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Exploring the utilization of healthcare resources in elderly patients with COPD

A cross-sectional study that explores how elderly Norwegian patients with COPD utilize healthcare resources in the primary- and specialist healthcare sector

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Abstract

Background: Chronic obstructive pulmonary disease (COPD) remains a major health problem worldwide (1) and the prevalence of COPD continues to increase (2, 3). It is a major cause of multimorbidity and mortality in Norway (4) and the healthcare utilization by COPD-patients is expected to increase in the future (5). To effectively allocate healthcare resources, it is necessary to have knowledge about how the resources are utilized (6). The present study aimed to describe and explore how elderly patients with COPD utilize healthcare in the health region of South-East in Norway. And to isolate the effect of having COPD by comparing this group of patients with the general population.

Methods: This cross-sectional study was based and conducted on data from three different Norwegian registers (KUHR, NPR and DSF). The study sample consisted of COPD-patients aged 66-105 years old, who had at least one contact regarding COPD with either the primary- or specialist healthcare sector between 2012 and 2016. Descriptive analyses were used to describe the sample of COPD-patients and the prevalence of type of contact they generated. Costs related to treatment in the specialist healthcare sector was based on DRG-codes and regression analyses were conducted to investigate the association between number of additional diagnoses, age, sex, and the costs related to treatment.

Results: There was a total of 35 185 COPD-patients registered in either the primary- or specialist healthcare sector from 2012 to 2016. This equals on average 6 442 and 2 789 unique COPD-patients registered in KUHR and NPR each year, respectively. The distribution between the sexes were equal, with 44,5% males. Mean birthyear was 1940 and average age was about 74 years old for both sexes.

COPD-patients generated on average more than 13 events in the primary healthcare sector and more than five events in specialist healthcare sector, each year. The total cost for treating COPD-patients in the specialist healthcare sector in 2016 exceeded 1.1 billion and the average cost of treatment per COPD-patient in the specialist healthcare sector was 82 247 NOK in 2015. The average cost for females was 5865 NOK lower than it was for males and the average cost per patient increased with 5 293 NOK for each additional diagnose that was added. The costs were more than 3.5 times higher for COPD-patients than it was for the general population. Concentration curves reveals that 20% of the COPD-patients in KUHR

are accountable for almost half of the events, and 20% of the COPD-patients in NPR are accountable for 60% of the events. The top 30% of COPD-patients who utilize most healthcare resources have a mean cost of treatment that is almost two times higher than the mean cost of treatment for the average COPD-patient.

Conclusion: The number of events COPD-patients generates in the primary- and specialist healthcare sector and the high costs related to treatment in hospitals confirms that COPD-patients imposes significant social and economic burden on patients and society. The results indicates that future research and allocation should focus on COPD-patients with multimorbidity and the share of COPD-patients that utilize the most healthcare resources.

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Abbreviations

ABF	Activity Based Funding
COPD	Chronic Obstructive Pulmonary Disease
DRG	Diagnosis Related Groups
DSF	The Central Population Register (Det Sentrale Folkeregister)
ER	Emergency Room
FEV	Forced Expiratory Volume
GOLD	The Global Initiative for Chronic Obstructive Lung Disease
GP	General Practitioner
HD	Norwegian Directorate of Health
Health South-East	South-Eastern Norway Regional Health Authority
HELFO	The Health Economics Administration
ICD-10	International Classification of Disease 10th revision
KUHR	Norway Control and Payment of Health Reimbursement
LOS	Length of stay
NEC	Not classified elsewhere
NIPH	Norwegian Institute of Public Health (Folkehelseinstituttet)
NOK	Norwegian krone (currency of Norway)
NPR	Norwegian Patient Register
NSD	The Norwegian Centre for Research Data
OECD	Organization for Economic Co-operation and Development
REC	Regional Committees for Medical and Health Research Ethics
SPSS	Statistical Package for Social Science
SSB	Statistics Norway (Statistisk Sentralbyrå)
UiO	University of Oslo
UiT	The Arctic University of Norway
WHO	World Health Organization

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1 Introduction

Healthcare resources are known to be scarce and the demand for it is increasing as the elderly population expands and ages (1). The resources required, and utilized, by the elderly needs to be explored, assessed, and probably reallocated to ensure that the resources are used in the most effective manner. Hence, the main intention of this master´s thesis is to explore and describe the healthcare resources patients diagnosed with chronic obstructive pulmonary disease (COPD) utilize in the primary- and specialist healthcare sector, and the costs related to treatment in hospitals. The objectives are outlined in more detail in Section 2.

1.1 Chronic obstructive pulmonary disease

There is a great deal to be said about COPD, this introduction will focus on the information that is most relevant to this master´s thesis. COPD is a common, preventable, and treatable chronic lung disease, which affects both males and females worldwide. In 2019, COPD was the third leading cause of death worldwide, and responsible for 3.23 million deaths and is estimated to still be the third leading cause of deaths in 2030 (7). COPD is a collective designation for a collection of chronic lung illnesses which attenuate the airflow through the respiratory tract. If the lungs have normal function, the air that one breathes goes down the respiratory tract to the two bronchi. The bronchi continue into separate lungs where they turn into millions of branches. From here, the oxygen from the air is transported over to the blood. In return, waste gas carbon dioxide is transported from the blood and over to the air that is breathed out again. COPD-patients suffer from inflammation and/or damage in mucous membranes in the bronchi, leading to narrower and damaged airways which reduces the ability to transport oxygen and excrete carbon dioxide (8). The body will then try to compensate by making the heart work harder, resulting in increased heart rate and respiratory rate. Common symptoms for COPD are coughing, wheeze breath and difficulty breathing (9).

The most frequently used method to set the diagnosis is to examine the patient's lung function by using spirometry. This test measures how much air the patient can exhale during the first forced breath, and the unit of measurement is called forced expiratory volume (FEV_1) (9). The results give a good indication of the capacity and function of the patient´s lungs (8). The disease varies in severity and is based on the patients FEV_1-results, individual symptoms, and history of acute exacerbations. As the disease progresses, the patient will be more susceptible to complications such as respiratory infections, heart problems, pulmonary hypertension, lung

cancer, depression, and anxiety, which increases the chance of exacerbations (9). The Global Initiative for Chronic Obstructive Lung Disease (GOLD) has created a system for grading the severity of COPD (9), Table 1 displays the division and explains the severity of each grade.

Table 1: The GOLD classification grading system.

GOLD classification	Severity	Characteristics
Grade 1	Mild	FEV_1 >80% predicted (More than 80% lung functioning)
Grade 2	Moderate	50% < FEV_1 < 80% predicted (Between 50-79% lung functioning)
Grade 3	Severe	30% < FEV_1 < 50% predicted (Between 30-49% lung functioning)
Grade 4	Very severe	FEV_1 < 30% predicted (Less than 30% lung functioning)

COPD can be a hereditary condition albeit often seen because the airways have been exposed to substances like smoke from tobacco or industrial contamination. That is, as much as 95% of those with COPD worldwide are current or former smokers. But COPD is most likely caused by multiple physiological, behavioral, environmental, and institutional factors rather than one single risk factor (4). COPD is a lasting disease and currently there is no cure, but if the patients are diagnosed at an early stage, it is possible to implement measures to slow down the progress of the disease (10), and non-medical measures may be just as important as medical measures (11). Healthy lifestyle habits will contribute to the best possible prognosis for COPD-patients. Use of medication will relieve the symptoms and increase quality of life, but is not likely to improve the prognosis and progression of the disease (10). Exacerbation of COPD normally occurs when the patient experiences infection in the lungs or airways caused by virus, bacteria, or by inhaling substances from the environment. Exacerbations can evolve quickly and is an acute, prolonged worsening of the patient's condition from a normal, day-to-day, stable state of disease. It may require additional treatment and possibly hospitalization (9, 12).

COPD often occurs in the presence of other diseases, where comorbidity is the presence of one additional chronic condition (13) and multimorbidity is the presence of two, or several, chronic conditions (14). Comorbidity is expected to be present in most patients with COPD. A study by Vanfleteren et.al (15) stated that 97.7% of the included COPD-patients had one or more conditions. 53.5% of the COPD-patients had four or more conditions. The cost of treating COPD-patients with comorbidities has been found to be 4,7 times higher than comorbidity-free COPD-patients. The underlying cause of additional conditions in COPD-patients is not yet fully recognized but the literature supports that COPD is associated with

other age-driven diseases and other diseases that share common risk factors (16). The most common conditions associated with COPD are lung cancer, other types of cancer, asthma, obstructive sleep apnoea syndrome, hypertension, cardiovascular disease, diabetes, osteoporosis, and mental disorders. Results from a Swedish study showed that 44%, 31.1% and 21.9% of COPD-patients suffered from cardiovascular disease, hypertension, and asthma, respectively (16). Multimorbidity normally leads to reduced quality of life and increases the risk of mortality (14).

A key element of this master´s thesis is the growing number of elderlies in the world (17). The fertility rates are decreasing while the life expectancy is increasing worldwide (2), and this naturally leads to an increase of elderly people. In the future, it is expected that we will have more elderly people than children and more people at an extreme age than we have ever had before (3). The number of people older than 65 years is estimated to increase from 524 million in 2010 to almost 1.5 billion in 2050 (3). Elderly people have a higher risk of developing chronic diseases compared to younger people, and chronic diseases increase the burden on the healthcare service as it usually demands more healthcare resources (2). Ageing may for example cause a progressive degeneration that has a negative impact on the structure and function of the lungs and other vital organs which increases the risk of developing COPD. Furthermore, the prevalence of COPD is expected to be two to three times higher in people older than 60 years compared to younger age groups (2).

1.2 Chronic obstructive pulmonary disease in Norway

Norway has a relatively healthy population with approximately 5.3 million inhabitants in 2018 with a life expectancy at birth of 81 years for males, and 84 years for females, with an growing ageing population (18, 19). In 2021, more than one out of nine in Norway was aged 70 years or older, and it is estimated that roughly every fifth person will be 70 years or older by year 2060 (18). The Norwegian population increased with 11% from 2009 to 2019. Elderly aged 66–79 years increased by 46% and those older than 90 years increased by 29.7%. It is expected that from 2020 to 2040, the age groups 66-79 years, 80-89 years and >90 years will increase by 36.6%, 105.5% and 128.1%, respectively (20). The prevalence of COPD is increasing in Norway, as it is in the rest of the world. It is estimated that between 250 000 and 300 000 inhabitants in Norway have COPD, although less than half of them have been diagnosed despite experiencing symptoms (11).

The Norwegian Directorate of Health (HD) published a "health atlas" for COPD (Helseatlas KOLS). The purpose of this report was to explore if COPD-patients, older than 40 years of age, received equal healthcare across Norwegian counties. The results showed that every 196 per 10 000 inhabitants in Norway were registered with the diagnosis COPD between 2013 and 2015. That is, 10 455 COPD-patients were admitted to intensive care between 2013-2015. The patients spent on average 9.9 days in the hospital and had 122 631 COPD-related consultations per year with a general practitioner (GP). About 8% of the COPD-related consultations were in the emergency room (ER) (11). Additional results from this report indicate that the elderly COPD-patients utilize a larger share of the health resources compared to younger COPD-patients. As many as two thirds of those with COPD were 60 years or older, and nine out of ten acute hospitalizations were patients of 60 years or older. Four out of five received treatment at a polyclinic, and two out of three received treatment from their GP or ER (11). The specialist healthcare services provide polyclinical consultations, which refers to treatment or consultation given to the patient without the patient being admitted to hospital. Out-patient treatment is treatment, tests or therapy given at the hospital without the patient staying over-night. In-patient treatment refers to when patients are admitted to stay at the hospital or institution over-night. In Norway, COPD is ranked as the third leading cause of death after cardiovascular diseases and cancer, and it is estimated that COPD caused approximately 2 000 deaths in 2012. However, the disease is complex and people with COPD are often burdened with other chronic diagnoses, so the number of deaths caused by COPD are expected to be higher (11).

In 2014, the general Norwegian population consulted their GP on average 2.6 times per year. Moreover, those in the age group 67 to 79 and 80 to 89 consulted their GP on average 4,2 times and 5 times a year, respectively (21), indicating that elderly utilize a larger share of the healthcare resources available than the younger population do. COPD-patients normally require consultation by specialists in lung- or internal medicine, but exacerbations are usually the reason for all acute hospitalizations, while planned hospitalizations are rarer with rehabilitation and prevention as the aim. Most exacerbations can be treated and handled by GPs (22), and exacerbations that require hospitalization are normally patients who suffer from multimorbidity (23).

1.3 Measuring utilization of healthcare resources

Donabedian (24) defines healthcare utilization as the outcome of the interaction between the healthcare personnel and the patient. Utilization of resources caused by medical status can be measured using different approaches and may for example be divided into direct utilization and indirect utilization. Indirect utilization refers to the value of decreased or lost productivity of the patient and is not related to medical management of the disease (25). For instance, if loss of labor productivity or loss of potential wage is a result of an illness (26). Direct costs refer to the value of the resources that are utilized or lost as a result of health status (25), which may be measured as hospital-at-home, out-of-pocket payment, days spent in care, and supplies and use of equipment during treatment (27). The direct utilization of healthcare is the least complicated to measure as it can be traced to the exact number of contacts with the GP, the exact cost of medicine or needed healthcare personnel for specific treatment, and it has the advantage that it easily can be compared to other direct measurements and costs. Direct utilization provides an indication of what impact the illness has on the society, institutions, or households, and is more relevant than indirect costs with respect to policy making. That is, when policy makers consider how to allocate healthcare resources to use them more efficiently, direct costs may inform the decision making process as they are more accurate than indirect costs (25). Benefits from allocating healthcare resources can be weighed differently. Some allocations bring direct benefits to the receiver of healthcare in form of for example improved health or treatment, others bring indirect benefits to the provider of healthcare in the form of economic gain for the society. Direct utilization is more relevant for this master´s thesis, as the datasets make it possible to estimate utilization of healthcare resources as directs costs.

1.3.1 Healthcare resources utilized by COPD-patients

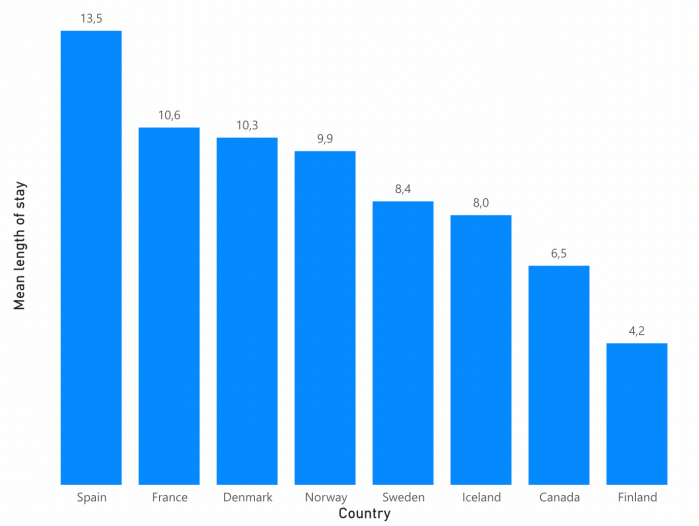
Several previous studies have investigated how patients with COPD utilize healthcare resources and the results have established that treating and rehabilitating COPD-patients imposes significant social and economic burden on patients, healthcare sector and society (6, 28-30). Several studies concluded that costs related to treating COPD-patients were significantly higher than the costs related to treating non-COPD patients (31-37) and other studies concluded that the costs related to treating COPD-patients increased with increasing severity stages and/or if exacerbation occurred (16, 32, 35-41). Furthermore, there is a direct relationship between the severity of the disease and the healthcare resources required (32, 35,

38, 40, 42), as COPD-patients with severe COPD or exacerbations utilized more healthcare resources and were hospitalized more often compared to COPD-patients with milder symptoms (28, 43).

A systematic review explored the expenses related to treating COPD in 9 different European countries. The results illustrated that Norway has the highest direct costs per patient each year related to treatment (€ 10 701), followed by Denmark (€ 9 580), Germany (€ 7 847), and Italy (€ 7 448) (44). A Norwegian study estimated that the costs related to treating COPD was 141 million euro in 2005, which is € 284 per patient/year (28). A Danish cohort study explored the total annual costs of general elderly care, and care in retirement homes, and it was discovered that the total expenses were three times higher among elderly with COPD compared to the general, elderly population (32). Another Danish study discovered that the incidence of hospital admissions was almost four times higher for COPD-patients, and they contacted their GP 12 times more often per year compared to the general population. Those with COPD spent on average 10.3 days in hospital (independent from cause) per year, while males without COPD spent on average 2.8 days in hospital per year (33).

A Finnish study executed in 2014 (N = 437) found that approximately half of COPD-patients had at least one hospital admission during the study year. They spent on average 4.2 bed days in hospital (45). 29.3% of the Norwegian COPD-patients were re-admitted to hospital within 30 days (11). For comparison, 16% of the general population aged 66 years old or older were readmitted within 30 days (46). The average length of stay (LOS) for hospital admissions due to any disease in Norway was 4.33 days in 2016 (47), whilst the average LOS for those admitted with COPD was 9.9 days (11). The Norwegian Burden of Obstructive Lung Disease (BOLD) study discovered that patients with severe COPD (FEV_1 <50%) had on average four hospitalizations per year (28). A study by Jannson et.al (40) revealed that patients with severe and very severe COPD had costs related to treatment that were three times greater than the costs for patients with moderate COPD, and more than 10 times greater than for those with mild COPD (40). And the presence of additional diagnoses is a dominant predictor of excessive utilization of healthcare resources (48). Figure 1 displays the average LOS/year in eight different countries.

Figure 1: Average LOS for hospitalizations caused by COPD



It is valuable to have access to international data in order to benchmark it and investigate if for example further reduction in LOS will cause unwanted consequences. For example, if short LOS increases the risk of readmission due to incomplete care. Results from a more recent study showed that frequent out-patient visits can contribute to reduce the risk of COPD-exacerbations that require hospital admissions by 45-60% (49).

Former studies emphasize that COPD-patients imposes a significant social and economic burden in the Norwegian society (18), and treatment of severe and very severe COPD requires a substantial share of healthcare resources compared to treating COPD-patients with less severe COPD (32). The purpose of discovering and describing how COPD-patients utilize healthcare resources is to make informed decisions on how to implement future intervention to prevent disease, manage and restructure the resources. Given the amount of resources related to treating COPD, and the expanding and ageing population that is currently evolving, this matter is urgent.

2 Objectives

2.1 Rationale

This is a descriptive and analytic cross-sectional study, designed to explore how patients diagnosed with COPD utilize healthcare resources. This is measured as prevalence of events generated by primary- and specialist healthcare services, as well as the costs related to treatment by specialist healthcare services, in the health region of South-Eastern Norway. Few

studies assess the utilization of healthcare resources and cost of treatment among those diagnosed with COPD as a group of patients. The Health Atlas for COPD (11) explored the prevalence of contacts with the healthcare sector by COPD-patients in Norway, but I did not succeed in finding studies that explored the prevalence of contacts with both the primary- and specialist healthcare sector, and the costs related to treatment in hospital for elderly COPD-patients. This thesis aims to explore the present research gap.

In this master´s thesis, healthcare utilization is explored in terms of number of events generated in the primary- and specialist healthcare sector. The costs related to treatment in hospital were assessed by computing the cost for each event by applying the diagnose-related group (DRG) reimbursement framework. This thesis is a sub-project and a part of a more comprehensive project led by The Norwegian Institute of Public Health (NIPH). NIPH aims to explore how patients with COPD and multimorbidity utilize healthcare resources and they intend this information to be applied when considering allocation of healthcare resources and implementing policies. NIPH´s first sub-goal is to explore and describe the utilization of healthcare resources by this group of patients. There are advantages in focusing on patients from only one health region and to not include the entire Norwegian population, as it may remove some of the variation caused by administrative and structural differences across healthcare regions. There are geographical differences in utilization of healthcare resources, some of the variation can be explained by socioeconomic status and distance to nearest hospital (11). To provide patients with sound healthcare, there is a need to understand how they utilize healthcare.

2.2 Research question

What amount of healthcare resources do patients with COPD utilize in the primary- and specialist healthcare sector?

2.3 Aims

The main purpose of this study is to explore the utilization of healthcare resources and the costs associated with treatment in the primary- and specialist healthcare sector among elderly patients diagnosed with COPD.

The questions that will be addressed are:

1. What is the prevalence of patients with COPD in South-Eastern Norway Regional Health Authority (Health South-East)?
2. What resources are utilized by COPD-patients in the primary- and specialist healthcare services?
3. How are the resources utilized by COPD-patients distributed in Health South-East?
4. What is the mean cost of treatment per COPD-patients in the specialist healthcare sector?
5. What factors affect the cost of treatment per COPD-patient in Health South-East?

2.4 Outcome

Resource utilization is measured by describing prevalence and average events in the primary healthcare sector, prevalence of polyclinical consultations, in-patient contacts and out-patient contacts, length of stay at hospital and number of acute hospital admissions. In addition, resource utilization is measured as cost of treatment based on DRG-weights.

3 Material

3.1 Study sample

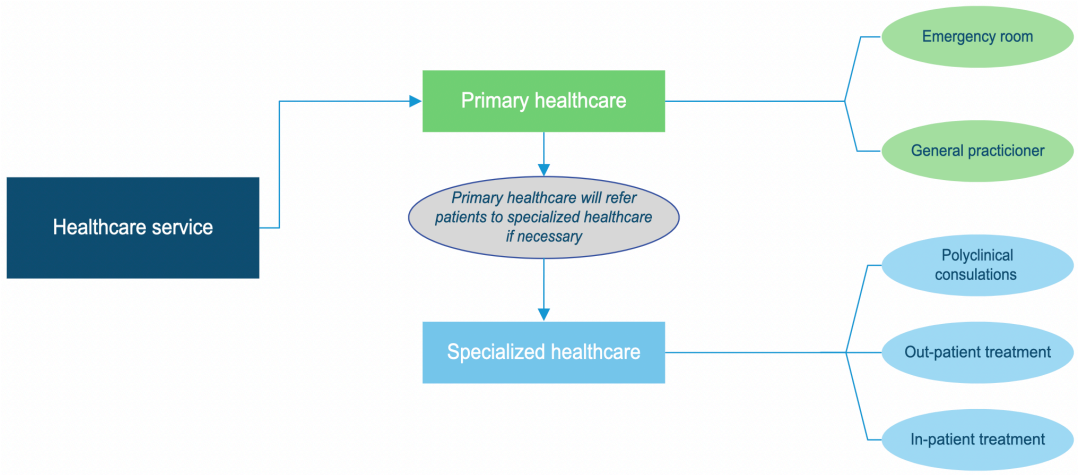
The study sample is every patient, older than 65 years, who has been in contact with either the primary- or the specialist healthcare sector regarding COPD in the region of Health South-East in Norway, in the period between the 1st of January 2012 to the 31st of December 2016 (5 years). Norway is divided into four health regions where Health South-East is the largest. It includes 2.9 million people in the 10 following counties: Østfold, Akershus, Oslo, Hedmark, Oppland, Buskerud, Vestfold, Telemark, Aust-Agder and Vest-Agder. This health region makes up 57% of the Norwegian population (50). From 1st of January 2020, the following counties have merged and formed one joint county: Aust-Agder and Vest-Agder (Agder), Akershus, Buskerud and Østfold (Viken), Vestfold and Telemark (Vestfold and Telemark), and Hedmark and Oppland (Innlandet) (51).

3.2 Data collection and sources of data

The analysis in this thesis is based on an investigation strategy that rests on utilizing quantitative data. Information concerning provided healthcare is based on three primary sources: Information of healthcare service provided at hospital level based on data from The

Norwegian Patient Register (NPR), information on healthcare service provided on primary healthcare level from Norway Control and Payment of Health Reimbursement (KUHR) and general descriptive information from Statistics Norway (SSB) retrieved from The Central Population Register (DSF). Healthcare provided can be divided into two main categories. The first is primary healthcare, which is provided in the municipalities for individuals making an initial approach to establish contact with their GP or a clinic for medical advice or treatment. The primary healthcare also includes the local ER. The second is specialized healthcare which consists of hospitals and other specialists and refers to the healthcare patients receive after having received primary healthcare services. The GP generally gives medical advice, prescribe medication, and consult patients. Furthermore, the ER mainly care for acute medical situations needless of prior appointment (11).

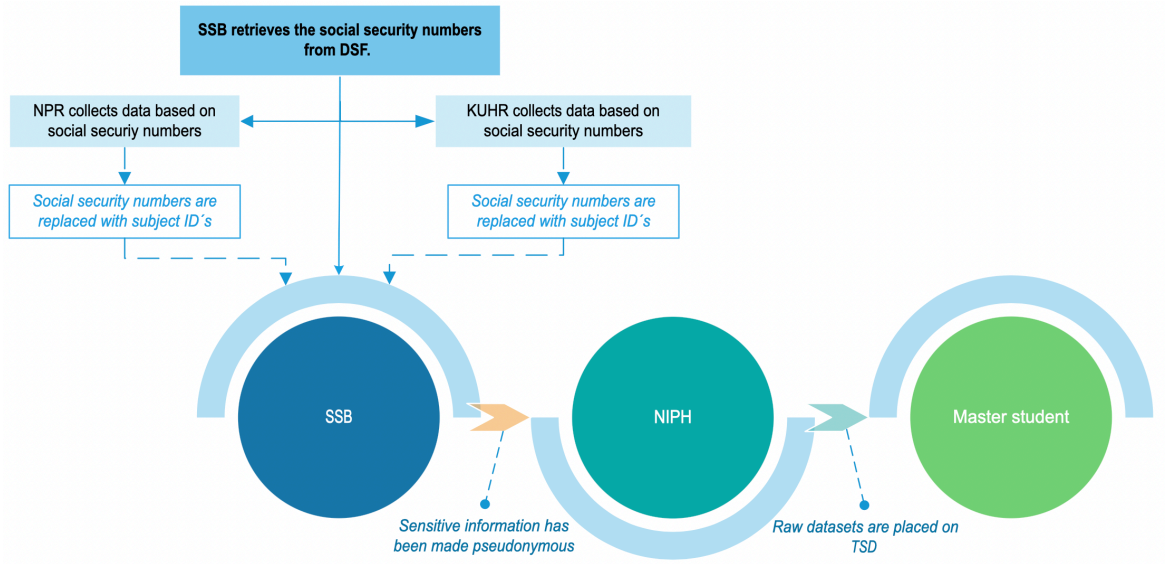
Figure 2: Organizational chart of the primary healthcare and specialist healthcare sector



The data was provided by NIPH, who received raw datasets from SSB with information from three registries (KUHR, NPR and DSF). SSB was the administrator of collecting the data and revising it. SSB identified those who met the eligibility criteria to be included in NIPH´s project, which was every person, older than 65 years, who has had one or more contacts with either the primary- or the specialist healthcare sector in Health South-East in the time-period between 2012 to 2016 (five years). KUHR and NPR received the social security number and their respective subject ID from SSB and used the social security number to retrieve data from their registries, they replaced the social security number with their respective subject ID and passed it on to SSB along with healthcare information about the patient. Type of contact, received healthcare, diagnosis and all other health-related information about every event is

registered by the healthcare personnel at the current institution. Based on the patient's social security number, descriptive statistics like municipality of residence and marital status were retrieved from DSF. SSB then revised all sensitive information to be pseudonymous before passing it on to NIPH. A graphical visualization of the process is presented in Figure 3.

Figure 3: Graphical visualization of the data collection process



3.2.1 The Central Population Register (DSF)

The data from DSF forms the basis for tax registry in Norway and provides variables including sex, municipality of residence, marital status, and month and year of birth. This registry is held by SSB, which is an institution that collects and publishes public statistics about the Norwegian population and it is normally independent from healthcare (52).

3.2.2 Norway Control and Payment of Health Reimbursement (KUHR)

KUHR is the register of reimbursement claims from primary healthcare providers to The Health Economics Administration (HELFO) (53). Every contact between patient and healthcare personnel registered in KUHR contains date of event, sex, year of birth, diagnostics, and type of contact. The diagnoses are coded according to the ICPD-2 classification system.

3.2.3 The Norwegian Patient Register (NPR)

NPR provides data on every patient who has been in contact with the specialist healthcare sector. There are three types of contact with the specialist healthcare sector (see figure 2) and

they can be of either planned or acute matter. This information is registered by the healthcare personnel at the institution of contact, both private and public (54). The data includes information about district of contact, year and month of hospitalization and discharge from hospital, DRG-codes and procedures done. The DRG-codes will form the basis for calculating the cost of treatment. In addition, the register has information about main- and bi-diagnoses, which is based on the ICD-10 classification system. The ICD-10 codes J40-J47 are classified as chronic diseases in the lower airways where the code for COPD is "J44". According to ICD-10 classification system, COPD includes chronic brochities and chronic obstructive asthma and chronic obstructive brochities (55). Table 2 displays all diagnostic variations within the code "J44".

Table 2: The different diagnostic variations of the ICD-10 code "J44" (55)

ICD-10 code	Definition
J44.0	Chronic obstructive lung disease with acute infection in lower airways (influenza is excluded).
J44.1	Chronic obstructive lung disease with acute unspecified exacerbation.
J44.8	Other specified chronic obstructive lung disease, with no acute exacerbation (J44.0 and j44.1 is excluded).
J44.9	Other unspecified chronic obstructive lung disease.

3.3 Diagnosis-Related Groups

Norway has, along with most of the OECD countries, implemented a DRG-based hospital reimbursement system as a fundamental component in the Activity Based Funding (ABF) payment system (56). In Norway, every contact with hospitals and polyclinical consultations in somatic institutions is assigned a DRG-code, it says something about what activity that has happened at the hospital. Hospitals receive reimbursement based on the number and assortment of patients they treat. A patient is assigned to a certain group based on their diagnosis and the treatment needed, these groups are referred to as DRGs. The groups consist of patients who are expected to utilize similar amounts of hospital resources (57). Each DRG-code is assigned a DRG-weight, which is a relative size that expresses how much the treatment for a specific diagnose is weighted from the average weight of all treatments. In other words, it is a measure that displays how much one mean DRG-weight is compared to the mean of the average DRG. The weight can be converted into an estimated unit price, which is based on LOS, required personnel and resources needed to treat the patient. The weights are updated yearly in relation to medical practice and changes in the operating conditions at the hospitals. In 2015, the price for a DRG that was weighted 1, was 41 462

Norwegian kroners (NOK) (58). This means, if a patient assigned a DRG-code which is weighted 0,5, the expected cost of treatment for that patient would be 20 731 NOK. The cost of a patient who is weighted 1,5, is expected to be 62 193 NOK. It is a useful system which enables summarizing a great number of treatments given to a diversity of patients into a transparent and manageable group, and it makes it possible to compare the utilization of resources between hospitals (59).

3.4 Inclusion and exclusion criteria

Patients from KUHR and NPR were included in the study sample as COPD-patients if:

- They were older than 65 years in the time-period between 2012 and 2016

and

- Had at least one contact with the primary healthcare sector in the region Health South-East between 2012-2016, registered with the ICPC-2 code "R95" (COPD) in dataset from KUHR.

or

- Had at least one contact with the specialist healthcare sector in the region Health South-East between 2012-2016, registered with ICD-10 code J44.0, J44.1, J44.8 or J44.9 (COPD) in the dataset from NPR

Events were excluded if:

- They were missing subject ID

3.5 Ethical considerations and data safety

This master´s thesis is a part of a larger project by NIPH, it was approved as a sub-project by the Regional Committee for Medical Research Ethics (REC North, ref. 2016/1986) and will be performed in accordance with the 1964 Helsinki declaration (60). The data was collected from Norwegian population registries and every event registered by the healthcare sector had an associated social security number that identifies the person. This makes it possible to trace sensitive information about diagnostic and treatment across the registries for each individual patient. But, when NIPH received the raw datasets from SSB, sensitive information about the patients had been made pseudonymous. This was achieved by replacing the patient's social security number with a unique subject ID. SSB modified the sensitive information and is the only party with access to the connection key between the social security numbers and the

subject IDs. SSB also depersonalized information by for example replacing date of birth, date of hospitalization and admission with month and year. However, by combining year of birth, sex, municipality of residence, time, and date of event, there is a hypothetical risk of backwards identification, but given the large number of patients the risk is minimal. The datasets will be stored in a platform called Services for Sensitive Data (TSD) at University of Oslo (UiO), which is a password protected server and accessible only to those included in the application to The Regional Committees for Medical and Health Research Ethics (REC). The students access to the datasets will be removed in accordance with the contract with NIPH.

4 Method

4.1 Processing the datasets

Most of the analyses were executed in IBM® SPSS® Statistics version 28 for Windows and some variables and graphs were computed in Microsoft 365® Excel. When the REC application was approved, and the Declaration of Confidentiality and data processor agreement between UiT and NIPH was signed, I was granted access to the TSD research platform where the raw datasets were located. Then, the process of handling the raw datasets could commence. The raw data consisted of five files from KUHR (one file for each calendar year), one file from NPR (containing all five years combined) and two files from DSF - one containing constant variables (for example, sex and year of birth) and the other containing time-based variables (for example, municipality of residence and marital status). All files were separately converted from text-data to Statistical Package for Social Science (SPSS). The raw data from the primary- (KUHR) and specialist healthcare sector (NPR) offered information on event-level, meaning each line in SPSS represented information about a unique event that had occurred.

In the datasets from KUHR, many of the events were missing their subject ID. The amount of missing subject IDs appears to be decreasing at a systematic rate. This might be explained by the National Regular General Practitioner (RPG) scheme that was implemented in Norway in 2001 (61). The scheme was meant to secure that everyone receives necessary, high quality, and general medical service within reasonable time by giving each inhabitant a designated GP. Accordingly, events with missing subject IDs are patients without at GP, but number of patients with a GP gradually increased over the study years. All events with missing subject

IDs were removed from all datasets KUHR before proceeding further. The share of events that had missing subject IDs, can be seen in Table 3.

Table 3: Share of events with missing subject IDs in KUHR

	2012	2013	2014	2015	2016
Percentage of missing subject IDs (n)	31.8% (333 234)	23.5% (1 055 004)	17.5% (816 239)	11.2% (542 227)	4.4% (220 969)

As stated, COPD is registered as "R95" in the KUHR-datasets, all events registered with "R95" were selected to identify the sample of COPD-patients in the primary healthcare service. After identifying all events registered with COPD, duplicates of the subject ID were removed to identify unique patients who are thought to be diagnosed with COPD. The group of patients from this process is referred to as the COPD-patients. Their unique subject ID was used to identify all other contacts they have had with primary healthcare, which were not necessarily caused by COPD, but all other events they have generated caused by any diagnose. This resulted in datasets containing all events generated by COPD-patients.

The variables containing information about sex, month and year of birth, marital status and municipality of residence were merged from the SSB-files using the command "merge files" in SPSS with subject ID as key variable. To identify COPD-patients in NPR, the same procedure that was executed for the datasets from KUHR was completed. COPD is registered as "J44" in NPR, and all events registered as either J44.0, J44.1, J44.8 or J44.9 as main diagnosis were included. The variables containing bi-main diagnosis and bi-diagnosis were excluded from this process.

4.2 Exploring characteristics with frequency- and descriptive analysis

Characteristics for COPD-patients are presented on patient-level and event-level for the primary- and specialist healthcare sector. As the datasets contained information on the event-level, they had to undergo several processes to make it possible to explore them on patient-level. To begin with, frequency analyses were performed for each year to identify how many events each unique COPD-patient had generated. The table SPSS displayed containing how many events each COPD-patient generated were the basis of forming the datasets containing patient-level information. Age was then calculated separately for each calendar year by first subtracting the year of birth from the variable containing month and year of birth (yyyy-mm),

creating an individual variable containing year of birth only. Then, the current calendar year was subtracted with the variable containing year of birth to create a new variable with the age each patient turned that year. Frequency analyses were performed to explore the prevalence of events and number of unique patients, and a correlation coefficient was performed with the variables "age" and "number of events" for each unique patient in KUHR for 2015. Descriptive analysis was performed to identify the mean number of events, mean birth year and age. To explore differences between males and females, the command "split by" was applied on the sex-variable. It was expected that most of the COPD-patients would be present in KUHR because patients' normally needs to be referred by the primary healthcare service to the specialist healthcare service. Therefore, KUHR is used as the base to explore the characteristics of COPD-patients.

The same procedures were performed on the dataset from NPR. Frequency analyses were performed on the subject ID of the events to discover how many events occurred for each unique COPD-patient, in total and for each calendar year. The NPR dataset was separated based on year of event for polyclinical consultations and year of discharge from hospital. Age was calculated for each year by applying the same procedure as for KUHR. The dataset did contain patients younger than 66 years old. For example, if one patient was in contact with the hospital in 2016, being 66 years old at the time, the events generated by this patient in 2015 was present in the dataset despite being 65 years old at the time. The events generated by patients younger than 66 years old were removed. Since the data contain every event and every person who has been in contact with the healthcare service in Health South-East, it was not necessary to perform t-tests to investigate if there was any statistical difference between groups, for example males and females. If a difference in the prevalence was observed, there was in fact a real difference.

4.2.1 Length of stay

LOS was discovered by selecting all events with bed days above zero days in the dataset from NPR. These events represent all in-patient treatments and excludes every polyclinical consultation and out-patient treatment. LOS was then explored with frequency- and descriptive analyses on both patient-level and event-level, and between males and females.

4.3 Exploring healthcare utilization in more detail

To explore utilization of healthcare resources in more detail it was decided to focus solely on year 2015, because of the large amount of data and limited time. The other study-years were not included in the following analysis. A single event can be registered with several diagnosis and the composition of registered diagnoses was presented in a single cell; the diagnoses were separated by commas. To be able to explore the number of diagnoses registered for each event, the dataset containing information on event-level from 2015 was exported to Excel. From here, the number of commas in the diagnoses-variable was counted by applying the following formula:

$Occurence\ of\ text\ or\ characthers$ = LEN(cell_ref) - LEN(SUBSTITUTE(cell_ref,"X",""))

"X" was substituted with "," and "cell_ref" is the cell containing the diagnoses. The number of commas for the selected event appeared in the cell the formula was applied in. Since the commas divide the diagnoses, the number of commas was summarized with 1 to reveal the complete number of diagnoses. This process was copied for all the events. To identify the most frequent diagnoses, the diagnoses needed to be separated into single cells. This was done by using the "Text to column" function in Excel, and diagnoses were split by commas. Thereafter, the dataset was imported back to SPSS, frequency analyses were performed, and the results were displayed with ascending values to identify the most frequent diagnoses. Frequency analysis was performed on the three first columns only, since most of the events were registered with one to three diagnoses, The top 5 most frequent diagnoses for the three first columns were summarized and can be seen in the results.

4.3.1 Concentration curves

Two concentration curves for each KUHR and NPR was created by using the frequency tables displaying the number of events per COPD-patient. Number of events were sorted by ascending values and the tables were separately exported to Excel. The subject IDs was assigned new values ascending from 1 to the total number of COPD-patients, these values were computed into cumulative percentages with the following formula:

$$Cumulative\ percentage\ =\ Cell\ value\ *\ \frac{total\ number\ of\ subjects}{100}$$

This formula was copied for both the column with the value for subject ID and the frequency of events. The concentration curves were made in Excel with the cumulative percentage of event on the y-axis and the cumulative percentage of COPD-patients on the x-axis, from lowest percentage to the highest.

4.3.2 Patients overlapping in primary- and specialist healthcare sector

To discover the prevalence of COPD-patients overlapping in NPR and KUHR, was unique COPD-patients registered in KUHR assigned value one and those in NPR were assigned value two. The two datasets were merged into the dataset from DSF containing constant variables (since this dataset contains every unique subject ID for every patient) with Subject ID as the key variable. A new variable was computed that summarized the new values assigned each patient. This variable indicates that the COPD-patients with value one was present in KUHR only, those with value two was present in NPR only, and those with value three was present in both KUHR and NPR. The new variable was used to form a pie-chart that represented the division of COPD-patients present in KUHR only, NPR only and COPD-patients present in both KUHR and NPR.

4.3.3 Cost of treatment based on diagnosis-related groups

The cost of treatment in the specialist healthcare sector was based on DRG-codes, which is assigned each event in NPR. The belonging DRG-weights for each DRG-code was downloaded as an Excel-file from the Norwegian HD (62). This was imported to SPSS and merged into the dataset containing event-level information with the DRG-codes as the key variable. Some DRG-codes had been revised or removed from the study year (2015) to 2019, which resulted in missing weights. Because of this, 126 out of 881 DRG-codes (14%) were removed from the dataset before proceeding further. The complete list of removed DRG-codes can be seen in Appendix III. The cost of each event was calculated by computing a new variable by applying the following formula:

$$DRG\ weight\ *\ 41\,462\ NOK\ =\ cost\ of\ DRG\ weight\ in\ NOK$$

41 462 NOK is based on the unit price for a DRG-weight in 2015 (63). Since the costs were calculated on event level, it was necessary to restructure the cost-per-event to line up according to subject ID to be able to calculate the total cost per COPD-patient. This was done

by using the restructure function in SPSS with subject ID as key variable. The total cost per COPD-patient was calculated by summarizing all variables containing cost-per-event for each patient.

To explore the difference in cost of treatment between COPD-patients and the general population located in Health South-East, a new dataset with the number of COPD-patients at every age from 66 to 105 was created. This was done by executing a frequency analysis on the variable "age" in the dataset from 2015 containing patient-level data. SSB has public online databanks with information about number of residents, at every age, for every year, in every county in Norway (64). This made it possible to create a dataset that contained the number of residents on the 1st of January 2015, for all ages between 65 to 105 years old in all ten counties that formed Health South-East before the municipality reform. The information was imported to SPSS where number of residents for every county were summarized to discover the total number of people, for all ages, living in Health South-East, in 2015. The dataset was then merged into the new dataset containing the distribution of COPD-patients for all ages, with age as the key variable. As the number of COPD-patients dropped below 100 patients when exceeding ages older than 89 years, all the ages above 88 years were removed from the dataset to reduce the risk of bias possibly induced by a low number of patients.

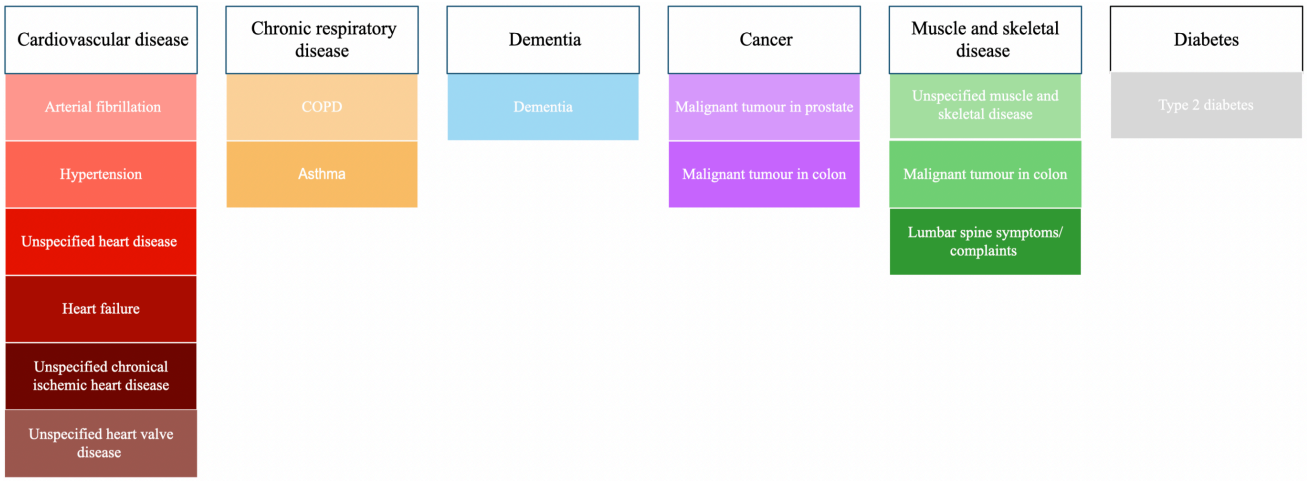
To further explore the differences in cost of treatment between COPD-patients and the general population, the cost of treatment for every single patient that was in contact with the specialized healthcare service in 2015 was required. This was calculated using the same processes that was applied when calculating the cost of treatment for COPD-patients. Thereafter, age was separated by using the "split by" command and descriptive analyses were performed to discover the total cost for all ages for both COPD-patients and all other patients who were in contact with the specialized healthcare service in 2015. These results were merged into the new dataset with age as the key variable. This resulted in a dataset that was based on age with the prevalence of COPD-patients and number of all other patients in Health South-East, and total cost per age. To discover the mean cost per patient for each age, two new variables were computed by dividing the total cost for each age by total number of patients for both the whole NPR-dataset and for COPD-patients separately. This made it possible to form a multiple line-graph, where age was placed on the x-axis and mean cost per patient on the y-axis, split by the general population and COPD-patients. Descriptive analyses were performed on the two variables containing mean costs to reveal age adjusted mean costs.

4.3.4 Linear regression

Several linear regressions were performed to isolate the effect of having COPD. The initial simple linear regression analysis was performed using patient-level data with information about every patient registered in NPR in 2015, including the costs of treatment. The dependent variable was the total cost of treatment per patient, and the independent was whether the patient had been registered with COPD or not. An additional multiple linear regression analysis was performed with the total cost of treatment per patient as the dependent variable, and sex, age, whether the patient had been registered with COPD or not, and the number of diagnoses as the independent variables.

The variable containing number of diagnoses was based on the data from KUHR in 2016. The selected diagnoses were based on the top 50 most frequent diagnoses registered in KUHR in 2016, which were discovered with frequency analysis. The complete list of the 50 most frequent diagnoses can be seen in Appendix IV. While every event in KUHR is registered with a diagnosis-code that refers to the cause of the event, some of the codes are not illnesses, but can for example be administrative purposes (A97) or unspecified health problems (A99). Temporary and transient conditions were excluded, including mental disorders. The selected diagnoses were divided into five main categories: cardiovascular disease, chronic respiratory disease, dementia, cancer, and muscle and skeletal disease. The diagnoses included in each category can be seen in Figure 4.

Figure 4: The diagnoses included in the different categories



One simple linear regression analysis included the total cost of treatment per COPD-patient as the dependent variable, and sex, age, and number of diagnoses as independent variables. The last simple linear regression explored the total cost of treatment per COPD-patient as the dependent variable and the diagnose-categories "cardiovascular disease", "chronic respiratory disease", "dementia", "cancer", "muscle and skeletal disease" and "diabetes" as the independent variables.

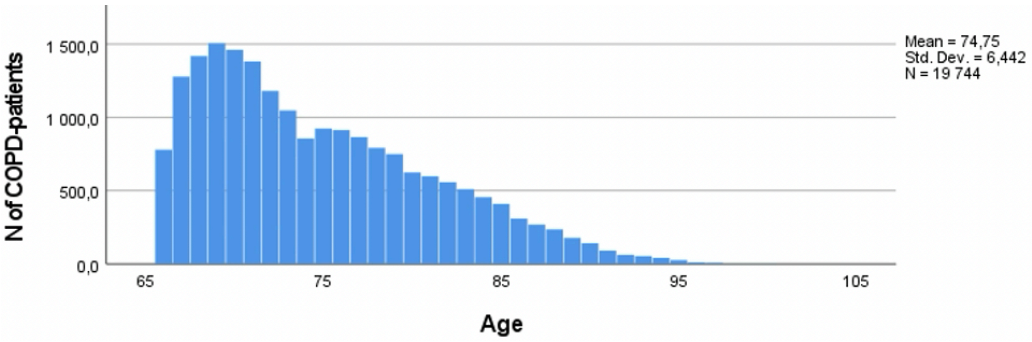
5 Results

5.1 Descriptive characteristics of study sample

5.1.1 The primary healthcare sector

A total of 35 185 unique COPD-patients were registered in either the primary- or specialist healthcare sector. Out of the total registered COPD-patients, 34 519 (91.6%) were registered in KUHR throughout the 5 years studied. The year of birth ranged from 1911 to 1950, mean year of birth was 1940, median was 1942 and mode was 1946. Average age for each year studied was approximately 74 years for both sexes. Figure 5 displays the distribution of age for COPD-patients in 2015 and show that a higher share of the COPD-patients is of younger age.

Figure 5: Distribution of age in 2015



Females constituted a slightly higher share of the COPD-patients (51.5%, n = 17 298) than males (48.5%, n = 16 299). Roughly half of the COPD-patients were married the year of contact, about 25% of them were cohabitants while about 19% were divorced. Most of the patients resided in Akershus, followed by Oslo, Østfold and Vestfold. Fewest of the patients resided in Aust-Agder. Table 4 displays the characteristics of the COPD-patients in more detail for each year.

Table 4: Characteristics of COPD-patients registered in KUHR

	2012	***2013***	***2014***	***2015***	***2016***
COPD-patients, n (mean age ± SD)	8 488 (73.8 ± 6.0)	13 570 (74.0 ± 6.2)	16 472 (74.6 ± 6.3)	19 744 (74.8 ± 6.4)	22 784 (75.1 ± 6.6)
Max age	97	99	104	104	105
Male	4 005 (73.6 ± 5.9)	6 524 (73.9 ± 6.1)	7 988 (74.2 ± 6.2)	9 621 (74.6 ± 6.3)	11 210 (75.0 ± 6.5)
Female	4 483 (74.0 ± 6.1)	7 046 (74.2 ± 6.3)	8 484 (74.5 ± 6.4)	10 123 (74.9 ± 6.5)	11 574 (75.2 ± 6.7)
Marital status, % (n)					
Unmarried	4.0% (343)	4.1% (558)	4.1% (683)	4.3% (857)	4.8% (1 092)
Married	52.8% (4 479)	52.3% (7 092)	51.4% (8 470)	50.3% (9 928)	49.2% (11 211)
Cohabitant	23.8% (2 019)	23.9% (3 247)	23.8% (3 915)	24.0% (4 747)	23.8% (5 427)
Divorced/separated	18.3% (1 554)	18.6% (2 518)	19.5% (3 218)	20.1% (3 927)	21% (4 786)
Widow/widower	1.0% (83)	1% (130)	1.0% (163)	1.1% (209)	1% (235)
Partner	0.1% (3)	0.1% (6)	0.1% (7)	0.1% (5)	0.1% (1)
Separated partner	-	-	-	-	-
Divorced partner	-	0.1% (2)	0.1% (1)	0.1% (1)	0.1% (1)
Surviving partner	-	0.1% (17)	0.1% (2)	0.1% (2)	0.1% (4)
Municipality of residence, % (n)					
Østfold	11.8% (1 003)	12.4% (1 658)	12.2% (2 015)	12.1% (2 404)	11.9% (2 732)
Akershus	17.0% (1 441)	16.7% (2 274)	16.7% (2 756)	16.1% (3 180)	16.5% (3 778)
Oslo	13.2% (1 123)	13.8% (1 882)	13.3% (2 203)	13.1% (2 593)	12.9% (2 944)
Hedmark	10.1% (885)	9.9% (1 352)	10.1% (1 676)	9.9% (1 973)	10.2% (2 346)
Oppland	7.3% (621)	7.1% (973)	7.5% (1 247)	7.4% (1 464)	7.6% (1 742)
Buskerud	9.3% (793)	9.5% (1 290)	9.5% (1 573)	9.8% (1 939)	9.7% (2 226)
Vestfold	10.6% (898)	10.9% (1 482)	9.4% (1 561)	11.4% (2 267)	11.3% (2 584)
Telemark	7.7% (657)	7.0% (958)	7.0% (1 159)	7.3% (1 459)	7.1% (1 634)
Aust-Agder	5.1% (431)	4.8% (686)	4.7% (788)	5.0% (1 003)	4.9% (1 138)
Vest-Agder	7.7% (657)	7.3% (991)	7.0% (1 168)	7.1% (1 420)	7.1% (1 621)

5.1.2 The specialist healthcare sector

There were in total 383 468 unique patients registered in NPR over the five study-years, whereof 45.0% were males (n = 172 654). As there were 468 064 residents in Health South-East in 2015, aged between 65 to 105 years old (64), 81.9% of every elderly resident was in contact with the specialized healthcare sector that year. COPD-patients constituted 3,6% (n = 13 947) of the total number of patients and sexes were equally distributed with 49.4% (n = 6 887) males. Year of birth for the COPD-patients ranged from 1915 to 1950, mean birth year = 1941, the median was 1942, and mode was 1945. Table 5 displays the prevalence of COPD-patients registered in NPR over the five years studied.

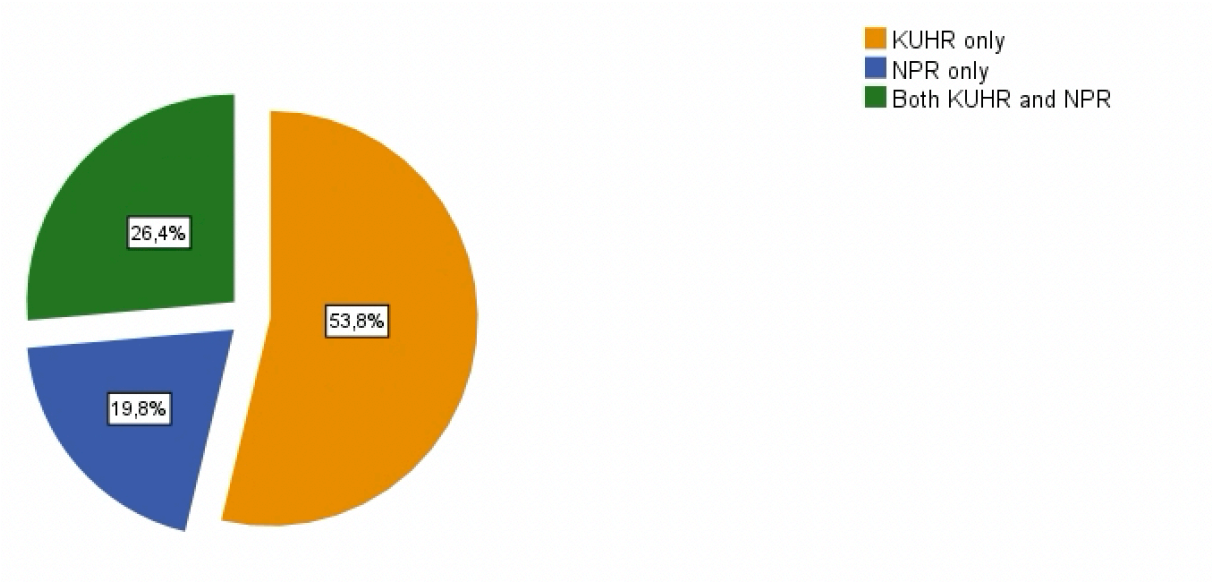
Table 5: Prevalence of COPD-patients in NPR

	2012	***2013***	***2014***	***2015***	***2016***
COPD-patients, n (mean age ± SD)	7 881 (73.6 ± 5.9)	8 850 (74.0 ± 6.1)	9 876 (74.3 ± 6.3)	10 830 (74.8 ± 6.4)	11 685 (75.3 ± 6.6)
Male	3 888 (73.3 ± 5.8)	4 354 (73.7 ± 5.9)	4 863 (74.1 ± 6.1)	5 346 (74.6 ± 6.3)	5 764 (75.2 ± 6.5)
Female	3 993 (73.9 ± 6.1)	4 496 (74.2 ± 6.3)	5 013 (74.5 ± 6.4)	5 484 (75.0 ± 6.6)	5 921 (75.5 ± 6.7)

5.1.3 Share of COPD-patients registered in NPR or KUHR

About half of the COPD-patients were registered in KUHR only (53.8%), about a quarter were registered in both NPR and KUHR (26.4%), and the least patients were registered in NPR only (19.8%). Most women were registered in KUHR only and in both KUHR and NPR. More men than women were registered in NPR only.

Figure 6: Share of COPD-patients who were in contact with either KUHR only, NPR only or both in 2015

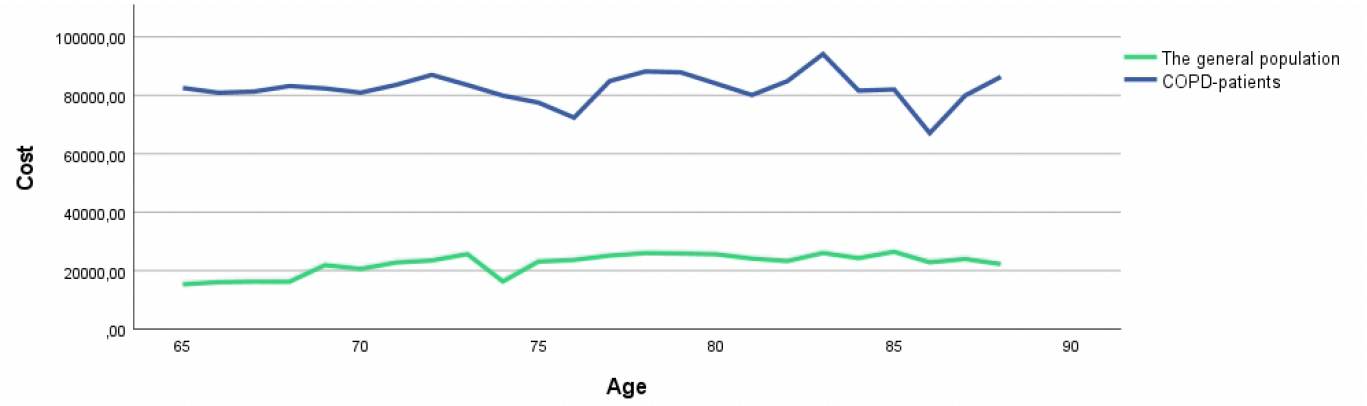


There were only two deaths registered in 2014, one in 2015 and five in 2016. As this seemed unusually low, number of deaths was not given further attention and is assessed under limitations in the discussion section.

5.2 The cost of treatment in the specialist healthcare sector

Figure 7 shows the difference in cost of treatment between COPD-patients and the general population in the specialized healthcare sector, for all ages. The mean cost of treatment per patient was more than 3,5 times higher for COPD-patients than it was for the general population. The mean cost was adjusted for age and revealed that it was 22 388 NOK for the general population while it was 82 247 NOK for COPD-patients, which equaled to a discrepancy in costs of 59 959 NOK in 2015.

Figure 7: Differences in the cost of treatment between COPD-patients and the general population in the specialist healthcare sector in 2015



A simple linear regression was performed to test if being diagnosed with COPD or not predicted the cost of treatment among all patients registered in NPR in 2015. The cost of treatment per patient increased with 41 820 NOK if the subject was a COPD-patient compared to the average cost of any other patient registered in NPR. The coefficient can be seen in Table 6.

Table 6: Coefficient table for simple linear regression for all patients in NPR

	Unstandardized Coefficients			
Model	B	Std. Error	t	Sig.
(Constant)	41018.5	211.8	193.7	0.000
COPD or not	41820.1	957.0	43.7	0.945

Dependent variable: Total cost of treatment per patient

The coefficient in the regression coefficients were statistically significant[1] F (1, 220257) = 1909,544 $p < 0.001$), with an R^2 of .009, where "COPD or not" is coded as 0 = not registered with COPD, and 1 = registered with COPD.

A multiple linear regression was performed to predict the cost of treatment based on age, sex, and number of diagnoses for every patient registered in NPR in 2015. Cost of treatment increased with 407 NOK when age increased with one, and it was on average 7 817 NOK lower for females than it was for males, The costs increased with 6 742 NOK for each additional diagnosis. The coefficients can be seen in Table 7.

[1] Significant at the 5% level.

Table 7: Coefficient table for multiple linear regression for all patients in NPR

	Unstandardized Coefficients			
Model	B	Std. Error	t	Sig.
(Constant)	18994.7	2282.2	8.3	0.000
Age	407.4	29.7	13.7	0.945
Sex	-7816.8	427.0	-18.3	0.000
N of diagnoses	6741.7	277.0	24.3	0.000

Dependent variable: Total cost of treatment per patient

The regression was statistically significant, (F (3, 212455) = 405.857), p = <.001), with an R^2 of .075. The predicted cost of treatment is equal to 18 994,664 - 7816,762 (sex) + 407,348 (age) + 6741,696 (n of diagnoses), where sex is coded as 1 = males and 2 = females.

The dataset was limited to COPD-patients only before performing an additional multiple linear regression analysis that was used to predict the cost of treatment for COPD-patients based on age, sex, and number of diagnoses. Cost of treatment increased with 5 659 NOK for each additional diagnosis. The coefficients can be seen in Table 8.

Table 8: Coefficient table for multiple linear regression for COPD-patients - age, sex, and number of diagnoses

	Unstandardized Coefficients			
Model	B	Std. error	t	Sig.
(Constant)	81615.7	17509.0	4.7	0.000
Age	15.6	227.1	0.1	0.945
Sex	-5301.9	2909.9	-1.8	0.068
N of diagnoses	5659.0	1773.0	3.2	0.001

Dependent variable: Total cost of treatment per patient

The regression analysis was statistically significant, (F (3, 10615) = 4.719), p = .003), with an R^2 of .036. The COPD-patients predicted cost of treatment is equal to 81616,668 - 5301,927 (sex) + 15,634 (age) + 5658,979 (n of diagnoses). While age and sex were not significant at the 5% level.

The following multiple linear regression was used to predict the cost of treatment for COPD-patients based on which of the six diagnoses they have. Cost of treatment for COPD-patients increased with 12 457 NOK and 22 466 NOK if the patient was diagnosed with cardiovascular disease and cancer, respectively. The coefficients can be seen in table 9.

Table 9: Coefficient table for multiple linear regression for COPD-patients - diagnoses

Model	Unstandardized coefficients B	Std. Error	t	Sig.
(Constant)	76975.0	3015.0	25.5	0.000
Cardiovascular disease	12456.9	2971.3	4.2	0.000
Chronic respiratory disease	-1409.2	3126.1	-0.5	0.652
Dementia	14531.3	10062.7	1.5	0.149
Cancer	22466.3	7016.0	3.2	0.001
Diabetes	3657.2	4594.2	0.8	0.426
Muscle and skeletal disease	-2263.2	4844.1	-0.5	0.640

Dependent variable: Total cost of treatment per COPD-patient

The regression was statistically significant, (F (6, 10612) = 5.259), $p < .001$), with an R^2 of .003. The predicted cost of treatment for COPD-patients is equal to 76973,866 + 12456,878 (cardiovascular disease) - 1409,209 (chronic respiratory disease) + 14531,245 (dementia) + 22466,284 (cancer) + 3657,154 (diabetes) - 2263,220 (muscle and skeletal disease). Cardiovascular disease and cancer are the only two diagnoses that were significant at the 5% level.

When exploring the costs generated by COPD-patients in more detail, it was discovered that the mean cost per COPD-patient and the total cost per year did increase throughout the five-year period. Mean cost per COPD-patient increased with 31 814 NOK from 2012 to 2016. Males had a higher mean cost of treatment compared to females. In addition, males' average cost of treatment increased at a higher rate than for females. Table 10 displays the costs for each year in detail.

*Table 10: Mean cost of treatment per COPD-patient**

	2012		***2013***		***2014***		***2015***		***2016***	
Mean cost per COPD-patient *n (±SD)*	66 099 (±128 004)		70 885 (± 137 716)		74 106 (± 141 221)		86 542 (± 153 084)		97 914 (± 160 971)	
Sex *n (±SD)*	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
	68 629 (± 136 101)	63 654 (± 119 625)	75 414 (± 154 408)	66 500 (± 119 206)	74 698 (± 142 525)	73 532 (± 139 956)	89 451 (± 163 967)	83 703 (± 141 620)	103 243 (± 177 128)	92 724 (± 143 325)
Total cost	505 792 575		610 814 701		731 868 773		935 084 028		1 142 554 278	

** Costs are presented in NOK*

5.2.1 Increasing cost and prevalence of COPD-patients

The prevalence of COPD-patients in the specialist healthcare sector increased each year studied, from 7 881 COPD-patients in 2012 to 11 685 in 2016. The average cost per COPD-patient registered with polyclinical consultations increased while the average cost per COPD-patient in in-patient treatment and out-patient treatment decreased. Acute hospitalizations had an average cost of 57 357 NOK while planned hospitalizations had an average cost of 6 016 NOK for.

5.2.2 What is behind the costs

COPD-patients generated on average about 6 events in the specialist healthcare sector. Males generated approximately one more event than females.

Table 11: The prevalence of events for COPD-patients and for polyclinical events, in-patient events, and out-patient events

	2012	***2013***	***2014***	***2015***	***2016***
Events by COPD-patients, n	55 315 (5.56)	60 209 (5.77)	63 936 (5.85)	72 356 (6.36)	82 765 (7.08)
Males (mean events)	28 690 (5.86)	31 454 (6.13)	32 876 (6.10)	38 325 (6.83)	44 852 (7.78)
Females (mean events)	26 625 (5.56)	28 755 (5.77)	31 060 (5.85)	34 031 (5.36)	37 913 (7.08)
Polyclinical events, n	40 836	43 780	45 708	50 648	56 681
Male (mean events)	20 945 (4.60)	22 813 (4.80)	23 360 (4.66)	26 677 (5.07)	30 327 (5.66)
Female (mean events)	19 891 (4.27)	20 967 (4.32)	22 348 (4.37)	23 971 (4.54)	26 354 (4.87)
In-patient events, n	9 873	11 242	12 404	14 799	17 576
Male (mean events)	4 898 (2.16)	5 625 (2.26)	6 100 (2.31)	7 397 (2.48)	8 870 (2.78)
Female (mean events)	4 975 (2.04)	5 617 (2.13)	6 304 (2.21)	7 402 (2.34)	8 706 (2.49)
Out-patient events, n	4 606	5 187	5 824	6 909	8 508
Male (mean events)	2 847 (4.81)	3 016 (4.76)	3 416 (4.83)	4 251 (5.06)	5 655 (6.09)
Female (mean events)	1 759 (3.04)	2 171 (3.14)	2 408 (3.26)	2 658 (3.50)	2 853 (3.34)

In-patient treatment had the highest mean cost per patient, followed by out-patient treatment and polyclinical consultations. The mean cost for polyclinical treatment increased during the five years studied, while the cost for in-patient treatment and out-patient treatment decreased. Descriptive statistics for 2015 revealed that the total sum of polyclinical treatment was 117 157 930 NOK, 828 114 016 NOK for in-patient treatment, and 35 626 638 NOK for out-patient treatment. The mean cost per COPD-patient can be seen in Table 12.

*Table 12: Mean cost per COPD-patient for polyclinical treatment, out-patient treatment, and in-patient treatment in 2015**

	Polyclinical treatment	***In-patient treatment***	***Out-Patient treatment***
N of events by COPD-patients	55 697	13 663	2 996
Male	30 006	6 800	1 519
Female	25 691	6 863	1477
Mean cost per event by COPD-patients *(± SD)*	2103 (± 1759.9)	60 610 (± 68 370.2)	11 891 (± 15 799.6)
Male	2 137	61 595	12 172
Female	2 064	59 634	11 602

** Costs are presented in NOK*

40% of the events (n = 5 685) were registered with in-patient treatment while having zero bed days, most of these events were acute (75%). 12% (n = 670) of these events were registered with COPD as cause, and a higher share of them were acute (91%).

Figure 8 and 9 displays the increase in polyclinical events and in-patients' events, each year. For polyclinical events, there was a decrease every year from June until August. In-patient events did not have the same pattern as polyclinical events have in the summer-months. However, there is a systematic increase in number of events in both events at the polyclinic and in-patient treatment during the study period.

Figure 8: The distribution of events at the polyclinic, per month for all 5 years

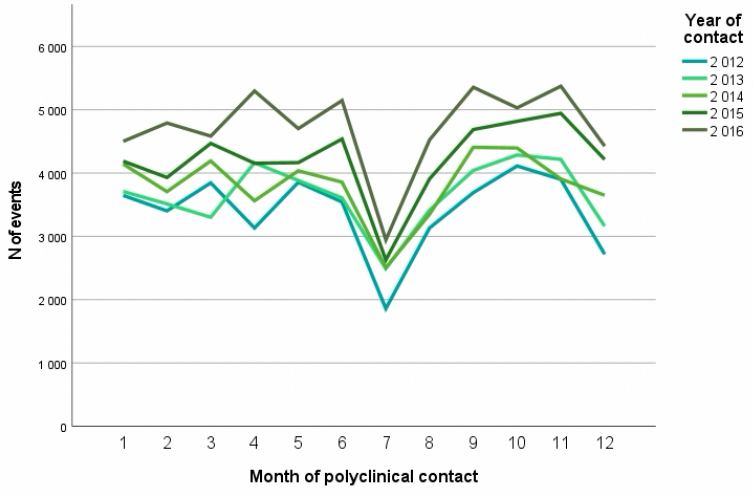
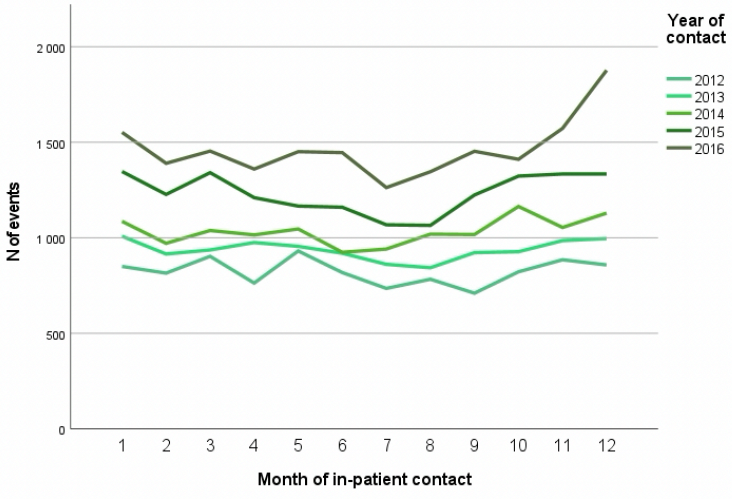


Figure 9: The distribution of all in-patient events, per month for all 5 years



5.2.3 Hospitalizations and length of stay

The prevalence of both acute and planned in-patient treatment increased during the years studied, as shown in Table 13. Moreover, most hospitalizations were acute events (> 71%)

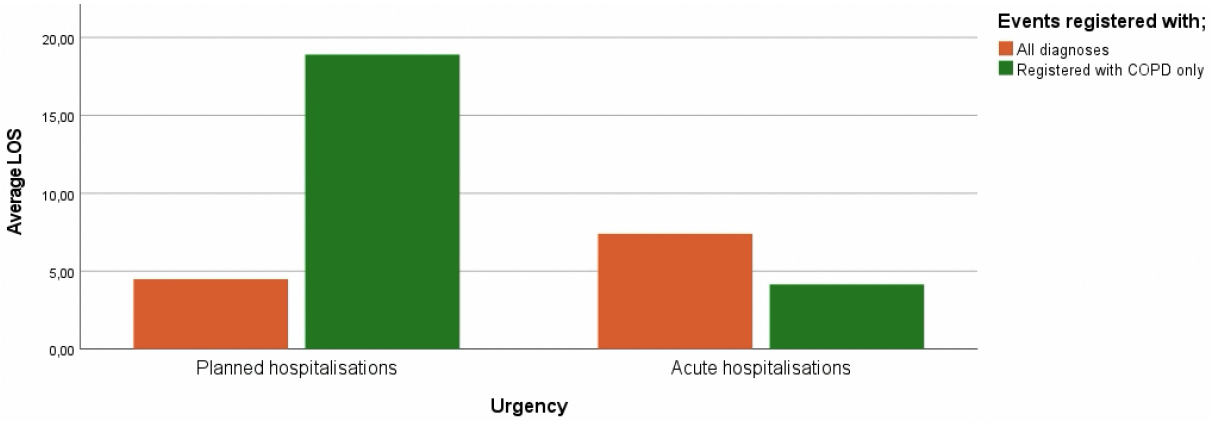
and the prevalence of acute hospitalizations increased at a more rapid rate than planned hospitalizations.

Table 13: Prevalence of acute and planned in-patient treatment for all five years

Type of urgency	*2012*	*2013*	*2014*	*2015*	*2016*	*Total*
Planned, n (%)	2 596 (28.4)	2 801 (27.2)	3 002 (26.7)	3 262 (23.9)	3 372 (20.7)	15 034 (24.8)
Acute, n (%)	6 544 (71.6)	7 512 (72.7)	8 283 (73.3)	10 411 (76.1)	12 879 (79.3)	45 635 (75.2)
Total	9 139	10 313	11 285	13 673	16 251	60 670

The average LOS for COPD-patients was 5.22 bed days, 75.2% of the hospitalizations were acute (n = 45 636) and had an average LOS of 7.40 bed days, while 24.8% (n = 15 073) of the hospitalizations were planned with an average LOS of 4.49 bed days. After delimiting the dataset to hospitalizations registered with COPD as cause, the average LOS increased to 7.05 bed days. About 80% (n = 10 617) of these hospitalizations were planned, with an average LOS of 18.90 bed days. While 19.6% of them were acute with an average LOS of 4.15 bed days. Figure 10 displays the distribution of planned and acute hospitalizations between all events and COPD-caused events.

Figure 10: Distribution of planned av acute hospitalizations



Almost 30% of the top 5 most frequently reported main diagnosis for hospitalizations were related to lung disease:

1. Unspecified acute exacerbation of COPD (J44.1, n = 5 392, 8.9%)
2. Unspecified COPD (J44.9, n = 4 354, 7.2%)
3. Unspecified bacterial pneumonia (J15.9, n = 4 198, 6.9%)
4. COPD with acute infection in the lower airways (J44.0, n = 3 156, 5.2%)

5. Unspecified pneumonia (J18.9, n = 1 449, 2.4%)

5.3 Concentration curves

Figure 11 and Figure 12 displays the concentration curves for every event caused by COPD-patients for all five years in either KUHR or NPR. The x-axis represents the cumulative percentage of COPD-patients, and the y-axis represents the cumulative percentage of the events they generated. These show that a minor share of the COPD-patients was responsible for a larger share of the events. In the primary healthcare sector, 20% of the patients were accountable for about 45% of all the events, 10% were accountable for 30% of the events and the top 5% patients were accountable for 20% of the events. And in the specialist healthcare sector 20% of the COPD-patients were accountable for 60% of the events, 10% were accountable for 20% of the events and the top 5% were accountable for 15% of the events.

Figure 11: Concentration curve of all events generated by COPD-patients in the primary healthcare sector

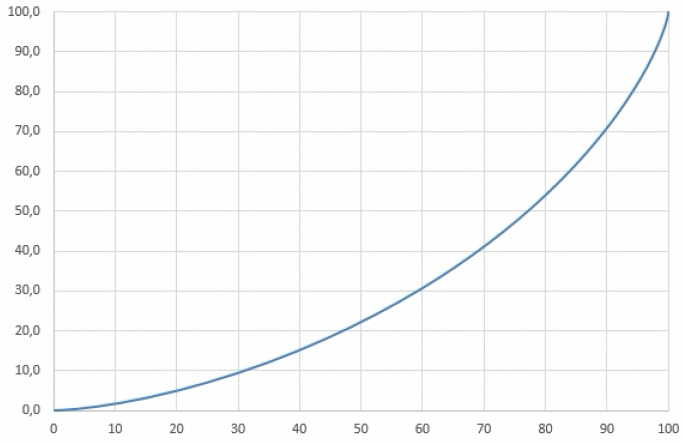
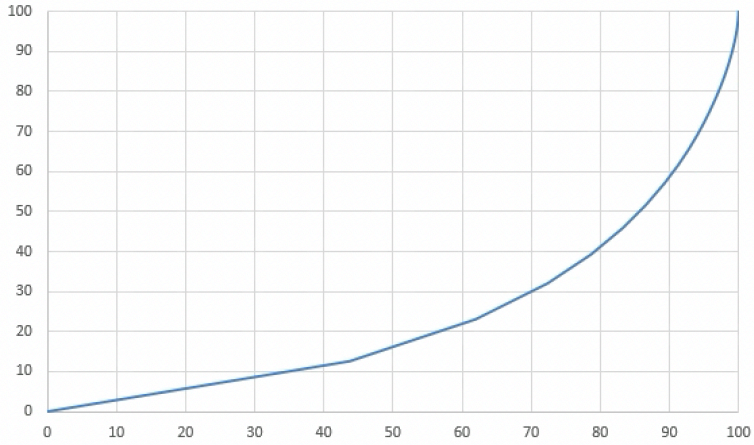


Figure 12: Concentration curve of all events generated by COPD-patients in the specialist healthcare sector



The top 30% consumers in NPR had a mean cost of treatment of 147 958 NOK, where 44.3% were males. The top 20% had a mean cost of treatment of 166 467 NOK, and the top 10% had a mean cost of treatment of 210 163 NOK. Mean age was 73 for all three divisions, but in the top 10% healthcare utilizers were over 60% of the COPD-patients females.

5.4 Resource utilization in primary healthcare

5.4.1 The primary healthcare service

COPD-patients generated in total 1 196 783 events in the primary healthcare sector, which equals 299 196 events on average per year, males were responsible for 44.7%. Diagnoses

were explored in detail for COPD-patients in 2015, most of the events in the primary healthcare sector were registered with only one diagnosis (65.5%), some were registered with two diagnoses (28.8%) and a smaller share with three diagnoses (3.6%). The remaining 2.1% events were registered with four or more diagnoses. About 27% of the events were regarding COPD, while 73% of the events were registered with other diagnoses. The top 5 most frequent diagnoses were:

1. COPD (R95, n = 88 449)
2. Ischemic heart disease (K97, n = 22 679)
3. Atrial fibrillation (K78, n = 16 832)
4. Hypertension (K86, n = 13 133)
5. Diabetes type 2 (T90, n = 3 981)

Descriptive analysis revealed that each COPD-patient generated more than 13 events on average in the primary healthcare sector each year. About four of these events were regarding COPD. Table 14 displays the characteristics of the events generated by COPD-patients in KUHR for each year in more detail.

Table 14: Prevalence of events in KUHR by COPD-patients

	2012	***2013***	***2014***	***2015***	***2016***
Events by COPD-patients, n	122 823	202 967	258 580	328 685	406 551
Male (mean event)	52 453 (13.1)	88 388 (13.6)	114 517 (14,4)	146 387 (15.3)	185 190 (16.5)
Female (mean event)	70 370 (15.7)	114 579 (16.3)	144 063 (17.0)	182 298 (18.0)	221 361 (19.1)
Min	1	1	1	1	1
Max	198	202	223	317	945
COPD-events by COPD-patients, n	28 081	55 542	70 107	89 424	110 114
Male (mean event)	12 506 (3.1)	25 351 (4.0)	32 447 (4.1)	41 207 (4.3)	51 308 (4.6)
Female (mean event)	15 575 (3.5)	30 191 (4.1)	37 660 (4.5)	48 217 (4.8)	58 806 (5.1)
Min	1	1	1	1	1
Max	49	97	99	94	99

Over the five years, 96% of the contacts were with GPs and the remaining 4% were with the ER. Females were responsible for about 56% of the contacts for both the GP and the ER. A Pearson correlation coefficient revealed that there was a positive correlation between the variables age and number of events, $r(19742) = .174$, $p < .001$. I.e., that number of events increases with increasing age.

6 Discussion

6.1 Summary of main findings

The main aim of this study was to examine what healthcare resources elderly patients diagnosed with COPD utilize in the primary- and specialist healthcare sector in South-Eastern Norway. Additional aims were to isolate the effect of having COPD, to explore the cost of healthcare resources utilized by this group of patients and to explore what exaggerated the costs. There were on average 7 037 unique COPD-patients each year, totaling 35 185 COPD-patients. In 2015, there were 19 744 and 10 830 COPD-patients registered in KUHR and NPR, respectively. The mean age was roughly 74 years old, and the share of females was slightly higher than the share of males.

The results from the analyses show that the average direct costs of treatment per COPD-patient in 2015 were 82 247 NOK, while average direct cost of treating the general population was 22 388 NOK. Meaning that the costs were more than 3.5 times higher for COPD-patients than it was for the general population. The average cost of treatment increased with 41 0189 NOK if the patient was diagnosed with COPD compared to the cost of a person from the general population. The mean cost per COPD-patient ranged from 66 051 NOK in 2012 to 97 914 NOK in 2016. Mean cost was highest in in-patient treatment, followed by out-patient treatment and polyclinical treatment. COPD-patients visited the primary- and specialist healthcare sector more often than the general population, COPD-patients visited their GP about 4.5 times more often than the elderly Norwegian population. The average LOS for acute hospitalizations among COPD-patients were 7.4 bed days while it was 4.5 bed days for the general Norwegian population in 2014 (65). The cost increased with 6 742 NOK per additional diagnosis added to any patient who visited the hospital in 2015, while the cost per added diagnoses for a COPD-patient were 5 659 NOK. Cancer was the diagnose that increased the costs the most, followed by cardiovascular disease. Males had a higher mean cost of treatment than women.

A small share of the COPD-patients is accountable for a large share of the utilization of resources. 10% of the COPD-patients were accountable for 30% and 20% of the events in NPR and KUHR, respectively. The sample of the top 30% of high consumers in the specialist healthcare sector had a mean cost of treatment of 147 958 NOK per COPD-patient. The mean cost of treatment was almost two times higher than the mean cost of treatment for every

COPD-patient. The top 20% of high consumers had a mean cost of treatment of 166 467 NOK, while the top 10% had a mean cost of 210 163 NOK, which is 2.5 times more than the mean cost for the overall COPD-patient. What is interesting is that mean age is 73 for alle three divisions. Males and females are equally distributed for the top 30% and 20%, while females constituted over 60% of the top 10%

The results set forth in this thesis shows an increase in mean events generated by COPD-patients and an increase in the cost of treatment in the specialist healthcare sector. In other words, the utilization of resources is increasing. There is also some interesting finds about the share of COPD-patients that utilize most resources.

6.2 Discussion of findings

While research on healthcare utilization is important, this study makes a small contribution to the field. This master´s thesis is context-dependent, and of relative importance, and can contribute to the issue of forthcoming increased need for healthcare resources among COPD-patients in Norway. Understanding patterns in healthcare utilization is important for planning purposes and for appropriate allocation of scarce healthcare resources to increase the quality of healthcare. There is a general understanding that COPD-patients utilize a statistically significantly higher share of healthcare resources compared to those who are not diagnosed with COPD, and all previous literature that was assessed supported the overall findings in this study.

The increase in mean events and average cost of treatment might be explained by an improvement and increased awareness of COPD-diagnostics in Norway in recent years. For example, has there been a considerable improvement in GPs ability to differentiate between asthma and COPD the past two decades (66). Even so, although diagnostic of COPD may have improved, the patients could have been discovered late in the course of their illness. It might explain why there has been an increase in the need for acute treatment, as late diagnostic is correlated with more frequent COPD-exacerbations and a higher rate of hospitalization (67). The use of healthcare services provided by the GP and the ER has increased for the overall Norwegian population. The Norwegian HD reported that the prevalence of acute hospitalizations increased with 5% among elderly with chronic diseases, and it increased the most for patients with influenza and pneumonia (68). The results in this

study show that more COPD-patients generate more contacts with the GP, and fewer COPD-patients generate more contacts in the ER, so the number of patients who utilize acute- or planned healthcare has not increased symmetrically. This may indicate that the need for acute healthcare has increased, or that COPD-patients were referred to acute healthcare at a more frequent rate than before, or that the prevalence of preventable hospitalizations increased. Some acute hospitalizations due to chronic diseases are preventable and can be avoided by adequate follow-up in the primary healthcare sector. A previous study suggests that people suffering from asthma would reduce their risk of exacerbation requiring hospital admission if they visited health clinics on a regular basis (69). And the health atlas for COPD revealed that regular follow-ups for COPD-patients are not common in Norway, despite being recommended by national guidelines (11).

The total cost per COPD-patient in this study was like other previous studies, but in the higher end. A systematic review estimated that the annual cost for treating COPD-patients was 78 655 NOK to 246 877 NOK ($11 446-$31). The expenses included the cost of visits to the GP, in-patient expenses, and out-patient expenses (70). A Swedish study estimated the total annual direct costs per COPD-patient to be 42 895 NOK (44 480 Swedish Krona) for COPD-patients with very severe COPD (40). But these studies did not measured cost of treatment based on data from registries and DRG-codes. One study from Japan calculated the costs based on DRG-weights, it estimated that the annual cost of treatment per COPD-patient (> 65 years old) is 44 901 NOK ($4 768) (71). A Norwegian study, which interviewed COPD-patients older than 40 years old, stated that the expenses related to treating COPD-patients were threefold the expenses treating the general population. They estimated that the annual cost of treating ever-smoking COPD-patients in hospital was 96 451 NOK (€9 503) (48). And the average healthcare expenses for treating 60 years old's were twice as high as the expenditure for 40 year old's (72). Since COPD is a progressive condition and elderly patients utilize more resources than younger patients, future research should differentiate between young- and elderly COPD-patients when conducting future studies. Also, when implementing future policies and when considered allocating of healthcare resources.

COPD is previously known as a male-dominated disease, but newer literature states that COPD affects both sexes equally (73, 74). However, while COPD affects both sexes equally, the way in which they utilize healthcare resources vary. A previous study did not detect any differences in the frequency of COPD-related visits to the GP between the sexes (75), but the

results in this study did. Female COPD-patients did visit the GP more often than males, independently from COPD-related causes, there were also small differences between the sexes when assessing frequency of contacts with the specialist healthcare services. It is well-known that there are differences between males and females when it comes to help-seeking behavior, where males utilize primary healthcare services to a lesser extent than females (76). Previous literature has also states that females are hospitalized more often and have a higher cost of treatment than males (9). In the current study, males amounted an average of about 5 000 NOK more than females did. 5 000 NOK constitutes about 6% of the average cost of treatment for males, and males were accountable for about 51% of the total costs related to treatment in 2015. Considering this, the differences in cost of treatment between males and females are relatively low. This is an interesting find as previous literature states that female COPD-patients have a higher burden of disease than males (9), it would therefore be reasonable to expect females to have a higher cost of treatment.

The prevalence and incidence of smokers have decreased the past 25 years (77). Results from the Tromsø Study observed a small decrease in COPD-morbidity from 2001 to 2017. The decrease might partly be due to less smokers, as the prevalence of daily smokers dropped between 2001 and 2017 from 29.9% and 31.4% to 14.1% and 12.8%, among females and males, respectively. The number of never-smokers increased from 34.3% to 43.3% from 2001 to 2017 (78), and since smoking is reported to be a main reason for up to 85-90% of the cases of COPD (79), it is expected that the incidence of COPD-patients will decrease as smoking becomes less prevalent. But as the incidence of smokers in the Norwegian population increased until 1973 (77) and the mean age of the COPD-patients in this study was 74 years old, it is reasonable to expect that the healthcare resource utilization among COPD-patients will increase before a considerable decrease is seen (because those who started to smoke at 18 years old in 1973 would turn approximately 67 years old this year (2022).

6.3 Generalizability

Generalizability refers to the extent to which the findings can be applied to other settings than the setting being studied (80). The external validity of this study is limited. The results are representable for the population of the region Health South-East, but the findings and conclusions that are true for this region may not apply in other health regions in Norway. According to the Health atlas for COPD (11), there are considerable geographical differences

in the prevalence of COPD-patients and the healthcare services within Norway, some of the variation may be explained by the expected occurrence of COPD, but not all. For example, the previous county Finnmark have large distances between settlements and the nearest hospital, a long and demanding travel route to nearest can increase the LOS compared to if the patients live closer to a hospital. Also, residents in Finnmark consulted their GP more than twice as often compared to those living in Oslo, and they have the highest density of smokers in Norway (81). While the findings in this study are not generalizable to the entire Norwegian population, they may be used to illuminate some interesting questions if the data is applied with caution. Indeed, there may be trends that applies to other health regions of Norway. The findings in this study may nevertheless be useful to get a better understanding of how the Norwegian population utilize healthcare resources, as more than half of the Norwegian population resides in this region.

6.4 Implications for future research and policy

Future studies should aim to explore how COPD-patients utilize healthcare resources in both the primary- and specialist healthcare sector in more detail, it should also differentiate between young and elderly COPD-patients, as mentioned earlier in the discussion of the findings. The findings of this study indicates that a small share of the COPD-patients is accountable for a larger share of all events in NPR and KUHR. As specified previously, it is well established that the utilization of healthcare resources increases as the disease progresses and exacerbates, COPD-patients who utilize a larger share of healthcare resources are for example often burdened with exacerbation (82, 83). The current dataset made it unfeasible to explore this share of patients further because of lack of information about for example grade of severity, but the group of COPD-patients that utilize a large share of the resources should be explored further. There are also few studies that assesses the patient's perspective of treatment. To effectively reallocate healthcare resources, knowledge on patient's perspective on their own utilization of healthcare and how the condition is affecting their health is valuable (84). Hospitalizations caused by acute COPD-exacerbations is a major burden to the specialized healthcare. If more frequent follow-ups and visits to the primary healthcare reduces the demand for acute healthcare should be investigated. The current study shows that number of additional diagnoses affects the healthcare utilization, therefore there is a need to explore how COPD affects, or is affected by, multimorbidity.

Future policy initiatives should take unwanted consequences into consideration. The public health literature suggests that an increase in planned healthcare treatment reduces the workload in acute healthcare (69). Notwithstanding, increasing the capacity in planned treatment does not necessarily lead to a decrease in acute events. When the workload in acute care is lowered, healthcare personnel, who refers patients to acute care lowers their threshold and tends to refer patients with less severe conditions in order to fully utilize the healthcare resources that has been released (85). To reduce this trend, I suggest establishing guidelines and clear consensus when it comes to the practice of referring COPD-patients to acute healthcare services.

6.5 Strengths and limitations

6.5.1 Strengths

It is important to be aware of and to understand all strengths and weaknesses when choosing a research method. As The Norwegian National Research Ethics Committee emphasizes, the most fundamental obligation of science is to pursue the truth, but at the same time research can never fully achieve this goal (86). Therefore, it is central to discuss what kind of implications the choice of method and theoretical approach can have. The data from KUHR and NPR used in this master´s thesis is comprehensive and contains a lot of detailed information, which is a strength, but it comes with limitations. The large datasets are a major strength, which reflects every patient, older than 65 years, who were in contact with either the primary- or specialist healthcare sector for an entire health region in Norway. This region makes up about half of the total Norwegian population, and such a study population ensures that the results are representative of the population in Health South-East. Hence, if any changes or differences were observed in the data, it was true for the whole region.

The prevalence of events registered in the primary- and specialist healthcare sector is expected to be valid, as Norway has strict routines for registering patients by their social security number whenever in contact with healthcare services. Information about every event and healthcare given at each institution has been consistently coded and reported to the registries using the same classification system across institutions, throughout the years studied. This leads to a low prevalence of missing data, which is an additional advantage of using data from registries. Every event is also expected to be registered with the correct date, time, and place by the healthcare personnel.

6.5.2 Limitations

The limitations related to the pre-collected data involves the quality and content of the variables, which are defined by the registries and not the research questions of this study. This master´s thesis was limited by the definitions set by the registries, and their level of detail and coding. For example, the data did not contain information about received healthcare beyond the primary- and specialist healthcare sector. It is likely that the COPD-patients utilized healthcare resources and had expenses related to over-the-counter medicine and traveling to and from treatment. In addition, COPD-patients could receive treatment like physiotherapy, treatment-at-home or stay in long-term healthcare providing institutions. Such utilization is not registered in the datasets, and therefore not assessed in this study. Some might also experience reduced ability to work and loss of wage because of the disease. For example, a Swedish study suggested that 40% of the direct cost of treating COPD-patients were related to medicine and 39% were related to hospitalizations (40). As COPD is a disease that progresses and the utilization of healthcare resources increases as the severity exacerbates, data on time of being diagnosed and grade of severity of COPD would be valuable for this study, as it is expected to highly affect resource utilization. Therefore, the findings of this thesis provide a partial representation of the resources COPD-patients utilize.

Death was not examined as the number of deaths per year was implausibly low. There is no explanation for this, and it might be due to error in the data. It may also be a result of the fact that data collection commenced in 2012, and the distribution normalized over the study period. This may have affected the results. As patients who for example die in the first months of a year utilize no resources after their death, while those who remain alive but eventually die at the end of the year are normally among the most expensive patients with a high burden of disease (87). A recent study based on Danish registries explored the trajectory in patients dying from COPD. The results showed that those who died because of COPD or cancer had a steep increase in utilization of healthcare resources the last year of life, with a significant increase the last 6 months of life, and an additional acceleration in utilization the last month (88). This may be the situation for the COPD-patients in this study as well, which could lead to an inaccurate perception of the costs increasing over the years.

6.6 Bias

Research studies are prone to errors, which can diminish or amplify the exactness and truth of the results. Cross-sectional studies take a snapshot view of the health status of the population at specified time-point, and such a study design is of a low level on the etiological hierarchy because any observed association is not evidence of causality (89). The cross-sectional design is often susceptible to selection bias and information bias, but it is often the starting point to conduct more powerful research (89). The determinants of healthcare utilization are complex, and this study explores a part of it. Regardless, information about the proportion of people who has a specific disease or the amount of healthcare they utilize is indispensable when assessing the health needs of a group of patients. This is information that is needed when planning and allocating healthcare resources in the future (90).

6.6.1 Selection- and information bias

Information bias occurs when measurements are inaccurate or distorted in some way. That is, the measurements´ data can be measured, collected, or interpreted inaccurately (91). Information bias involves misclassification that either is differential or non-differential (90). The data used for this study contains every event registered in Health South-East, and the data is large and contain a representative sample for said health region. Fortunately, this limit or even excludes, the risk of selection bias. The completeness of the dataset minimizes risk of non-response bias and loss to follow-up (92). Another strength of the data being collected independently from the study is that non-differential classification is avoided (92).

A possible selection bias occurs from the process were the sample of COPD-patients were selected (which was based on the diagnose registered for the events), because of possible errors in the registers. They might be prone to systematic misclassification, for example, a test to state that a patient does not have COPD might be registered with COPD as main diagnosis, even if the tests are negative. A report from The Office of the Auditor General of Norway shows that the medical information hospitals provide to NPR is of low quality and there might be mistakes in the diagnostics. For example, among patients with pneumonia, the main diagnosis had been reported incorrectly for 41% of the hospital admissions, and every third incorrect coding is because the patients' medical journal describes a condition other than pneumonia (93).

The report also uncovers that the Regional Health Authorities do not have adequate follow-up of the practice of coding to ensure that the information about the patients and their treatment is good enough. The practice of registration will naturally vary across institutions and between personnel, and this makes the data prone to differential misclassification. The quality of the data the primary healthcare provides to KUHR is also of low quality, partly because GPs do not hold sufficient knowledge about medical coding (93). These limitations might be problematic when assessing specific events, but this study relies on a large dataset and not on the validity of the diagnoses being registered correctly for a small set of events. I.e., there might be some patients that were misclassified as COPD-patients. But because of the large size of the dataset, the consequence this might have on the results is optimistically reduced.

6.6.2 Other biases

The DRG-codes assigned each event in NPR made it possible to estimate the cost for each event and for each COPD-patient in the specialist healthcare sector. It is important to acknowledge that the intention of the DRG-system is not to estimate resource utilization on patient level, but it is meant to measure the effectivity on hospital- and institution-level, and for them to be compared with each other. To apply DRGs to estimate cost of treatment in this way is likely to either underestimate or overestimate the costs per patient. Also, 14% of DRG-weights were not included in the cost analysis because of missing values. Other than that, converting healthcare services into costs is a measure that is easy to understand and relate to.

7 Conclusion

The intention of this master´s thesis was to explore how COPD-patients utilize healthcare resources and the cost related to treatment, and to isolate the effect of being diagnosed with COPD. The prevalence of COPD is increasing worldwide, and it imposes significant social and economic burden on patients and the society. The results in this study indicate that there is a forthcoming increase in the prevalence of COPD-patients accompanied with an increased need for healthcare resources.

The prevalence of COPD-patients increased each year studied, as did the mean number of events which they generated in both the primary- and the specialist healthcare sector. Females utilized more healthcare resources and were in contact with both the primary- and specialist health care service more frequently compared to males. However, the differences between the

sexes are relatively small. The mean cost of treatment per COPD-patient increased for each year and they were more than 3.5 times higher for COPD-patients than for the general population. Less than 30% of the COPD-patients utilize a larger share of the available healthcare resources than the remaining 70%, and the treatment for this share of COPD-patients has a mean cost almost two times higher than the mean cost for an average COPD-patient. For each additional diagnose added to a COPD-patient, the cost of treatment increased with 5 293 NOK.

Not only should the utilization of healthcare resources for this share of COPD-patients be explored further, but also the resource utilization beyond the primary- and specialist healthcare sector. To quit smoking is an effective measure in decreasing the prevalence and exacerbation of COPD. But as the disease evolves slowly, being diagnosed, and receiving treatment at an early stage is important to slow down the progression of symptoms and reduce the risk of exacerbation (28, 40, 43). Increasing the concerted action between COPD-patients and the healthcare workers in both the hospital and the community can reduce the LOS and costs of treatment in hospitals (94).

This study assesses a disease-specific analysis of one group of patients, in one health region over a relatively short period of time. There are previous studies that explores the healthcare resource utilization of COPD-patients in different countries, using different sources of data and applying different methods. This study was done using data from an entire population within a health region in Norway. The datasets are valid, reliable and contain information of quality, and the external validity within Health South-East is high, but the results provide a partial representation of the resources COPD-patients utilize.

Given the essential rapid aging of the population and the burden of COPD, the findings of this study highlight the urgency to further understand and address the interaction between COPD-patients and the healthcare resources they utilize. As such, it is vital that policy makers are aware of the increasing elderly population and their changes in health status and need of healthcare. Interventions that build and strengthen the system around COPD-patients, and which helps patients to navigate them more effectively, through treatment and healthcare are more likely to improve the effectiveness of healthcare utilization.

As established in this thesis, patients diagnosed with COPD have a high burden of disease, and the need for healthcare among this group of patients is expected to increase. To provide future patients with sound healthcare and to ensure that the healthcare resources are used in the most effective manner, one should strive to understand how they utilize healthcare. Therefore, there is a need for rapid awareness, investigation, and response to ensure that this group of patients receive effective and sound healthcare.

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Appendix

Appendix I - declaration of confidentiality

Statistisk sentralbyrå
Statistics Norway

SSB-ref: 19/1395

Taushetserklæring

Jeg forstår

- at jeg i arbeidet med *«Ressursbruk i helsetjenesten blant eldre med KOLS eller multisykdom»* vil kunne få kjennskap til opplysninger som av hensyn til offentlige, enkeltpersoners, institusjoners eller bedrifters interesser, ikke må bli kjent for uvedkommende
- at statistikklovens bestemmelse om taushetsplikt § 2-4 gjelder for de opplysninger jeg får tilgang til utlevert fra Statistisk sentralbyrå

Jeg forplikter meg til

- å vise aktsomhet i behandlingen av alle opplysninger som er utlevert fra Statistisk sentralbyrå og arbeide i samsvar med retningslinjer og instrukser gitt av Statistisk sentralbyrå og Datatilsynet.
- ikke å gi opplysninger videre til noen personer i eller utenfor Folkehelseinstituttet (FHI).

Jeg er klar over

- at brudd på taushetsplikten og misbruk av informasjon jeg får kunnskap om, for meg selv eller andre, kan medføre straffansvar
- at taushetsplikten også gjelder etter at mitt arbeid tilknyttet Folkehelseinstituttet (FHI) er avsluttet.

Jeg er gjort kjent med og har forstått

- Statistikkloven § 2-4. Taushetsplikt.

  (1) De som utfører arbeid eller tjeneste for et organ som forbereder eller utarbeider offisiell statistikk, plikter å hindre at uvedkommende får adgang eller kjennskap til det de under forberedelsen eller utarbeidelsen av en statistikk får vite om personlige forhold, drifts- eller forretningsforhold, eller tekniske innretninger og fremgangsmåter. Taushetsplikten gjelder bare de opplysninger som er hentet inn med sikte på utarbeidelse av offisiell statistikk.

  (2) Taushetsplikten gjelder også etter at vedkommende har avsluttet arbeidet eller tjenesten. Vedkommende kan heller ikke utnytte opplysninger som nevnt i denne paragraf i egen virksomhet eller i arbeid eller tjeneste for andre.

  (3) Forvaltningsloven § 13 til § 13e kommer ikke til anvendelse.

- Straffeloven § 209

  (1) Med bot eller fengsel inntil 1 år straffes den som røper opplysning som han har taushetsplikt om i henhold til lovbestemmelse eller forskrift, eller utnytter en slik opplysning med forsett om å skaffe seg eller andre en uberettiget vinning.

  (2) Første ledd gjelder tilsvarende ved brudd på taushetsplikt som følger av gyldig instruks for tjeneste eller arbeid for statlig eller kommunalt organ.

  (3) For den som arbeider eller utfører tjeneste for et statlig eller kommunalt organ, rammer første og annet ledd også brudd på taushetsplikt etter at tjenesten eller arbeidet er avsluttet.

  (4) Grovt uaktsom overtredelse straffes på samme måte.

  (5) Medvirkning er ikke straffbar.

Denne taushetserklæring er undertegnet i to eksemplarer, hvorav underskriver og SSB beholder hver sitt eksemplar.

Tromsø, 18.01.2022
Sted/dato

Ida K. A
Signatur

IDA-KRISTINE ANDREASSEN, STUDENT
Navn/tittel med blokkbokstaver

Appendix II - REC approval

REK
REGIONALE KOMITEER FOR MEDISINSK OG HELSEFAGLIG FORSKNINGSETIKK

Region:	Saksbehandler:	Telefon:	Vår dato:	Vår referanse:
REK sør-øst C	Anders Strand		06.08.2021	17100
			Deres dato: /	

Hilde Synnøve Vollan

Prosjektsøknad: Ressursbruk i helsetjenesten blant eldre med KOLS eller multisykdom
Søknadsnummer: 2016/1986
Forskningsansvarlig institusjon: Folkehelseinstituttet

Prosjektsøknad: Endring godkjennes.

Søkers beskrivelse

Dette prosjektet vil gi kunnskap om hvilke ressurser som brukes i kommunal helse- og omsorgstjeneste og spesialisthelsetjeneste for eldre med KOLS eller multisykdom i Helse Sørøst. Forskjellige mål, som for eksempel sykdomsbyrde ("levd tid med sykdom"), innleggelser i sykehus og antall timer med hjemmesykepleie, brukes for å beskrive ressursbruken og sammenligne mellom kommuner. Slik kan også innsats ved innføring av nye kommunale tjenestemodeller beskrives. Resultater fra studien kan benyttes som utgangspunkt for å målrette helse- og omsorgstjenester for eldre med KOLS eller multisykdom. I tillegg kan metoden fungere som modell for å beskrive ressursbruk i helsetjenesten for andre pasientgrupper. Prosjektet gjennomføres som en populasjonsbasert registerstudie. For å få tilstrekkelig informasjon til å beregne ressursbruk og sykdomsbyrde er det nødvendig å koble data fra flere registre: Folkeregisteret, Norsk pasientregister, KUHR, IPLOS og Resptregisteret.

REK viser til endringssøknad mottatt 04.08.2021, for prosjekt «Ressursbruk i helsetjenesten blant eldre med KOLS eller multisykdom». Sekretariatet i REK sør-øst C har vurdert søknaden på fullmakt fra REK sør-øst C, med hjemmel i helseforskningsloven § 11.

Den omsøkte endringen består i inklusjon av to nye prosjektmedarbeidere:

- Ida-Kristine Andreassen (UiT)
- Karianne Mørken (UiT)

Begge skal bidra som masterstudenter i arbeidet med å utføre delmål 1 "Ressursbruk i helsetjenesten blant eldre med KOLS eller multisykdom".

REKs vurdering

Sekretariatet i REK har vurdert søknaden og har ingen forskningsetiske innvendinger til endringen av prosjektet.

REK sør-øst C
Besøksadresse: Gullhaugveien 1-3, 0484 Oslo
Telefon:22 84 55 11 | **E-post**:rek-sorost@medisin.uio.no
Web:https://rekportalen.no

Appendix III - DRG-weights that were removed from dataset

104D	209B	26	33	370	379	388A	40	48	74	915Q
112P	209H	279	333	371	380	388B	405	481C	801X	91A
112Q	209I	282	340	371O	381	388C	417N	481O	81	91B
123	209J	288O	342N	372	381O	389A	422	481P	813R	98A
137	212	295	351	373	382	389B	426A	49C	814P	98B
156	220	298	353O	373O	383	389C	426C	530	814R	996P
163	224A	30	359Q	374	384	390	42P	530O	814S	
184A	224B	307N	362	375	385A	391	430A	531	823R	
184B	224P	307O	36E	376	385B	391O	430B	571	823T	
186	224Q	314	36P	377N	385C	393	446	60N	908G	
190	252	322	36R	377O	386N	393O	448	70A	908H	
191A	255	327	36S	378N	387N	396	451	70B	914Q	

Appendix IV - The top 50 most frequent diagnoses in KUHR, 2016

	ICPC-2 code	Diagnosis
1	A97	Contact/examination regarding administrative purposes
2	K78	Atrial fibrillation/flutter
3	K86	Uncomplicated hypertension
4	A99	Unspecified health problem
5	T90	Type 2 diabetes
6	U71	Urinary tract infection
7	P06	Sleep disorder
8	R95	Chronic obstructive pulmonary disease
9	A89	Complications with prosthesis
10	A29	General symptoms/problems
11	P70	Dementia
12	T91	Vitamin deficiency/nutritional disorder
13	K99	Cardiovascular disease (NEC)
14	K77	Heart failure
15	Y77	Malignant tumour of prostate
16	T86	Hypothyroidism/soft tissue edema
17	P76	Depressive disorder
18	L88	Rheumatoid arthritis
19	L90	Osteoarthritis of the knee
20	K76	Chronic ishemic heart disease (NEC)
21	D01	Abdominal pain/general cramping
22	L89	Hip osteoarthritis
23	L99	Musculoskeletal disease (NEC)
24	R05	Cough
25	T93	Lipid metabolic disorder
26	L13	Hip symptoms/joint
27	S97	Chronic skin ulcers
28	K90	Stroke
29	R81	Pneumonia
30	A13	Anxious about treatment
31	L02	Back symptoms/joint
32	U99	Urinary tract infection (NEC)
33	L15	Knee symptoms/joint
34	N17	Dizziness (NEC)
35	L03	Lower back symptoms/joint
36	P01	Feeling of anxiety/nervousness/tension
37	A91	Unnormal result on examination (NEC)
38	L95	Osteoporosis
39	P74	Anxiety disorder
40	L84	Back syndrome without pain radiation
41	R02	Shortness of breath/dyspnoea
42	R96	Asthma
43	R78	Acute bronchitis
44	L91	Arthrosis (NEC)
45	L87	Bursitis/tendinitis (NEC)
46	K83	Heart valve disease (NEC)
47	S29	Skin problems
48	R74	Acute upper respiratory tract infection
49	U04	Urinary incontinence

50	D75	Malignant tumour of the colon