common cold can on its own can be deadly: complications from a cold can cause serious illnesses and even death – particularly in people who have a weak immune system (Barlow, 2019). As early as in the 1400s, it was known that people that had gotten smallpox and didn't die from it, where not getting smallpox ever again (even when people around them did have smallpox). Therefore, health practitioners started to first expose healthy people to smallpox– a practice known as *variolation*. The first inoculation of a virus was in 1721, but the real breakthrough was in 1796 when Dr. Edward Jenner created the first successful vaccine (WHO.int, *A Brief History of Vaccination*).

3.2 Vaccination

Vaccination is an effective way of protecting the body against harmful diseases before someone comes in contact with them. Because, when you get vaccinated, your immune system makes antibodies to protect you from the viruses included in the vaccine (Mayoclinci.org, Flu shot: Your Best bet of avoiding influenza, 2022). Vaccines are most often given in the form off an injection. The vaccine consists mostly of ingredients to make your immune system fight of the disease. The most important one is 'the *antigen*'. This is a killed or weakened form of a pathogen, which trains our bodies to recognize and fight the actual disease if we encounter it in the future. Vaccines train your immune system to create antibodies, just as it does when it is exposed to a disease. However, because vaccines contain only killed or weakened forms of germs like viruses or bacteria, they do not cause the disease or put you at risk of its complications. Our immune systems are designed to 'remember'. Once exposed to one or more doses of a vaccine, we typically remain protected against a disease for years, decades or even a lifetime (WHO.int, *How do vaccines work,* 2020).

3.2.1 Yearly vaccinations

Even though our bodies are spectacular in recognizing and *remembering* a virus infection, you still need the flu shot every year. The reason behind this is the fact that viruses are able to change very quickly, which can mean that last year's vaccine may not protect you from current viruses any longer. New flu vaccines are made every year to keep up with the rapid changing flu viruses. But there is another reason why you sometimes need to get a vaccinated more than once for a specific pathogen, viruses can mutate.

3.3 Mutations

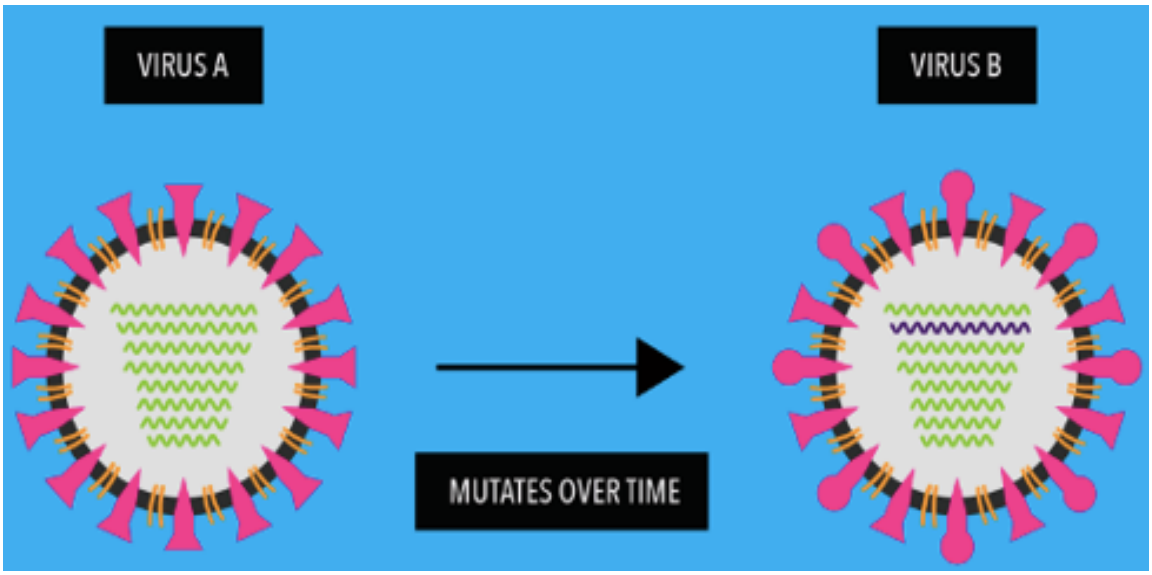
Within two years of the COVID-19 pandemic, people have had the opportunity to get the COVID-19 vaccination. Even people that got COVID-19 without being vaccinated, where asked to still get the COVID-19 vaccination afterwards. The reason for this is the fact that COVID-19 mutated multiple times during the pandemic. As with all viruses, a virus will continue to evolve as long as it continues to spread. The more that the virus spreads, the more pressure there is for the virus to change: they need to 'adapt' (WHO.int, *Coronavirus disease (COVID-19)* 2022). A virus needs to mutate in order to adapt to their surroundings and to more effectively move from host to host (Sobhanie, 2021). In other words: undergoing a genetic (DNA) change. In order to make you sick, one single virus cell needs more; it has to make *replicas* or *mutate* itself in order to 'take over' your immune system. As a virus replicates, its genes undergo random copying errors (i.e., genetic mutations). Over time, these genetic copying errors can, among others, change the virus and lead to alterations in the virus's surface. Each of these changes is a mutation (*image 1*).

A virus with one or more mutations is called a variant of the original virus. Some mutations can lead to changes in important characteristics of the virus, including characteristics that affect its ability to spread and/or its ability to cause more severe illness and death. The way a mutation occurs can be different every time because it depends on the body of the host (there may be another infection already inside, the immune system of the host is weak(er), etc.) (WHO.int, Tracking SARS-CoV-2 variants, 2022).

When a virus survives long enough, the strains of the first virus can be changed so much that the vaccines you got against the initial (now old) strains will no longer be as effective against the new mutated strains. This also means that the immunity of the previous vaccination against these specific viral infections is no longer guaranteed. A person then can become

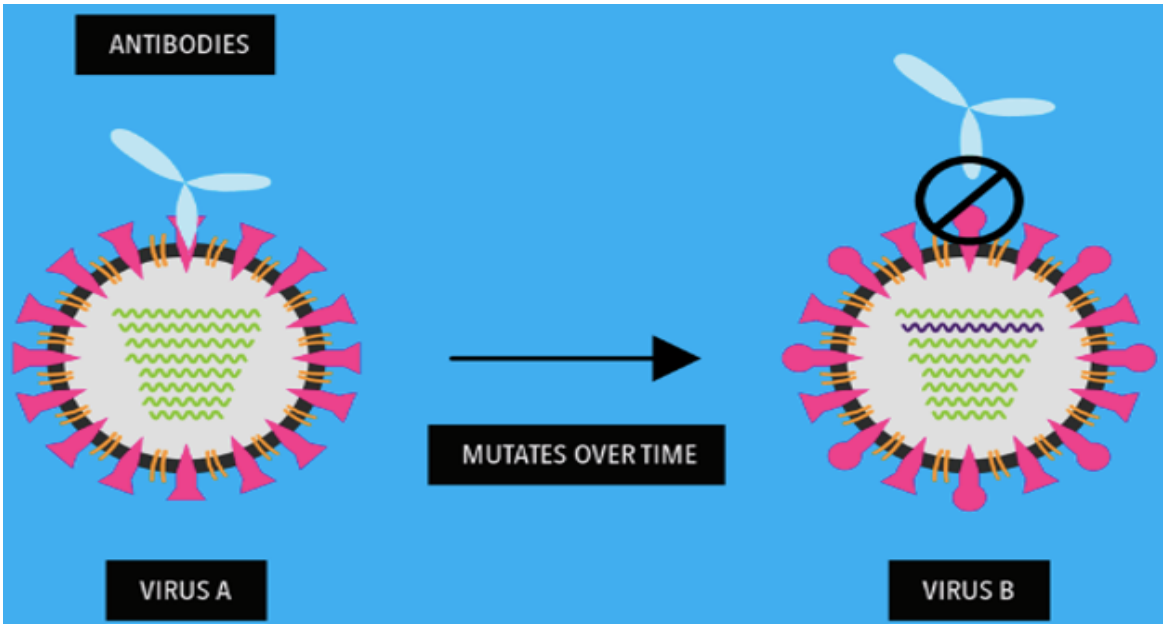
vulnerable again to the newer, mutated virus and needs a new vaccination for this mutation (*image 2*). While the idea of "viral mutation" may sound concerning, it's important to understand that many of these mutations are minor, and don't have an overall impact on how fast a virus spreads or potentially how severe a viral infection might be. In fact, some mutations could also make the virus less infectious (Pfizer, 2020).

Image 1
Mutation of a virus



Source: Pfizer, 2020

Image 2
Antibodies are ineffective for mutation variant



Source: Pfizer, 2020

3.4 Pandemic's & Epidemics

For many people, COVID-19 was the first (and hopefully last) epidemic/pandemic they have ever experienced. But what is the difference between them?

- **Epidemic:** A sudden outbreak of an infectious diseases that spreads rapidly among the population and affects many people (rapid contagion in a particular area).
- **Pandemic:** An epidemic that spreads across several countries or continents and effects many people (similar to an epidemic but intercontinental).

For example, COVID-19 was first discovered in some regions in China, and therefore the term epidemic was used. But as soon as it spread to other countries and continents it was changed to 'pandemic'. Pandemics and epidemics are not new, there have been many throughout history. Especially in large urban communities, before the days of vaccination, epidemics occurred every two to three years. Epidemics on a continental scale occurred annually in the United States and European countries (Burrell, et al., 2016). Underneath is a list of five viruses that caused pandemics:

Pandemics Throughout History

DATE	PATHOGEN	LOCATION	DEATHS
Dec. 2019 – now	COVID-19	Worldwide	†5.500.00
2010 – 2015	Plague	worldwide	†3.248
1981 – 2020	Aids	worldwide	†32.000.000
1900 – 2000	Smallpox	worldwide	†100.000.000
1346 – 1353	Black Death	Asia/Africa/Europe	†200.000.000

Source: Piret & Boivin, 2021.

3.5 Conclusion

Pathogens are organisms, such as bacteria, viruses, or parasites hat can cause infectious diseases in the human body. Some infectious diseases can be passed from person to person, those are called 'contagious infectious diseases'. Most contagious diseases only spread from human to humans or animal to animals, but some can be transmitted from animals to humans, and vice versa. Viruses can change and mutated, causing rapid spread over the world (pandemic). Many infectious diseases can be prevented by vaccinations. A vaccine (a fluid

consisting of antibodies) is a preparation that is used to stimulate the body's immune response against diseases that is administered primarily to prevent a disease from making you sick. A vaccine can create active immunity against the specific harmful agent you have been vaccinated for, by stimulating the immune system to attack the agent. Once you have gotten the vaccine, your antibody-producing cells will remain sensitized and ready to respond to the agent (disease). Due to the rapid mutation of a virus, you need the get vaccinated multiple times in order to stay protected. For some vaccinations this means getting vaccinated every year.

4. Climate change and the spread of pathogens

Global warming and climate change are often used interchangeably. Strictly speaking, global warming merely refers to the increase in average surface temperature and climate change includes all changes in weather and climate due to this increase in temperature (Kennedy & Lindsey, 2015). All major climate changes have disruptive effects around the world and could lead to the extinction of many species, the migration of populations and major changes in land surface and ocean circulation. Climate change will also have consequences for the availability of food and water and general health and safety. The effects of climate change on human health vary, but this thesis will only look at the effects of climate change in relation to the (re)emergence of pathogens.

4.1 Effects of Climate change in relation to pathogens

Climate change will have three major consequences that will add to the rising danger of the (re)emergence of pathogens, which will be further explained hereafter.

1. Loss of liveable land.
2. Melting of the ice caps/glaciers.
3. Disease-carriers will move around.

4.1.1 Loss of liveable land

Climate change causes literal changes in the land surface: some places become extremely dry (maybe also with heat waves) and other places become wetter (even resulting in flooding). These changes will cause for liveable land to decrease, and some liveable places might even disappear. Humans and animals will need to live on land resulting in an increasing population on the reduced amount of liveable land: organism's, such as human beings and animals, will have to live on a smaller surface. Not only will the liveable surface decrease and population density increase, humans and animals will have to live closer together.

4.1.2 Humans living closer together

While it is impossible to precisely predict population levels for the coming decades, researchers are certain of one thing: the world is going to become an increasingly crowded place. New estimates issued by the United Nations in July 2022 predict that, by 2030, our current 7.3 billion will have increased to 8.4 billion humans. That figure will rise to 9.7 billion by 2050, and to a mind-boggling 11.2 billion by 2100 (United Nations, *World population*, 2017) resulting in dramatically increased population density around the world. The density of populated areas will cause for host density[6] and so diseases and viruses will be able transmit with ease and faster among populations: Research has shown that in areas of high human population density (the population is high relative to the size of the country), the likeliness of an outbreak of a virus is 4.000 more likely (Carlson, et al., 2022).

4.1.3 Animals living closer together

The effects of climate change with the spreading of pathogens are almost the same for animals:

- Due to loss of habitat/living space.
- Meeting of new species.

Loss of habitat

As previously discussed in the human case, loss of habitat as a result form overpopulation, also applies to animals. Due to loss of habitat, animals are forced to live on smaller surfaces but without decrease of their population. This means that viruses have an easier chance to infect an entire group due to the reduced “transmission space” and viruses get free rein to infect the animals in that dense population a lot faster and easier (Smith, et al., 2009).s

Meeting of new species

As the planet heats up, animals big and small, on land and in the sea, are headed to the poles to get out of the heat. These species on the move will mingle with many others. Some may have never encountered each other before and when they start mingling there will be high changes of virus exchange (Talukdar, 2022). This could spark new disease outbreaks in many

[6] Which is a prominent factor that makes for a better transmission of directly transmitted pathogens (Dimijian, 2000).

wildlife populations, that could ultimately spread to humans, also known as the spread of zoonosis[7] (zoonotic disease or zoonoses -plural) (Cohen, 2022).

4.1.4 Animals and humans living closer together

The loss of habitat (due to climate change) forces animals and humans to migrate. This can potentially lead to animals and humans having to live in close proximity of each other, share the same food and water resources or even getting in direct contact with each other. This al will create a higher change for transmission of zoonotic – or animal to human- disease (Jordan, *spread diseases*, 2020). These zoonotic diseases can create new variants that we do not have any vaccines or cures for, nor do we know the danger they can cause on humans or animals.

4.2 Melting glaciers

Bacteria and viruses (microorganisms) can survive for millions of years frozen in glaciers, ice sheets and permafrost[8] (Zhong, et al., 2021). These trapped microorganisms will be released as the world warms and the ice thaws. Thawing could lead to the release of the permafrost's enormous reserves of greenhouse gases CO^2 and methane.

With the thawing of the ice, the active layer that keeps all these microorganism 'frozen in time', will melt. These microorganisms locked up in the ice contain fragments of DNA and RNA from diseases such as smallpox, bubonic plague, as well as the 1918 influenza virus. These are diseases we have not had in centuries and since our current immune system is not familiar with these 'new' microorganism, therefore will have trouble fighting them. Some other microorganisms in the permafrost around the Arctic are from buried human and animal remains (some hundreds or even thousand years old). With these corpses, we don't know which disease will get free once these mortal remains are 'freed from the ice' (Everett, 2020).

When eventually the ice melts, the unfrozen water that arises becomes a new habitat for the microorganisms and will activate biological processes. Once unfrozen, these permafrost microbes must find a host in order to survive (Boren, 2020). With organisms living together on smaller surfaces finding a host would not be difficult for a virus that is

[7] Is an infectious disease that is transmitted from animals unto humans.

[8] It's any earth material at or below 0 degrees Celsius for 2 or more consecutive years. Earth material can be anything: organic soil, mineral soil, sand, gravel.

escaping from the glacier, especially considering that human and animals will move towards the poles (see 1.1.2: *Meeting new species*).

4.3 Disease-carriers on the move

As the globe heats up, mosquitoes, insects naturally living in hot and damp climates will roam beyond their current habitats, shifting the burden of diseases. These insects usually only live in tropical and subtropical areas, where the climate is warmer (mainly countries in Africa and Asia) (Nieuwsblad.be, 2022). Mosquitoes and other biting insects transmit many of the most infectious diseases (malaria, dengue fever, chikungunya and West Nile virus). By entering the body of the host, through inoculation by the bite of an insect (direct transmission), the organisms are carried in or on the insect's body and are deposited and can cause an infection (Jordan, *climate change*, 2020).

Due to the current climate these 'disease-carriers' have not yet entered the Northern Hemisphere countries (with cooler temperatures). But with the changing of the climate and Northern Hemisphere countries getting warmer this can soon change.

4.4 Conclusion

Climate change will be the main reason for the birth and spread of (new) viruses and diseases. The reason for this is that three big things will happen (due to climate change) that will cause for new viruses/disease to emerge and to spread globally amongst humans and even animals:

First: The loss of living space for both animals as humans. Loss of living space will create three ways for (new) viruses to emerge and spread: 1) The remaining living area becomes 'overpopulated'. This overpopulation causes for viruses to 'jump' more easily between humans and animals. 2) The cross border between animals and humans shrinks. Both are forced to move closer to on other, which will also lead to the spread and creation of new viruses (zoonotic diseases). These zoonotic diseases can even be more deadly to both species. 3) Animal species will be on the move and start mingling. This 'mingling' will be the reason for viruses to jump to new species and possible new creations of viruses may occur.

Second: Melting of the glaciers. The microorganisms that have been frozen in the permafrost will get be released with the melting waters. Once released, they will find a host (perhaps even

change and become a new variant) and will spread further to human and animals. With many of these microorganisms we are not familiar with.

Third: Disease carriers will move to new and other places. With the climate getting warmer in more places, disease-carriers (such as insects and mosquitos) get on the move and will spread to other parts of the planet (they haven't lived before). This will cause for the spreading of a virus and potentially lead to the creation of new variants.

The impact that climate change will cause in relation to infectious diseases is serious. Due to climate change, various things will come into effect that will have beneficial consequences for viruses and diseased, and therefore drastic consequences for both humans and animals. Viruses have always posed a real threat to humans. So far, we have always managed to get (most of the) viruses under control (e.g., Ebola and COVID-19). Yet, climate change will not just cause one virus to spread quickly and cause serious health risks. So many things related to climate change will happen simultaneously, that the magnitude of the threat from viruses will be unprecedented, and so action and prevention against these epidemic hazards must be taken.

5. Dutch Vaccination Policy

The constitution states that the Dutch government must take care of its citizens: it must provide and improve public health. But what can the Dutch government do to protect its citizens against the new (due to climate change) health risks such as the arrival of (new and often deadly) pathogens?

5.1 Dutch Health Policy

The Dutch government takes care of its citizens by drawing up a health policy plan every 4 years. As of May 2023, the most current health policy in the Netherlands is *The National health policy memorandum 2020-2024* (in Dutch*: De Landelijke nota gezondheidsbeleid* 2020-2024). This health policy plan sets out the actions that the government will take over the next four years to safeguard public health and improve it where necessary. This health policy plan is the result of the input of various groups in the field of health. This does not mean that every hospital, every individual health insurer or scientific researcher knocks on the government's door when they see a (negative) 'trend' emerging somewhere. In the Netherlands, all individual organizations fall under their own 'main' organization (for example: a general practitioner is part of the 'association of general practitioners in the Netherlands'). These main organizations ultimately fall under an umbrella organization that collects all data and can use it to go to the government. The two organizations in the field of health are the GGD and the RIVM (Loketgezondleven.nl, 2020).

5.1.1 GGD

The GGD, or Municipal Health Services (in Dutch: *Gemeentelijke Gezondheidsdiensten*) is an organization that protects, monitors and promotes the health of the inhabitants of the Netherlands. They are an umbrella organization that includes many other agencies. They ensure that all data from these organizations comes together, and subsequently use this information to warn the government if deemed necessary. For example, they receive documents from all school doctors in the Netherlands, and see a pattern being formed where, children between the age of 12 and 14 are becoming overweight. They can send these findings to the government. It could also be used when the Dutch Organization of Psychologists (to which all psychologists are affiliated) see that more and more people seek out help with mental complaints (such as depression). They ask the GGD to control all the documents they

have, so they are able to lookout for trents. The GGD then present their findings to the government together with an approach/advice. However, it is up to the government to determine if steps need to be taken. (GGDGHOR.nl, 2021).

5.1.2 RIVM

The National Institute for Public Health and the Environment (RIVM) (in Dutch *Rijksinstituut voor Volksgezondheid en Milieu*) is the organization that deals with the prevention and control of infectious diseases. They collect, analyse, discover data and then issue reports, which could be used by the government. The RIVM mainly conducts a lot of research into infectious diseases for example, following an investigation by the RIVM, it was decided that a national vaccination program should be set up that would vaccinate babies against 12 serious infectious diseases. Now know as *The National Immunization Program* (RVP). The RIVM recently conducted research into HPV. Resulting in the conclusion that vaccinating girls alone was not enough to protect girls against cervical cancer, boys should also be vaccinated to protect girls against HPV. Because of the results of this study, since February 2023 boys starting from the age of 14 are being asked to get vaccinated.

In addition, the RIVM also conducts research into changes in the 'environment'. For example, they have conducted the latest research into Dutch sewage water. The research showed that many hormones could be found in the sewage water measurements. Pills that are swallowed (such as antidepressants, the birthcontroll-pill, painkillers, etc.) partly appear with our urine into the sewer. Because medicines break down slowly and spread downstream, these substances can harm plants and animals that live in these waters (Van Schayck, 2021).

During Corona, the RIVM conducted research into the virus itself (by means of samples from the sewer and blood samples from people), but they also researched people's behaviour during COVID-19. Providing insight into the question of how the government can help people to continue to follow the rules of conduct (Rijksoverheid.nl, 2022). But also, to the willingness of citizens to be vaccinated and what prevents them from getting vaccinated (RIVM.nl). The RIVM may not respond or act on its own after their research. For example, if they see that something is happening somewhere that causes damage to people and nature, they must submit their investigation/report to the Dutch government. The government then determined

what will happen. This makes the RIVM an independent research institute, which the government does listen to when issuing advice.

5.2 Dutch Policy on infectious diseases

The GGD and RIVM are the two main organizations the government asks for advice on drawing up the four-year health policy plan. But one cannot know what kind of viruses will come four years from now. COVID-19, for example, came as a shock to the whole world and the Netherlands was not well prepared.

So, what about all the pathogenic risks that the Netherlands will face due to climate change? The government has set up a separate organization for these types of major 'infection threats': the Centre for Infectious Disease Control (in Dutch: *Centrum Infectieziekte Bestrijding)*. The Cib are constantly researching the current viruses in the world and in the Netherlands. The Cib's mission is to identify, combat and prevent infectious diseases for the benefit of public health in the Netherlands. The Cib works closely with the European Centre for Disease Prevention and Control (ECDC) in Stockholm. All information received by the Cib is passed on to the Centre for Immunology of Infectious Diseases and Vaccines of the RIVM. They use this information to subsequently conduct research into the immune systems response to infectious diseases and to vaccinations used in the context of infectious disease control. This not only concerns current infections, but also offers vaccinations for emerging infectious diseases in the future.

Ultimately, the Cib collects all the available information and advises the government on the best course of action. The Cib tries to provide the most appropriate - sometimes far-reaching - measures that the government can take to prevent or combat infectious disease crises. This could for instance be the advice to stop all air traffic to and from the Netherlands, or to close (primary) schools.

But because infectious diseases are unpredictable, the Cib always advises the government to focus on a vaccination program (RIVM.nl, Cib). In addition, the Cib has already advised the government on 'compulsory vaccination' (like, excluding unvaccinated children from day care centres and obligatory flu shot for healthcare personnel) (Huis in 't Veld et al., 2019).

5.2.1 Vaccination-policy

Vaccinating is considered one of the greatest public health achievements of the 20th century and is fundamental to the control and elimination of infectious diseases (Figueiredo de et al., 2020, p.8). Therefore, the Netherlands established *The National Immunization Program* in 1967 (in Dutch: *Rijksvaccinatieprogramma*), with the aim of protecting the population as well as possible against serious infectious diseases such as polio, measles and rubella. All national vaccination programs fall under the National Immunization Policy (Jong, 2019, p.9).

In the first program, babies from 5 months to 12 months are vaccinated against 12 infectious diseases. (Rijksvaccinatieprogramma.nl, *Rijksvaccinatieprogram*).
The next program is from age 9, for the HPV vaccine. This vaccine has been given since 2019, but then it was only for girls (cervical cancer). Since February 2023, boys from the age of 14 (and all men who have not yet had the HVP shot) are now eligible for this vaccine. (Rijksvaccinatieprogramma.nl, *HPV*). Women who are pregnant at 22 weeks are also advised to take the DKT-vaccine. This to protect themselves and the babies against whooping cough, tetanus and diphtheria. (Rijksvaccinatieprogramma.nl, *22weken*).
Over the years, the number of vaccinations has steadily expanded. The COVID-19 vaccine has also been added since 2022 and all children from the age of 12 can receive the vaccine. All vaccines within the national vaccination program are arranged by the government and are free for all Dutch citizens.

5.3 National vaccination rate

Because the government arranges vaccinations and citizens do not have to pay for the vaccinations, the government hopes that the willingness to vaccinate among its citizens will remain high and that the vaccination rate (which is important for the protection of herd immunity) will not drop.

5.3.1 Decline vaccination rate

The Perceptions towards the importance, safety and effectiveness of vaccines has declined across the EU between 2020 and 2022 (health.ec.europa.eu, 2022). Public concerns over vaccines are as old as vaccines themselves (Poland & Jacobson, 2011). And, although the

vaccination rate did not fall further in 2022, there was a slight decrease in vaccination coverage in the Netherlands in the preceding five years (Jong, 2019, p.9).

5.3.1.1 Vaccination (dis)trust

The reason for this decline might be because of the decreasing vaccination-trust.

In a rapport from Figueiredo et al. (2020, p5 & p20.), stated that the percentage of respondents agreeing that vaccines are safe has fallen in the Netherlands by 5.7%.

Because of the internet there is a lot of information to provide when it comes to vaccination. Meaning that there is also a lot of 'fake news' about vaccinations. It is difficult for a large group of people to see which news is true and which is not. Due to this large influx of fake news, more and more people (especially young people) are reluctant to take vaccinations.

For example, an evaluation done by the European Union (State vaccine confidence, 2022) has shown that a large 'vaccine confidence gap' has arisen between young people and the elderly: 18-34-year-olds becoming less confident about vaccinations between 2018 and 2022.

The distrust of this group may be an important reason why (young) parents do not have their children vaccinated. This group of 18-34 year olds may cause the vaccination rate to drop even more in the coming years.

5.3.1.2 Anti-vaxxers

There has also been an increase in the group of people who are strongly against vaccination, the so-called 'anti-vaxxers'. The anti-vaxxers are generally against vaccination, however they are divided into different 'clusters'.

- There are people against vaccines because they believe the government wants to control them (microchips are being present in the vaccines).
- There are groups that don't want it from religious beliefs (it is God's will whether you get sick/die).
- Group who wonders why you would get yourself injected with a vaccine against a disease that no longer exists in a certain region.
- A group who believes that vaccinations are harmful and entail other health risks (vaccination can lead to autism).
- And there is a group who think it is not a good idea to expose a healthy body to a pathogen, even if it is very diluted.

Many of the arguments cited by anti-vaxxers come from fake-news or very ‘phony’ sources (Demaakbaremens.org, 2020). Yet this group is getting bigger, partly due to the many ambiguities about the corona vaccine. People were especially 'shocked' that the vaccine was ready within a year. This gave the anti-vaxxers ground to attract so many people.

5.3.2 Measures to increase vaccination rate

Vaccination is really necessary to protect against pathogens. That is why the drop in vaccination coverage is concerning. Politicians believe that they should take measures to prevent a further decline and to raise the willingness to vaccinate again.

For this reason, the Dutch Government has asked for research into additional measures to increase vaccination coverage, looking at measures in other countries, their effects and their applicability in the Dutch context (Jong, 2019, p.5). This investigation has resulted in the following measures:

- Measures with a financial incentive
- Logistical measures
- Measures in the field of communication and knowledge promotion
- Measures with a mandatory character

5.3.2.1 Measures with financial incentive

A possible incentive to get people vaccinated is by attaching a financial reward to it. This roughly means that you get money when you get vaccinated. This happened in the US for example, where the government decided) to give people money (mainly in in various places where vaccination attendance was low) directly after they got a vaccination (Waarlo, 2021). Giving money can thus be seen a positive incentive to persuade people.

There are two types of financial measures that the government can use to increase vaccination coverage (Jong de, 2019, p.27):

- financial benefits for parents who have their children vaccinated
- financial reward for people who get vaccinated

This way of rewarding people financially for taking vaccination is already being used in a number of countries. In Australia, for example, parents who have their child vaccinated can

receive a contribution towards the costs of childcare. In addition to a reward linked to vaccination, the Australian government has also linked a 'punishment' to not vaccinating: parents who do not get their children vaccinated, can have their Family Tax Benefit (similar to the Dutch child benefit system) reduced by approximately 29 Australian dollars (18 Euro) per two weeks. As a result, the national vaccination rate increased from about 91% in 2012-2013 to almost 94% in 2016.

England has also adopted a similar measure to increase the national HPV vaccination rate. They conducted a trial where girls who got vaccinated against HPV, received a financial reward. The reward consisted of a gift card that could be redeemed in multiple stores. With each vaccination, the girls received a gift card (23 euros for the first vaccination, six euros for the second and again 23 euros for the third vaccination in the series). Vaccination coverage in the intervention group was 10% higher than in the control group (Jong de, 2019, p.24).

Rewarding people financially for taking a vaccine also has caveats. According to many people, vaccination serves a public health interest, and getting yourself vaccinated means an act of solidarity with others. These financial incentives can undermine the ethical nature of “joining the vaccination program”. However, a financial reward for vaccination can also be a sign of recognition for the commitment of the parents or the young person who 'helps to keep society healthy'. This financial incentive can also generate solidarity towards the government. Vaccination can in fact be associated with costs, which can be reduced through a financial reward. Think of having to free up time for the vaccination, if this is planned during working hours (Jong de, 2019, p.26).

The financial contribution as a reward for vaccination can therefore ensure that people get vaccinated more quickly, and the National vaccination rate rises.

5.3.2.2 Logistical measures

Another measure that can be taken to increase vaccination coverage is to remove obstacles from the providers of vaccinations as well as from parents and their children. Sometimes it can simply be the case that people do not get themselves or their children vaccinated because there are too few locations (and you may have to travel far to get a vaccination) and the threshold is therefore too high for people. A possible solution could be to offer vaccinations at alternative locations (not only in hospitals) and for a longer period of the day.

According to an international literature review (Owsiank & Gańczak, 2015) on HPV vaccination strategies, HPV vaccination rates are generally highest in countries where the vaccine is distributed free of charge and offered in school campaigns.

For example, Sweden ran a campaign in 21 districts where the vaccine was offered everywhere (free) in primary health care institutions and schools. The districts that offered the so-called "catch-up vaccination" in schools, achieved the highest increase in vaccination coverage (Rehn, et al., 2016). Since 2010, Flanders has also offered the HPV vaccination for girls free of charge at schools. This has also led to a substantially higher vaccination rate than before 2010 (Lefevere, et al., 2016).

Another advantage that seems to be present when vaccinating in schools is that certain target groups are better reached. In Flanders, socio-economic differences in HPV vaccination coverage appeared to have decreased since 2010 (Lefevere, et al., 2016), while in Italy, provision through schools mainly resulted in a higher vaccination coverage among boys (Disiante, et al., 2017). Vaccination campaigns in schools are also an option for regions that traditionally have a low vaccination rate. In a rural region of Kentucky in the US for instance, providing vaccinations at school increased the vaccination rate. (Vanderpool, et al., August 2015).

By making it easier to participate in the vaccination program, the perception of vaccination can also be positively influenced. When things are made easier for citizens (through extended opening hours and more locations), this can be seen as a service to the citizen. This 'service' can then improve the appearance of vaccination instead of 'something that has to be done'. As a result, solidarity regarding vaccination is returning and the national vaccination rate is rising (Jong de, 2019, p.36).

5.3.2.3 Communication and knowledge promotion

It is important that people are given the space to make decisions about health and care, and that they are supported in this. Simply stating that 'vaccination is the only way to protect against infectious diseases' is too simplistic and can make people feel that they have no 'free choice'. That is why the communication around vaccination should be good and more information about vaccination should be promoted.

The level of knowledge of the target group must also be taken into account when providing information. Part of the population is unable to understand basic written health information or to interpret tables and statistical comparisons. (Jong de, 2019, p46). Knowing how to effectively communicate with the target group is important to explain the added value and possible side effect of vaccinations. (Jong de, 2019, p44). Ways to present this information in an understandable way can be by providing parents of newborn babies with information about vaccinations against childhood diseases. This allows parents to read in peace and decide for themselves what they think is best for their newborn baby, without experiencing pressure from hospital doctors (Jong de, 2019, p.40).

Another possibility is to make vaccination for children part of biology lessons. This allows children to think about their own vaccinations, hopefully resulting in them being better informed when they are faced with the choice of having their children vaccinated.

In addition, it is important that the information available about vaccinations is independent. And that it contains everything about vaccines, vaccinations and the benefits and possible side effects. This is important because doubters do not (always) trust the information provided by the government, RIVM and other authorities involved. However, it is still unclear how this information can be provided independently and easily, and especially by whom. Therefore, this should be further elaborated (Jong de, 2019, p45).

5.3.2.4 Measures with a mandatory character

In the world there are a number of countries where a general legal obligation for vaccination is applied. In Europe, there are eleven countries where one or more vaccinations are mandatory (Belgium, Bulgaria, Croatia, Czech Republic, France, Greece, Hungary, Italy, Latvia, Poland and Slovakia (Bozzola, et al., 2018)). The obligation may consist of a general obligation, or an obligation related to access to school or childcare. There is a great deal of variation across these countries regarding the implementation of the obligation to vaccinate. Most countries with a general obligation already have a long tradition of compulsory vaccination. For example, France has introduced compulsory vaccination for smallpox since 1902 and Italy for diphtheria in 1929 (Atwell, et al., 2018). The United States is the leader in mandatory vaccinations: Mississippi since 1900, West Virginia since 1905 and California since 1972 (Colgrove & Lowin, 2016).

The most recent mandatory vaccinations come from Italy and Germany:

- The Italian Parliament passed a Law in 2017, the Law No. 119, which extends the number of compulsory vaccinations to ten vaccines for students up to the age of sixteen. Anyone who does not vaccinate their child risks a fine and schools may exclude these unvaccinated children. Due to this vaccination obligation, the vaccination rate has increased (the measles vaccination rate for instance went from 87 percent in 2016 to 94 percent in 2018) (Chirico, 2018).
- When Germany was struggling with several measles outbreaks in March 2015, an amendment to the law *Infektionsschutzgesetz* was adopted in the Bundestag. In this new law was stated that parents who do not have their child vaccinated against measles, needs to have a counselling meeting with a doctor (Eichner, et al., 2017). Failure to participate in this interview can lead to a fine of 2,500 euros (Atwell, et al., 2018). However, the law was not a great success because after the counselling interview, parents were still free to decide to vaccinate their child or not. Resulting in Germany passing a new law in November 2019: children who go to day care or school must have had a measles vaccination. Making it possible to refuse children who have not been vaccinated at schools and nurseries. This law is the next step in a development towards a more mandatory vaccination policy in Germany.

There are also countries that have an indirect obligation to vaccinate. In Australia for instance (where vaccination is a condition requirement to receive full childcare) if parents do not have their child vaccinated, their child benefit will be reduced (Atwell, et al., 2018). However, it is important that such an obligation is also enforced if it is to have an 'effect'. For example, in North Dakota (USA) virtually no use was made of the possibility offered by the law to refuse children access to school if they have not been vaccinated after 30 days after admission. In school districts that do actively enforce, vaccination rates increased (Hall, et al., 2017).

Getting people to be vaccinated sounds easier than it is. First of all, mandatory vaccinations regularly lead to attempts to change the law or to lawsuits by parents (who, because of the belief that their child has become ill due to a vaccination or because of their beliefs, do not want a (new) vaccination). Countries that have introduced mandatory vaccinations often have

exemptions on medical or life-considering grounds, but there is often a (social) discussion about whether or not to allow exemptions on the basis of these grounds.
Germany, for example, acknowledges that their 'compulsory measles vaccination' can lead to a restriction of individual freedom, but they say that it is also about the individual's responsibility for others (Eijsvogel, 2019).

So far, mandatory vaccinations in several countries have led to an increase in national vaccination rates.

5.4 Conclusion

This chapter looked at the health policy of the Dutch government and how it is created and implemented with regard to infectious diseases. Dutch health policy has insisted that vaccination is the biggest player in preventing infections, but also in maintaining national vaccination coverage. Research by the European Union has shown that several countries, including the Netherlands, are experiencing a decline in the willingness to vaccinate among citizens. The reason for this is an increase in the mistrust of vaccinations by citizens. The reasons for this distrust are the ever-increasing influx of (internet) information that is sometimes not well understood by citizens or cannot distinguish between fake and real news. Because a high vaccination rate is necessary to maintain herd immunity, it is important that the government intervenes. Especially when the consequences of climate change make it clear that a lot of (new) infectious diseases will spread around the world that we have to arm ourselves against. The government can implement four types of measures to raise vaccination rates:

- Measures with a financial incentive
- Logistical measures
- Measures in the field of communication and knowledge promotion
- Measures with a mandatory character

The first three measures mainly respond to the feeling of solidarity towards the other. Wanting to protect each other and therefore not only doing it for yourself but also for others. These three measures can have a positive effect on the rising vaccination rate, but this is not a guarantee. The fourth measurement (mandatory vaccination) could guarantee it . Because the choice is being taken away from people whether or not to vaccinate, the government now

obliges citizens to get vaccinated. Because people have to be vaccinated (despite the fact that there are 'exemptions'), the vaccination rate is increasing. When people have the choice to vaccinate, it can happen faster that a high percentage of vaccinated is not achieved. By making this obligatory, this will happen and will have a direct positive impact on vaccination coverage.

6. Mandatory vaccination in The Netherlands

In previous chapters it became clear that vaccination is the most effective means of preventing and combating infectious diseases. It has also become clear that people's willingness to vaccinate is decreasing. This can ultimately be a danger to society as a whole, because the national vaccination rate (herd immunity) cannot be achieved as a result. This gives existing viruses free reign, but also means that the (new) viruses that will appear as a result of climate change pose an extra great threat. As discussed in the previous chapter, the government can take various measures to increase vaccination coverage. However, three of those measures are still voluntary and may still pose a hazard. The last measure that the government can take is to make vaccinations mandatory, but there is a lot to consider when making vaccinations mandatory.

6.1 Mandatory Character

Mandatory vaccination in an obligation form can be divided into three variants:

- Literal phrase
- Vaccination urge
- Forced vaccination

Literal phrase

Vaccination obligation in a literal sense means a legal obligation to vaccinate, whereby a refusal means that the law is violated. When breaking the law, people can run the risk of being prosecuted (fine, criminal record or even imprisonment).

Vaccination urge

Vaccination push implies that the government cuts off access to important social goods or services for people who choose not to vaccinate themselves or their children (for non-medical reasons). For example, the government can require that only children who have been vaccinated are allowed access to day-care centres or schools.

Forced vaccination

Forced vaccination means that the court orders coercion to vaccinate against the will of the person/parents of the child in question. For example, the court can remove parents from their parental authority for a certain period of time to have a child vaccinated.

These three forms of mandatory vaccination show that making vaccinations mandatory is not as black and white as it seems. Making vaccinations mandatory can also consist of a variant in which you set a full vaccination obligation (where all vaccinations determined by the government become mandatory) or make a limited number of vaccinations mandatory. Compulsory vaccination 'under duress' does not exist anywhere in the world. It is always about measures that stimulate vaccination and impose a fine or punishment on people who refuse to do so (Jong, 2019, p18).

In the end, all these three forms of mandatory vaccination have the same end goal in mind. Yet you see that some mandatory characters are 'more intense' than the others. It is up to the government to choose which of these three forms of compulsory vaccination they would like to introduce in order to increase vaccination coverage and ensure herd immunity (Gezondheidsraad, 2021, p.2).

6.2 Legal position

The fact that there are already countries where compulsory vaccination exists for various vaccinations helps to look at making compulsory vaccination possible in the Netherlands. To see if mandatory vaccination is possible in the Netherlands, this thesis will zoom in on the Dutch legal system. To understand the Dutch legal system, you have to understand that the Netherlands has two types of civil law rights: fundamental right and all other rights.
Fundamental rights always take precedence over other rights, with the exception of European Rights such as the European Convention on Human Rights (although the Dutch fundamental rights are almost equal with European laws and are therefore not in confliction) (Europa-nu.nl, Nederlandse Grondwet).

6.2.1 Mandatory vaccination

Mandatory vaccination involves more than just making ‘something mandatory'. When people talk about mandatory vaccination, there are always counterarguments to be heard. One of the most common arguments from dissenters is that compulsory vaccination violates human rights. However, a crucial point in the vaccine debate is that human rights entitle all people to be protected from harm. COVID-19 posed a major risk to public health – not only for people who have not voluntarily been vaccinated, but also for those who are not yet able to get vaccinated, such as children under 12 years old, etc. (Todd, 2021).

From a legal point of view compulsory vaccination can indeed clash with existing Law articles, for instance with Article 11 (right to inviolability of the body). And in a European context articles 2[9] (right to life), 8[10] (right to respect for private, family and family life) and 9[11] (freedom of thought, conscience, and religion) of the ECHR are important in the context of vaccination. But there are also articles in the law that actually support compulsory vaccination. For example, the Dutch Article 22 (government takes measures to promote public health).

Due to a case law, the European Court of Justice seems to have already assessed whether mandatory vaccination is allowed at all: In the Vavricka case[12], the European Court of Human Rights (ECHR) ruled in April 2021 that mandatory vaccination of children, when entering daycare-centers, is not in conflict with European law Article 8: the right to private life.
The vaccination obligation and the exclusion (of unvaccinated people) have a direct basis in a law approved by parliament and are thus legitimized. An obligation to vaccinate is indeed an infringement of personality rights, but this infringement is justified by the protection of (the rights of) others and public health. According to the Court, this infringement is necessary and proportionate in relation to the objective: to protect public health.

These articles show that the Dutch and European legal systems provide starting points for making vaccinations compulsory (Buijsen, 2022). Even though, making vaccination mandatory in the Netherland is more, and specifically legally, complicated.
In order for the Dutch government to take (legal) action regarding compulsory vaccination, a disease must first be classified as an infectious disease of category A in the Public Health Act (COVID-19 was such an infectious disease). Mandatory vaccination however does not mean forced vaccination: one is not literally forced to be vaccinated. But it does mean that non-compliance with mandatory vaccination is considered a criminal offense and can be sanctioned.

[9] Article 2 EVRM
[10] Article 8 EVRM
[11] Article 9 EVRM
[12] The law case and ruling can be found at: https://hudoc.echr.coe.int/fre#{%22itemid%22:[%22001-209039%22

If this rule is followed, there is nothing to prevent the Dutch government from opting for compulsory vaccination in the future, provided that this is necessary and proportionate in relation with the threat to the Dutch public health (Exter, 2021).

6.3 Ethical dimensions

Mandatory vaccination opens up a world where it is not only necessary to look at whether it is legally allowed, but whether we should (want to) do this and especially if it is ethical to make vaccination mandatory. From an ethical perspective, there are objections to compulsory vaccination measures. So, there are several questions:

- *Is it ethically acceptable for the government to mandate certain vaccinations?*

Maintaining the level of vaccination coverage of the population for the benefit of public health is a core task of the government. The government has various means at its disposal to fulfill this task. The government can take initiatives that encourage the population to get vaccinated, including compulsory vaccination. The government could impose this if there were serious reasons for this, such as a decline in the coverage rate due to voluntary vaccination in certain subgroups of the population, or real indications of a serious epidemic.
By wanting to protect the entire population, the government fulfils its ethical duty. However, a government must provide proper compensation for the very rare situations in which this vaccination leads to serious undesirable effects (Jong, 2019, p22).

- *Is it ethically acceptable for the government to deny access to various things to people who have not been vaccinated?*

As discussed earlier, there are countries where there are consequences for not vaccinating. This is especially the case with vaccination of children who go to childcare: if children have not been vaccinated, they will be refused at childcare. Motivating and stimulating to get vaccinated must always be given priority over the sanction of refusal of access to, for example, the day-care. However, when a public health problem threatens to arise, e.g. as a result of a too low coverage against a serious disease (against which effective protection through vaccination is possible) it is ethically acceptable of the government. Vaccination becomes a condition for access to daycare, since the enjoyment of the benefits of the vaccination (safe childcare) can be made dependent on the willingness to actively participate in the

maintenance of this system. However, incentive measures also have a negative effect: for example, cutting child benefit can lead to financial problems for some families, and this is then passed on to the child (Jong, 2019, P5).

Ultimately, it comes down to ethics that making vaccination mandatory restricts the freedom of choice for one's own body. A general obligation can only be ethically justified in emergency situations. What also should be considered is the fact that measures can provoke resistance. Not only in making vaccination mandatory, but also in limiting freedoms from unvaccinated persons (VAC.org, 2021). The most important thing is that not allowing a child to go to childcare because it is not vaccinated, is just not ethical. In addition, this measure is not full effective due to the fact that unvaccinated children will have contact with other children outside of school (Giubilini, 2020).

6.4 Political dimensions

What counts more, the right to health or the right to physical integrity, education and faith? These are questions that play a role in the political debate when mandatory vaccination is discussed. As a result of the COVID-19 crisis and the slowly rising vaccination rates, the political debate about mandatory vaccination is more topical than ever. Following statements by Ursula von der Leyen, President of the European Commission, who wants EU countries to consider mandatory vaccination (for corona), the debate has erupted. There is absolutely no agreement within the Dutch Parliament about mandatory vaccination (BNR Webredactie, 2021).

For example, the **SGP** [*Reformed Political Party]* (right-wing & conservative party) says it has always been against forced vaccination in any form. They believe that with compulsory vaccination, the government is forcing itself into people's personal lives. According to them, the government should not force people to do something that goes against their conscience (SGP.nl *, vaccineren*).

The D66 (right progressive) argues that compulsory vaccination only works if it is properly enforced. (D66, corona).

Partij voor de Dieren *[Party for the Animals*] (left progressive party) is against compulsory vaccination. They believe that every person has the right to dispose of his or her body and

therefore also the right to refrain from vaccination for himself or his or her minor children. (Partijvoordedieren.nl, 2021).

GroenLinks *[GreenLeft]* (left progressive party) is against a direct or indirect obligation to vaccinate. The party thinks that vaccine are important, but they also think that people should be able to make their own choice whether they want it or not (groenlinks.nl, vaccineren).

So far as of May 2023, the debate about mandatory vaccination is still ongoing and the Dutch government will first have to conduct research before they can decide whether they want to (partially) make vaccinations mandatory.

6.5 Conclusion

From a legal point of view, there are starting points for the Dutch legislator to make vaccinations compulsory (in the future). The existing laws show that there is a basis for developing a law that makes this possible. Whether this will actually happen is another matter. Dutch law and regulatory systems are complicated. Because the Dutch government consists of elected leaders, a 'motion' to amend the law will first have to be submitted. If this even comes through the 2nd chamber, it must be approved by the 1st chamber afterwards. If this happens, it still can take months, if not years, before the law is actually in force and can also be enforced/checked. In the end it may all take a long time, but if we have learned anything from COVID-19 it is that another pandemic could potentially prove even more fatal if we do not at least think about mandatory vaccinations. An honest and European-deliberate debate must take place whether the idea of mandatory vaccination will save the human race from pathogen diseases due to climate change.

7. Conclusion

Concluding, the main objective of this thesis study was to examine if there were sufficient legal grounds to make vaccination mandatory in the Netherlands. Given the history of vaccine hesitancy and resistance, it is questioned whether making vaccinations mandatory will help to be able to obtain herd immunity. This thesis has tried to find information to map out what should be needed to make mandatory vaccinations legally possible in the Netherlands.

The findings from this explorative study suggest that the Dutch and European legal systems provide starting points for compulsory vaccination. There is therefore support for making vaccinations compulsory, provided that the government can substantively demonstrate that it is not only done in the public interest, but because it can be the possible last solution. Meaning that, in order for the Dutch government to take (legal) action regarding compulsory vaccination, a disease must first be classified as an infectious disease of category A in the Public Health Act (COVID-19 was such an infectious disease). But when vaccination is made mandatory, some (human) rights are also being violated, such as the inviolability of the human body. From an ethical point of view, questions can therefore be raised as to whether mandatory vaccination is the solution. But with the falling vaccination rate, the government must act. Maintaining the level of vaccination coverage of the population for the benefit of public health is a core task of the government. If the government sees no other options but making vaccination mandatory in order to protect its people, this fulfils the governmental ethical duty, and thus making it legally possible by law.

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