Leveraging Personal Health Data to Improve Social Determinants of Health in Denmark

Christina Nellemann

Aalborg University, Denmark

cnelle14@student.aau.dk

ABSTRACT

The purpose of this study is to investigate how a framework of using personal health data can be created, which can improve social determinants of health in Denmark. This research will be based on reviewing existing scientific literature and data about the economics in the Danish health care system. The research results in a framework, which explains how citizen's personal health data can be collected and processed to create a health score, which can serve policy-makers by providing a foundation for driving more effective and sustainable healthcare practices. Giving citizens a health score based on their health data can create a framework that can be used by authorities to ensure that people are living a healthy lifestyle, which can result in a decrease of health expenditures.

Author keywords

Health data, preventative healthcare

INTRODUCTION

One of the big health risks in modern societies is a rise in obesity and sedentary lifestyles. Obesity is among the greatest public health challenges and is one of the largest risk factors in developing non-communicable diseases (NCD) and has been declared a global epidemic by The World Health Organization (WHO) in 1997 [4][17][55]. NCDs are diseases that cause slow deterioration of overall physical health, often caused by lifestyle. These diseases are responsible for 70-74% of all premature deaths and 80% of disabilities [59][60][76][77][78].

In an effort to create a better future for the current generations as well as the generations to come, The United Nations has designated 17 sustainable development goals that countries, which are parts of The United Nation, should aim to reach by 2030. The most relevant development goal in the context of this study is #3 *"Ensure healthy lives and promote well-being for all at all ages"* This goal has a number of sub-targets. The specific focus in this study is sub-target #3.4: *"By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being"* [3].

According to the data from World Obesity's Global Obesity Observatory there is a correlation between a country's living standard and obesity, which indicates that our living standards have become too high and therefore result in the increase of obesity and sedentary lifestyle [54]. WHO also presents the phenomenon of social determinants of health. Social determinants of health are social values and structure as well as environmental factors that play a role in determining people's health [16]. Another study argues that NCDs are in fact communicable, but are instead socially transmitted [58].

Therefore, the viewpoint of this study is that development goal #3.4 can be achieved in Denmark by changing the social determinants of health in Denmark by leveraging the citizen's personal health data. Therefore, the following research question is sought to be answered:

How can the collection and processing of personal health data be leveraged to motivate people to live healthier lifestyles and thereby improve the social determinants of health in Denmark?

The aim is to create a framework for leveraging the citizen's health data in a way, which can be used to promote social determinants of health and thereby improve public health. The purpose of this framework is to collect and process personal health data, and score each citizen based on particular sets of health data, which are known to be great markers of physical health. This framework will serve as the basis for implementing data driven systems, which can help guide healthcare policies and improve the health of citizens.

MOTIVATION

Denmark has a welfare model, which is inspired by the writer N.F.S. Grundtvig's thoughts on creating a society in which "few have too much and fewer too little" [71]. This welfare model was created based on the founding ideology *"contribute what you can and get what you need"* [71]. But over the years, the reality of this ideology has left us

with a society in which the ideology is *"contribute what you can and get in proportion to your contribution"* [71], which on the contrary breeds a sense of entitlement into our society. This has in return created an imbalance in our society, where there are fewer resources to help the people who need it, despite public expenditures being at an all time high [71]. This individualistic sense of entitlement that characterizes our society may contribute to people's unhealthy lifestyles with fewer regards to the economical consequences that the society faces based on people's individual choices.

According to the Danish Health Board, a person who is obese costs an average of 5 mil DKK a year in health expenditures due to non-communicable diseases caused by obesity. They claim that there is a need for scientific research on how a population oriented effort can best be organized to help prevent obesity among adults, as there currently are none [18].

In a report created by the Danish Council of Ethics in 2019, an idea was presented about using wearables as a means to collect health data from the Danish citizens in order to promote preventative health care. This report describes the use of people's personal health data as a necessity, which indicates that this realistically could become a part of our everyday lives. Some insurance companies are already giving people discounts based on how many steps they take, if people are willing to share their data [69]. Therefore, the motivation of this study is investigating how the use of personal health data can promote better health using citizen's personal health data .

RELATED WORK

During the 20th century people's life expectancy has increased from 50 to 80 years in developed countries. This increase is due to many factors such as food security, mass production of drugs and the development of modern medical technologies [72]. This, however, comes at a great cost and has forced a lot of European countries into debt. The sustainability in these countries has become fragile and are in need of drastic change. One study suggests smart healthcare as a solution to improve the quality and lower the cost of healthcare, which is done by utilizing wearable electronics, miniaturized sensor technologies, and big data analysis [72].

Another study suggests "smart healthcare". It elaborates on how it believes that the use of big data, internet of things (IoT), cloud computing and artificial intelligence can improve the healthcare system. Additionally, it explains how these technologies can be utilized in disease prevention and risk monitoring [40]

The American Medical Informatics Association put together a group of stakeholders to investigate how a national framework for using citizen's health data could be created. The purpose of this was to improve healthcare experiences, gather research material, gain a better understanding of the effectiveness and efficiency of the healthcare system, improve public health etc. In this study, they are talking about a lack of policies and standard practices for how to handle citizen's health data [24].

These findings show an increasing interest from governments around the world of utilizing citizen's health data to improve various aspects of their healthcare systems and society.

METHOD

A literature review is conducted to investigate the current health and economic status situation in Denmark, and thereby figure out what health factors to focus on, when creating a framework. Based on these findings, a survey is conducted to investigate how Danes would feel about the government using their personal health data. The purpose of this is to make sure that the framework is designed in a manner, which realistically could be accepted by the citizens and make a difference. When the framework is designed, a meta-analysis literature review is conducted to investigate what types of data that are known to be markers of physical health and how to measure these [70]. The purpose of this literature review is to identify what markers of health can indicate if someone has an increased risk of getting any non-communicable diseases in the future and how these markers can be categories.

Current situation in Denmark

The purpose of this literature review is to gather information on what diseases are the biggest economic burdens on the welfare system, as well as how the money is distributed within this sector.

In 2015 a report was conducted by the The Health Board in Denmark. In this study data was gathered about the diseases that have the biggest impact on the Danish healthcare system [37]. In Figure 1 an illustration of how much these diseases cost is shown, which is calculated based on the numbers from the report.

Diagnose	Behandling	Produktionstab	I alt
Anxiety	948.700.000	8.606.600.000	9.555.300.000
Schizophrenia	2.612.600.000	5.646.900.000	8.259.500.000
Lower back pain	1.816.600.000	4.836.200.000	6.652.800.000
Stroke	2.032.000.000	2.628.100.000	4.660.100.000
Osteoarthritis	2.438.000.000	2.169.000.000	4.607.000.000
Substance abuse	785.300.000	3.795.600.000	4.580.900.000
Depression	1.218.100.000	3.105.500.000	4.323.600.000
Ischemic heart disease	1.762.900.000	1.869.000.000	3.631.900.000
Diabetes	1.972.500.000	1.172.600.000	3.145.100.000
Neck pain	917.000.000	2.027.500.000	2.944.500.000
Breast cancer	1.590.100.000	1.352.600.000	2.942.700.000
Lung cancer	772.800.000	1.909.000.000	2.681.800.000
Chronic obstructive pulmonary disease	1.293.000.000	1.199.500.000	2.492.500.000
Colon and rectal cancer	1.118.800.000	981.600.000	2.100.400.000
Chronic liver disease	198.900.000	1.486.500.000	1.685.400.000
Migraine	419.200.000	997.300.000	1.416.500.000
Alzheimer's and other dementias	778.100.000	633.400.000	1.411.500.000
Prostate cancer	654.000.000	156.100.000	810.100.000
Asthma	519.700.000	177.400.000	697.100.000
Osteoporosis	124.300.000	144.500.000	268.800.000

Figure 1: Total costs in DKK of selected diseases in Denmark from 2010-2012.

The first pattern that arises is that four of the top seven diseases with the biggest expenditures are mental illnesses like anxiety, schizophrenia, substance abuse and depression. Anxiety alone has expenditures for 9.6 billion DKK each year, which is one fourth of the entire cost of physical diseases. But despite mental illnesses having such a high cost, these diseases have the lowest treatment funding compared to their production loss of all the diseases on this list. This indicates that mental health is not prioritized, which may contribute to the overall higher expenditures because people do not get the treatment they need.

Another pattern that arises is how all of these diseases, except schizophrenia, are all lifestyle related, which means that a big part of them could possibly have been prevented [76].

These findings indicate that the majority of both physical and mental diseases, which have the biggest health expenditures and premature mortality, are preventable if people make lifestyle changes and live a healthier life.

One of the major causes of lifestyle diseases is obesity. The World's Health Organization (WHO) has termed these rising rates of obesity as the epidemic of the 21st century [17]. Even some of the mental disorders like anxiety and depression are closely connected to Obesity. Multiple studies show that there is a direct correlation between anxiety, obesity, and depression.

In a study from 2019, a meta-analysis looking through medical databases was conducted, and found that the odds ratio (OR) for obesity was 1.3 with a 95% confidence interval (CI) at 1.20-1.41, and the OR for people who were overweight was 1.10 with a CI on 1.00-1.21 [42]. These numbers shows that there is a correlation between being overweight or obese and the prevelance of anxiety. They also indicate that the risk of experiencing anxiety increases with the BMI, because the OR is 0.2 higher amongst the obese group than the overweight group. However, there is no evidence on whichever of these diseases caused the other. Another meta analysis was conducted, in which data was analyzed using a Behavioral Risk Factor Surveillance System. The data from this study shows a clear correlation between the severity of smoking, obesity, physical activity, binge drinking and heavy drinking (Fig. 2).

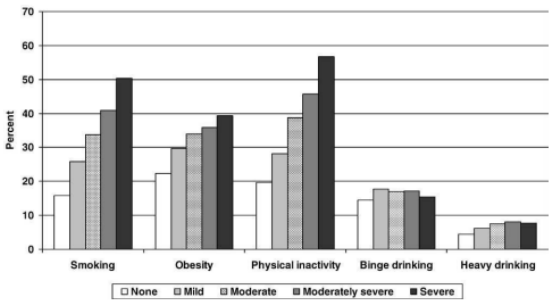

Figure 2: Relationship between severity of depression in relation to obesity and for unhealthy habits [44].

The analysis also shows that there is a lower prevalence of obesity and all four habits among people who have never been depressed (Fig. 3). The pattern also shows that the highest prevalence of these habits, especially physical activity, are seen amongst people, who are currently depressed. And amongst people who have previously been depressed there is a significant reduction in obesity and bad habits, but it has not been lowered to the same prevalence as for people who have never experienced depression. This indicates that obesity and bad habits might be difficult to change once people have recovered.

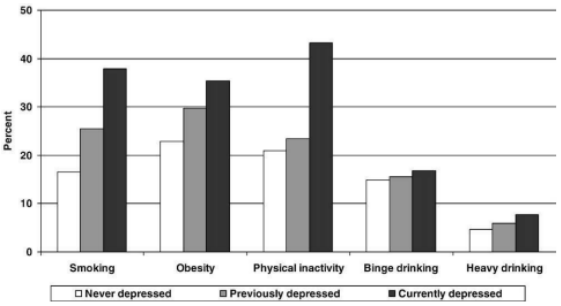

Figure 3: Relationship between people's history with depression, obesity and four unhealthy habits [44].

This data not only shows a clear correlation between unhealthy habits and obesity, but also shows the importance of focusing on preventative health care instead of only treatment, as it is difficult to fully treat someone who has already experienced any of these diseases.

According to this data, all the diseases except one are NCDs, and one common factor among all of them is obesity. Therefore, the focus

in this study is what data can be used to measure and prevent obesity.

Survey

A survey was conducted to collect a general understanding of Danish citizens' thoughts on the government collecting and processing their health data as well as getting a tax reduction if they meet specific requirements. The questionnaire method was used because it is a low cost method, which can also reach a large sample size [66]. The questionnaire method was also used because it allowed the participants to be anonymous. It was believed that it is important for the participants to be able to stay anonymous because it might be easier for people to be honest as this is a political matter. Some limitations of using a questionnaire might be that it is not possible to get any further explanation to participants' replies.

To acquire participants a snowball sampling method was used. This sampling method relies on the participants referring the survey to other people. By using these methods it is possible to expand the reaches of the survey [65]. Some of the benefits of this sampling method is that it makes it easier to reach a larger number of participants and to find participants from communities that are hard to reach. Some limitations to this sampling method is that it is dependent on the researchers bias, when the initial participants are selected, which will shape the reach of the sampling group [61].

The questionnaire was designed to focus on the respondents thoughts on sharing their personal health data with the government (Appx. 1). The participants were not given any details on what data the government would need, or on how a possible public programme is going to be designed. Giving the participants these details could possibly change their mind and interfere with the responses the survey aims to obtain.

Findings

The questionnaire reached a total of 15 participants from all age groups except 46-55, 73.3% of them being male (Appx. 1). When the respondents were asked if they would be willing to participate in this type of programme, 57.1% said yes, 14,3% did not know, and 28.6% were against it.

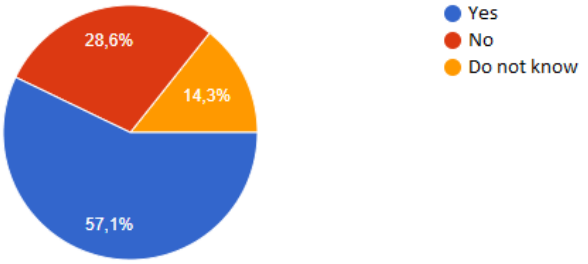

Figure 4: Distribution of responses to question #6 (Appx. 1).

Other statistics from this questionnaire showed that 73.3% had already been measuring their health stats previous to this questionnaire. These statistics indicate that most participants are already used to tracking their health data and would not mind if they could use this data to get monetary benefits.

When analyzing the written responses, the responses were placed into different categories based on the topics that occurred. The categories that arose were:

Topics
Increased motivation based on the size of the benefits
Freedom
Invasive
Voluntary participation
Improved health care
Unfair to people who are not able to participate
Want the data locked because of distrust to the government

Table 1: Topics from analysis of the questionnaire

An overall consensus among all participants was apparent that if they were to participate in this programme, it would only be acceptable if it was voluntary. No participants believed that it would be acceptable if this programme was forced.

Although most respondents answered that they would like to participate in this programme, there were still a lot of concerns. One of the concerns was individual freedom. They were mostly concerned about individual freedom if the programme was not voluntary. They did not like the thought of being forced to live a certain lifestyle. They also found this form of force invasive.

Other participants expressed how their motivation for participating in this programme would be affected by how high an eventual tax

reduction would be. One participant answered that they would not participate in this if it was only a couple of percentages, but would like to if the percentage was marginally higher.

Another topic was that people did believe that this could improve both health and the healthcare sector. However, they were concerned about people who are already struggling and answered that it would be unfair to these people, which might also increase inequality.

When asked about the healthcare system collecting their data, 80% answered that they were fine with this. But multiple people expressed concern about the government's access to this data. Therefore, they would prefer if the government only knew your status, but not the actual data behind the status.

The takeaway of this survey is that most people would like to participate in this programme, but only if it was voluntary, as they believed that this could lead to great health benefits and personal gain. But they also expressed concern for people, who might not be able to participate in this programme, despite them wanting to.

The findings from this questionnaire are not conclusive because of the low sample size. To gather more conclusive evidence a larger sample size is needed. It is also important to acknowledge that people are often eager to please when participating in surveys, and could have different opinions if this was about to become reality.

Suggested solution

Based on the data from the Danish Health Board and the findings from the survey, this study suggests creating a Health Pass, which is supposed to collect and store the citizen's health data and calculate this data based on a point system, which will result in an overall health score. If this health score is above a certain amount of points, the pass will be considered active. If the citizen has an active Health Pass, they will be eligible for a benefit, e.g. tax reduction.

It was discovered early in this study that a majority of healthcare expenditures are due to the lifestyle choices of the citizens. This discovery indicates that by changing the lifestyle of citizens, towards a lifestyle that is medically known to increase longevity, they will be less at risk of developing certain diseases throughout their lives. This will also result in a lowering of health care expenditures. Because of the findings from the survey, this Health Pass has to be voluntary, as the overall purpose is to improve well-being. The findings indicate that this Health Pass could possibly have the opposite effect if this was a forced programme. By allowing citizens a reward for having a healthy lifestyle in terms of a tax reduction and daily feedback, a positive reinforcement of their behavior can occur [36][34].

Some of the inspiration for this Health Pass comes from the Corona pass app, which was used by all the citizens in Denmark during Covid-19. The Danish citizens had to have a valid pass to be able to enter and use public spaces and services, as well as many private spaces. This pass was valid if the user had recently had a negative Covid-19 test.

A part of the Health Pass design is going to work in a similar way as the Corona Pass [28]. Based on the data that the smart devices collect in conjunction with the results of the health tests, the citizens get at a health facility, they will be given a health score. If the health score is above a certain amount of points, the Health Pass is valid and the user will then receive extra benefits from the government. To illustrate this framework, an illustrative model was created (Fig. 5).

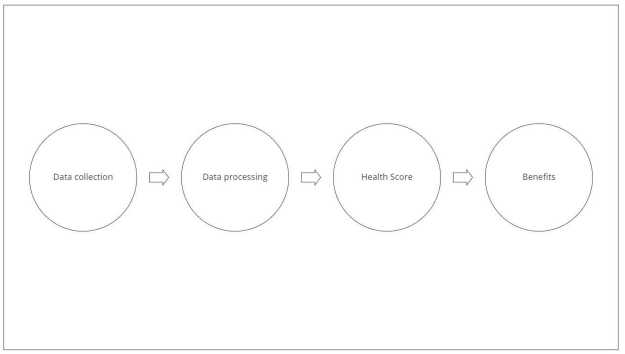

Figure 5: Framework for the Health Pass (Appx. 2)

This model illustrates how processes start with collecting the citizen's data, which is done through both a smart device and tests done at a health care facility. When the data has been collected it is going to be processed, which will result in a final health score.

Health marker data

In this section the most appropriate data markers of physical health are identified. After identifying each of these, a categorization of each data point is introduced, based upon the cited studies.

A study, from 2017 on lifestyle diseases, presents a list of apparent causes for premature mortality. These modifiable causes are bad food habits, sedentary lifestyle, excessive alcohol use and eating and smoking tobacco. These complex etiologies can result in measurable data, which is obesity, increased blood glucose levels, raised blood pressure, elevated blood lipids [59][29][73]. These data types correlate with the preview data from this study, and are therefore going to create the foundation for the design of the health score algorithm.

Waist to hip ratio

The first data type to consider is a data type that can measure if a person is obese or close to being obese. This is an important type of data to consider because obesity poses great risks for non-communicable diseases.

The World's Health Organization (WHO) has termed these rising rates of obesity as the epidemic of the 21st century [17]. Even some of the mental disorders like anxiety and depression are closely connected to obesity [43]. Multiple studies show that there is a direct correlation between obesity and other NCD to an extent that it indicates that obesity is a common denominator in many other NCDs [42][44].

It is therefore important to make sure that the citizen is at a healthy weight to eliminate these risks as much as possible.

There are severel ways to measure if a person is obese e.g. body mass index (BMI), body fat percentage and waist to hip ratio. And it is important to pick the most reliable and correct method because this method will affect the citizen's lives when this data is going to be used to

One way to measure obesity is measuring people's BMI. This is done by using the following equation:

$$\frac{W}{H^2}$$

Where W is the weight in kilograms, and H is the height in meters.

Based on the results from this calculation, people are placed into different categories that are supposed to reflect their body fat status [23].

However, in a study from 2001, they discuss how body mass index measurements might not be the best method used for classification of obesity [19].

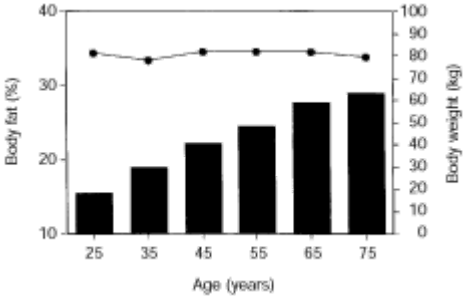

Figure 6: Age related increase in BMI [19]

As seen in Figure 6 there is a correlation between aging and body fat. This is due to the progressive decrease in muscle mass that humans experience with age [20]. The statistics shown in Figure 6 are especially relevant because they are from before obesity was named an epidemic.

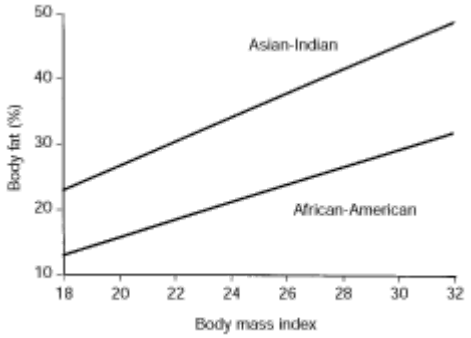

Figure 7: Difference in BMI and body fat percentage between races [19]

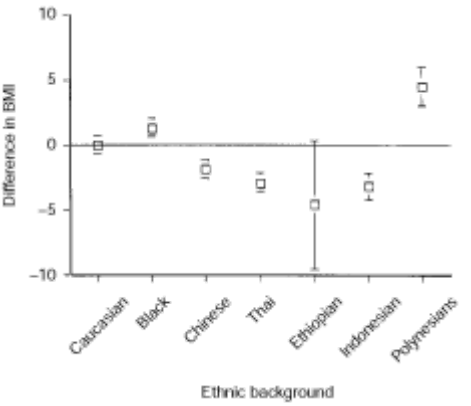

Figure 8: Difference in BMI and body fat percentage between races [19]

There is also a significant difference in body fat between races. In Figure 7 it is illustrated asian-indian people have twice the amount of body fat as an african-american. However, in a report from 2000, in which they were trying to redefine obesity, they found a significant difference in body fat in urban and rural areas [21] This indicates that it might not necessarily be due to differences in race. It might instead be because of cultural differences, economic welfare or a mix of the three.

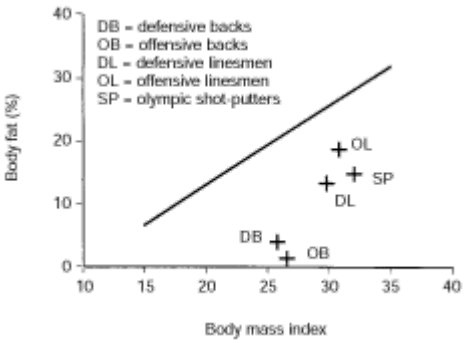

Figure 9: Unmatching BMI and body fat in athletes [19]

Another statistic, which indicates that BMI is not an accurate and reliable measurement method is illustrated in Figure 9. This figure shows different

types of athletes and their BMI and body fat. As seen on the figure, there is a correlation between BMI and body fat, but not enough to be a reliable measurement.

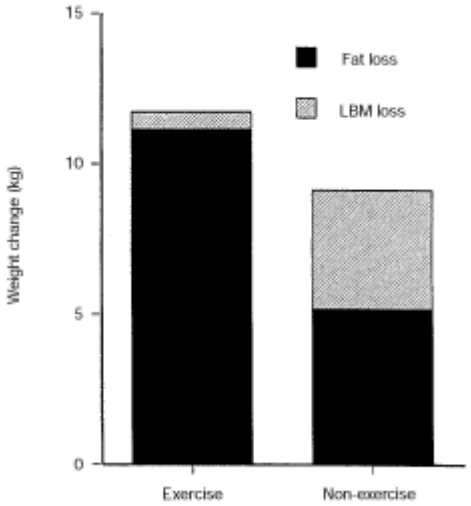

Figure 10: The effect of weight loss with or without exercise [19]

When being on a diet and losing weight, a portion of the weight loss is due to loss in muscle mass. In a literature review published in 2017, they found that people within the normal weight range had a muscle loss of about 35% of the overall weight loss. They also found the the muscle loss was less severe in people who started their weight loss while being obese. Their loss of muscle mass was only about 20-30% of their total weight loss [22]. In Figure 10 is an illustration of a study, which was done on 72 obese men, who partook in a weightloss experiement. The experiment showed that people who only lost weight without additional exercise lost a significant amount of muscle and less fat. The group who was exercising lost about 11.2 ± 1.5 kg fat, and the non-exercising group lost about 5.2 ± 1.6 kg fat. According to this data, there is a significant difference in the distribution of body fat, which a BMI measurement alone cannot quantify.

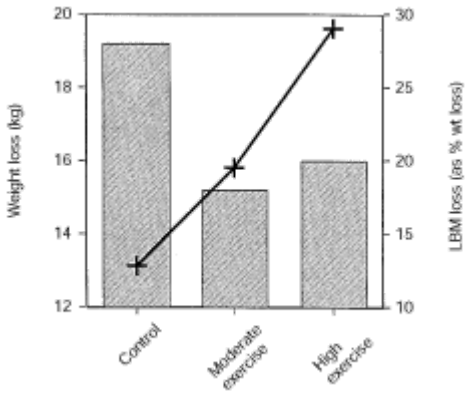

Figure 11: The effect of weight loss with different levels of exercise [19]

Figure 11 shows results from the same study as Figure 10. In this figure it is illustrated how the control group of people, who did non-exercise based weight loss, lost about double the amount of lean body mass as the people in the exercise group. But despite the non-exercising group losing more lean body mass, they lost less overall body mass.

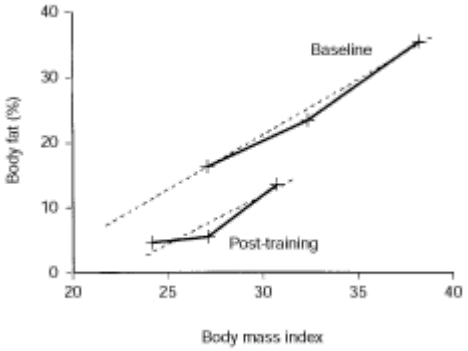

Figure 12: Change in the body fat ratio when working out more often [19]

In another study presented in [19] the participants were divided into three different groups, Group 1 = 25.0–29.9 kg m−2; Group 2 = 30.0–34.9 kg m−2; Group 3 = > 35.0 kg m−2. The groups lost 8.6, 15.7 and 22.0 kg. As illustrated in Figure 12 the participants did not just move down the BMI scale when losing weight, they moved onto a new line with different intercept.This shows that the lean to fat ratio has been changed.

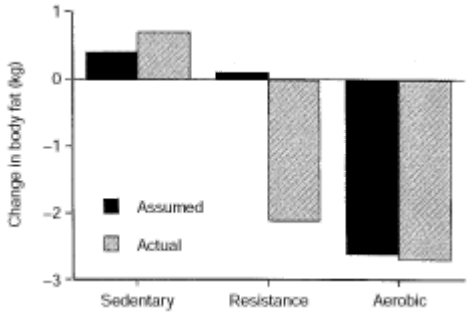

Figure 13: Change in body fat when doing resistance or aerobic exercises [19]

When staying on the same weight, but altering one's fitness level the BMI can change as well (Figure 13). This data is from an analysis of studies, which analyzed change in body fat when maintaining body weight, but did either no exercise, resistance training, or aerobic exercise. The study found that people who maintained their weight without exercising ended with a higher

body fat percentage. This matches what was mentioned in Figure 6, where people experience an increase in body fat when they age. But when doing both resistance and aerobic training, they experience a large decrease in body fat.

The conclusion of these studies is that BMI is not a valid and reliable measurement method. BMI is not an accurate measure because it focuses on body weight. But as proven in these studies, it is different depending on people's lifestyle how big a percentage of their body weight is fat and lean body mass. The lean to fat ratio can also change over time, which makes BMI even more unreliable.

Another measurement method, which was widely used in the previous mentioned studies, is measuring body fat percentage.

In a study from 2014 it was investigated whether body fat percentage can be a method of value used to predict health outcomes and risks in addition to BMI and waist-to-hip-ratio (WHR). More than 15,000 Europeans were followed over the course of 11.7 years [5]. Their method was that the researchers did a prediction on the participant's health risks based on measurements such as BMI and WHR, and then had the participants come in for examination multiple times over a mean period of 11.7 years.

The results of the study showed a connection between a higher BMI and WHR, with WHR being superior in predicting future health. The results also indicated that measuring body fat percentage did not add to the prediction of future health risks.

After investigating both BMI and body fat percentage as potential measurements for obesity and predicting future health risks, it was clear that these two measurement methods were not adequate and reliable. BMI did not provide any valuable information about dangerous fat in the body because it only measures weight as a whole and did not take into account if the weight came from lean body mass or fat. Body fat percentage provided a better understanding for what type of fat was in the body, which can indicate an overload of fat compared to lean body mass, which to some extent can measure obesity. But it was also discovered that the unhealthy fat was visceral fat, which is the fat that is located around the abdomen, and that the fat stored on the lower body is independently predictive of risks of cardiovascular disease. These studies indicate that solely measuring body fat as a way to categorize obesity and predict future health risks is not adequate. Additionally, one study found that measuring body fat did not add any value to predict future health risks when the waist to hip ratio was already measured [5].

WHO also recognizes that measuring BMI and body fat percentage is not sufficient in measuring body fat distribution. Instead they suggest using waist hip ratio measurements, because of the importance of abdominal fat when identifying increased risks of NCDs [53]. Therefore, this study is going to measure people's body fat status by using waist to hip ratio. The waist to hip ratio data is going to be referred to as WHR throughout this study.

In Table 2 is the categorization of the health risks based on the WHR collated from a health care facility.

Health risk	Men	Women
Low	0.95 or lower	0.80 or lower
Moderate	0.96-1.0	0.81-0.85
High	1.0 or higher	0.86 or higher

Table 2: Categorization of health risks based on WHR.

Step count

As sedentary lifestyle and obesity is one of the major causes of NCDs, making sure that people stay active is important. A study was conducted in 2009 [1], in which they investigated the pattern of physical activity as well as the effects that physical activity has on the elderly in terms of personal wellness and preventative diseases. The study was conducted in a medium Japanese town with approx. 500 participants at the age of >65, over the course of >8 years. The data was collected from a smart device, which was tracking their daily step counts and metabolic equivalent (MET) levels. The findings of the study was that both sexes had better physical health if they took >8000 steps per day and/or >20 min at the intensity of >3 METs.

In addition to the physical health of the participants, the study also showed evidence that mental health was increased when the participants took >4000 steps per day or >5 min per day at an intensity of >3 METs.

Another study from 2006 with 1,848 participants investigated the effect that added daily steps had on the participant's waistline [2]. The study showed that the participants, who were walking approximately 2000 steps per day and during the study added an extra 2000 steps had a reduction of 2.8cm (95% confidence interval (CI): 2.1,4.4)for men, and 2.2cm (95% CI: 0.6, 3.9) for women compared to before the study. The participants who already walked more than 10,000 steps per day had a lower reduction of 0.7 (95% CI 0.3, 1.1) cm.

The findings from these studies confirm that there is a clear correlation between the activity levels that the participants have when adding extra steps. It is not possible to measure people's current state of health using their step count, but making sure that people keep being active is an essential part in preventing obesity and

mental health disorders caused by sedentary lifestyle.

The step count categories are designed based on the findings that resp. 4000-8000 steps made a difference in both mental and physical health. The participants, who had >4000 steps per day showed increased mental health, and the participants, who had >8000 showed an increase in both physical and mental health. That is why the step count for the best category is set to 2.4 mil, which is an average of 8000 steps per day for 300 days during the recent 365 days, and the moderate category is set to an average of 4000 steps per day for 300 days during the recent 365 days (Table 3). Everything that is below the moderate step counts will be in the low category because no evidence shows any difference in people, who take fewer steps per day. Despite the evidence suggesting that people have to take this amount of steps every day to be healthy, this study acknowledges that this is not realistically possible. Therefore, people would only have to take their daily steps 300 days of the year. The step count data will be referred to as *SC* in this study.

Category	Step count
High	2.4 mil
Moderate	1.2 mil
Low	<1.2 mil

Table 3: Categorization of health risks based on *SC*.

Resting heart rate

In a Danish study they studied 16,516 healthy people over the course of 33 years. During these 33 years there were a total of 8,709 deaths. with 3,821 of these being from cardiovascular disease. The results showed that the survival rate between the RHR highest quartiles, which is > 80 bpm (beats per minute) and the lowest quartiles, which is < 65 bpm is 4.7 years for men and 3.6 years for women [51]. The connection between RHR and years of survival is illustrated in Figures 14 and 15 for men and women resp.

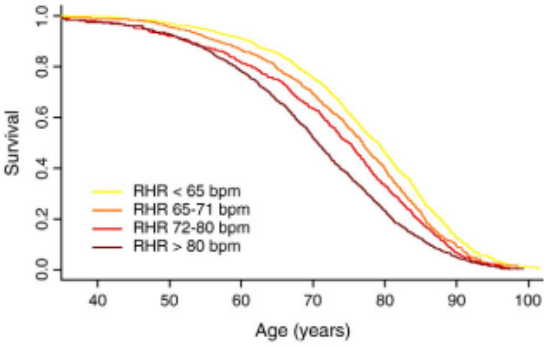

Figure 14: Total mortality by RHR quartiles in men [51].

When looking into the men's mortality chart there is a significant difference between the participants depending on what category of RHR they are in.

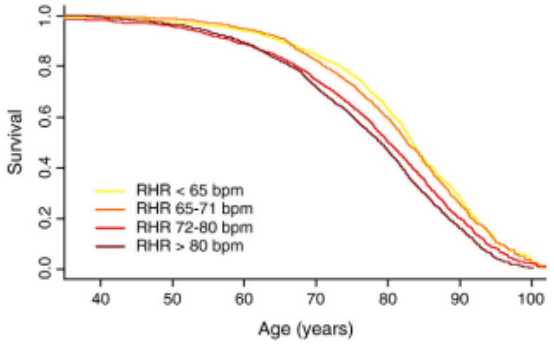

Figure 15: Total mortality by RHR quartiles in women [51].

But when looking into the women's mortality chart the RHR of 72-30 bpm and >80 are closer than in the men's chart. This also goes for the RHR of <65 and 65-71 bpm. The study does not specifically answer why there is a difference, but this could potentially be due to environmental or lifestyle factors.

In another study a group of 5,713 men between the ages of 42 and 53, who did not have any symptoms of cardiovascular disease, were tested over a period of 23 years. During these years 81 people suddenly died from myocardial infarction (heart attack). The risk of this sudden death was increased in people with a RHR of >75 with a 95% CI at 1.91 to 8.00 [52]. The RHR data will be referred to as *RHR* in this study.

The user's RHR is divided into three different groups, which are Low, Moderate and High (Table 4). As seen in Figure 14 and 15 there is a difference between mortality in men and women based on each category of RHR. However, the categorization in this study will not be sex specific because no sufficient evidence was found in current literature that there is a difference in RHR for men and women.

Category	RHR
Low	<65
Moderate	65-75
High	>75

Table 4. Categorization of health risks based on *RHR*.

This categorization is designed specifically for this study. The lower limit, which is the healthiest category, is set to <65. This is because of the findings from the Danish study, in which participants with a RHR of <65 had the longest survival rate. A low RHR is the healthiest one and

is associated with a lower all cause mortality [49]. The upper limit, which is the least healthy category, is set to above >75. This is because of the other study, which found an increase in sudden deaths among participants with a RHR above >75.

Blood sugar

When someone has elevated levels of blood sugar, it can indicate that they either have prediabetes or diabetes. There are two types of diabetes. Type 1 is a chronic autoimmune disease, where the body is not able to produce enough insulin [57]. Type 2 diabetes is a condition caused by obesity and unhealthy lifestyle [56]. Type 2 diabetes can develop if someone has elevated levels of blood sugar for a long amount of time, which is called prediabetes [89].

In a Finnish study, they did an ongoing trial lasting 5 years with 523 people in resp. an intervention group and a control group. The intervention group would be advised to do more physical activity and eat a healthier diet. The results of the study were that 41.8% of the intervention group had lost at least 5kg and had a reduction in blood glucose, insulin, systolic and diastolic blood pressure and serum triglycerides [34].

In another study, which also focussed on managing risks of getting diabetes through intervention, they had similar results. This study was ongoing for 6 years with a 20 year follow up. The result of this study was a 43% lower incidence after the 20 year follow up with a 95% CI 0.33–0.73 [25].

There is also a correlation between diabetes and depression, with diabetics having twice the prevalence of depression compared to healthy individuals [45].

These studies show a correlation between high blood sugar, other NCDs and lifestyle.

Measuring blood sugar levels is done using the A1C test. This test measures blood sugar levels over the past three months. This test can be used to diagnose pre-diabetes and diabetes. The results of the A1C are divided into three categories, which are shown in Table 5 [48]. The blood sugar data will be referred to as BS in this study.

Category	Blood sugar level
Normal	Below 5.7%
Prediabetes	5.7% to 6.4%
Diabetes	6.5% or above

Table 5: Categorization of health risks based on BS.

Blood pressure

Increased blood pressure can lead to hypertension, which is one of the most prevalent causes for cardiovascular diseases [63]. There are many different factors, which can aggregate with hypertension like abdominal obesity and diabetes and is one of the most prevalent causes of cardiovascular diseases [62].

In one study, they did an analysis of 36 year follow up data from another study in which they discovered that hypertension contributes to a 2-3 times increased risk of getting major types of cardiovascular diseases. Their conclusion was the importance of weight control, healthy diet and exercise [46].

As previously mentioned, there is a correlation between diabetes and high blood pressure. Hypertension effects approx. 70% of people with diabetes. The overlap between these two also further increases the risk of getting ischemic cerebrovascular disease and other diseases [47].

Diagnosing hypertension is done by measuring both systolic and diastolic blood pressure. There are different ways to measure optimal blood pressure and hypertension. In one study, they explain how new measuring boundaries were discovered in 2017, with hypertension occurring at ≥130/≥80 [50]. However, in Denmark the JNC 7 criteria is still used [26]. As this framework is designed for Denmark, this study will also use the JNC 7 criteria to create the boundaries for blood pressure measurements categories (Table 6) [62]. The BP data will be referred to as BS in this study.

Category	Systolic	Diastolic
Optimal	<120	<80
Normal	120–129	80–84
High normal	130–139	85–89
Hypertension	>139	>89

Table 6: Categorization of health risks based on BP.

Coronary artery calcium scoring

High total cholesterol (CL) is associated with higher risk of Coronary heart disease (CHD) and other NCDs [35][59]. There are two types of cholesterol, high-density lipoprotein (HDL), which is known as the good type of cholesterol, and cholesterol and low-density lipoprotein (LDL) cholesterol, which is known as the bad type of cholesterol.

[64] LDL cholesterol can be determined using the Friedewald formula (FF)[38]:

$$total\ CL\ -\ HDL\ CL\ -\ \frac{triglycerides}{5}$$

The result of this formula tells if someone has a high amount of LDL cholesterol, which can increase the risks of CHD. However, this

measurement is not enough to calculate this risk. When calculating the risk of getting CHD, both the result of FF is needed in conjunction with other types of information such as age and ethnicity. Because of this they started the The Multi-Ethnic Study of Atherosclerosis (MESA) study.

The MESA study is an ongoing cohort study, in which they investigate characteristics and risks of getting CHD. The study is investigating more than 6000 asymptomatic people from different demographics, who do not currently have CHD or diabetes [27][30].

Based on this study, they developed a MESA risk score, which uses the data from the study in conjunction with the coronary artery calcium (CAC) score [31].

The CAC score is calculated based on the result from the Agatston score. The Agatston score is calculated by using ultrafast computed tomography, which can detect and quantify levels of coronary artery calcium [32]. However, it was found that the CAC score was neither enough to calculate the risk of getting CHD [33].

The MESA risk score calculates a 10-year CHD risk percentage based on multiple demographic factors in conjunction with the CAC [39].

There is no index of what a good percentage is as more research is still needed about how to calculate risks of CHD. Therefore, the percentages used in this study are only meant as current guidelines specifically made for this study, which should be reevaluated when more research is done (fig. x). The CHD risk data will be referred to as CHD in this study.

Category	CHD risk (10 years)
Low	<5%
Moderate	5-10%
High	>10%

Table 7: Categorization of 10 year CHD risk based on CHD.

Final set of data points

The result of the literature review is a final set of data types that can have an impact on preventative health care. These data types are as follows:

Data types	Name
Step count	SC
Heart rate	HR
Waist to hip ratio	WHR
Resting heart rate	RHR
Blood sugar levels	B
Blood pressure	BP
CAC Score	CHD

Table 8: List of the final health data types and their reference names.

Data collection

When having a final list of data points necessary to create the score for the Health Pass, it is important to investigate how this data is going to be collected.

When collecting citizen's health data for the Health Pass, it is done from various sources and devices. It is going to happen through data sources that are already an integrated part of our healthcare system, current possible technologies and smart devices. Smart devices are already a well integrated part of our society as 73,3% of the survey participants responded that they had previously measured their health stats on smart devices.

The focus in this study, regarding data collection, is therefore to identify the following data data collection sources: Smart devices, smartphones and existing data controllers of health data in private and public healthcare facilities. To illustrate these data sources and processes, a model component is created (Fig. x)

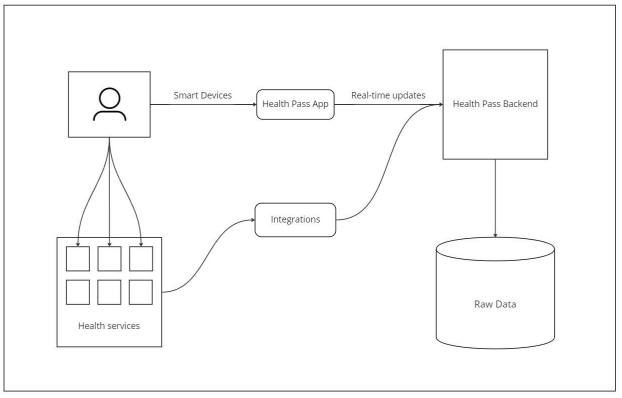

Figure 16: Graphical representation of the data collection process (Appx. 3).

This model component shows the citizen, whose data is sought to collect. Data is gathered through two different channels, the citizen's smart device

and through integrations with existing systems used throughout the current healthcare system.

I. Smart devices, smartphones and an application

The data that is gathered through the citizen's smart device is data such as SC and RHR. This data is temporarily stored in the citizen's phone via an associated application. At certain periodic intervals, decided by the application implementation, as best suited for technical performance, the application will transmit the measurements from the interval to the Health Pass backend. These raw measurements, once received by the backend, are stored in a database, containing all raw measurements reported.

Introducing an application for the user's smartphone, can assist in validating the user's identity and collect health data through approved smart devices. This device can aggregate and report the collected health data to the system.

II. Requirements for reporting health data

In this framework, existing healthcare systems should be mandated by law to integrate with the resulting system. This integration should be implemented as a relatively simple but powerful web API, which enables a rapid integration, but supports a wide array of measurement types. This API can also be utilized by the associated smartphone application. There should also be a requirement for healthcare professionals to report measurements at the time they are made.

III. Guidelines for data collection

A series of guidelines should be put into place regarding data collection, requirements for data quality, granularity etc. The system should strive for data reporting as often as technically feasible, within reason, and be of the highest possible granularity. It is more useful to report the amount of steps taken in smaller time intervals throughout the day instead of reporting the total amount of steps once per day. This makes it easier to find patterns in the data, which can be used for fraud detection.

Fraud detection

When collecting citizen's daily health data and using this as a parameter to give them benefits, it can lead to different types of fraud. When people use a technology device, which can track their daily steps and heart rate, it can be easy to commit fraud by making someone else wear the device. This can also lead to one person wearing multiple people's devices, or even turn a profit for helping people reach better stats and getting an active Health Pass.

There is a newly released app, which is called Walken [14], which has a concept similar to the Health Pass. This app pays its users in NFTs, when they walk. The more they walk, the more they earn. This app has a feature, which counts both the user's steps and their validated steps. The steps are all the steps that the app picks up from the user's phone, and the validated steps are steps that have been checked and validated through the use of machine learning. The ways that Walken makes sure that the user's do not cheat is through three steps, healthKit access, cheating and validation. Walken needs access to the user's phone's health data, because it needs to export steps and distance data. It prevents the user from cheating by using this data, which is done through pattern recognition. The pattern recognition can detect if the user is shaking their phone up and down to mimic steps. Validation of the steps happens when the data matches. If the user has moved a long distance, but has only moved a couple of steps, it will assume that the user is in a moving vehicle, and the steps will not get validated.

In the Health Pass it is necessary to validate the health data as well. This is especially important because it has to do with both individual and public economics. This can be done in the same way as in the Walken app. Though, the pattern recognition should be more advanced because of the added level of importance of the Health Pass.

When using pattern recognition for fraud detection it is necessary to collect different types of data. This data can be collected through the different types of sensors that can be incorporated into the smart device.

When doing fraud detection the first thing that is important to address is to make sure that it is the right person wearing the device. As mentioned, one way that the user's can cheat is if one person wears a lot of people's devices. The user will then not do the healthy activities themselves. It is therefore necessary to identify that it is the right person wearing the watch whenever the watch is on someone's wrist.

One way to make sure that it is the right person is if the user has to use a fingerprint scanner on the device every time the device is put on. However, this can also lead to fraud, as the person can use their fingerprint identification, while the device is on someone else's wrist. One way to prevent this from happening is using machine intelligence and pattern recognition. If a person puts on their device and validates their identity through fingerprint identification, and the device notices that the person's walking patterns are different than they usually are, then it could prompt the user for another fingerprint validation.

This level of fraud detection requires a high granularity of data. Having a high granularity can improve the effectiveness of how well machine learning can detect patterns in the data.

Data processing

When all the data has been collected the data will be placed into different categories based on the measurements (Table 9). The health score is designed using a weighting method, where each data type will be given points based on how good the results are. The sum of these points will then result in a final score. If this final score is above a certain boundary, the Health pass will be valid and the person will be eligible for a tax reduction.

The health score can be calculated, when someone has been wearing a smart device and collected their health data for at least 365 days. People do not need to wear the device all the time, as this is an unrealistic expectation. They will have to wear the device for the amount of time it takes the device to measure their RHR and the amount of steps they would like the device to track. At this point, they can go to visit a health professional, who will then collect the rest of the data. When all the data is collected, a score can be calculated.

It is possible for someone to get a new calculation at any time. If someone e.g. started walking more or lost a significant amount of weight over the recent few months, they could possibly get a better score if they got a new calculation because it is calculated based on data from the previous 365 days.

It is advised that people do a physical exam 1-3 years depending on their age and current health status [79][80][81][82][75][74]. Therefore, if someone has a valid Health Pass, this would be valid for one year, whereafter they would have to do another check up. The decision to have a validity lasting for only one year is also because people would otherwise be able to put in the same effort, but still get the benefits of someone with a healthy lifestyle.

Health score

For each measurement type, a score is defined (Table 9). These different score is assigned the name of the type of health marker with an added S for score, e.g. WHR_S.

For most of the data types, the weight of the weight is +10 points for good values, 0 points for moderate values and -10 for bad values. However, BS_S and BP_S are weighted differently. This is because if someone has the worst values in BS_S and BP_S They already have hypertension and/or diabetes and are already costing society extra expenditures. Diabetes is one of the NCDs that cost the most in both public health and personal health expenditures [76]

Data	Category	Criteria	Weight
WHR_S	Low	≤0.95	10
	Moderate	0.96 - 1.0	0
	High	≥1.0	-10
SC_S	High	≥2.4 mil	10
	Moderate	$\geq$ 1.2 *mil*	0
	Low	<1.2 mil	-10
RHR_S	Low	<65	10
	Moderate	65 - 75	0
	High	>75	-10
BS_S	Normal	<5.7%	10
	Pre-diabetes	5.7 - 6.4%	-10
	Diabetes	≥6.5%	-20
BP_S	Optimal	<120/<80	10
	Normal	120 - 129 / 80 -84	0
	High normal	130 - 139 / 85 -89	-10
	Hypertension	>139 / >89	-20
CHD_S	Low	<5%	10
	Moderate	5-10%	0
	High	>10%	-10

Table 10: Scores based on the assigned categories for the quantified data.

The final health score is defined as:

$$H_S = WHR_S + SC_S + RHR_S + BS_S + BP_S + CHD_S$$

A passing boundary PB is defined, and the health score is set to pass if:

$$H_S >= PB$$

For this study's currently given example scores, $PB = 20$.

Table 11 is an example of how four different people's stats can look like.

Data point	Example1	Example 2	Example 3	Example 4
WHR_s	10	-10	0	10
SC_s	0	0	10	10
RHR_s	-10	0	10	10
BS_s	10	10	0	10
BP_s	10	0	0	10
CAC_s	0	-10	10	10
Total	20	-10	30	60
Status	True	False	True	True

Table 11: Health score examples

The criteria, weighting and passing boundary is merely a proposal and has to be further established by medical professionals. Therefore, the system has to be configurable for experts to change these criteria, weight and passing boundary, which is also important if new or more research becomes available.

Limitations

There are two main limitations to this study. One limitation is the inadequate medical knowledge, which could have brought more or different perspectives and knowledge to the development process of the Health score.

Another limitation is the small sample size of the survey. The results of the survey would have been more reliable if the sample size reached at least 1000 participants. Additionally, the study could have benefited from a more qualitative approach with a more selective sampling method, which could ensure representation from all groups of people.

Discussion

According to both the findings from the survey and the supplementary literature, the vast majority of the people would like to have a public programme like the Health Pass. It seems like people value the overall benefits more than their privacy. One study found that 68% of their participants would like to share their personal data if it involved privacy, and 56% would be "more" and "much more" likely to share their personal data if they were compensated [67]. In another qualitative study they found that 98% of the participants believed that the altruistic benefits of sharing their personal health data would outweigh the risks [68]. These studies indicate that people in general are open to the idea of sharing their personal health data for the greater good, but do still have some concerns about their privacy and about their data getting into the wrong hands.

These findings are similar to the ones from the survey made in this study. Most of the participants would be willing to join a programme like the Health Pass, provided that it is voluntary. Though, it seems like most of the participants were not concerned about their privacy, as most of the participants did not mention this. However, people were concerned about their freedom to live as they please. This is why some people mentioned that they would only want to be a part of this if it was a choice, but not if it was forced. The participants also replied that they would be more likely to participate in a programme like the Health Pass if there were significant benefits, but explained how a few percentages of tax reduction would not be sufficient for them to give up more of their freedom.

If the Health Pass were to be positively received by most people and implemented into society, it could have great benefits, both regarding people's health and the economy of Denmark, which could in return further improve people's health because there would be a bigger budget for people, who are in need.

But despite these potentially positive benefits, some potential drawbacks could also arise.

As some of the participants expressed, there is a concern about depriving people of some of their individual freedom. The argument here being that people are forced to live a certain way. This can negatively affect both people, who are not capable of changing their lifestyle and the people who are. Some people might not be able to change their lifestyle due to both physical and physiological diagnosis, which prohibit them from living a different lifestyle. Other people who come from specific socio economic layers in society, might also find it difficult to change their behavioral

patterns, due to social constructivism [15][6]. On the opposition, there are people, who either have been raised in a different socio economic layer, which might have taught them or given them more resources to live a healthier lifestyle, or people who possess greater adaptability.

Some people cope with their troubles and find happiness in eating more unhealthy food and being more sedentary. If they were forced to live healthier they would be deprived of their choice to cope with their troubles in their own way. But living this way has a price, which is a burden on the finances of fellow citizens. These fellow citizens might also have troubles of their own, but would rather find happiness in working less, traveling and being able to freely enjoy their time as they please. However, if the first mentioned group of people are going to keep their freedom, the other group of people keeps having their freedom deprived and have to live a less happy and fulfilled life. In this study, the argument is that everyone deserves to be happy, no matter how they find their happiness. Using this solution could make sure that both groups can make a choice and freely decide how they would want to live. If someone finds happiness in snacking and watching tv all day, then they should be able to do so. However, this has a cost in the long run, which they will contribute to throughout their life by accepting that they pay more taxes. And the people who find happiness in working less and traveling can decide to participate in this solution and thereby get more free time and money, which they can spend in other ways to find their happiness.

This could also result in another drawback, which is the division of the society into two different groups. The people who are living healthier lifestyles and therefore having better ressources vs. the people who either choose to live a more unhealthy lifestyle or have some troubles, which could prohibit them from living a healthy lifestyle. One example is by accepting this Health Pass, we also accept that some people are going to be negatively affected. A current example of this is the tax, which is added onto cigarette packs. People are aware that despite the government raising the prices on the cigarette packs, there are people who are not capable of quitting. Some people might not be capable of quitting because they are highly addicted and have been for many years, and some might have mental issues, which prohibit them from doing so. Therefore, these added taxes do not help these people quit smoking, but instead makes their cost of living higher, which negatively affects their lives. Despite this, society accepts that some people are going to be negatively affected, in the hope that future generations might be less likely to start smoking. A possible solution to this could be that people, who have certain types of diagnoses could be exempt from participating until they have recovered, if this is possible.

Another drawback could be that people have different prerequisites for completing parts of this solution such as step count. Some people automatically get their steps on the job, while other people have sedentary jobs. People who have sedentary jobs would have to spend extra time every day outside of work to make sure that they reach their goal. This could make it easier for some groups of people to receive a valid Health Pass, which could also result in a division of society. However, this could also start socio economic change, which could lead to improved social determinants of health. If someone has an office job and is sitting at a desk for 8 hours a day, 5 days a week, it could create higher demands from the employees to either work fewer hours or getting ekstra equipment for their work stations, like an under desk treadmill. It might especially be easier for the employee to set these kinds of demands if they are based on government measures. This could change the structures of our society, which could make it easier for more people to live healthier lives. This might also affect the sense of entitlement, which has been arising in Denmark. It might lessen the sense of entitlement because people are reminded that their actions have consequences for their fellow citizens, which could improve community spirit and solidarity. However, it could concurrently enhance the sense of entitlement because people could potentially begin making more demands on healthier work-life balances, products, public and private environments.

These are important aspects to consider, as it is not the intention of the study to create a divided society. The intention is bringing back the community spirit and solidarity, upon which Denmark was built, and through this, improve our health, longevity and physical well-being, and thereby also improving mental well-being as mentioned earlier in this study [41].

Ethics

This study encourages a debate about the ethics of using and storing citizen's personal health data. One ethical concern is citizen's right to privacy. Danish citizen's privacy is protected by the law. The law *3.1.3.3. The right to privacy, paragraph 2, article 8*, explains how no public authority is allowed to intervene with these rights unless it is in compliance with the law and is necessary in a democratic society in consideration of national security, public safety, or the country's economic welfare, to protect against disturbances and crime, to protect the health or morality, or to protect other people's rights and freedom [7].

This law emphasizes how it is legal to invade people's privacy if it is a matter of public health or public wealth. This research paper presents a possible research backed solution to

how citizen's health data can be utilized in a way, which can promote better health and disease prevention, which can result in better economy and sustainability within the healthcare system. Collecting, storing and using citizen's health data can therefore legally be justified because it can promote *economic welfare* and *protect the health* of the citizen's, which are some legal reasons for invading people's privacy.

Storing health data is also something that is already a part of the Danish system. The citizen's stored data is managed by the Health Data Protection Authority, whose main responsibility is to support the health care system by collecting and making health data available to health professionals as well as to decision makers and citizens [8]. The law surrounding the use of citizen's health data also prohibits the deletion of this data. Neither the citizens nor health authorities are allowed to delete any health data [9].

It is not necessarily ethical or moral to collect, store and use citizen's health data solely because of the current laws and practices in Denmark. It is therefore necessary to further debate if this research paper's possible solution is ethical and moral.

Utilitarianism, on which our society is partially built, is a philosophy based on the belief that *"The greatest happiness for the greatest number of people"* [10]. Mill wrote a book on utilitarianism, in which he compared historical writers' understanding and interpretation of utilitarianism. Stuart Mill refers to utilitarianism as the *Greatest Happiness Principle*. It is in these principles understood that actions are *right* if they promote happiness, and wrong if they produce the reverse of happiness. He argued that happiness came from pleasure and the reverse of happiness came from pain [11]. Scarre also cites Mill in his book and explains how Mill in some of his writings moved away from the belief that happiness came solely from pleasure and reverse happiness came solely from pain. He then started to believe in an Aristotelian concept, in which a happy person is also concerned about developing the excellence of their character [12].

Despite both Mill and Scarre writing about how utilitarianism is about happiness, it is likewise, as the name indicates, about utility. Hume describes how utilitarianism is not solely about being happy, but also about welfare, either of the individual og society. Hume argues that utility is about the usefulness of the individual and the services that they perform to society [13].

Correlating these different understandings of utilitarianism, the overall understanding is that utilitarianism is about the greater good of the people, in which good is what makes people happy. This greater good can be obtained if the citizens, who are a part of a bigger system, each contribute to the happiness and wellbeing of the rest of the system. Therefore, it can be argued that giving people a chance to contribute to the system by sharing their personal health data as well as actively staying healthy is for the greater good of the system and everyone in it. Making this contribution to society is not only for the greater good of the system and everyone in it, but can also promote the personal development of the excellence of people's character, which can intrinsically lead to happiness.

The conclusion is therefore, that collecting, storing and using people's data is ethical and moral because it is for the greater good and promotes both collective and individual happiness.

Conclusion

According to WHO, NCDs have become a global epidemic, which has created a social and economic imbalance in our society. 70-74% of NCDs are often caused by unhealthy lifestyles. One of the reasons why people are living unhealthy lifestyles is because of social determinants of health. Through the following research question it was sought to find a possible solution, which could improve these social determinants of health in Denmark:

How can the collection and processing of personal health data be leveraged to motivate people to live healthier lifestyles and thereby improve the social determinants of health in Denmark?

By collecting citizen's health data, both at a health care facility and at their wrists through a smart device, it is possible to create a score, which can determine their current health and possible NCD risks. If this score reaches a set boundary, the citizen is granted a valid Health Pass, which makes them eligible for a tax reduction. This can motivate them to live healthier lifestyles and possibly change the structures and values of society. Making these changes can result in an improvement of social determinants of health in Denmark.

It is not possible to verify through this study if this solution would improve public health, the healthcare system and social determinants of health. In this study it was discovered in the survey that the majority of people would be willing to participate in this programme. However, it cannot be confirmed that participants will actually change their lifestyle if they start to participate. The study also found that some of the people, who would willingly participate in this programme, could possibly be willing to do this because they are already living a healthier lifestyle.

Despite not being able to predict if this programme will have the desired effect, it could still be useful as a reminder of the importance of

healthy living, which could improve public awareness of health.

Future work

Free Pass

In the findings from the survey, someone expressed concern about people, who have either physical or mental issues, which will make them unable to participate in this arrangement. Therefore, this study suggests that a Free Pass is designed for people, who cannot participate on equal terms as everybody else. Despite the Health Pass being voluntary, it would not be fair if someone would not be able to get these benefits even if they wanted to.

Equality

In addition to the Health Pass, other programmes should be considered as well. In the survey, someone expressed that they believe that giving people benefits for living healthier lifestyles would end up increasing inequality. This could potentially be sorted by taking more action educating people about good health. One of the respondents from the survey expressed that they believed that information for an important part of making people live healthier lives. Another suggestion would be decreasing the amount of hours that people work, which could give them more time and energy to pursue a healthier lifestyle.

METS

To make sure that people are staying active, the focus in this study was to count the citizen's steps. However, some people get exercise through other activities. In the Japanese study about the effect of walking a certain amount of steps, they mention that it has a similar effect to having >5/>20 min of activity at the intensity of >3 METs. Implementing into the system that people can either walk 4000/8000 steps per day or >5/>20 min of activity at the intensity of >3 METs, could give the citizens more freedom to choose how they want to stay active.

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