UiT The Arctic University of Norway

Department of Community Medicine

Level of education and risk for self-reported cardiovascular disease – The Tromsø Study, 1994-2016

Master of Public Health

Master's Thesis

Celina Janene Cathro

HEL-3950, Autumn 2021

Main Supervisor: Sairah Lai Fa Chen

Co-Supervisor: Tormod Brenn

Acknowledgements

First, I would like to thank my supervisor, Sairah Lai Fa Chen. It was with her guidance, support, and mentorship that this thesis was possible. I am so grateful to have had such an intelligent, down-to-earth, approachable, and friendly mentor throughout this journey. I could not have done this without you, and I could not have asked for a better supervisor.

Secondly, I would like to thank my co-supervisor, Tormod Brenn. Thank you for sharing your knowledge and insights and for being ever so patient with me throughout this journey. I certainly appreciate your friendliness and everything you have taught me about statistics.

To those who participated in the Tromsø 4 and Tromsø 7 Studies, I would like to extend my gratitude. Without all of you and your willingness to help advance medical/health research, none of this would be possible.

To the Department of Community Medicine at the University of Tromsø and all the wonderful staff and faculty who have been there to help answer my many questions along the way and who have taught me ever so well, thank you.

To my dear friends that I made throughout the MPH program and during my time in Tromsø, all of you made this experience so much more enjoyable. You were my rocks. You shared a laugh, a smile, a coffee and ensured I understood a tricky concept whenever I was struggling.

To my friends and family back home in Edmonton, Canada (especially my father, Meagan, Paige, and Jacy), thank you for your support and encouragement throughout this process. I love you all.

Most importantly, I would like to thank my mother. Without her enormous will to support me in every way she could, I would have never been able to start, nor finish this journey. You mean the world to me, and I love you dearly.

Lastly, to my employers, I would like to thank you for your support and for allowing me to go on an educational leave so that I could pour all my energy into writing this thesis.

Abstract

Introduction & Background: Cardiovascular disease (CVD) is one of the most prevalent non-communicable diseases (NCDs) globally. In 2018, CVD claimed 12,091 lives in Norway, and between 2005-2016 approximately 21% of the Norwegian population were administered therapeutic drugs to treat or prevent CVD. The World Health Organization has created a target to reduce NCD deaths by 33% between 2010-2030 for those under age 70. Although Norway is well on its way to achieving this goal due to advances in medical technologies and reductions in certain risk factors, it is expected that in the coming decades CVD prevalence will increase as the population ages. In Norway, education is tuition free, and healthcare is covered by a single-payer system. Yet, health inequalities are still large within the country, especially between populations with different educational levels. Previous research has shown education to be a risk factor for CVD. Therefore, it seems prudent that we conduct more research on the relationship between educational attainment and CVD in Norway. The Norwegian government could then use this research to implement programs to help lessen the burden of CVD on the healthcare system as well as on individuals in the future.

Objective: To investigate the association between educational attainment and self-reported CVD (heart attack, stroke, and angina) in Tromsø, Norway.

Materials & Methods: This prospective cohort study included 12,400 adults from Tromsø, Norway enrolled in the Tromsø 4 and 7 studies between 1994-2016. Exposure information was collected during Tromsø 4 via onsite measurements and questionnaires. Outcome information was collected during Tromsø 7 using questionnaires. Logistic regression was used to obtain odds ratios (OR) and 95% confidence intervals (CI).

Results: The OR for CVD was 0.84 (95% CI: 0.80-0.88) and 0.96 (95% CI: 0.92-1.01) for the crude and multivariate models, respectively. In the crude and multivariate models for heart attack, the OR was 0.82 (95% CI: 0.77-0.87) and 0.97 (95% CI: 0.91-1.05), respectively. For stroke, the OR was 0.89 (95% CI: 0.83-0.96) for the crude model and 1.01 (95% CI: 0.93-1.09) for the multivariate model. For angina, the OR was 0.90 (95% CI: 0.82-0.98) and 1.04 (95% CI: 0.95-1.14) for the crude and multivariate models, respectively.

Conclusion: There was a significant risk reduction for self-reported CVD with increased educational attainment in the crude model. The association was present in both genders with a

stronger risk reduction in women. In the age stratified models, only those aged 30-49 at baseline had significant reductions in CVD risk. No association was present in the multivariate models, likely due to covariates acting as mediators. However, educational attainment was a strong predictor for CVD.

Keywords

- Angina
- Cardiovascular disease
- Cohort study
- Education
- Heart Attack
- Logistic regression
- Mediator
- Myocardial infarction
- Noncommunicable disease
- Norway
- Odds ratio
- Socioeconomic status
- Stroke
- Tromsø
- Tromsø Study
- Tromsø 4
- Tromsø 7

Abbreviations

BMI	Body mass index
CI	Confidence interval
CMNN	Communicable, maternal, neonatal, and nutritional diseases
CVD	Cardiovascular disease
DPC	Data- and Publication Committee
EL1	Education Level 1 (7-10 years primary/secondary school, modern secondary school)
EL2	Education Level 2 (Technical school, middle school, vocational school, 1-2 years senior high school)
EL 3	Education Level 3 (High school diploma (3-4 years))
EL4	Education Level 4 (College/university, less than 4 years)
EL5	Education Level 5 (College/university, 4 or more years)
HDI	Human development index
HPA	Hard physical activity
ISM	Department of Community Medicine
LPA	Light physical activity
MI	Myocardial infarction
NCD	Non-communicable diseases
OR	Odds ratio
PPV	Positive predictive value
Q1	Questionnaire 1

REK	Regional Committee for Medical Research Ethics
SBP	Systolic blood pressure
SD	Standard deviation
SDG	Sustainable development goal
SES	Socioeconomic status
SNL	Store Norske Leksikon (Large Norwegian Encyclopedia)
SSB	Statistisk sentralbyrå (Statistics Norway)
UNN	University Hospital of Northern Norway

List of Tables

List of Figures

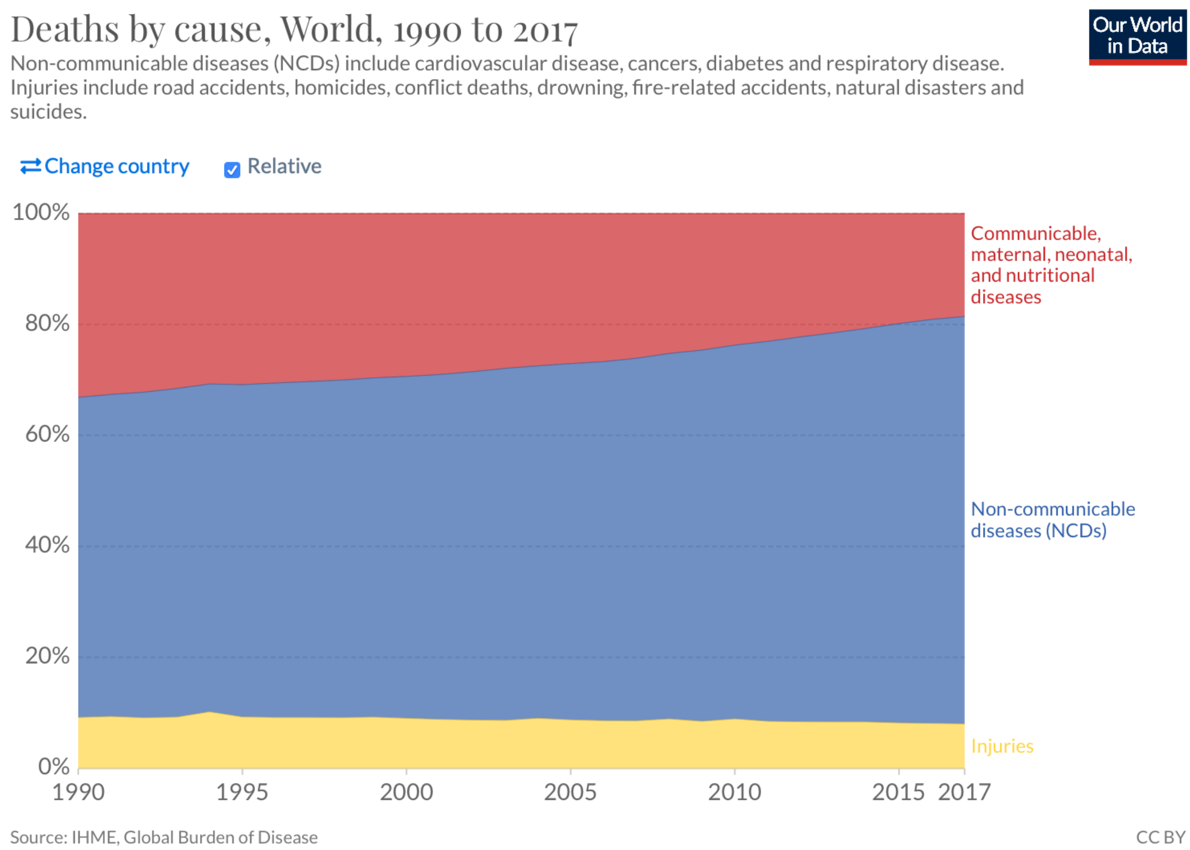
Table of Contents

1 Background

1.1 Non-communicable diseases

Non-communicable diseases (NCD), interchangeably referred to as chronic diseases, are defined as diseases with a prolonged duration (1). The most prevalent NCDs globally include cardiovascular disease (CVD), cancer, respiratory diseases, and diabetes, in order of prevalence (1). NCDs are responsible for over 70% of deaths globally, killing approximately 41 million people each year; higher than the number of deaths due to injuries (8.02%) and communicable, maternal, neonatal, and nutritional diseases (CMNNs) (18.57%) combined, refer to *Figure 1* (1, 2).

Figure 1: Change in global causes of death from 1990 to 2017 (2).



Over recent decades, the number of global deaths due to CMNNs have been decreasing, while the number of deaths resulting from NCDs have been increasing; an event known as the epidemiological transition (2, 3). Numerous advances in medical technology, cultural, biological, and environmental factors, along with the rise in global life expectancy, can help to explain this transition (4).

1.2 Cardiovascular disease

CVD refers to a wide variety of conditions relating to the heart and/or blood vessels (5). CVD is most commonly associated with atherosclerosis – the build-up of fat within ones arteries which can result in blockage of blood flow and blood clots (5, 6). For the purposes of this study, we will focus on three types of CVD: heart attack, angina, and stroke. A heart attack, also known as a myocardial infarction (MI), can happen when a blood clot cuts off part of the blood supply to the heart (6, 7). Though difficult to distinguish from a heart attack, angina is a temporary disturbance in the supply of oxygen and blood to the heart resulting in pain and discomfort (8). A stroke on the other hand affects the brain and can happen in one of two ways – either the blood supply to the brain is blocked (ischemic stroke) or a blood vessel within the brain bursts (haemorrhagic stroke) (7). A stroke can cause severe, irreparable harm to the brain cells, affecting basic skills like walking and talking (7).

1.2.1 Global cardiovascular disease status

Among all deaths resulting from NCDs, CVD kills the greatest number globally taking 17.9 million lives each year (1). Currently, the World Health Organization has created a target to reduce NCD deaths by 33% for those under 70 years of age between 2010 and 2030 (also part of the Sustainable Development Goals (SDGs)) (9). Thus far, Norway is on track to reach that goal as the country has already reduced NCD deaths by 25% between 2010 and 2018 (for trends in NCD mortality, refer to *Figure 2)* (9, 10).

Figure 2: NCD mortality among Norwegians age 30-69 (2005-2018) (10).

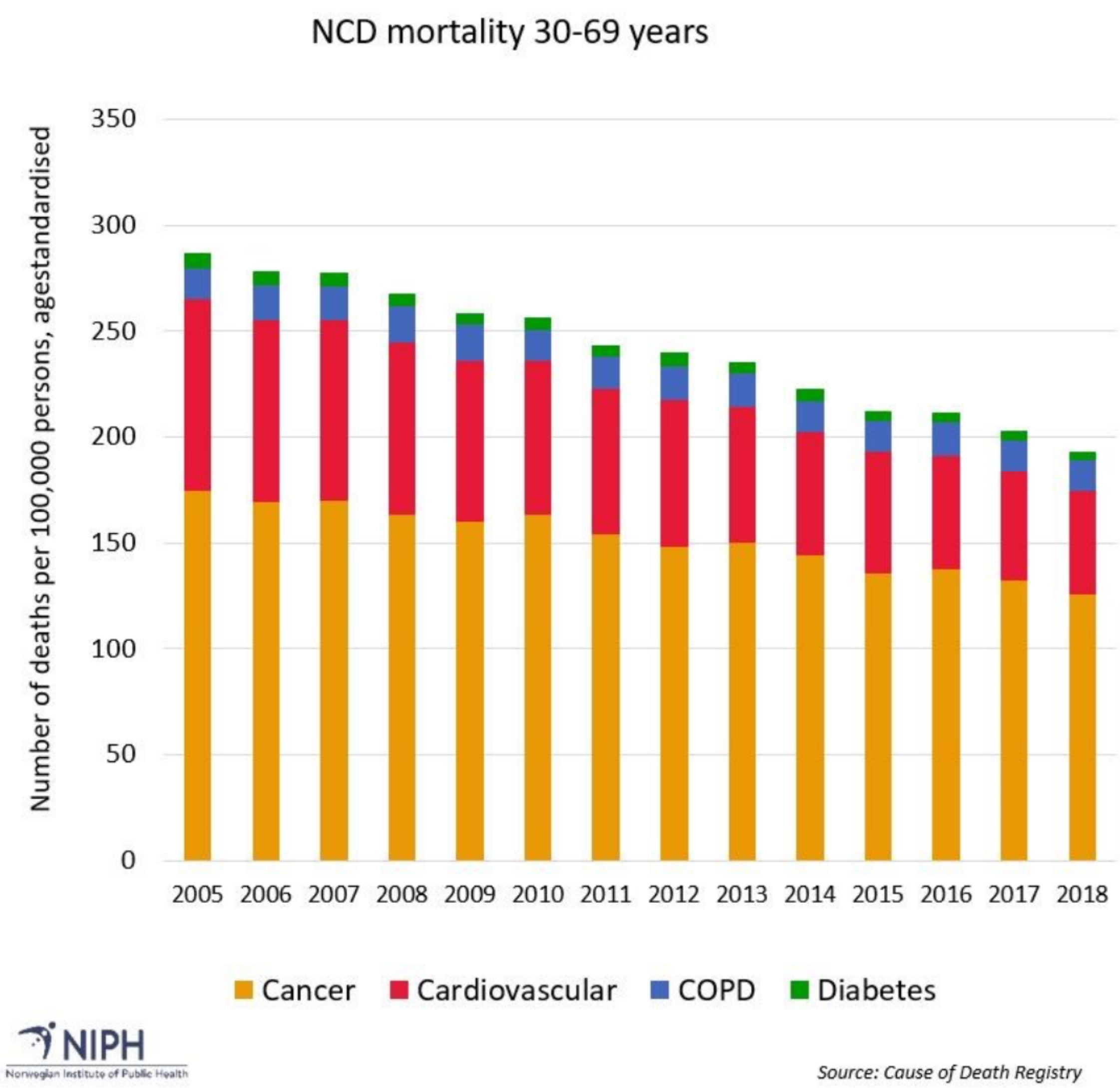


Figure 1: Mortality rate of the NCDs of cancer, cardiovascular disease, chronic obstructive pulmonary disease (COPD) and diabetes in Norway, 2005-2018. 30-69 age group, deaths per 100 000 population, age-standardised. Source: Cause of Death Registry, Norwegian Institute of Public Health. See table below.

1.2.2 Cardiovascular disease in Norway

Currently, CVD is the second leading cause of death in Norway after cancer (11, 12). In 2018 alone, CVD in Norway claimed 12,091 lives, continuing to make it a large issue within the country (11). In a population of approximately 5.3 million people, approximately 21% of Norwegians were administered therapeutic drugs between 2005-2016 to prevent or treat a CVD, as shown in *Figure 3* (6, 13). In recent years, the incidence and mortality rate of CVD in Norway has been decreasing due to advancing medical technologies and a decline in certain risk factors such as smoking, cholesterol and blood pressure (6). However, it has been projected that CVD prevalence will increase in future years due to the ageing population (6).

Figure 3: Percent and number of Norwegians that were administered therapeutic drugs for CVD from 2005 to 2016 (6).

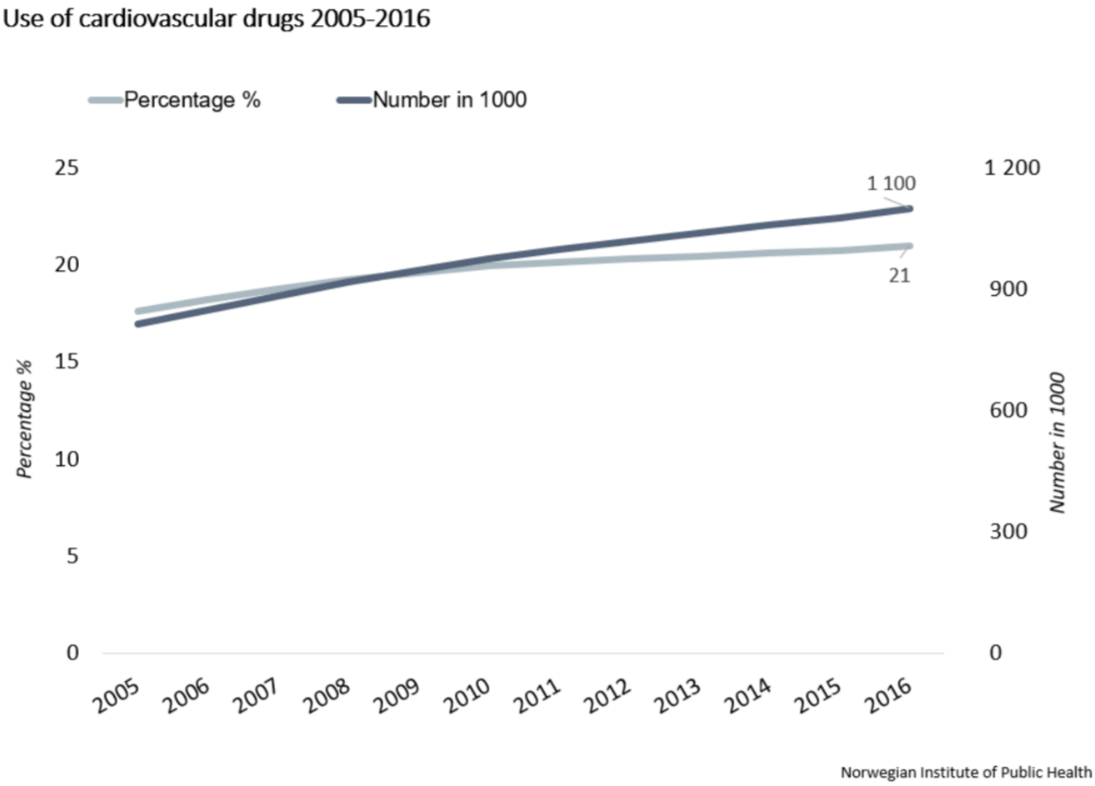


Figure 1. Number and percentage of the population receiving at least one drug for the treatment of cardiovascular disease (ATC code C) during the period 2005 to 2016. In 2016, there were approximately 1.1 million users (blue/turquoise curve), which represents 21 per cent of the population (purple curve). Source: Norwegian Prescription Database. NIPH

Every year many Norwegians receive specialist care for CVD (6). Approximately 40,000 people are treated for a heart attack or angina, and 11,000 for stroke each year (6). In order to help treat Norwegians living with CVD diagnoses or symptoms, a large portion of the country's healthcare services are required (6).

1.3 Risk factors

Numerous risk factors can play a role in the development of CVD, and these factors can be sorted into two categories: modifiable and non-modifiable risk factors (14-16). Modifiable risk factors are factors that can be changed, or reversed such as high blood pressure, high cholesterol, diabetes mellitus, smoking, high body mass index (BMI) (i.e., obesity), an unhealthy diet, physical inactivity, alcohol consumption, low socioeconomic status (SES), and more (14-16). In the United States, the most preventable risk factor for CVD is smoking as smokers are twice as likely to develop CVD than non-smokers (16). Non-modifiable risk factors would include things that one cannot change such as old age, gender (being a man), and family history of CVD (14-16).

1.3.1 Socioeconomic status & social inequalities

As noted above, SES is a modifiable risk factor for CVD (15). It can be broken down into three main categories: education, occupation, and income (17). SES has been shown to be a predictor for CVD risk in high income countries (18) as well as for general health and disease in Norway (19); that is, those with a higher SES would be less likely to develop CVD than those of a lower SES.

There are several reasons for this negative association between SES and CVD risk; one reason is that healthcare costs for treatment can be too expensive for many families to afford, pushing them into poverty (1). However, Norway uses a single-payer healthcare system where patients only pay a small user fee for services until a yearly maximum of NOK 2,460 (equivalent to $292 US Dollars), as of 2021, has been reached (20). Thus, out-of-pocket spending for healthcare in Norway is relatively low (13). Another reason is the relationship between SES and dietary quality (21). As healthy diets tend to cost more in Western countries, lower income families may not be able to afford nutritious diets rich in fruits and vegetables (21). Data shows that low-income families are more likely to eat energy dense food lacking in diverse nutrients such as pre-packaged foods, sugary drinks, sweets, pasta, white bread, and cereal (21). Conversely, high income families tend to have a much greater intake of fruits and vegetables, whole grains, fibre, and low glycaemic index foods (21). Furthermore, geographic location such as neighbourhood of residence can also play a role in CVD risk as poorer neighbourhoods often have fewer grocery stores than wealthier neighbourhoods and may consume more ready to go foods (17, 21). In Oslo, individuals can have varying life expectancies of up to eight years depending on which community one resides in (19). Additionally, families with a low SES are more likely to become obese, develop hypertension, and develop multimorbidities (21, 22).

1.3.2 Education in Norway

Norway currently operates under a welfare model, meaning that many services such as education, healthcare, and social security (i.e., illness/unemployment benefits) are provided to all citizens through the redistribution of tax kroners (23). In 2016, Norway was ranked one of the top ten most educated countries globally for citizens between the ages of 25 to 64 years that hold some level of tertiary education (24). Perhaps Norway's high ranking could be explained by the fact that higher education remains free from tuition within the country (25). The general level of education has been increasing over recent decades (26). Perhaps this could be attributed to the nine years of primary school that became compulsory for students to take in 1969 (26), or furthermore because in 1994 Norwegians gained the right to obtain an upper secondary education (26). Additionally, in the 1970's higher education institutions began growing rapidly (26) and by 2019, the country had 33 accredited and 18 non-accredited higher education institutions (27). According to the Large Norwegian Encyclopedia (SNL), in 1970, 53.2% of the population only had a primary education, 39.4% had high school, 5.7% had short university/college education, and only 1.7% had long university/college education (26). In 2018 however, 25.8% had only a primary education, while 37.2% had high school, 24.1% had short university/college education, and 10.0% had long university/college education (26).

Since Norway has a highly developed healthcare and education system, ranking number one on the human development index (HDI) in 2017 (28), one might presume that health inequalities do not persist. However, health inequalities are considerably large within the country, especially between populations with different levels of educational attainment (19). In fact, there are stark differences in life expectancy between groups with differing educational attainment (i.e., lower secondary, upper secondary, and higher education) among both genders, as seen in *Figure 4* (19).

Figure 4: Changes in life expectancy for Norwegian men and women of differing educational levels from 1961 to 2015 (19).

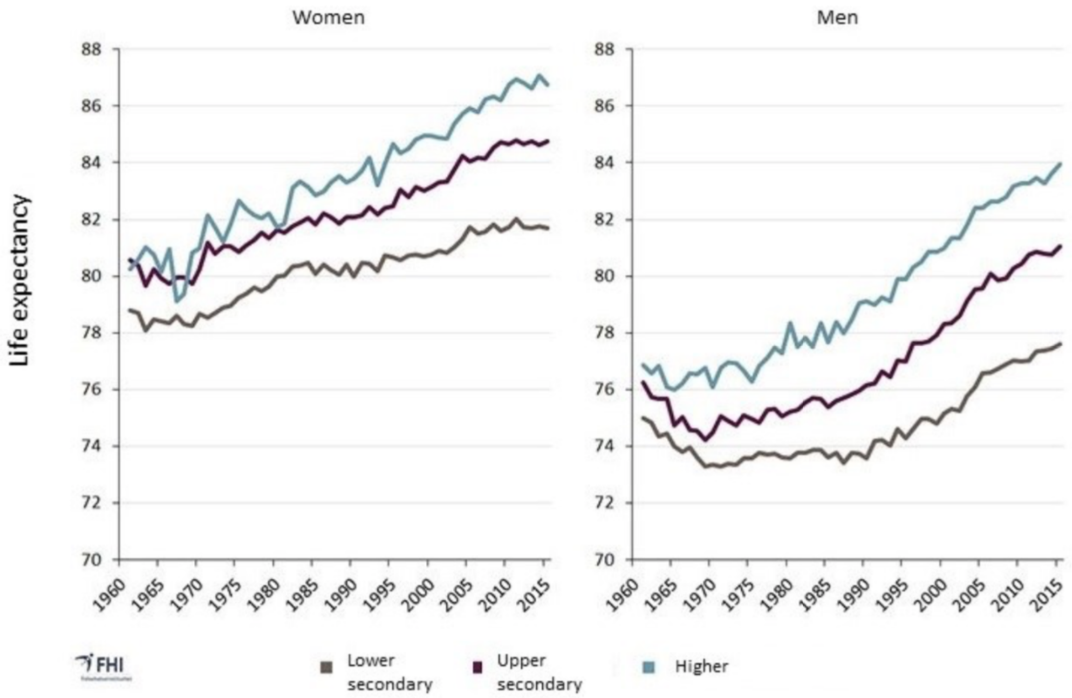


Figure 1. *Life expectancy for women and men aged 35 in Norway, 1961–2015, grouped by education level. Source: 1961-1989: Steingrimsdottir (2012), 1990-2015: Statistics Norway/Norhealth*
The level of the figures from Steingrimsdottir (2012) has been slightly adjusted for comparability.

On average, the most highly educated Norwegians will live five to six years longer than those with the lowest level of education (19). Furthermore, smoking is less prevalent among groups with higher education levels, see *Figure 5 (19)*.

Figure 5: Percent of daily smokers for different levels of educational attainment for both men and women aged 25-74 in 2017 (19).

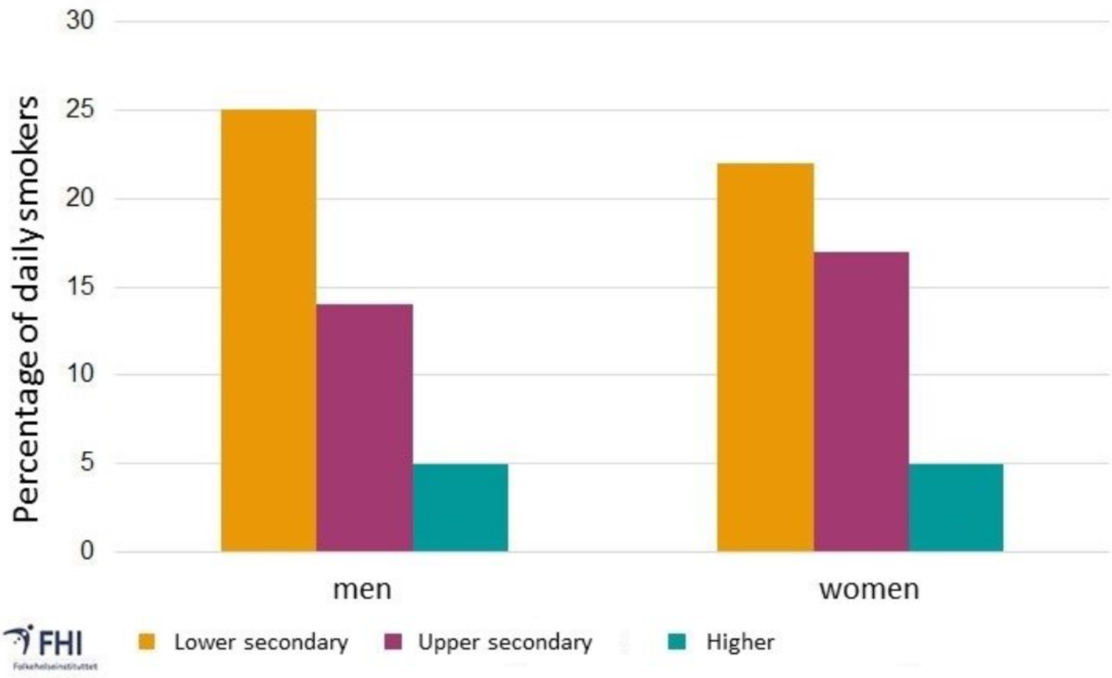


Figure 4a. *Daily smoking among women (kvinner) and men in the 25-74 year age group by highest educational achievement, 2017. Per cent, standardised. Lower secondary, upper secondary and higher education. Source: Norhealth, Statistics Norway.*

One study observed that of the different SES variables analysed, educational level was the only variable associated with an increased risk of major adverse cardiac events for patients who underwent a percutaneous cardiac intervention after an acute MI in South Korea (29). Not only are less educated people at higher risk for a cardiac event, but they are also more likely to have less optimal short- and long-term outcomes after a cardiac event (18). As well, a Norwegian study in 2014 found that first heart attacks are more common among people with lower educational attainment (30). The more education one has, the more likely they are to be able to make informed decisions regarding their health, as those with less education are more likely to have a lower level of health literacy (17, 18). Additionally, those with higher educational attainment are more likely to gain secure employment and higher earnings, allowing them to better afford a healthier lifestyle and adequate healthcare (17). Though previous research has found associations between education and CVD, this relationship has not been established among the inhabitants of Tromsø, Norway.

1.4 Objectives

This study aims to investigate the association between educational attainment and self-reported CVD in Tromsø, Norway. Heart attack, stroke, and angina will be analysed as separate outcomes. We will investigate both crude and multivariate associations, overall and in strata of age groups and gender.

2 Materials and methods

This section outlines the Tromsø Study, the study population, methods of data collection, variables, inclusion/exclusion criteria, statistical analysis, ethics, and funding.

2.1 The Tromsø Study

The Tromsø Study is a population-based cohort study that has been conducted in Tromsø, Norway since 1974 and has involved over 45,000 participants in seven surveys (Tromsø 1-7) (31). The data for the Tromsø Study was collected through several methods, including measurements, questionnaires, biological samples, and clinical surveys (31). The Tromsø Study began in an effort to learn more about CVD, but has since evolved to collect data for many diseases, health, and lifestyle factors (31).

2.2 Study population, design, and data collection

This study used a prospective cohort design, with baseline starting at the fourth survey of the Tromsø Study (Tromsø 4) in 1994 and follow-up ending at the seventh survey of the Tromsø Study (Tromsø 7) in 2016 (31). All men and women residing in the municipality of Tromsø over the ages of 25 and 40 were invited to participate in the Tromsø 4 and Tromsø 7 studies, respectively (32, 33). A total of 18,480 men and 19,078 women were invited to participate in the Tromsø 4 Study (33). The response rate was 69.6% for men (12,865 participants) and 74.9% for women (14,293 participants) (33). For the Tromsø 7 Study, 16,052 men and 16,539 women were sent invitations to participate via mail (32). This yielded 21,083 participants (10,009 men and 11,074 women), for a response rate of 62.4% and 67.0%, respectively (32). The first questionnaire (Q1) (*Appendix C*) was sent in the mail with the option to fill out the paper version and mail back, or use the password and username sent to login online and complete a digital version of Q1 if preferred (34). All residents who participated in both studies were considered for inclusion in this study. Data collection was conducted by the Department of Community Medicine (ISM) in conjunction with the University Hospital of Northern Norway (UNN), Tromsø City Council, and the Norwegian Institute of Public Health (34).

2.3 Exposure assessment

Baseline exposure information was collected from the Tromsø 4 Study in 1994-1995. A questionnaire was used to collect information on education, alcohol intake, smoking, physical activity, self-reported previous or current diabetes, heart attack, angina, and stroke (33). Measurements for BMI (i.e., height and weight), systolic blood pressure (SBP), and blood samples for cholesterol were taken on-site (33). Participants were asked to select their highest obtained level of education, which included education level 1 (EL1) 7-10 years primary/secondary school, modern secondary school; education level 2 (EL2) technical school, middle school, vocational school, 1-2 years senior high school; education level 3 (EL3) high school diploma (3-4 years), education level 4 (EL4) college/university, less than 4 years; and education level 5 (EL5) college/university, 4 or more years *(Appendix B) (35, 36)*.

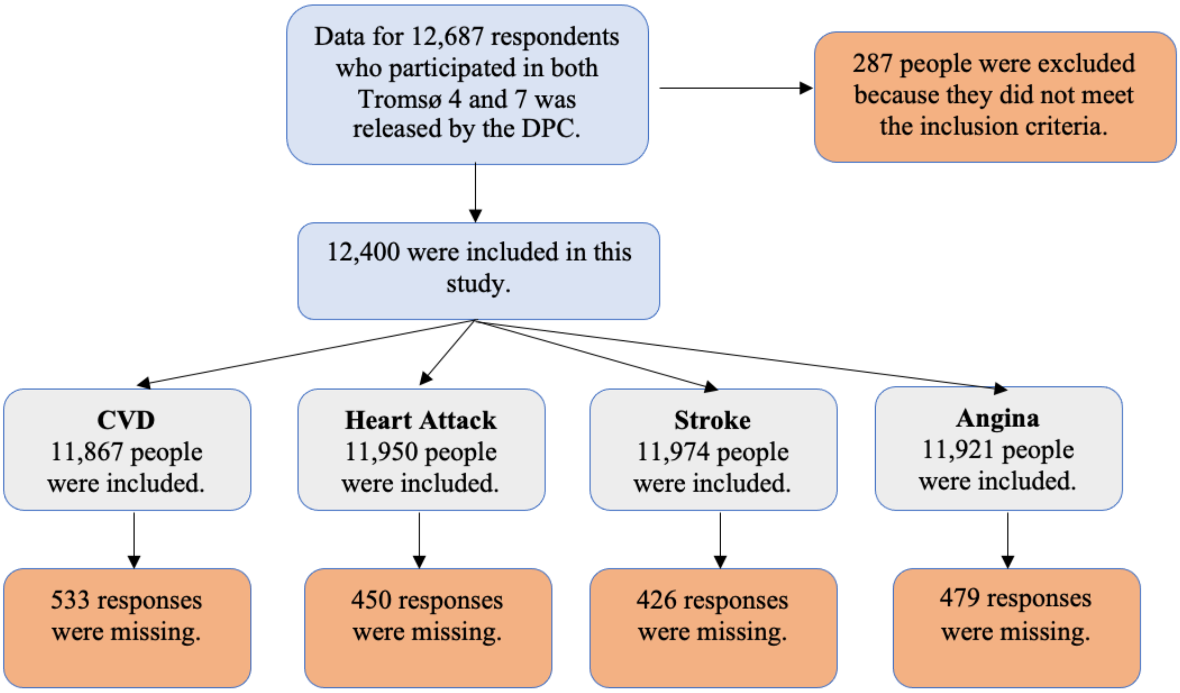
2.4 Outcome assessment

Participants from the Tromsø 4 study were followed-up in the Tromsø 7 study for information on CVD. Previous and current cases of CVD, which included heart attack, angina pectoris, and/or cerebral stroke/brain haemorrhage, were self-reported in Q1 *(Appendix C) (37)*.

2.5 Inclusion/exclusion criteria

To be included in this study, the participants must have participated in both the Tromsø 4 and Tromsø 7 studies and responded to educational attainment in the Tromsø 4 Study *(see Appendix B)*. Any person who responded yes to one or more of the CVD questions in Tromsø 4 were excluded. In addition, anyone who did not answer all three of the CVD questions in Tromsø 4 were also excluded from the study. Furthermore, only participants who were under the age of 70 during Tromsø 4 were included in this study. Refer to *Figure 6* for more information on how participants were chosen for this study.

Figure 6: Flowchart of sample selection (32).



From *Figure 6*, 12,400 people were included in this study, while 287 people were excluded for not meeting the inclusion criteria. However, only 11,867 participants were included in the CVD analysis because 533 responses were missing for this variable at Tromsø 7. Similarly, different numbers of participants were included in each of the primary CVD analyses as each variable had a different number of responses missing in Tromsø 7 (refer to *Figure 6*).

2.6 Statistical analysis

The characteristics of the study population were described by calculating the mean education level by age, gender and for those with and without self-reported CVD, as well as the number of participants with and without self-reported CVD. Continuous covariates, including SBP, cholesterol, and alcohol, were described by calculating the mean and standard deviation (SD) within each level of education. Categorical variables, including, age, gender, diabetes, smoking, light physical activity (LPA), hard physical activity (HPA), and BMI, were described by calculating the percent of participants within each level of education for each category.

To estimate the association between self-reported CVD and education, logistic regression was used to obtain odds ratios (OR), 95% confidence intervals (CI), and p-values. For all outcomes (CVD, heart attack, stroke, and angina), crude and multivariate logistic regressions were performed with education modelled first as an ordinal variable and subsequently as a categorical variable. To determine which covariates would be included in the multivariate model, backwards elimination was used. The following covariates were considered in the backwards elimination process: gender, age (25-29, 30-39, 40-49, 50-59, 60-69), LPA (i.e., not sweating or out of breath: none, <once/week, once or twice a week, 3 or more times per week), HPA (i.e., sweating/out of breath: none, <once/week, once or twice a week, 3 or more times per week), alcohol (number of times per month, 0 if less than once per month), daily cigarette smoking (yes or no), previous or current diabetes (yes or no), BMI (<25, >=25 and <30, or >=30), SBP (mmHg, mean of second and third reading), and total cholesterol (mmol/l) (35, 37). The final multivariate models for CVD as the outcome variable included age, gender, SBP, cholesterol, and smoking as confounders. Furthermore, models were stratified on age and gender in further logistic regressions for both crude and multivariate models. After performing backward elimination, the final multivariate models for stroke and angina included the following confounders: education, age, gender, SBP, cholesterol, and smoking. The multivariate models for heart attack included: education, age, gender, SBP, cholesterol, smoking, alcohol, and BMI.

IBM SPSS Statistics Version 26 was used for all statistical analysis.

2.7 Ethics

Together with my supervisors, I applied for access to data from the Tromsø Study through the Data- and Publication Committee (DPC) and was approved. Regional Committee for Medical Research Ethics (REK) approval was unnecessary due to the anonymization of data provided by the DPC (Case 5 57/20) *(Appendix A)*. The author has no conflicts of interest to declare.

2.8 Funding

As all master's theses using data from the Tromsø Study are exempt from paying any fees in order to use data for their project along with one publication (38), the author required no funding to write this paper.

3 Results

3.1 Characteristics of study population

A total of 12,400 participants were included in the analysis, of which 6,673 were women and 5,727 were men. Overall, 1,024 participants had self-reported at least one CVD event, 542 had self-reported heart attack, 366 had self-reported stroke, and 261 had self-reported angina. Characteristics of the population are presented in *Table 1*. The most common education level was EL2 (n=3,717 or 30.0%) followed by EL1 (n=3,106 or 25.0%), EL4 (n=2,213 or 17.8%), EL5 (n=2,093 or 16.9%), and EL3 (n=1,271 or 10.3%). The average education level was slightly higher among men (2.76) than women (2.68) and was also higher among younger Norwegians than older Norwegians (ages 25-29: 2.98, 30-39: 2.89, 40-49: 2.72, 50-59: 2.34, 60-69: 2.01). The average education level of those without self-reported CVD was higher (2.77) than those with self-reported CVD (2.41).

Within each education level, the percentage of participants that were daily smokers decreased as education level increased (EL1: 44.5%, EL2: 38.8%, EL3: 34.4%, EL4: 26.9%, EL5: 17.8%). Overall, fewer people reported being daily smokers (34.1%), than not (65.9%). The percentage of participants who reported getting less than one hour of physical activity per week decreased as educational attainment increased for both LPA (EL1: 12.8%, EL2: 9.9%, EL3: 6.6%, EL4: 5.7%, EL5: 4.4%) and HPA (EL1: 53.8%, EL2: 42.9%, EL3: 33.1%, EL4: 30.7%, EL5: 25.0%). As well, the percentage of participants who reported getting at least three hours of physical activity per week increased as educational attainment increased for both LPA (EL1: 34.1%, EL2: 36.5%, EL3: 40.3%, EL4: 41.6%, EL5: 45.3%) and HPA (EL1: 10.5%, EL2: 11.3%, EL3: 12.1%, EL4: 12.2%, EL5: 14.6%). Similarly, the percentage of participants who had a BMI greater than or equal to 30 decreased with increasing levels of education (EL1: 10.7%, EL2: 7.8%, EL3: 7.6%, EL4: 6.8%, EL5: 4.7%). Furthermore, the percentage of participants within each education level in the <25 BMI range was highest in the most highly educated (EL5: 64.7%) and lowest among the least educated (EL1: 49.9%). Among the continuous variables, mean SBP was lowest for those with a mid-range education (EL3: 126.3) and highest among those with the lowest level of education (EL1:131.9). Additionally, mean cholesterol was again lowest for those with a mid-range education (EL3: 5.5) and highest for those with the least education (EL1: 6.2). Mean monthly alcohol intake increased with increasing levels of education (EL1: 2.3, EL2: 2.8, EL3: 2.9, EL4: 3.6, EL5: 4.8).

Table 1: Mean (SD) and percentages within each level of education and overall, Tromsø 4 (1994-95).							
	Education level						
	EL1	EL2	EL3	EL4	EL5	Overall	% Missing
N (%)	3106 (25.0)	3717 (30.0)	1271 (10.3)	2213 (17.8)	2093 (16.9)	12400 (100.0)	0.0
Age (%)							0.0
25-29	6.9	12.2	27.9	15.2	12.5	13.1	
30-39	22.8	34.4	43.0	35.7	34.8	32.7	
40-49	35.7	33.3	21.0	32.3	37.7	33.2	
50-59	26.6	16.4	6.5	13.8	13.5	17.0	
60-69	8.0	3.7	1.7	3.0	1.6	4.1	
Gender							0.0
% Women	57.7	51.0	59.7	50.2	53.3	53.8	
SBP (mmHg)	131.9 (16.3)	129.5 (15.5)	126.3 (14.2)	128.0 (15.4)	126.8 (14.2)	129.0 (15.5)	0.1
Cholesterol (mmol/l)	6.2 (1.2)	5.9 (1.2)	5.5 (1.1)	5.6 (1.2)	5.6 (1.1)	5.8 (1.2)	0.2
Diabetes							0.1
% Yes	0.5	0.6	0.3	0.5	0.4	0.5	
Cigarettes							0.1
% Current daily smoker	44.5	38.8	34.4	26.9	17.8	34.1	
Alcohol	2.3 (2.8)	2.8 (3.0)	2.9 (3.2)	3.6 (3.6)	4.8 (4.6)	3.2 (3.5)	7.7
Light physical activity (%)							0.4
None	12.8	9.9	6.6	5.7	4.4	8.6	
<1	18.0	16.6	17.0	15.0	13.5	16.2	
1-2	35.1	37.0	36.1	37.7	36.8	36.5	
>=3	34.1	36.5	40.3	41.6	45.3	38.7	
Hard physical activity (%)							0.5
None	53.8	42.9	33.1	30.7	25.0	39.4	
<1	17.8	22.5	27.9	29.1	28.6	24.1	
1-2	18.0	23.3	26.8	28.1	31.7	24.6	
>=3	10.5	11.3	12.1	12.2	14.6	11.9	
BMI (%)							0.1
<25	49.9	55.2	61.0	59.0	64.7	56.8	
>=25<30	39.4	37.0	31.4	34.1	30.6	35.4	
>=30	10.7	7.8	7.6	6.8	4.7	7.8	

3.2 CVD

In the crude model, the OR for educational attainment and self-reported CVD was 0.84 (95% CI: 0.80-0.88). When education was modelled as a categorical variable, compared to EL1, the OR and 95% CI for EL2-EL5 was as follows: EL2 (OR:0.83, 95% CI: 0.70-0.97), EL3 (OR: 0.39, 95% CI: 0.30-0.52), EL4 (OR: 0.67, 95% CI: 0.55-0.81), and EL5 (OR: 0.48, 95% CI: 0.38-0.59). Results for crude models stratified by gender and age group are presented in *Table 2*.

In the multivariate model, the OR for educational attainment and self-reported CVD was 0.96 (95% CI: 0.92-1.01). When education was modelled as a categorical variable, the OR for each level of education in comparison to EL1 was 1.08 (95% CI: 0.91-1.28) for EL2, 0.83 (95% CI: 0.61-1.12) for EL3, 1.01 (95% CI: 0.82-1.24) for EL4, and 0.83 (95% CI: 0.66-1.05) for EL5. Results for multivariate models stratified by gender and age group are presented in *Table 2*.

Table 2: *Associations between educational level and risk for CVD. The Tromsø Study 1994-2016.*

	Crude			Multivariate		
	Cases/n	OR (95% CI)	P	Cases/n	OR (95% CI)	P
Ordinal [a]	1024/11867	0.84 (0.80-0.88)	<0.001	1023/11825 [e]	0.96 (0.92-1.01)	0.13
Categorical [a, b]	1024/11867			1023/11825 [b, e]		
EL1: 7-10 years primary/secondary (ref)	332/2894	1.00 (Ref)		332/2883	1.00 (Ref)	
EL2: Technical, middle, vocational school, 1-2 years senior high school	343/3551	0.83 (0.70-0.97)	0.02	342/3538	1.08 (0.91-1.28)	0.39
EL3: High school diploma (3-4 years)	60/1235	0.39 (0.30-0.52)	<0.001	60/1229	0.83 (0.61-1.12)	0.21
EL4: University < 4 years	171/2150	0.67 (0.55-0.81)	<0.001	171/2144	1.01 (0.82-1.24)	0.96
EL5: University >= 4 years	118/2037	0.48 (0.38-0.59)	<0.001	118/2031	0.83 (0.66-1.05)	0.13
Ordinal, age stratified [a, c]						
25-29	39/1589	0.86 (0.67-1.11)	0.24	39/1578 [c, e]	0.98 (0.76-1.28)	0.90
30-39	159/3913	0.81 (0.72-0.91)	0.001	159/3897	0.92 (0.81-1.04)	0.19
40-49	374/3960	0.89 (0.83-0.96)	0.002	374/3954	0.94 (0.87-1.02)	0.12
50-59	334/1967	0.96 (0.88-1.04)	0.30	333/1960	0.97 (0.89-1.06)	0.56
60-69	118/438	1.13 (0.96-1.32)	0.14	118/436	1.12 (0.95-1.33)	0.18
Ordinal, gender stratified [a, d]						
Women	343/6341	0.73 (0.67-0.80)	<0.001	343/6320 [d, e]	0.95 (0.87-1.04)	0.29
Men	681/5526	0.88 (0.83-0.93)	<0.001	680/5505	0.97 (0.91-1.03)	0.27

[a] Education included as an ordinal variable with values 1-5.

[b] Categorized by education level, where level 1 (EL1) is the reference (ref) level.

[c] Stratified by 10-year age groups.

[d] Stratified by gender.

[e] Adjusted for education, age, gender, SBP, cholesterol, and smoking.

3.3 Primary CVD variables

This subsection discusses the results presented in *Tables 3 and 4* for all three primary CVD variables: heart attack, stroke, and angina

3.3.1 Heart attack

In the crude model presented in *Table 3*, the OR for educational attainment and self-reported heart attack was 0.82 (95% CI: 0.77-0.87). When education was modelled as a categorical variable, when compared to EL1, the OR and 95% CI for EL2-EL5 was as follows: EL2 (OR:0.79, 95% CI: 0.64-0.98), EL3 (OR: 0.34, 95% CI: 0.23-0.51), EL4 (OR: 0.66, 95% CI: 0.51-0.85), and EL5 (OR: 0.42, 95% CI: 0.31-0.57). Results for crude models stratified by gender and age group are presented in *Table 4*.

In the multivariate model presented in *Table 3*, the OR for educational attainment and self-reported heart attack was 0.97 (95% CI: 0.91-1.05). When education was modelled as a categorical variable, the OR for each level of education in comparison to EL1 was 1.05 (95% CI: 0.83-1.33) for EL2, 0.69 (95% CI: 0.44-1.08) for EL3, 0.98 (95% CI: 0.73-1.32) for EL4, and 0.91 (95% CI: 0.65-1.28) for EL5. Results for multivariate models stratified by gender and age group are presented in *Table 4*.

3.3.2 Stroke

In the crude model presented in *Table 3*, the OR for educational attainment and self-reported stroke was 0.89 (95% CI: 0.83-0.96). When education was modelled as a categorical variable, when compared to EL1, the OR and 95% CI for EL2-EL5 was as follows: EL2 (OR:0.95, 95% CI: 0.73-1.23), EL3 (OR: 0.54, 95% CI: 0.35-0.84), EL4 (OR: 0.78, 95% CI: 0.57-1.07), and EL5 (OR: 0.63, 95% CI: 0.45-0.90). Results for crude models stratified by gender and age group are presented in *Table 4*.

In the multivariate model presented in *Table 3*, the OR for educational attainment and self-reported stroke was 1.01 (95% CI: 0.93-1.09). When education was modelled as a categorical variable, the OR for each level of education in comparison to EL1 was 1.22 (95% CI: 0.93-1.60) for EL2, 1.09 (95% CI: 0.69-1.72) for EL3, 1.13 (95% CI: 0.81-1.57) for EL4, and 1.04 (95% CI: 0.73-1.49) for EL5. Results for multivariate models stratified by gender and age group are presented in *Table 4*.

3.3.3 Angina

In the crude model presented in *Table 3*, the OR for educational attainment and self-reported angina was 0.90 (95% CI: 0.82-0.98). When education was modelled as a categorical variable, when compared to EL1, the OR and 95% CI for EL2-EL5 was as follows: EL2 (OR:0.75, 95% CI: 0.55-1.02), EL3 (OR: 0.47, 95% CI: 0.28-0.80), EL4 (OR: 0.74, 95% CI: 0.51-1.06), and EL5 (OR: 0.62, 95% CI: 0.42-0.92). Results for crude models stratified by gender and age group are presented in *Table 4*.

In the multivariate model presented in *Table 3*, the OR for educational attainment and self-reported angina was 1.04 (95% CI: 0.95-1.14). When education was modelled as a categorical variable, the OR for each level of education in comparison to EL1 was 1.00 (95% CI: 0.73-1.39) for EL2, 1.00 (95% CI: 0.58-1.73) for EL3, 1.16 (95% CI: 0.79-1.69) for EL4, and 1.16 (95% CI: 0.77-1.74) for EL5. Results for multivariate models stratified by gender and age group are presented in *Table 4*.

Table 3: Associations between educational level and risk for heart attack, stroke, and angina. The Tromsø Study 1994-2016.

	Crude			Multivariate		
	Cases/n	OR (95% CI)	P	Cases/n	OR (95% CI)	P
Heart Attack						
Ordinal [a]	542/11950	0.82 (0.77-0.87)	<0.001	488/11000 [c]	0.97 (0.91-1.05)	0.45
Categorical [a, b]	542/11950			488/11000 [b, c]		
EL1 (Ref)	185/2929	1.00 (Ref)		158/2569	1.00 (Ref)	
EL2	181/3577	0.79 (0.64-0.98)	0.03	169/3309	1.05 (0.83-1.33)	0.67
EL3	28/1246	0.34 (0.23-0.51)	<0.001	24/1161	0.69 (0.44-1.08)	0.12
EL4	92/2159	0.66 (0.51-0.85)	0.002	82/2037	0.98 (0.73-1.32)	0.90
EL5	56/2039	0.42 (0.31-0.57)	<0.001	55/1924	0.91 (0.65-1.28)	0.58
Stroke						
Ordinal [a]	366/11974	0.89 (0.83-0.96)	0.002	365/11932 [d]	1.01 (0.93-1.09)	0.89
Categorical [a, b]	366/11974			365/11932 [b, d]		
EL1 (Ref)	107/2935	1.00 (Ref)		107/2924	1.00 (Ref)	
EL2	124/3580	0.95 (0.73-1.23)	0.69	123/3567	1.22 (0.93-1.60)	0.15
EL3	25/1245	0.54 (0.35-0.84)	0.01	25/1239	1.09 (0.69-1.72)	0.72
EL4	62/2163	0.78 (0.57-1.07)	0.13	62/2157	1.13 (0.81-1.57)	0.47
EL5	48/2051	0.63 (0.45-0.90)	0.01	48/2045	1.04 (0.73-1.49)	0.84
Angina						
Ordinal [a]	261/11921	0.90 (0.82-0.98)	0.02	261/11879 [d]	1.04 (0.95-1.14)	0.35
Categorical [a, b]	261/11921			261/11879 [b, d]		
EL1 (Ref)	84/2924	1.00 (Ref)		84/2913	1.00 (Ref)	
EL2	77/3555	0.75 (0.55-1.02)	0.07	77/3542	1.00 (0.73-1.39)	0.98
EL3	17/1239	0.47 (0.28-0.80)	0.01	17/1233	1.00 (0.58-1.73)	0.99
EL4	46/2161	0.74 (0.51-1.06)	0.10	46/2155	1.16 (0.79-1.69)	0.45
EL5	37/2042	0.62 (0.42-0.92)	0.02	37/2036	1.16 (0.77-1.74)	0.49

[a] Education included as an ordinal variables with levels 1-5.

[b] Categorized by education level, where level 1 (EL1) is the reference (ref) level.

[c] Adjusted for education, age, gender, SBP, cholesterol, smoking, alcohol, and BMI.

[d] Adjusted for education, age, gender, SBP, cholesterol, and smoking.

Table 4: *Associations between educational level and risk for heart attack, stroke, and angina, stratified by age and gender. The Tromsø Study 1994-2016.*

	Crude			Multivariate		
	Cases/n	OR (95% CI)	P-value	Cases/n	OR (95% CI)	P-value
Heart Attack						
Age stratified [a]						
25-29	19/1596	0.95 (0.67-1.35)	0.77	18/1472 [c]	1.14 (0.78-1.67)	0.51
30-39	84/3935	0.81 (0.69-0.96)	0.01	76/3676	0.98 (0.81-1.18)	0.80
40-49	193/3976	0.87 (0.79-0.97)	0.01	183/3717	0.95 (0.85-1.06)	0.34
50-59	184/1997	0.93 (0.83-1.03)	0.18	163/1769	0.98 (0.87-1.12)	0.81
60-69	62/446	1.04 (0.84-1.27)	0.73	48/366	1.06 (0.83-1.36)	0.63
Gender stratified [b]						
Women	144/6395	0.62 (0.54-0.72)	<0.001	125/5777 [d]	0.89 (0.76-1.04)	0.15
Men	398/5555	0.88 (0.81-0.94)	<0.001	363/5223	1.00 (0.92-1.09)	0.95
Stroke						
Age stratified [a]						
25-29	15/1597	0.90 (0.60-1.33)	0.59	15/1586 [e]	1.01 (0.67-1.54)	0.96
30-39	55/3950	0.86 (0.70-1.05)	0.13	55/3934	0.94 (0.76-1.15)	0.52
40-49	133/3982	0.93 (0.83-1.05)	0.25	133/3976	0.97 (0.86-1.10)	0.63
50-59	118/1989	1.00 (0.88-1.14)	0.97	117/1982	1.01 (0.88-1.15)	0.89
60-69	45/456	1.25 (1.00-1.55)	0.05	45/454	1.22 (0.97-1.53)	0.09
Gender stratified [b]						
Women	143/6405	0.83 (0.73-0.94)	0.003	143/6384 [f]	1.01 (0.89-1.15)	0.84
Men	223/5569	0.92 (0.84-1.02)	0.10	222/5548	1.00 (0.91-1.10)	0.94
Angina						
Age stratified [a]						
25-29	11/1591	1.07 (0.68-1.69)	0.78	11/1580 [e]	1.29 (0.81-2.07)	0.29
30-39	39/3938	0.87 (0.69-1.10)	0.25	39/3922	0.94 (0.74-1.19)	0.60
40-49	97/3970	0.95 (0.83-1.09)	0.44	97/3964	1.01 (0.88-1.17)	0.86
50-59	80/1980	1.01 (0.87-1.18)	0.91	80/1973	1.08 (0.92-1.27)	0.34
60-69	34/442	1.13 (0.87-1.46)	0.36	34/440	1.24 (0.94-1.63)	0.13
Gender stratified [b]						
Women	105/6381	0.75 (0.64-0.87)	<0.001	105/6360 [f]	1.02 (0.88-1.19)	0.80
Men	156/5540	1.00 (0.89-1.11)	0.94	156/5519	1.08 (0.96-1.21)	0.21

[a] Adjusted for education and stratified by age.

[b] Adjusted by education and stratified by gender.

[c] Adjusted for education, age, gender, SBP, cholesterol, smoking, alcohol, and BMI and stratified by age.

[d] Adjusted for education, age, gender, SBP, cholesterol, smoking, alcohol, and BMI and stratified by gender.

[e] Adjusted for education, age, gender, SBP, cholesterol, and smoking and stratified by age.

[f] Adjusted for education, age, gender, SBP, cholesterol, and smoking and stratified by gender.

4 Discussion

4.1 Educational attainment

Overall, the most common level of education in this study was EL2 (30.0%), followed by EL1 (25.0%), EL4 (17.8%), EL5 (16.9%), and EL3 (10.3%). However, according to Statistics Norway (SSB), the most common educational attainment for the entire Norwegian population aged 16 and older in 2020 was: upper secondary (36.9%), basic school level (24.8%), higher education, short (24.7%), higher education, long (10.6%), and tertiary vocational education (3.0%), respectively (39). The percentage of respondents within each level of educational attainment for both this study (1994-95, ages 25-69) and SSB (2020, ages 16+) (39) are quite similar. Approximately 25% of both populations fell into the category of below upper secondary education, while approximately 40% had some level of upper secondary education and/or vocational training (39). It is difficult to compare 1-2 years of upper secondary, high school diploma and/or vocational training as the educational categories assessed in Tromsø 4 and SSB were slightly different (39). As well, approximately 35% of both populations had residents with some level of higher education (39). However, our study had a larger portion of participants fall into the higher education, long category (16.9%) compared to the Norwegian population (10.6%) (39).

4.2 Crude models: All outcome variables

The main finding of this study was that educational attainment was significantly associated with self-reported CVD. With each increase in level of education, there was a 16% reduction in CVD risk. Furthermore, associations were also found between educational attainment and all primary CVD variables. That is, with higher education, the risk of heart attack, stroke, and angina all decreased by 18%, 11%, and 10%, respectively. These results are in alignment with the large body of existing literature concluding an inverse association between educational attainment and CVD morbidity in high-income countries (18, 30, 40-45). A possible explanation for this relationship could be one's ability to make better informed decisions regarding their health with greater education (17). An American systematic review found that poor health literacy skills were present among an average of 39% of heart failure patients included in their study (46). The study also reported an association between one's level of health literacy and their medication compliance (46). Furthermore, in an increasingly digital world, a recent survey of the Norwegian population found a link between education and one's ability to use digital health services (47). It also found that those who require healthcare services most often are unfortunately the least equipped to use these types of services digitally (47).

The Norwegian Institute of Public Health reports increasing age as a risk factor for CVD in Norway (6). When the crude model for CVD was stratified by age, only those in their 30's and 40's at baseline had significant risk reductions with increasing education – 19% and 11%, respectively. Similarly, those aged 30-39 and 40-49 had significant reductions in risk – 19% and 13% for heart attack, respectively. No associations were found in any age group for stroke or angina. In 2016, 67% of Norwegians using therapeutic drugs for CVD prevention/treatment such as cholesterol lowering or antihypertensive drugs were between the ages of 70-74 (6). Furthermore, the same year, half of all CVD related deaths occurred over age 83 and 89 for men and women, respectively (6).

When the crude models were stratified by gender, inverse associations were found between education level and CVD. However, these risk reductions were stronger for women than for men. Inverse associations were also found between education level and all three primary CVD variables for women, but only found for men when analysing heart attack. These findings are similar to those of previous research where discrepancies between the sexes were also observed (18, 48). For example, a systematic review and meta-analysis by Backholer et al. (48), which included over 22 million participants from 116 cohorts, found a much stronger inverse association between educational attainment and CVD as well as coronary heart disease in women than in men. The results also showed a 24% and 18% greater excess risk of coronary heart disease and CVD, respectively, for women than men (when comparing lowest level of education to the highest) (48). One potential reason for this difference is that women are disproportionately affected by poverty and therefore, more susceptible to the ill health and poor quality of life that can result from lower income (18). Although education was associated with a greater reduction in CVD risk for women in our study, on average, men were more likely to suffer from CVD. This is consistent with data released by the Norwegian Institute of Public Health, showing that per capita, more men are affected by a first MI than women (6).

When education was modelled as a categorical variable, associations were found between all education levels (EL2-EL5) in comparison to EL1 for CVD. The higher the level of education in comparison to EL1 (reference category), the greater the risk reduction was, except for EL3 where the risk reduction was the greatest (61%). In comparison, those in EL5 decreased their risk of CVD by 52%. Participants in EL2 and EL4 had 17% and 33% decreased risks, respectively. Although the associations for education categories do not appear to be strictly linear, the p-value for linearity was significant. Importantly, there is still an overall trend in that having any level of education greater than EL1 lowered the risk of CVD. Similarly, associations were found between education level and heart attack in our study for all levels of education in comparison to the reference level. The decrease in heart attack risk was greater as education level increased, apart from EL3 where the risk reduction was greatest (66%). However, associations were only found between education and stroke for EL3 and EL5 in comparison to EL1. There was a null association for EL2 and an insignificant decrease in risk for EL4. The greatest reduction in stroke risk came from EL3 (46%). Likewise, associations between education and angina were only found at EL3 and EL5, with the largest reduction coming from EL3 (53%). EL2 and EL4 displayed insignificant reductions in risk in comparison to the reference group. These findings somewhat reflect those in the study by Woodward et al. (45) in Australasian populations (Australia and New Zealand) where the p-value for linearity was <0.001 for the association between educational attainment and all CVD (fatal or non-fatal) when not adjusted for modifiable risk factors (i.e., age and sex only): primary or none (hazard ratios (95% CI)) (1.23 (1.10-1.39)), secondary (1.12 (0.99-1.27)).

4.3 Multivariate models: All outcome variables

After adjusting for the covariates in their respective models, there were no observed associations between education level and CVD, as well as for heart attack, stroke, and angina when examined separately. These associations were null for both the ordinal and categorical models for all four outcome variables. Furthermore, no associations were found between education and any of the outcome variables during age or gender stratification. Contrary to our findings in the multivariate model, a systematic review and meta-analysis by Khaing et al. (43), which analysed 72 cohorts across Europe, America, and Asia (including only studies that adjusted for covariates in the pooled analysis), concluded that overall, lower levels of education were associated with an increased risk for cardiovascular outcomes. On the other hand, Woodward et al. (45) compared the relationships between education and CVD in Asian and Australasian populations using 24 cohort studies. This comparison adjusted for many modifiable risk factors including SBP, cholesterol, BMI, diabetes, smoking, and alcohol consumption (45). In the high-income Australasian populations, the findings were similar to our study. That is, in the model where all CVD was adjusted for modifiable risk factors the findings were insignificant for both secondary (1.04 (0.92 to 1.18)) and primary or none (1.11 (0.99 to 1.25)) in comparison to tertiary education (45). Woodward et al. (45) also similarly found no association between education and all CVD when looking at age: (HR (95% CI) <65 (1.12 (0.95, 1.31)), >=65 (1.11 (0.97, 1.26)) or sex: men (1.09 (0.95, 1.24)), women (1.23 (0.94, 1.62)).

4.3.1 Mediation

A possible explanation as to why this significant decrease in risk disappears once the multivariate models were used could be that many of the variables that we adjusted for are acting as mediators. This means that educational attainment may have an influence on the covariates or mediator variables (i.e., blood pressure, physical activity, etc.), which then have an effect on the outcome variable (i.e., CVD) (49). So, by adjusting for these covariates, we may have actually been accounting for the effect of the mediator variables in this relationship, thus explaining why the relationships were so significant when no adjustments were made (49). This explanation reflects the results of a Dutch study by Kershaw et al. (50) including 15,067 participants where 56.6% of the association between educational attainment and coronary heart disease was explained by behavioural and biological risk factors such as smoking and obesity acting as mediators. Part of the reason why many of these variables could be acting as mediators is because higher education can enable more job opportunities and the potential for higher income (45), which is one of the indicators of SES and is also associated with lower CVD risk (18, 21, 41). With increased income comes the ability to better afford a healthier lifestyle, for instance, diet and exercise (17, 21). This is important for CVD prevention as certain lifestyle factors such as diet and physical inactivity are recognized as CVD risk factors by the Norwegian Directorate of Health (6). Additionally, smoking is a known risk factor for CVD (6, 40) and research shows that in high income countries, people of a lower SES are more likely to smoke (41, 45). According to the Centers for Disease Control and Prevention, smoking greatly reduces one’s risk of experiencing CVD, and this risk reduction begins immediately (51). After five continuous years of not smoking, a previous smoker’s risk of stroke will be nearly the same as a non-smoker (51). In fact, in our study there was a strong association between smoking and CVD, as smokers had an 85% increased risk for CVD. Furthermore, similar to the findings by Woodward et al. (45), we found that, on average the more educated drank more than their less educated counterparts, while the review by Psaltopoulou et al. (21) found that those of a lower SES were more likely to drink to in excess. Research has shown that the effects of alcohol consumption on heart health follow a J-shaped curve, meaning moderate alcohol consumption is associated with a decreased risk of cardiovascular events, while excessive drinking increases this risk (21, 52). A Danish descriptive cross-sectional study by Mortensen et al. (53) found that people of a higher SES were more likely to drink wine, which was associated with optimal functioning in comparison to those of a lower SES, who were more likely to drink beer which had an association with suboptimal functioning. As you can see from the examples given above, there are multiple variables associated with both SES and CVD, which could potentially be acting as mediators in the relationship between education and CVD in this study.

4.4 Methodological considerations

This section discusses the internal and external validity of this study to help the reader understand the validity of the results and to what extent these results could be generalized to the Norwegian population at large.

4.4.1 Internal validity

Internal validity means that a study was conducted correctly, without error and therefore produced valid results among the study population (54, 55). There are two types of error that can affect the internal validity of a study: 1) random error, and 2) systematic error (55). One way a researcher can try to mitigate random error from occurring, is by having a large sample size (55). Therefore, random error was not a large concern in this study, since we had a large sample size of 12,400 participants. Systematic error on the other hand, can arise when errors occur within the methods of a study and includes two main types of bias: 1) information bias, and 2) selection bias (55). It is possible that this study may include some form of information bias. Since the exposure variable (education) and the outcome variable (CVD), along with many of the covariates (smoking, alcohol, diabetes, LPA, and HPA) are self-reported variables, there is the possibility that the correct information may have been distorted due to improper recall (recall bias) (55) or that participants knowingly deviated their answers from the truth. However, in a study by Engstad et al. (56) on the validity of self-reported stroke in Tromsø 4, the authors concluded that it is acceptable to use questionnaires for assessing previous stroke. The study reported a positive predictive value (PPV) of 0.79, with sensitivity and specificity values of approximately 80% and 99%, respectively (56).

Regarding selection bias, this study was robust in ensuring a representative sample. This study was very inclusive, as all men and women residing in the Tromsø municipality that were at least 25 and 40 years old (in Tromsø 4 and Tromsø 7, respectively) were invited to join, irrespective of any other factors (32, 33). However, even with such inclusivity for the age ranges mentioned above, it does leave out all residents under the age of 25 and 40 (in Tromsø 4 and 7, respectively), therefore excluding a substantial portion of the adult population from the study. Yet, even with such inclusive invitations being sent to the residents of Tromsø, another bias known as volunteer bias can affect the response level (55). A study by Langhammer et al. (2012) found that nonparticipants were more likely to be male, have CVD, and have a lower SES than their participant counterparts (57). Therefore, this study could have an underrepresentation of individuals with low educational attainment and previous CVD events, possibly making it more difficult to draw an unbiased conclusion about the association between CVD and educational attainment. The fact that fewer men participated in this study could also interfere with the results as men are more likely than women to suffer from a first MI (6).

Although this study used a prospective cohort design, one potential shortcoming is loss-to-follow-up bias (55). Exclusive to the number of participants we lost due to not meeting the inclusion/exclusion criteria, there were also less participants in the Tromsø 7 Study (21,083) than there were in the Tromsø 4 Study (27,158) (31). Loss to follow-up has the potential to distort the results of a study, that is, if the loss was non-random (55). This is because if loss to follow-up is selective (i.e., the less healthy participants with a lower SES drop out), there could be an underestimation of the study results, thus resulting in bias (58).

4.4.2 External validity

If a study is externally valid, this means that the results of the study could be generalized to the population for which the sample was meant to represent (54, 55). However, without internal validity, a study cannot be externally valid (54, 55). The fact that we have a large sample size (as discussed earlier) helps to better estimate the population as a whole (59). Furthermore, the inclusiveness of this study could also help us to better generalize the results to the source population. As well, if comparing the educational levels of this study with the national levels reported by SSB (39), it is important to note that there were some differences in the data collection as noted in section 4.1. It is possible that these differences could be explained by the fact that the participants of this study were between the ages of 25-69, while the educational statistics collected for the population of Norway included residents aged 16 and older (39). Another plausible consideration for these differences is that those in the "higher education, long" category from SSB included only those with greater than 4 years of higher education (39), while those in the "college/university 4 or more years" (EL5) from our study included those with greater than or equal to four years of higher education. Another possible explanation for this difference could be that the municipality of Tromsø has its own University – the

University of Tromsø, which offers masters and PhD level programs for its students (60). Within counties where there are large universities (i.e., Tromsø), the level of educational attainment is higher than other areas of Norway (61). Even though there are differences between the data for educational attainment at the municipal and national level, they are still largely similar, both capturing the different levels of education.

4.5 Future Research

Findings from this study may be of use to future researchers investigating differences in the relationship between educational attainment and CVD outcomes on a global scale, i.e., amidst countries of varying incomes. The findings of this study could contribute useful knowledge to help Norway reach SDG 3 ("Good health and well-being") (62), as it can help identify groups in the Norwegian population that are more susceptible to CVD. I would recommend for future researchers to investigate the effectiveness of strategies that could be implemented to help attenuate the differences for CVD risk between residents with different education levels and even between the sexes. Since CVD prevalence in Norway is expected to increase in the future (6), I believe it is important for governments to support and review research into the determinants of health and implement plans to mitigate future illness as early as possible.

5 Conclusion

In conclusion, our study found that there was an association between educational attainment and self-reported CVD with a significant reduction in risk with each increase in level of education when no other variables were considered. This association and risk reduction was present in both genders, with a stronger risk reduction observed in women. Further, CVD risk reduction was only present among those in the age groups 30-39 and 40-49. However, when lifestyle factors and other participant characteristics were considered, there were no remaining associations between education level and any CVD outcome. It is possible that this loss of association is due to the mediating effects of the covariates that were included in the multivariate models.

Works cited

1. World Health Organization. Noncommunicable diseases [Internet]. 2018 [cited 2020 Nov 3]. Available from: https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases.
2. Hannah Ritchie. "Causes of Death". Published online at OurWorldInData.org. [Internet]. 2018 [cited 2020 Nov 2]. Available from: https://ourworldindata.org/causes-of-death.
3. Collaborators GBDCoD. Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980-2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet. 2018;392(10159):1736-88.
4. Wahdan MH. The epidemiological transition [Internet]. 1996 [cited 2020 Nov 12]. 8-20]. Available from: https://applications.emro.who.int/emhj/0201/emhj_1996_2_1_8_20.pdf.
5. NHS. Cardiovascular disease [Internet]. 2018 [cited 2021 Jan 17]. Available from: https://www.nhs.uk/conditions/cardiovascular-disease/.
6. Norwegian Institute of Public Health. Cardiovascular disease in Norway [Internet]. 2020 [cited 2021 Jan 15]. Available from: https://www.fhi.no/en/op/hin/health-disease/cardiovascular-disease-in-norway---/.
7. American Heart Association. What is cardiovascular disease? [Internet]. 2018 [cited 2021 Jan 17]. Available from: https://www.heart.org/en/health-topics/consumer-healthcare/what-is-cardiovascular-disease.
8. Heart and Stroke Foundation of Canada. Angina [Internet]. c2020 [cited 2021 Jan 17]. Available from: https://www.heartandstroke.ca/heart-disease/conditions/angina.
9. Norwegian Institute of Public Health. Main Points [Internet]. 2020 [cited 2020 Nov 8]. Available from: https://www.fhi.no/en/op/Indicators-for-NCD/summary/hovudpunkt/?term=&h=1.
10. Norwegian Institute of Public Health. Premature mortality from non-communicable diseases (Indicator 1) [Internet]. 2020 [cited 2021 Jan 21]. Available from: https://www.fhi.no/en/op/Indicators-for-NCD/premature-mortality/for-tidlig-dod-av-ikke-smittsomme-sykdommer-indikator-1/.
11. Norwegian Institute of Public Health. Norhealth [Internet]. [cited 2020 Nov 8]. Available from: http://norgeshelsa.no/norgeshelsa/.
12. Norwegian Institute of Public Health. Causes of death & life expectancy [Internet]. [cited 2020 Nov 8]. Available from: https://www.fhi.no/en/hn/cause-of-death-and-life-expectancy/.
13. IMHE. Norway [Internet]. c2020 [cited 2021 Jan 15]. Available from: http://www.healthdata.org/norway.
14. Institut de Cardiologie de Montréal. Risk Factors [Internet]. 2020 [cited 2020 Nov 2]. Available from: https://www.icm-mhi.org/en/prevention/adopt-healthy-lifestyle/risk-factors.
15. World Health Organization. Risk factors [PDF]. [cited 2020 Nov 3]. Available from: https://www.who.int/cardiovascular_diseases/en/cvd_atlas_03_risk_factors.pdf.
16. USCF Health. Understanding your risk for heart disease [Internet]. c2002-2021 [cited 2021 Jan 12]. Available from: https://www.ucsfhealth.org/education/understanding-your-risk-for-heart-disease.
17. Olsen JA. Principles in health economics and policy. 2 ed. New York, USA: Oxford University Press; 2017.

18. Schultz WM, Kelli HM, Lisko JC, Varghese T, Shen J, Sandesara P, et al. Socioeconomic Status and Cardiovascular Outcomes: Challenges and Interventions. Circulation. 2018;137(20):2166-78.
19. Norwegian Institute of Public Health. Social inequalities in health [Internet]. 2018 [cited 2021 Jan 13]. Available from: https://www.fhi.no/en/op/hin/groups/social-inequalities/.
20. Helse Norge. User fees at the family doctor [Internet]. 2021 [cited 2021 Jan 13]. Available from: https://www.helsenorge.no/en/payment-for-health-services/user-fees-at-the-family-doctor/.
21. Psaltopoulou T, Hatzis G, Papageorgiou N, Androulakis E, Briasoulis A, Tousoulis D. Socioeconomic status and risk factors for cardiovascular disease: Impact of dietary mediators. Hellenic J Cardiol. 2017;58(1):32-42.
22. Kivimäki M, Batty GD, Pentti J, Shipley MJ, Sipilä PN, Nyberg ST, et al. Association between socioeconomic status and the development of mental and physical health conditions in adulthood: a multi-cohort study. Lancet Public Health. 2020;5(3):e140-e9.
23. New in Norway. A welfare state [Internet]. date unknown [cited 2021 Jan 22]. Available from: http://www.nyinorge.no/en/Familiegjenforening/New-in-Norway/About-Norway/History/A-welfare-state/.
24. Charlton E. These are the most educated countries in the world [Internet]. 2018 [cited 2021 Jan 13]. Available from: https://www.weforum.org/agenda/2018/09/most-educated-countries-in-world-korea-japan-canada/.
25. Klitkou ST, Wangen KR. Educational attainment and differences in relative survival after acute myocardial infarction in Norway: a registry-based population study. BMJ Open. 2017;7(8):e014787.
26. Thune TR, Ø.; Askheim, S. Skole og utdanning i Norge [Internet]. 2019 [cited 2021 Oct 22]. Available from: https://snl.no/Skole_og_utdanning_i_Norge.
27. NOKUT. general information about education in Norway [Internet]. date unknown [cited 2021 Oct 22]. Available from: https://www.nokut.no/en/norwegian-education/general-information-about-education-in-norway/.
28. Roser M. Human Development Index (HDI) [Internet]. 2019 [cited 2020 Nov 2]. Available from: https://ourworldindata.org/human-development-index#citation.
29. Kim JH, Jeong MH, Park IH, Choi JS, Rhee JA, Lee DH, et al. The association of socioeconomic status with three-year clinical outcomes in patients with acute myocardial infarction who underwent percutaneous coronary intervention. J Korean Med Sci. 2014;29(4):536-43.
30. Igland J, Vollset SE, Nygård OK, Sulo G, Ebbing M, Tell GS. Educational inequalities in acute myocardial infarction incidence in Norway: a nationwide cohort study. PLoS One. 2014;9(9):e106898.
31. UiT The Arctic University of Norway. The Tromsø Study [Internet]. date unknown [cited 2021 Jan 31]. Available from: https://uit.no/research/tromsostudy?p_document_id=708030.
32. UiT The Arctic University of Norway. The seventh survey of the Tromsø Study [Internet]. date unknown [cited 2021 Jan 31]. Available from: https://uit.no/research/tromsostudy/project?pid=708909.
33. UiT The Arctic University of Norway. The Fourth Tromsø Study [Internet]. date unknown [cited 2021 May 12]. Available from: https://uit.no/research/tromsostudy/project?pid=708901.
34. UiT The Arctic University of Norway. The Tromsø Study [Internet]. [cited 2020 Nov 1]. Available from: https://en.uit.no/forskning/forskningsgrupper/gruppe?p_document_id=453582.

35. Universitet I Tromsø. The Tromsø Study [Internet]. [cited 2020 Nov 3]. Available from: http://tromsoundersokelsen.uit.no/tromso/.
36. University of Tromsø. Health Survey [Internet]. date unknown [cited 2021 Sep 12]. Available from: https://uit.no/Content/271764/T4_Q1.pdf.
37. The Tromsø Study. Questionnaire Q1 [Internet]. 2015-2016 [cited 2021 Jan 31]. Available from: https://uit.no/Content/686864/cache=20201407122756/Sporreskjema.Q1.engelskTromso7.pdf.
38. UiT The Arctic University of Norway. Applying for access to data for statistical analyses [Internet]. 2020 [cited 2021 Feb 1]. Available from: https://uit.no/research/tromsostudy/project?pid=709148.
39. Statistisk sentralbyrå Statistics Norway. Educational attainment of the population [Internet]. 2021 [cited 2021 Sep 28]. Available from: https://www.ssb.no/en/utdanning/statistikker/utniv.
40. Beauchamp A, Peeters A, Wolfe R, Turrell G, Harriss LR, Giles GG, et al. Inequalities in cardiovascular disease mortality: the role of behavioural, physiological and social risk factors. Journal of Epidemiology & Community Health. 2010;64(6):542-8.
41. de Mestral C, Stringhini S. Socioeconomic Status and Cardiovascular Disease: an Update. Curr Cardiol Rep. 2017;19(11):115.
42. Havranek EP, Mujahid MS, Barr DA, Blair IV, Cohen MS, Cruz-Flores S, et al. Social Determinants of Risk and Outcomes for Cardiovascular Disease: A Scientific Statement From the American Heart Association. Circulation. 2015;132(9):873-98.
43. Khaing W, Vallibhakara SA, Attia J, McEvoy M, Thakkinstian A. Effects of education and income on cardiovascular outcomes: A systematic review and meta-analysis. Eur J Prev Cardiol. 2017;24(10):1032-42.
44. Rosengren A, Smyth A, Rangarajan S, Ramasundarahettige C, Bangdiwala SI, AlHabib KF, et al. Socioeconomic status and risk of cardiovascular disease in 20 low-income, middle-income, and high-income countries: the Prospective Urban Rural Epidemiologic (PURE) study. The Lancet Global Health. 2019;7(6):e748-e60.
45. Woodward M, Peters SA, Batty GD, Ueshima H, Woo J, Giles GG, et al. Socioeconomic status in relation to cardiovascular disease and cause-specific mortality: a comparison of Asian and Australasian populations in a pooled analysis. BMJ Open. 2015;5(3):e006408.
46. Cajita MI, Cajita TR, Han HR. Health Literacy and Heart Failure: A Systematic Review. J Cardiovasc Nurs. 2016;31(2):121-30.
47. Le CF, H. S.; Pettersen, K. S.; Joranger, P.; & Guttersrud, Ø. health Literacy in the Norwegian Population. English Summary. In *Befolkningens helsekompetanse, del I.* The International Health Literacy Population Survey 2019-2021 (HLS19) - et samarbeidsprosjekt med nettverket M-POHL tilknyttet WHO-EHII. The Norwegian Dictorate of Health. [PDF]. 2021 [cited 2021 Oct 1]. Available from: https://www.helsedirektoratet.no/rapporter/befolkningens-helsekompetanse/Health%20Literacy%20in%20the%20Norwegian%20Population.%20English%20summary.pdf/_/attachment/inline/a08fec5e-16c7-435e-abf8-e2f0ba05cc84:c576b33bcd3eb386c58124a817bc3b01fde33df8/Health%20Literacy%20in%20the%20Norwegian%20Population.%20English%20summary.pdf.
48. Backholer K, Peters SAE, Bots SH, Peeters A, Huxley RR, Woodward M. Sex differences in the relationship between socioeconomic status and cardiovascular disease: a systematic review and meta-analysis. J Epidemiol Community Health. 2017;71(6):550-7.
49. Breitborde NJK, Srihari VH, Pollard JM, Addington DN, Woods SW. Mediators and moderators in early intervention research. Early Intervention in Psychiatry. 2010;4(2):143-52.

50. Kershaw KN, Droomers M, Robinson WR, Carnethon MR, Daviglus ML, Monique Verschuren WM. Quantifying the contributions of behavioral and biological risk factors to socioeconomic disparities in coronary heart disease incidence: the MORGEN study. Eur J Epidemiol. 2013;28(10):807-14.
51. CDC. Smoking and cardiovascualr disease [PDF]. date unknown [cited 2021 Nov 3]. Available from: https://www.cdc.gov/tobacco/data_statistics/sgr/50th-anniversary/pdfs/fs_smoking_CVD_508.pdf.
52. O'Keefe JH, Bhatti SK, Bajwa A, DiNicolantonio JJ, Lavie CJ. Alcohol and cardiovascular health: the dose makes the poison…or the remedy. Mayo Clin Proc. 2014;89(3):382-93.
53. Mortensen EL, Jensen HH, Sanders SA, Reinisch JM. Better psychological functioning and higher social status may largely explain the apparent health benefits of wine: a study of wine and beer drinking in young Danish adults. Arch Intern Med. 2001;161(15):1844-8.
54. Patino CM, Ferreira JC. Internal and external validity: can you apply research study results to your patients? J Bras Pneumol. 2018;44(3):183.
55. Tripepi G, Jager KJ, Dekker FW, Zoccali C. Selection bias and information bias in clinical research. Nephron Clin Pract. 2010;115(2):c94-9.
56. Engstad T, Bonaa KH, Viitanen M. Validity of self-reported stroke : The Tromso Study. Stroke. 2000;31(7):1602-7.
57. Langhammer A, Krokstad S, Romundstad P, Heggland J, Holmen J. The HUNT study: participation is associated with survival and depends on socioeconomic status, diseases and symptoms. BMC Med Res Methodol. 2012;12:143.
58. Howe LD, Tilling K, Galobardes B, Lawlor DA. Loss to follow-up in cohort studies: bias in estimates of socioeconomic inequalities. Epidemiology. 2013;24(1):1-9.
59. Field A. Discovering statistics using IBM SPSS Statistics. 5 ed. London, UK: SAGE Publications Ltd; 2018.
60. UiT The Arctic University of Norway. UiT Study Catalogue [Internet]. date unknown [cited 2021 Sep 28]. Available from: https://en.uit.no/education?studtype=4.
61. Statistisk sentralbyrå Statistics Norway. Educational attainment of the population, 1 October 2015 [Internet]. 2016 [cited 2021 May 2]. Available from: https://www.ssb.no/en/utdanning/statistikker/utniv/aar/2016-06-20.
62. United Nations. Goal 3 [Internet]. date unknown [cited 2021 Feb 24]. Available from: https://sdgs.un.org/goals/goal3.

Appendix A.

Approval letter for data request from the DPU stating that REK approval was not required for this project.

UiT
NORGES ARKTISKE UNIVERSITET

Tromsø-undersøkelsen

Helsefak / ISM
Arkivref.: :l/Tromsøundersøkelsen
Dato: 21.12.2020

Til

Tormod Brenn

VEDTAK FRA DATA- OG PUBLIKASJONSUTVALGET FOR TROMSØUNDERSØKELSEN (DPU)

Sak 5

57/20

Søknad om utlevering av data, studentprosjektet "Exploring the association between education and self-reported CVD in the Tromsø 7 Study".
Prosjektleder Tormod Brenn, masterstudent i folkehelse Celina Cathro

DPU registrerer at søknaden gjelder data fra Tromsø 7 og er oppgitt til 1 artikkel.

Ved å gruppere på alder og KMI ansees datasettet som anonymt. Det vil da ikke være nødvendig med egen REK-godkjenning for prosjektet.

DPU ber om at norsk tittel og sammendrag legges inn i søknadsskjemaet. Det norske sammendraget publiseres på Tromsøundersøkelsens nettsider som del i formidling av hva Tromsøundersøkelsens data brukes til, beregnet både til deltakere og allment publikum.

Studentprosjekter er fritatt for avgift for utlevering av data. Inkludert i dette er tillatelse til å publisere inntil 1 artikkel pr studentprosjekt.

Vedtak: *DPU stiller seg positiv til prosjektet og innvilger tilgang til data så snart ovennevnte er avklart og avtale om utlevering av data er signert.*

Postboks 6050 Langnes, N-9037 Tromsø / 77 64 40 00 / postmottak@uit.no / uit.no

UNIVERSITETET I TROMSØ

Appendix B.

Health Survey Questionnaire, Tromsø 4 (Only pages with questions used in this study were included) (36).

YOUR OWN HEALTH

What is your current state of health? *Tick one box only.*

Poor	12	1
Not so good		2
Good		3
Very good		4

Do you have, or have you had:

		Yes	No	Age first time
A heart attack	13			years
Angina pectoris (heart cramp)	16			years
A cerebral stroke/ brain haemorrhage	19			years
Asthma	22			years
Diabetes	25			years

Do you use blood pressure lowering drugs?

Currently	28	1
Previously, but not now		2
Never used		3

Have you during the last year suffered from pains and/or stiffness in muscles and joints that have lasted continuously for at least 3 months? 29 Yes No

Have you in the last two weeks felt:

		No	A little	A lot	Very much
Nervous or worried?	30				
Anxious?	31				
Confident and calm?	32				
Irritable?	33				
Happy and optimistic?	34				
Down/depressed?	35				
Lonely?	36				
		1	2	3	4

SMOKING

Did any of the adults at home smoke while you were growing up? 37 Yes No

Do you currently, or did you previously, live together with daily smokers after your 20th birthday? 38 Yes No

If "YES", for how many years in all? 39 Years

How many hours a day do you normally spend in smoke-filled rooms? 41 Hours

Put 0 if you do not spend time in smoke-filled rooms.

Do you yourself smoke:

		Yes	No
Cigarettes daily?	43		
Cigars/ cigarillos daily?	44		
A pipe daily?	45		

If you previously smoked daily, how long is it since you quit? 46 Years

If you currently smoke, or have smoked previously:

How many cigarettes do you or did you usually smoke per day? 48 cigarettes

How old were you when you began daily smoking? 52 Age years

How many years in all have you smoked daily? 54 Years

EXERCISE

How has your physical activity in leisure time been during this last year? *Think of your weekly average for the year.*

Time spent going to work counts as leisure time.

		Hours per week			
		None	Less than 1	1-2	3 or more
Light activity *(not sweating/out of breath)*	56				
Hard activity *(sweating/ out of breath)*	57				
		1	2	3	4

COFFEE

How many cups of coffee do you drink daily?
Put 0 if you do not drink coffee daily.

Coarsely ground coffee for brewing	58	Cups
Other coffee	60	Cups

ALCOHOL

Are you a teetotaller? 62 Yes No

How many times a month do you normally drink alcohol? *Do not count low-alcohol beer.*
Put 0 if less than once a month. 63 Times

How many glasses of beer, wine or spirits do you normally drink in a fortnight? 65
Do not count low-alcohol beer.
Put 0 if less than once a month.

Beer	Wine	Spirits
Glasses	Glasses	Glasses

FAT

What type of margarine or butter do you usually use on bread? *Tick one box only.*

Don't use butter/margarine	71	1
Butter		2
Hard margarine		3
Soft margarine		4
Butter/margarine mixtures		5
Light margarine		6

EDUCATION/WORK

What is the highest level of education you have completed?

7-10 years primary/secondary school, modern secondary school	72	1
Technical school, middle school, vocational school, 1-2 years senior high school		2
High school diploma (3-4 years)		3
College/university, less than 4 years		4
College/university, 4 or more years		5

What is your current work situation?

Paid work	73
Full-time housework	74
Education, military service	75
Unemployed, on leave without payment	76

How many hours of paid work do you have per week? 77 No. of hours

Do you receive any of the following benefits?

Sickness benefit (sick leave)	79
Rehabilitation benefit	80
Disability pension	81
Old-age pension	82
Social welfare benefit	83
Unemployment benefit	84

ILLNESS IN THE FAMILY

Have one or more of your parents or siblings had a heart attack or had angina (heart cramp)? 85 Yes No Don't know

Appendix C.

Questionnaire Q1, Tromsø 7 (Only pages with questions used in this study were included) (37).

The Tromsø Study 2015–2016

CONFIDENTIAL

The questionnaire will be optically read. Please, use blue or black inked pen only. Use block lettering. Refrain from the use of comma.

Date for filling in the questionnaire:

HEALTH AND DISEASES

1.1 How do you in general consider your health to be?

Excellent	Good	Neither good nor bad	Bad	Very bad
☐	☐	☐	☐	☐

1.2 How is your health now compared to others of your age?

Excellent	Good	Neither good nor bad	Bad	Very bad
☐	☐	☐	☐	☐

1.3 Have you ever had, or do you have?
Tick once for each line.

	No	Yes, currently	Previously, not now	Age first time
High blood pressure	☐	☐	☐	
Heart attack	☐		☐	
Heart failure	☐	☐	☐	
Atrial fibrillation	☐	☐	☐	
Angina pectoris *(heart cramp)*	☐	☐	☐	
Cerebral stroke/ brain haemorrhage	☐		☐	
Diabetes	☐	☐	☐	
Kidney disease, not including urinary tract infection *(UTI)*	☐	☐	☐	
Bronchitis/emphysema/COPD	☐	☐	☐	
Asthma	☐	☐	☐	
Cancer	☐	☐	☐	
Rheumatoid Arthritis	☐	☐	☐	
Arthrosis	☐	☐	☐	
Migraine	☐	☐	☐	
Psychological problems for which you have sought help	☐	☐	☐	

1.4 Do you have persistent or constantly recurring pain that has lasted for three months or more?

☐ No ☐ Yes

DENTAL HEALTH

2.1 How do you consider your own dental health to be?

	1	2	3	4	5	
Very bad	☐	☐	☐	☐	☐	Excellent

2.2 How satisfied or dissatisfied are you with your teeth or denture?

	1	2	3	4	5	
Very dissatisfied	☐	☐	☐	☐	☐	Very satisfied

USE OF HEALTH SERVICES

3.1 Have you during the past 12 months visited?

	Yes	No	Number of times
General practitioner *(GP)*	☐	☐	
Emergency room	☐	☐	
Psychiatrist/Psychologist	☐	☐	
Another medical specialist than a general practitioner *(GP)* or a psychologist or psychiatrist *(not at a hospital)*	☐	☐	
Dentist/dental services	☐	☐	
Pharmacy *(to buy/get advice about medicines/ treatment)*	☐	☐	
Physiotherapist	☐	☐	
Chiropractor	☐	☐	
Acupuncturist	☐	☐	
CAM provider *(homeopath, reflexologist, spiritual healer etc.)*	☐	☐	
Traditional healer *(helper, "reader" etc.)*	☐	☐	
Have you during the past 12 months communicated with any of the services above by using the Internet?	☐	☐	

3.2 Have you over the past 12 months visited a hospital?

	Yes	No	Number of times
Hospital admission	☐	☐	
Visited an out-patient clinic:			
Psychiatric out-patient clinic	☐	☐	
Other out-patient clinics (not psychiatric department)	☐	☐	