# Do place and socio economic status matter?

*Analysis of inequalities in the probability of PCI for AMI in Norway 1999-2007 with respect to geographical location, socio economic status and demography*

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15.05.2009

# Acknowledgements

Acute myocardial infarction or more commonly called heart attack, is the most common cause of death in Norway. During my work with this master thesis, friends of mine have unfortunately experienced close family members having a heart attack; luckily the treatment of them has been excellent. Whether all patients in the whole of Norway have access to the same adequate treatment for heart attack is investigated in this thesis.

My sincere thanks go to my supervisor Professor Terje P. Hagen at the Institute of Health Management and Health Economics, who has patiently guided me through the process. Thank you for all valuable inputs and feedback along the way.

My former employer, Rikshospitalet HT, made it possible for me to combine work with my master's degree study. My thanks go to my former colleagues for their support and to Rikshospitalet for giving me this opportunity. My employer during the work on my master's thesis, South-East Norway Regional Health Authority, has made it possible to pursue both work and a master's degree at the same time by offering me flexible work conditions and lots of support. My colleagues and their cheerful mood, good humour and interest in my study has been highly appreciated. To all of you, my sincere thanks!

Finally, my heartfelt gratitude goes to my dear Christian for proof-reading my drafts, cheering me up and being supportive. I am the luckiest having you by my side.

Support for this study was provided by a grant from the University of Oslo.

Vanja Strømsøe

Oslo, May 2009

# Abbreviations and Acronyms

| | |
|---|---|
| HDI | The Human Development Index |
| RHA | Regional Health Authority/Regionale Helseforetak |
| HT | Hosptital Trust/Helseforetak (sykehus) |
| SES | Socio Economic Status |
| GP | General Practitioner/Fastlege |
| AMI | Acute Myocardial Infarction |
| PCI | Percutaneous Coronary Intervention |
| CABG | Coronary Artery Bypass Graft |
| NHS | National Health Service in the UK |
| NPR | Norsk Pasient Register |
| ICD-10 | Tenth revision of the International Classification of Diseases |
| SSB | Statistisk sentralbyrå |
| NSD | Norsk samfunnsvitenskapelig datatjeneste |
| CK-MB | Creatine Kinase – type MB (blood sample) |

| | |
|---|---|
| ECG | Electrocardiogram |
| ABF | Activity Based Financing/Innsatsstyrt Finansiering |
| IHD | Ischemic heart disease |

# Abstract

Achieving equality in the distribution of health care services, in the form of equal use for equal need, is an objective for many health care systems. This study investigates inequality in the supply of Percutaneous Coronary Intervention (PCI) treatment for Acute Myocardial Infarction (AMI) in Norway during the years 1999 to 2007. The study aims to assess whether consumption of PCI varies with need, or whether the consumption varies with other factors such as age, gender, socioeconomic status (SES), distance to treatment centre and geographical location.

The numbers of AMI-patients and PCI-treatments are gathered from all hospital admissions during the period of analysis. The explanatory variables are analysed for their effects on the dependent variable, the probability of PCI ($\frac{PCI}{AMI}$).

The analysis is performed as a multiple linear regression analysis with dummy variables for Hospital Trusts and years.

The results show an increase in the probability of PCI from 1999 – 2007 for the whole of Norway. The main result of this study is that there are significant differences in the probability of PCI during the period of analysis. The differences are relatively large in the beginning of the period. Due to decreasing differences with time, the differences are relatively small in the end of the period of analysis.

The independent variables with significant results are age, gender, mortality from ischemic heart diseases, population share above 80 years, distance to PCI-treatment centre, eighteen dummies for Hospital Trusts and seven year dummies.

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# 1. Introduction

Norway is one of the worlds most wealthy countries and has for several years been on the top of The Human Development Index (HDI) (United Nations Development Programme 2008). The welfare state of Norway is known to be very comprehensive; the state providing amongst others safety, education and national health- and pension insurances for its citizens. Equality for all citizens is the primary goal for the distribution of public services, within public health precisely defined in the commission documents from The Royal Norwegian Ministry of Health and Care Services to the four Regional Health Authorities (RHA) in 2009 as follows: “The primary goal for the health care sector is to provide adequate and appropriate health care services for everyone in Norway, irrespective of individual financial circumstances, social status, age, sex and ethnicity” (Helse- og omsorgsdepartementet 2009b).

Main determinants of health are hereditary factors, individual lifestyle factors and general socioeconomic, cultural and environmental factors. In addition to this, inequalities in health care access and consumption may influence cure or survival from diseases, accidents and other life threatening or life quality reducing conditions (Manson-Siddle and Robinson 1998). The pursuit of equality as a key objective for the distribution of and the access to public health care services, has lead to a financing of the RHAs and the Hospital Trusts (HT) which seek to compensate for the differences in demography, dispersed settlements and Socio Economic Status (SES) found in Norway. Despite this, there has been revealed inequalities in the general access to health care services and variations in consumption per capita due to general practitioner (GP) coverage, distance to hospital and different geographical locations in Norway (Nerland and Hagen 2008).

The present study is designed to investigate more specifically the access and variations in the consumption of treatment for acute myocardial infarction (AMI) in Norway during the period 1999 – 2007. In the 1990’s percutaneous coronary intervention (PCI) developed as the recommended treatment method for AMI. Thrombolytic therapy (pharmacological treatment) is administered if primary PCI is not immediately available. Primary PCI trials suggest lower mortality rates for AMI when PCI-treatment is given compared with thrombolytic treatment alone (Spinler et al. 2001). Because of the advanced technology and the necessity for cardiology specialists performing the PCI-intervention, PCI-treatment is centralised to six (after 2002 seven) secondary care HTs in Norway.

Evidence from several countries indicate that the access to and the supply of treatment for cardiovascular disease, and especially AMI, is unequally distributed. In Canada, rates of revascularisation (PCI and CABG[1]) are higher in the western provinces than elsewhere (Johansen et al. 1998). In the United States substantial geographical variation in the treatment of AMI is pointed out (O'Connor et al. 1999). In England, socioeconomic variations in investigation and revascularisation within the former Yorkshire Region are found, suggesting unequal supply of treatment. The deprived in the region consume less treatment relative to their need than the affluent. Also, small areas that are close to cardiology centres have high rates of investigation and surgery, while more remote areas tend to have fewer procedures (Manson-Siddle & Robinson 1998). In Scotland, variations in investigation and revascularisation are demonstrated by age, sex, geography and socioeconomic deprivation (MacLeod et al. 1999).

This study investigates inequality in the probability of getting PCI-treatment for AMI (probability of PCI) in Norway during the years 1999 to 2007. The main research question is:

1) Is there significant evidence for unequal access, measured as varying probability of PCI, in Norway in the period of analysis?

Secondly, if indeed there is significant evidence of unequal access:

[1] CABG-treatment (Coronary Artery Bypass Graft) is a treatment for AMI given to a large extent as elective treatment.

2) Is there significant evidence for an unequal probability of PCI between those patients living in the catchment area of HTs *with* PCI-treatment and those living in the catchment area of HTs *without* PCI-treatment?

3) Is there significant evidence for an unequal probability of PCI within the group of HTs *with* PCI?

4) Is there significant evidence for an unequal probability of PCI within the group of HTs *without* PCI?

5) Are demographical variables, SES-variables and geographical location independently associated with the probability of PCI?

A data set containing all in-patient visits to Norwegian HTs is used to identify patients admitted with AMI between 1999 and 2007. The proportion given PCI-treatment during their hospital stays is identified by their procedure code and the probability of getting PCI ( $\frac{PCI}{AMI}$ ) is calculated. The probability of PCI is used as the dependent variable in a multiple linear regression analysis. Age, gender, SES-variables, mortality from ischemic heart disease and distance to treatment centre are used as independent variables to investigate if some of these are independently associated with the probability of PCI. Dummies for HTs and years are included in the analysis to capture the unequal supply side effects between the HTs and between the years. The data is handled and analysed with the statistical software SAS.

The results show an increase in the probability of PCI from 1999 – 2007 for the whole of Norway. A significant variation in geographical location is detected; patients living in the catchment area to a Hospital Trust *without* PCI-treatment centre have a lower probability of PCI than patients living in the catchment area of a Hospital Trust *with* PCI-treatment centre.

Other independent variables with significant results are age, gender, population share above 80 years, distance to PCI-treatment centre and mortality from ischemic heart disease.

## 1.1 Medical background

Cardiovascular diseases are the number one cause of death and are projected to remain so both globally and in Norway (Nasjonalt folkehelseinstitutt 2002;WHO 2009a). Cardiovascular diseases include coronary heart disease (AMI), cerebrovascular disease, raised blood pressure (hypertension), peripheral artery disease, rheumatic heart disease, congenital heart disease and heart failure. In Norway during the period of analysis, 12 000 to 20 000 cases of AMI were registered every year (NPR data for the years 1999 – 2007). Among the cardiovascular diseases AMI is the most common cause of death. The mortality rate through the last 25 years is halved for AMIs (see Figure 1.1), but whether this is a result of less people than before experiencing AMI (prevention effect) or whether this is a result of lower mortality rates amongst those having an AMI (treatment effect) is not known for certain (Nasjonalt folkehelseinstitutt 2002).

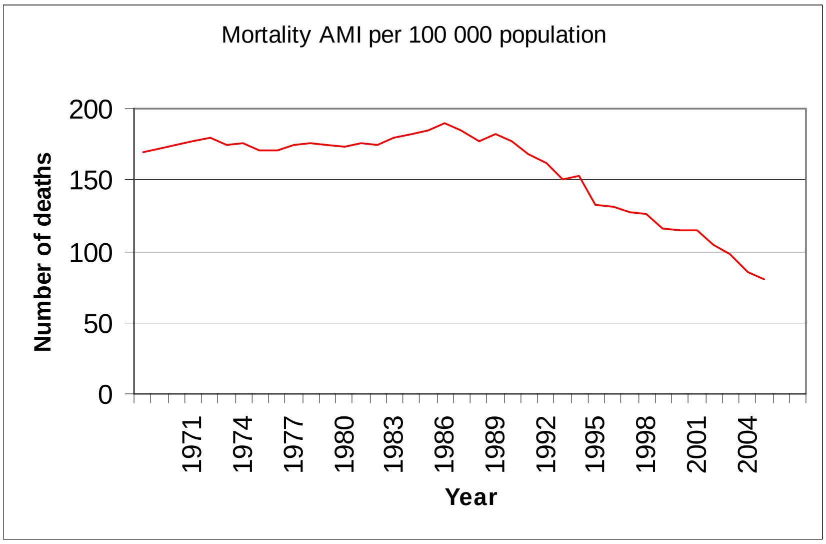


*Figure 1.1 Total number of AMI caused deaths per 100 000 population.*

*(Statistisk Sentralbyrå 2009).*

Norway is a country with densely populated urban areas along side with smaller coastal communities and scattered inland settlements. A long coastline, urban cities, forests and mountainous areas contribute to a great variety in the physical environment for the inhabitants of Norway. This variety is bound to create some differences in economic activity and lifestyles across the country and the resulting variation in income and access to public services do not follow the political ideology of equality for all citizens (Nerland & Hagen 2008).

Being investigated in this study is the possible inequality in the access to PCI-treatment. A National Health Insurance for all citizens in Norway ensures that the patients do not have to pay out of pocket for necessary treatments like PCI-treatment for AMI. The Norwegian State, through the ownership of the RHAs and the HTs, has the responsibility of supplying necessary treatment, such as PCI-treatment, equally to all citizens according to their need.

The two main treatments for AMI are PCI and thrombolytic therapy. Thrombolytic therapy is a medical treatment given intravenously and is not dependent on being administered by cardiologists. PCI-treatment on the other side is defined as a highly technological invasive procedure performed by cardiologists. PCI is recommended as standard treatment because of a lower death-rate and fewer re-infarctions and strokes (see chapter 2.3). Guidelines for establishment of medical procedures advise that there should only be established PCI-treatment centres where day and night preparedness is justifiable due to population- and transportation conditions. There should be at least 400 patients a year, meaning about 300 000 people living in the catchment area of the HT to justify an establishment of a PCI-treatment centre. In addition, the transportation to the HT has to be organised in an appropriate way so that the travel time to the hospital is minimised (Sundar 2003). The varying physical environment and scattered population of Norway clearly do not justify establishment of PCI-treatment centres in all parts of the country without an extensive transportation plan including helicopter transportation in many places. Such a standby preparedness is very expensive and during the period 1999 – 2007 there were established six (seven after 2002) PCI-treatment centres in Norway (see chapter 3.1.).

The geographical location of the PCI-treatment centres and the areas covered by the 90 minutes travel time criteria for PCI with ambulance and helicopter is shown in Figure 1.2. (see chapter 2.4) (Bendz 2009). Extra treatment capacity is indicated by dotted circles (Arendal and Oslo). Thrombolytic therapy is the alternative if PCI is not available. In the period 1999 – 2007 the hospital in Bodø (Nordlandssykehuset HT) did not perform any PCI-treatments.

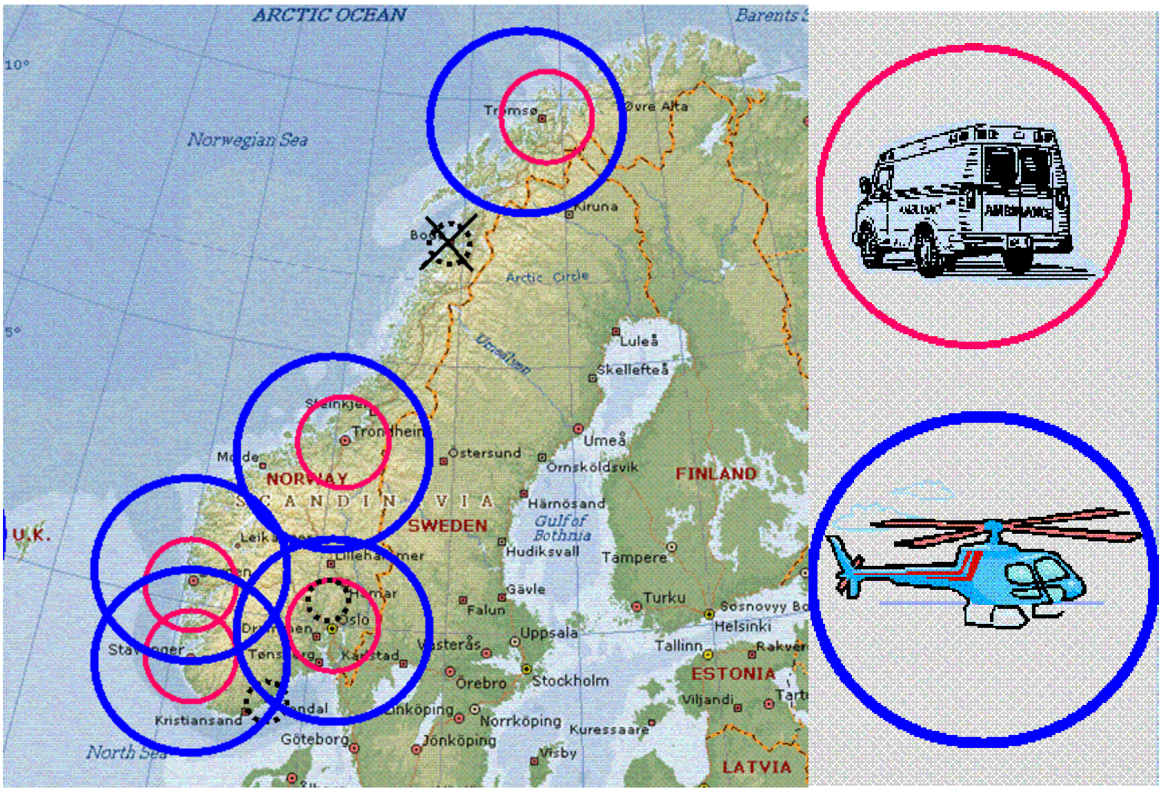


*Figure 1.2 Geographical locations of PCI-treatment centres. Areas covered by 90 minutes travel time with ambulance and helicopter.*

*(Bendz 2009).*

## 1.2 Equal access to health care services

The welfare state of Norway and its aim of providing fair, just and equal services for all citizens is in many ways similar with how Daniels (Daniels 1985) argues for “equality of opportunity" as a fair and just way of allocating scarce resources. Every citizen has a legal right to have their share of the normal opportunity range protected by the society. By offering public health services and national health insurances the Norwegian welfare state seek to protect each citizen’s normal opportunity range from being lowered or harmed unnecessarily by health problems.

Public health care systems across the world, like the National Health Service (NHS) in the UK (Gatrell et al. 2002;Morris et al. 2005), the New Zealand public health system (Peacock et al. 1999), the Dutch public health system (ter Meulen and van der Made 2000), the Norwegian public health system (Iversen and Kopperud 2002a) and many others, have this pursuit of equality as a key objective for their distribution of, and their access to, public health care services. Because equality can be defined in many ways, a common understanding of equality in a health care service context is useful. Elster's (Elster 1989) theories of distributive justice give examples of different principles that can be followed when resources are to be allocated in a just way. The principle of distribution according to need defines equality as equal consumption for equal need, and the The Royal Norwegian Ministry of Health and Care Services rests on this definition of equality in its work for a fair and just allocation of health care resources. This definition of equality will also be used in this thesis.

## 1.3 Data

The data is gathered from all in-patient data in Norway during the years 1999 to 2007 reported to the Patient register of Norway (Norsk Pasientregister (NPR)). A selection of the NPR-data based on the main diagnosis for AMI is made. The diagnosis for AMI is identified from ICD-10[2], see Table 1.1.

[2] International Statistical Classification of Diseases and Related Health problems, 10th Revision, version for 2007.

*Table 1.1 ICD-10 codes included in the data set containing only AMI admissions.*

| ICD-10 code | Description |
|---|---|
| I21 | Acute myocardial infarction |
| I21.0 | Acute transmural myocardial infarction of anterior wall |
| I21.1 | Acute transmural myocardial infarction of inferior wall |
| I21.2 | Acute transmural myocardial infarction of other sites |
| I21.3 | Acute transmural myocardial infarction of unspecified site |
| I21.4 | Acute subendocardial myocardial infarction |
| I21.9 | Acute myocardial infarction, unspecified |
| I22 | Subsequent myocardial infarction |
| I22.0 | Subsequent myocardial infarction of anterior wall |
| I22.1 | Subsequent myocardial infarction of inferior wall |
| I22.8 | Subsequent myocardial infarction of other sites |
| I22.9 | Subsequent myocardial infarction of unspecified site |

(WHO 2009b)

The data set containing only AMI admissions contained 147 396 observations. This data set is used in the further analyses. The proportion of the 147 396 AMI admissions given PCI-treatment during their hospital stay is identified by their NCMP and NCSP procedure code[3].

*Table 1.2 NCMP/NCSP procedure codes for PCI-treatment.*

| NCSP procedure code | Description |
|---|---|
| FNG | Expansion and recanalisation of coronary artery |
| FNG 02 | Percutaneous transluminal coronary angioplasty |
| FNG 05 | Percutaneous transluminal coronary angioplasty with insertion of stent |

(KITH 2008;NOMESCO 2007)

Statistics Norway (SSB) and Norwegian Social Science Data Services (NSD) provide information about demography and SES-variables. A matrix over the distances in kilometres from each municipality centre to the centre of the hospital municipality, prepared and calculated by InfoMap Norge AS (Iversen and Kopperud 2002b;Kopperud 2002), is also included in the analysis.

# 2. Medical information

## 2.1 AMI

Acute myocardial infarction (AMI) is a frequent cause of mortality and morbidity in Norway and in other Western industrialised countries. 12 000 – 20 000 cases of AMI is registered in Norway every year (NPR data for the years 1999 – 2007, see Figure 2.1) and elderly patients are especially in the risk group. The mean age for AMI in the period of analysis is 70 years and the death-rate from AMI increases with the patient's age (Jortveit and Brunvand 2006).

Each individual's genes and hereditary characteristics have impact on the probability of experiencing AMI. Some people inherit genes with a tendency of causing high cholesterol levels. Hereditary factors will therefore together with risk factors play a part when a person's probability of getting AMI is decided. High cholesterol levels are the main risk factor for AMI for both men and women. Other risk factors are smoking, elevated blood pressure, diabetes and obesity. Physical activity and consumption of fruits and vegetables are protective (Nasjonalt folkehelseinstitutt 2008). Recent studies suggest that shift work and night work are risk factors for cardiovascular diseases. Long work days and small amounts of sleep are also associated with negative health effects, and especially with cardiovascular diseases. Due to methodological problems the studies investigating the relationship between stress and cardiovascular diseases can not make any final conclusions (Kjuus 2008). Data from Norwegian health surveys imply that smoking, unhealthy lifestyle, obesity, little physical activity and diabetes are strongly socially skewed (Nasjonalt folkehelseinstitutt 2007b) implying that people with low SES are exposed to more risk factors for AMI than others.

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[3] The NOMESCO Classification of Medical and Surgical Procedures

Figure 2.1shows number of reported AMI-admissions in Norway during the period 1999 – 2007.

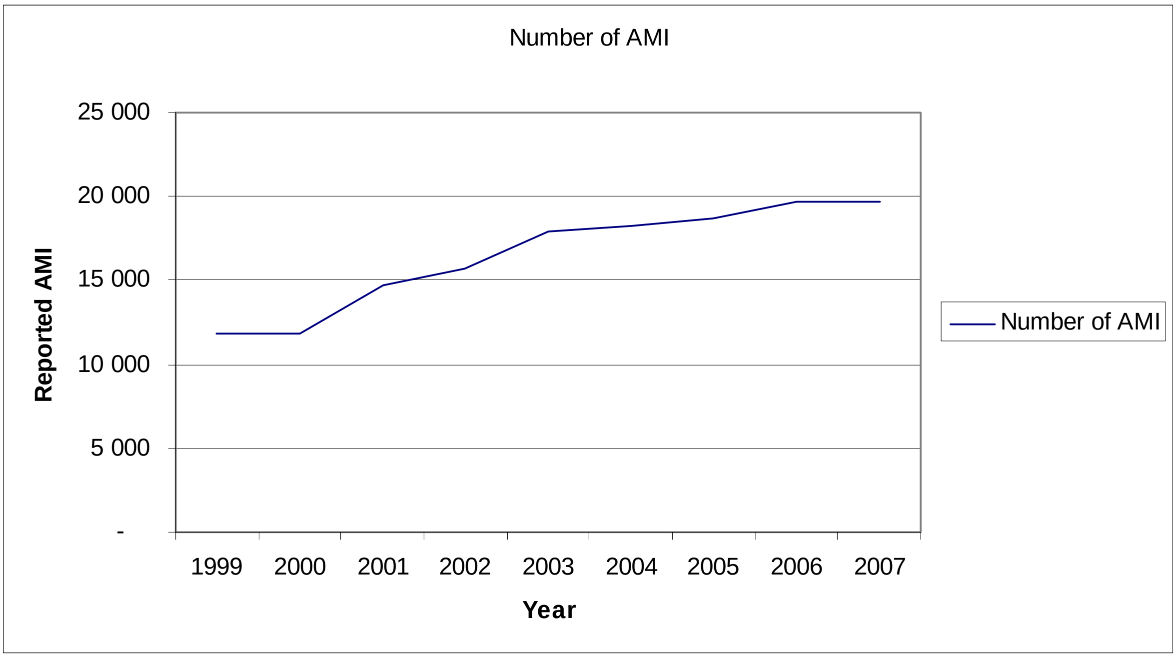



*Figure 2.1 Number of reported AMI during the period 1999 – 2007.*

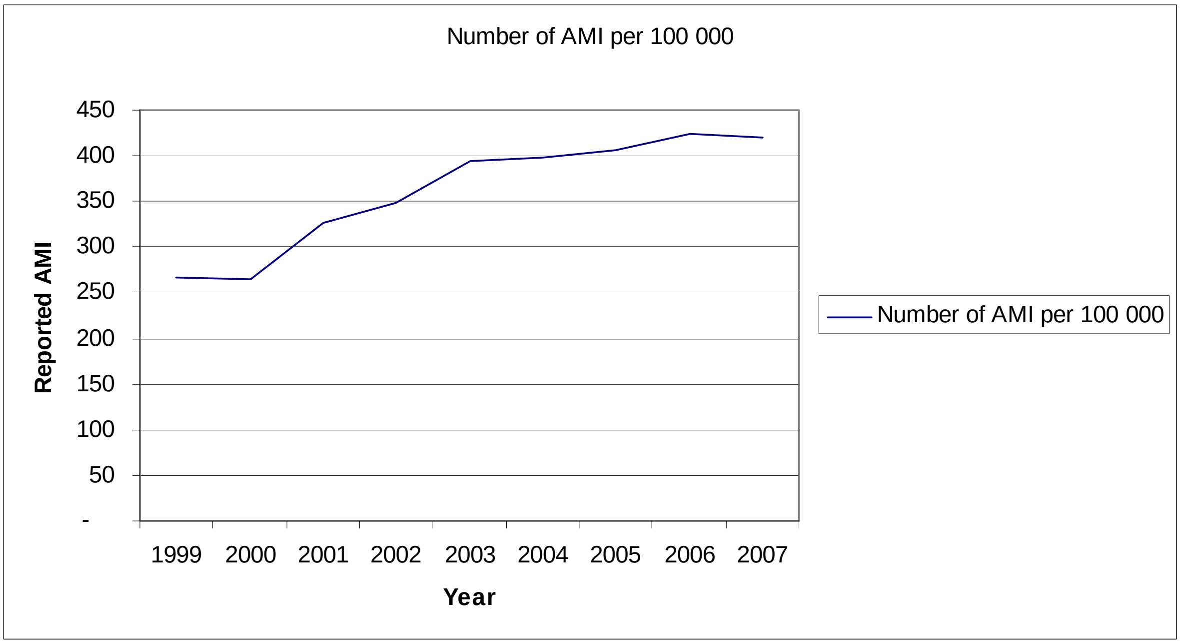



*Figure 2.2 Number of reported AMI per 100 000 population during the period 1999 – 2007.*

Figure 2.1and Figure 2.2 show that there is a steady growth in the numbers of diagnosed AMIs from 2000 until 2006/2007 when the growth seems to stagnate. However, in the 1990s there was a decrease in the numbers of diagnosed AMIs. After year 2000 this trend was replaced by an increase in the numbers of diagnosed AMIs instead. This increase of diagnosed AMIs seems to be the result of a set of new cardiac markers/bio markers (troponin) used in the diagnostics of AMI and not as a result of increased incidence of AMI (Hagen and Reikvam 2003;Nordrehaug 2001).

## 2.2 Diagnostics

When diagnosing AMI, typical increase and gradual reduction of troponin or rapid increase and reduction of CK-MB (Creatine Kinase) are used as main criteria. In addition, at least one of the following criteria should be present: symptoms of ischemia/chest pains, development of pathological Q waves in electrocardiogram (ECG) or ischemic ECG changes (ST-elevation/depression).

Figure 2.3 shows different stages in the diagnosing of AMI. Model 1 represents a stenotic (narrowed) part of a coronary artery with segments built up of cholesterol laden plaques. The ECG is non-striking and there is no extra release of troponin (troponin -). Model 2 shows a leakage in the capsule that envelops the cholesterol laden plaques. When the plaques and blood creates a contact surface, additional thrombosis (blood clot) is created. The coronary artery narrows further and because the blood stream is considerably reduced, a ST depression shows at the ECG. An unstable angina is different from a non-ST elevation infarction (non-STEMI) because the latter has an increase in troponin or other cardiac markers indicating myocardial damage. Model 2 indicates no extra release of troponin (troponin -). Model 3 shows considerable thrombosis. Parts of the thrombus drift with the blood and cause micro infarctions which increase the level of troponin (troponin +). The name “non-STEMI” arose from the fact that there is no ST elevation (non-STE) and “MI” for myocardial infarction. Model 4 shows a total blockage of the coronary artery. Because of the standstill in the blood stream, the ECG shows a ST elevation.

Troponin is released (troponin +) and if the artery is not re-opened the patient will get a heart attack (AMI/MI) (Helse Vest RHF 2003).

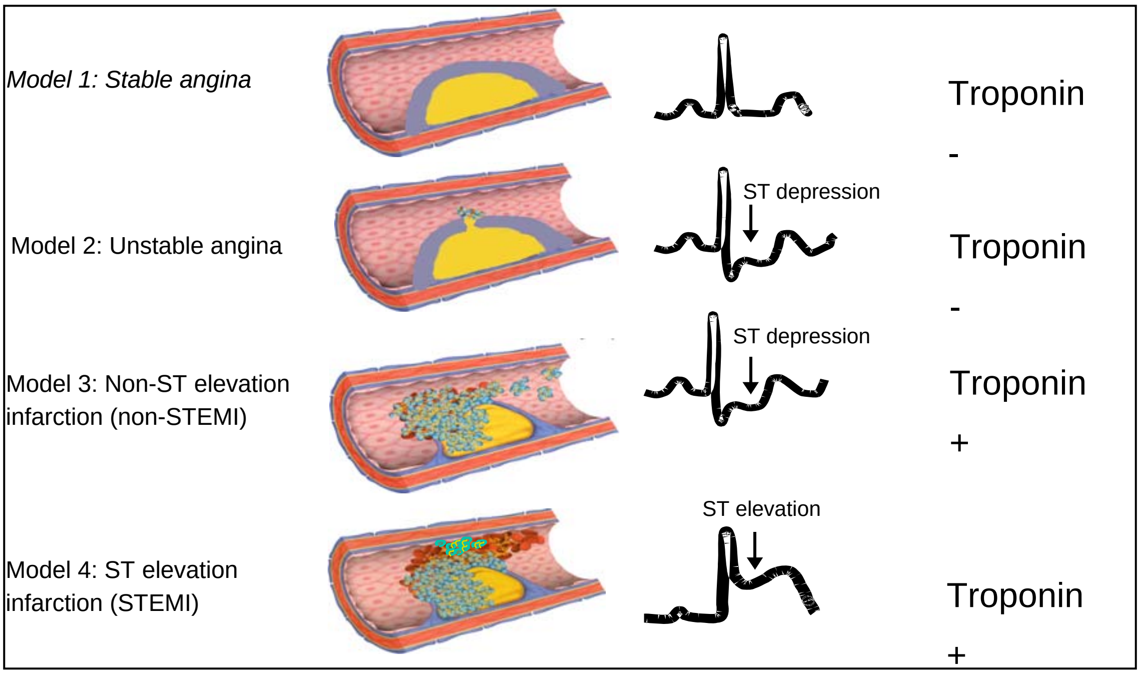



*Figure 2.3 Stages in the diagnosing of AMI.*

*(Helse Vest RHF 2003)*

The use of troponin in AMI diagnostics was in the year 2000 together with CK-MB recommended by The Joint European Society of Cardiology and by the American College of Cardiology Committee for the Redefinition of Myocardial Infarction as part of the routine diagnostics of AMI. The number of cases of AMI was predicted to increase because of the better diagnostics as the troponins point out myocardial damage also in cases where the patient has a normal CK-MB-value. For Norway, this was predicted to lead to an increase in number of persons getting the diagnose AMI to an extra 1 000 – 2 000 persons per year (Nordrehaug 2001). As pointed out in chapter 2.1 there is an increase in the number of diagnosed AMI cases between 2000 and 2001. Taking into account that cases and persons are different units (one person may cause several cases due to several heart attacks or transfer from one hospital to another) the data seems to comply with the estimates made by Nordrehaug.

## 2.3 Treatment: PCI versus thrombolytic therapy

If the coronary arteries, which work as the blood suppliers to the heart, are blocked (occlusion) and the blood circulation can not be re-established, the heart muscles peripheral for the occlusion will be damaged or die. This is called myocardial infarction (MI) or acute myocardial infarction (AMI). AMI (I21 – I22) is the diagnosis being further investigated in this study. There are two main treatments for AMI. Thrombolytic therapy (medical treatment of decomposition of blood clot/thrombosis) is meant to help the thrombosis in the narrowing in the coronary artery to dissolve so that the coronary circulation can be re-established. Thrombolytic therapy is given intravenously and is not dependent on being administered by specialists in cardiology. Percutaneous Coronary Intervention (PCI) is a non-medical treatment for AMI, which mechanically expands the coronary artery, see Figure 2.4. A catheter is lead through the narrowed part of the coronary artery and a balloon is inflated to block out the occluded area. A stent can be used to permanently keep the earlier stenotic area open, but the intervention can also be done without stent. The stent will be left in the artery after the catheter is removed. PCI treatment demands advanced technological equipment and specialized personnel (Grut 2007).

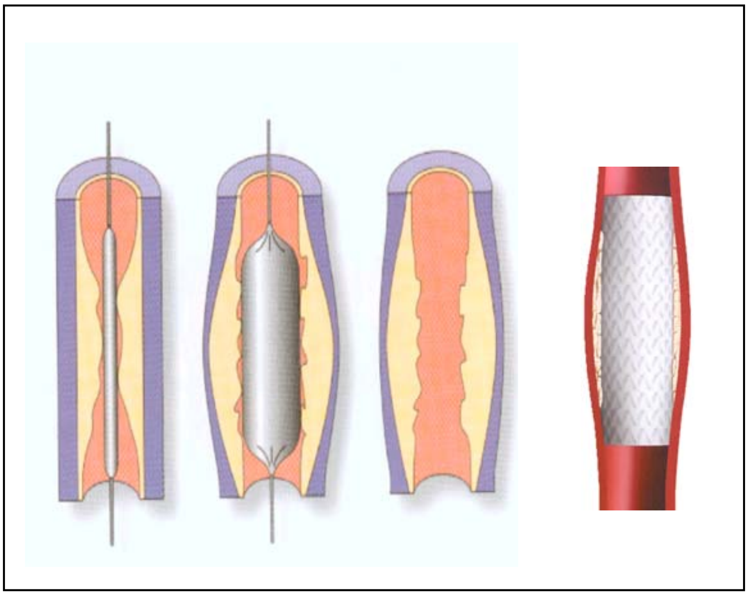


*Figure 2.4 To the left: Drawing of the PCI procedure with balloon pump. To the right: Drawing of the PCI procedure with stent.*

*(Helse Vest RHF 2003)*

The effect of both thrombolytic therapy and PCI treatment is dependent of how fast the treatment is started after the occlusion. Damaged or destroyed heart muscles can not be regained and thus makes the time factor very important. Time from occlusion to the death of heart cells is illustrated in Figure 2.5:

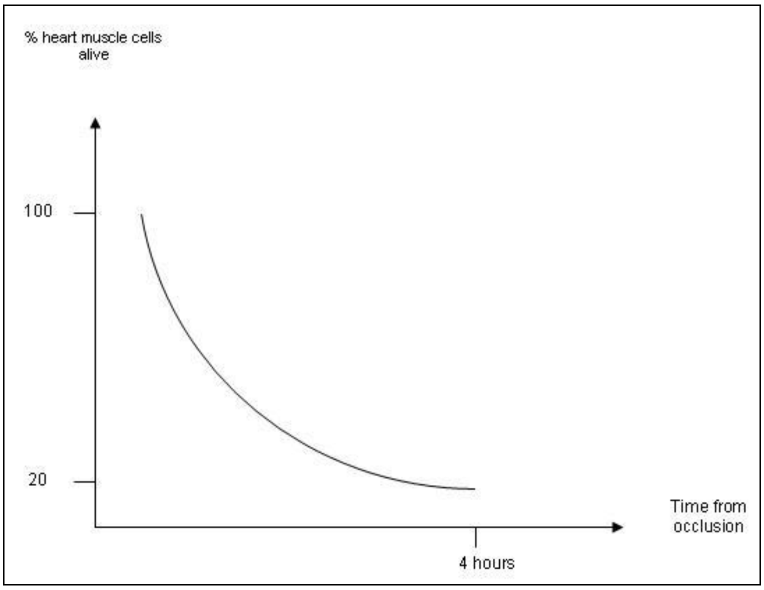



*Figure 2.5 Time from occlusion to fatal damage/death of heart muscle cells. (Helse Vest RHF 2003).*

For every hour the treatment is delayed, the mortality from AMI increases. The faster the treatment is started, the less is the probability of both acute and long-term mortality. Also, the risk for a new AMI, complications like cerebral infarction and long in-patient stays are lowered (Helse Vest RHF 2003).

”Norsk legemiddelhåndbok” (Norsk legemiddelhåndbok 2009) and the report: “PCI ved akutt hjerteinfarkt. SMM-rapport nr. 5/2002” (Sundar 2003) recommend PCI as standard treatment for AMI. Compared with thrombolytic treatment, PCI leads to lower mortality and fewer re-infarctions and strokes.

## 2.4 Guidelines for treatment of AMI

If patients with AMI are less than 90 minutes from a hospital offering PCI-treatment, PCI is preferred over thrombolytic therapy. If the symptoms of AMI have been present for less than 3 hours and the travel time to the nearest invasive centre (PCI centre) is more than 90 minutes, thrombolytic therapy is recommended. If there have been symptoms for more than 3 hours PCI-treatment is recommended (Norsk legemiddelhåndbok 2009).

In addition, different guidelines within the RHAs may specify the treatment of AMI within the region due to special regional conditions (Helse Vest RHF 2003).

# 3. Institutional details and theoretical considerations

## 3.1 The Norwegian public health care system

The Norwegian health care sector with the Royal Norwegian Ministry of Health and Care Services as the office in charge has the overall responsibility for government policy on health care services in Norway. The primary goal for the health care sector is to provide adequate and appropriate health care services for everyone in Norway, irrespective of geographical location, financial circumstances, social status, age, sex and ethnical background (Helse- og omsorgsdepartementet 2007;Helse- og omsorgsdepartementet 2009b).

The primary care, supplied by the municipalities after law number 66 of November the 19th 1982, covers nursing and care services, emergency wards, midwife services and GPs for the citizens of the municipality. The secondary care covers all other health care services not included in the primary care (Helse- og omsorgsdepartementet 2006). In 2002 the RHAs were given the responsibility for the secondary health care services. The supply of secondary care services were organised in HTs, which primarily where the old hospitals earlier owned by the counties in Norway. Each HT was assigned a catchment area (municipalities) which the HT should provide adequate health care services to, according to the need of the population.

The merge of the Regional Health Authority East and the Regional Health Authority South in the middle of 2007 did not have any impact on the supply of AMI treatment. The catchment areas in the period being analysed were not altered and are therefore equally treated in the analysis before and after the merge.

The tertiary care is the highly specialised hospitals with national responsibilities. These hospitals may have both primary- and secondary care responsibilities in addition, but certain specialised services can be given a tertiary care status meaning that patients from the whole of Norway can be referred treatment at this hospital.

PCI-treatment for AMI was in the period 1999 – 2002 assigned to six secondary care HTs which were meant to meet the demand for PCI-treatment of AMI within their RHA. From 2003 – 2007 there were seven secondary care HTs offering PCI-treatment.

*Table 3.1 Hospital Trusts with PCI-centres, geographical location and Regional Health Authority.*

| Hospital | Municipality | Regional Health Authority |
|---|---|---|
| Rikshospitalet HT | Oslo | South Norway RHA* |
| Sørlandet Sykehus HT (after 2002) | Arendal | South Norway RHA* |
| Ullevål Universitetssykehus HT | Oslo | East Norway RHA* |
| Stavanger Universitetssykehus HT | Stavanger | West Norway RHA |
| Haukeland Universitetssykehus HT | Bergen | West Norway RHA |
| St. Olavs Hospital HT | Trondheim | Mid Norway RHA |
| Universitetssykehuset Nord-Norge HT | Tromsø | North Norway RHA |

* Merged to South East Norway RHA summer 2007.

The catchment areas of the HTs were often coincident with county areas. In the period of the analysis there were 26 HTs established in Norway, see table 7.1 in the appendix.

One private hospital in Eidsvoll municipality, Feiringklinikken AS, also offered PCI-treatment during the period of analysis. This private hospital is not included in the analysis. Feiringklinikken AS is not comparable to the other HTs due to its status as a private hospital without a catchment area. Instead patients are given elective treatment, meaning that Feiringklinikken receives referrals from all parts of Norway according to agreements with the RHAs. The relatively few cases of PCI-treatment at Feiringklinikken compared to the cases from the HTs support the decision of excluding Feiringklinikken from the analysis.

## 3.2 Possible financial effects on the access to health care services

Even though the financing of the somatic health care activity during the period of this study has changed according to the Activity Based Financing (ABF) (ABF share ranging from 40% to 60%), the concept of supply of health care services according to need has been kept as a main objective. The establishment in 2002 of five Regional Health Authorities with provider responsibility for the citizens did not change this.

The RHAs' somatic income in the period being analysed consisted of a basis granting and an ABF based granting. With these resources the RHAs were responsible for supplying somatic health care services to its citizens according to their needs[4]. The resources allocated to the RHAs have been discussed and investigated during the period of analysis and also in later years (Carlsen 2006;NOU 2003:1 2003;NOU 2008:2 2008). Especially the North Norway RHA has been subject for discussions about the size of the basis granting given to this RHA. Table 3.2 shows the basis grants (BG) for 2003 as they would have been if they were based on the amounts given in earlier grants. The effects on the basis grants if the grants were 100% based in the cost keys suggested in NOU 2003:1 are also shown. The cost keys included travel distance, defined as share of population with travel time more than 1,5 hours to nearest hospital, and age criteria (proportion of citizens in different age groups). The age criteria were weighted with 96% of the total cost key while the travel distance was weighted to 4% (NOU 2003:1 2003).

[4] The RHAs also have the responsibility for other health care services such as habilitation, rehabilitation, mental health care, treatment for alcohol and drug dependency etc. in addition to the responsibility for education, research etc. These areas are outside the scope of this study and are therefore not investigated further.

*Table 3.2 Change in basic grants to RHAs, historic level of basis grants and grants based 100% on cost keys (mill. 2003-NOK).*

| | EN RHA | SN RHA | WN RHA | MN RHA | NN RHA | Sum |
|---|---|---|---|---|---|---|
| **BG 2003** | 17 476,00 | 9 931,00 | 8 980,00 | 6 726,00 | 5 848,00 | 48 961,00 |
| **BG, cost keys (100%)** | 17 351,00 | 9 571,00 | 9 675,00 | 7 048,00 | 5 316,00 | 48 961,00 |
| **Change in NOK (mill.)** | (125,00) | (360,00) | 695,00 | 322,00 | (532,00) | - |
| **Change in percent** | (0,70) | (3,60) | 7,70 | 4,80 | (9,10) | |

BG=Basis grant, EN=East Norway, SN=South Norway, WN= West Norway, MN=Mid Norway, NN=North Norway

(Helse- og omsorgsdepartementet 2003)

It was especially paid attention to the negative effects for North Norway RHA. Thus, in the final basis grants from the Royal Norwegian Ministry of Health and Care Services to the RHAs these effects were levelled out by basing only 50% of the basis grants on the suggested cost keys, leaving 50% to the historic level of basis grants to the RHAs. In addition, redistributing of “the North Norway grant”[5], income covering depreciation and other grants given in 2003 to the RHAs resulted in the following basis grants:

[5] The “North Norway grant” was financed by the other RHAs achieving larger amounts of basis granting due to NOU 2003:1.

*Table 3.3 Basic grants to RHAs in 2003 (mill. 2003-NOK).*

| | EN RHA | SN RHA | WN RHA | MN RHA | NN RHA | Sum |
|---|---|---|---|---|---|---|
| **BG 2003** | 17 476,00 | 9 931,00 | 8 980,00 | 6 726,00 | 5 848,00 | 48 961,00 |
| **50% cost key, 50% Historic BG, "North Norway grant", income depreciation, other grants** | 17 400,00 | 9 751,00 | 9 187,00 | 6 827,00 | 5 796,00 | 48 961,00 |
| **Change in NOK (mill.)** | (76,00) | (180,00) | 216,00 | 92,00 | (52,00) | - |
| **Change in percent** | (0,40) | (1,80) | 2,40 | 1,40 | (0,90) | |

BG=Basis grant, EN=East Norway, SN=South Norway, WN= West Norway, MN=Mid Norway, NN=North Norway

(Helse- og omsorgsdepartementet 2003)

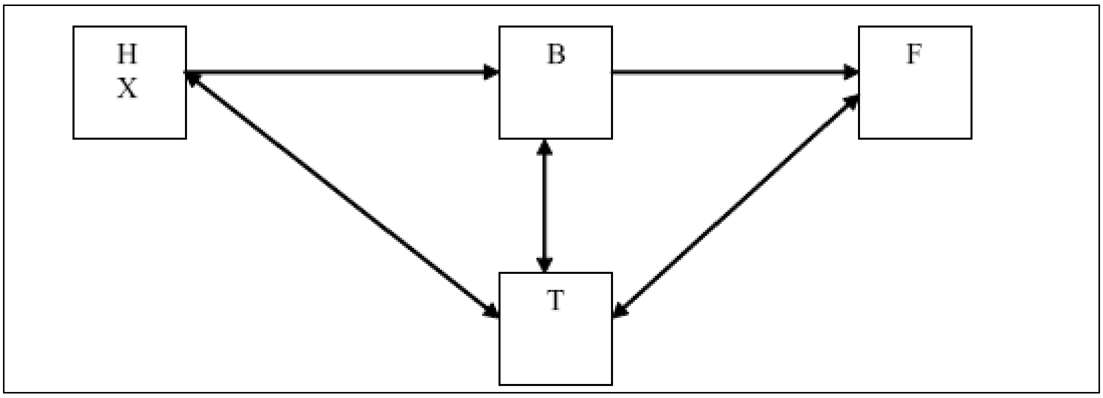
The negative effects for North Norway RHA were compensated for as Table 3.3 shows. This left the RHAs with only minor changes in their basis grants both compared to what they previously had got and to what they would have got if the cost keys were implemented 100%.

The allocation of financial resources to the RHAs is meant to give them the same opportunities to develop equal health care services across the whole of Norway. Yet, there has been revealed inequalities in the access to health care services in Norway (Nerland & Hagen 2008) and the allocation of resources to the RHAs thus may affect the equality of health care services in Norway.

## 3.3 The relationship between need, demand and consumption

When defining equality as equal consumption for equal need (see chapter 1.2) it follows that there is equality if relative differences in consumption reflects the same relative differences in need. The need for health care services, however, is difficult to measure exactly.

The need for health care services on an aggregated level is based on subjective considerations of individual need. Individual need is normally considered to be a result of the individual health status and the present medical technology which together decide the individual's possibility to utilize the given health care services. The health status and the possibility of utilization of health care services may again differ according to factors like age and different SES-variables. Figure 3.1 shows the relation between health status, SES-variables, need, supply and demand for health care services.




| | |
|---|---|
| H: | Health status |
| X: | SES characteristics (including gender and age) |
| B: | Need (unobserved) |
| F: | Consumption of health care services |
| T: | Supply side characteristics |

*Figure 3.1 The relation between health status, SES-variables, need, supply and consumption of health care services.*

*(NOU 2008:2 2008).*

The need for health care services (B) occurs as a result of normal conditions like giving birth, regular screening programmes and check ups etc, and of more acute conditions like injury, sickness and suffering because of some condition. The general health status of the population (H) is the basis from which the need for health care services is developed. Factors such as age, gender and SES-variables (X) can affect the need for health care services, indirectly by affecting the general health status, or directly if the need, given a certain health status, varies according to the factors. The need may lead to a demand for certain health care services, and in cases where the demand is greater than the supply, the consumption (F) will be restricted by the level of supply (T). Unmet need in this case arises if need does not create a demand, or if the demand is not met. The supply can affect the consumption of health care services not only by supplying less than is being demanded (restriction), but also by laying premises for the need. Preventive campaigns and medicine, screening and vaccination programs, healthy lifestyle advises and other early treatments offered to the population can both increase and decrease the need for health care services. In addition, the need may vary with a changing incidence/prevalence of diseases. The demand may vary with the conditions being treated or not, the consumers information about patient rights and possible treatment methods. The consumption of services may be affected by defensive medicine (over treatment) and different thresholds for offering treatment.

The demand for health care services is placed as a variable between need and consumption in the following simplified way:

Need = Demand, if no restrictions in the supply

Demand = Consumption, if the supply > the demand

This means that in cases with no restrictions in the supply, the need can be observed through the consumption (NOU 2008:2 2008). Unfortunately, using consumption as a measure of need does not incorporate the fact that:

- the consumers of health care services may not be the ones in most need of the services

- there may be population groups which systematically under- or over consume health care services when compared to their need

In situations like these, the hidden needs of the population results in a gap between the need and the consumption.

Epidemiological data, on the other hand, gives a description of the health status and illness of the population independent of the consumption of health care services, and thus gives a more precise description of need. Epidemiological data is often collected in the form of national or regional health surveys, either through interviews or most usually through self-reporting/self-completing (questionnaires). The following factors may distort the results from surveys relying on interviews and self-reporting/self-completing:

- Selection/sampling bias: The selection of participants does not represent the population. Different/low response rates for different population groups may lead to a result that is not representative for the whole population.

- Intervention bias: Different treatment of study groups. The interviewer may influence the respondent’s answers so that the answers are biased by the interviewer.

- Measurement bias: Recall bias or reporting bias occurs when the respondent’s answers are affected by the memory of the respondent.

(Peat et al. 2002)

There may also be a varying understanding of the occurrence of a condition from one place to another and the way conditions are measured can also be influenced by cultural and geographical variation.

Medical registers are another source of epidemiological data. The registers contain data gathered from small areas or patient groups, such as “Kreftregisteret” (the Cancer Registry of Norway). As there are no such register over heart diseases in

Norway (The Royal Norwegian Ministry of Health and Care Services submitted in the beginning of 2009 a matter of establishing a national register of heart diseases), using a registry is no alternative for this study.

Considering these options, the use of consumption data from HTs for the analysis purposes stated in this investigation, seems most fitted. The results from the analysis have to be controlled for the population's need for such treatment. Precise data on the need, measured as the incidence of AMI in the population, is not available because the data has to include both hospitalised patients and those not hospitalised. Using consumption data from hospitals as an indicator of need does not incorporate those cases not registered at a hospital. Epidemiological data on the prevalence of cardiovascular disease for the whole population of Norway is not available on municipality/county level. Similar studies (Ben-Shlomo and Chaturvedi 1995;Gatrell, Lancaster, Chapple, Horsley, & Smith 2002) use mortality data for ischemic heart disease (IHD) as a proxy measure of "need". Using mortality as a proxy measure of incidence may lead to problems if the coding and diagnosis of death is not accurate. Also, mortality from IHD includes not only AMI (ICD-10 code I21 – I22), but also other diagnoses (ICD-10 code I20 – I25). For less acute diagnoses, referral thresholds and waiting times may have an impact on the mortality data. Furthermore, mortality data does not give information about how many AMI-patients that did not die because of correct and life saving treatment. Because of these problems with finding a precise measure of need for PCI-treatment, mortality data on IHD is included in the analysis as a separate variable which is analysed for its effect on the probability of getting PCI-treatment. At the same time the estimates for the other variables are controlled for need. If the probability of getting PCI is high in geographical areas where the mortality is high, and lower in areas where mortality is lower, there might be evidence of supply of health care services according to need.

## 3.4 Need/demand side independent variables

### 3.4.1 Age

Elderly patients are especially in the risk group for AMI. The mean age for AMI in the period of analysis is 70 years. Age is also a factor influencing the distribution of PCI. Traditionally, PCI is given in less extent to older patients (80 years and older). However, cardiologists say that nowadays "…a more liberal referral rate of elderly patients to invasive cardiac treatment has to be assumed" (Kristiansen 2003). Also acute medical treatment for AMI (thrombolytic treatment) is in less extent given to older patients (Jortveit & Brunvand 2006). Reasons for giving less treatment to older patients may be doubts about the utility value from the treatment and/or a higher risk for complications.

This analysis investigates both the effect age have on the individual probability of getting PCI-treatment, and the effect the municipality age structure have on the probability of getting PCI for a patient living in a certain municipality.

**Individual age effect**

Investigating the effect age has on the individual probability of getting PCI is expected to show an increasing probability with age until a certain old age where the probability starts decreasing as a result of less PCI-treatment given to the very old patients. This effect is captured by two variables; a linear variable "Age" and a quadratic variable $(Age)^2$.

**Municipality age structure effect**

Evidence for decreasing consumption of health care services with increasing waiting lists in municipalities (Nerland & Hagen 2008), implies inequality. Patients living in areas where the demand for a certain health care service is relatively high compared with the actual supply of the service (supply side restrictions) tend to consume less than what is needed or demanded. The majority of new AMIs occur in the age group 60 – 90 years (Hagen & Reikvam 2003). Since age is one of the major risk factors for

AMI, one may assume that areas with a relatively large population in age groups with elevated risk for AMI, experience a higher ratio of AMIs per 100 000 population than other areas.

This study investigates whether there is evidence of lower probability of PCI in areas where the share of older patients is relatively high. Different age groups are included in the regression analysis as independent variables and are analysed for their effect on the probability of PCI for a patient living in a given municipality. The number of people in the age groups “45 to 66 years old”, “67 to 79 years old” and “80 years and older” are found for each municipality for each year of the analysis. The share of the municipality population in these groups are calculated and included in the analysis. Younger age groups are excluded from the analysis because AMI is a diagnosis most common in older age groups (see chapter 2.1).

It is expected that the probability of getting PCI is low in municipalities having a large share of the citizens in the age risk groups for AMI. However, results showing the opposite effect would imply a better supply of PCI-treatment in these municipalities than in others. Such evidence would imply that relative differences in need are reflected by the same relative differences in supply and consumption.

### 3.4.2 Gender

Cardiovascular diseases (for definition see chapter 1.1) are the number one death cause for Norwegian women. Cancer is the second most deadly disease. Historically, middle aged and older men with unhealthy lifestyles have been the main risk group for cardiovascular diseases, but the gap between men and women is decreasing. Figure 3.2 shows historic mortality numbers from IHD (ICD-10 code I20 – I25) for males and females[6].

[6] Mortality numbers from AMI for males and females are not available, mortality numbers from IHD is therefore used in stead. IHD (ICD-10 code I20 – I25) includes AMI (ICD-10 code I21 – I22).

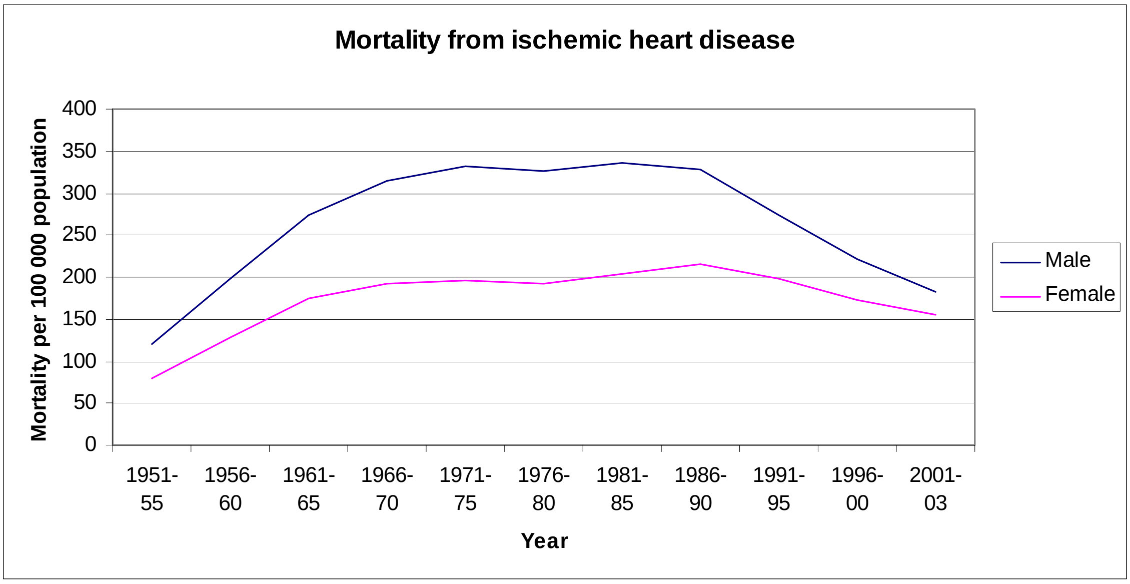



*Figure 3.2 Mortality from IHD per 100 000, 1951 – 2003.*

*(Dødsårsaksregisteret 2009).*

Risk factors, symptoms and types of heart diseases can differ from men to women. Diagnosing women is often more difficult because of diffuse symptoms, additional diseases (elevated blood pressure and diabetes) and a higher age (Krüger 2007). Men are more likely to develop a stenosis (narrowing) in the coronary artery, which in many cases can be treated with PCI. Women often experience a more diffuse disease in the artery walls with cholesterol laden plaques gathering without causing a stenosis. In cases like these, PCI is no longer the best treatment method. When AMI is diagnosed women more often than men die or experience a heart failure after the AMI (LHL 2009). Because of the different symptoms and diffuse disease characters women often experience, the actual need for PCI-treatment for women is difficult to estimate. Kristiansen (Kristiansen 2003) found that men have 200 – 400 % higher rate of intervention (CABG, PCI) than women. A more diffuse disease character combined with other treatment methods, may contribute to some of the differences. Gatrell (Gatrell, Lancaster, Chapple, Horsley, & Smith 2002;Kristiansen 2003) also found that PCI treatment are given in less extent to women. The study is controlled for need, which is measured by mortality from ischemic heart disease (see discussion of mortality as a proxy for need in chapter 3.3).

Gender is included as an independent variable in the regression analysis to estimate the different probability of getting PCI for males (value 1) and females (value 2). The estimate is expected to show a lower probability for women getting PCI.

### 3.4.3 SES

Health status is a result of heredity (genes, diseases etc.), environment (pollution, housing, hygiene etc.) and lifestyle (smoking, alcohol, physical activity, nutrition, stress, sleep etc.). Evidence from many different countries has| established a link between low SES and poor health, as SES especially affects the environment and lifestyle of the individuals. Consumption of health care services however, may help improving the health status either by preventive help or by immediate help. The question is whether individuals with low SES achieve the health care services they need or not. Studies investigating the effect of SES-variables on consumption of health care services have found evidence of underconsumption for people from low SES (Ben-Shlomo & Chaturvedi 1995;Manson-Siddle & Robinson 1998). Measures or variables that indicate the SES of individuals or groups most often include education, income and occupation (unemployed, disabled, type of work) (Carlsen 2006;Nasjonalt folkehelseinstitutt 2007a;NOU 2008:2 2008).

**Municipality education level effect**

In Norway during the 1990s, the life expectation for men ranged from 71,8 years for those with only junior high school to 76,7 years for those with a university degree. For women, the same range was from 78,0 years to 81,4 years. The link between education and mortality may come from unobserved factors such as for instance cognitive ability. Cognitive ability may lead to good health and better education. Education may improve health related knowledge and thereby initiate healthier life styles, which again reduce the mortality risk. As an important determinant of occupational career, education may lead to a high and stable position in the labour market. A high work position constitutes a continuous opportunity for ensuring high income and favourable living conditions, which again may lead to better health status (Strand and Kunst 2007).

A high education level is assumed to influence the purchasing power of health care services upwards, as people's education influence their life style and health consciousness. Municipality data for each year on the share of the municipality population having only lower education (primary school/junior high school) is included in the regression analysis as an independent variable to estimate the effect education has on the probability of PCI. A low education level in a municipality is assumed to have a negative effect on the probability of getting PCI for the citizens of the municipality.

**Effect of personal income, municipality level**

A link between low income and poor health has also been established. In Norway in the period 1994 – 2003 those with low income had higher mortality rates than those with high income. For women, the differences between low and high income groups increased in the period 1994 – 2003. The differences for men in the same period were unchanged (Nasjonalt folkehelseinstitutt 2007b).

Education and income are assumed to have the same effect on the purchasing power of health care services, life style and health consciousness. Municipality data per year on mean income for the inhabitants is gathered and included in the regression analysis (see chapter 4.8.1 for test for multicollinearity). Data from 2007 is not available (see chapter 4.5 for description of extrapolation). The income is converted to 2007 NOK level. A high income is assumed to influence the purchasing power of health care services upwards, as people's income may influence their life style and health consciousness. A low mean municipality income is assumed to have a negative effect on the probability of getting PCI for the citizens of the municipality.

**Municipality unemployment effect**

Involuntarily loss of salaried work represents a complex psychosocial load as a result of a weakened social network, loss of identity and lowered self respect. The most common health problems resulting from unemployment are depression and anxiety. Somatic diseases resulting from unemployment are less common than psychological diseases, but there is evidence of the unemployed consuming more health care services, medicaments and intoxicating substances than others. The unemployed also have higher mortality rates (Nylenna 2009).

The share of unemployed per municipality per year is included as an independent variable in the regression analysis to estimate the effect of unemployment. A high share of unemployed is assumed to have a negative effect on the probability of PCI.

**Municipality disability effect**

Similarly, a link between disability and a corresponding lowered health status seems possible. Carlsen (Carlsen 2006) found that a higher number of disabled are correlated with a higher consumption of health care services, indicating a lower health status amongst the disabled.

The share of disabled per municipality per year is included as an independent variable in the regression analysis to estimate the effect of disability. A high share of disabled is assumed to have a negative effect on the probability of PCI.

### 3.4.4 Mortality from IHD

Several studies use mortality data on IHD as a proxy measure of incidence to overcome the problem of estimating the exact need for treatment. They do this by comparing the variations in procedure rates with variations in mortality rates (see chapter 3.3). Since mortality data include patients dying also outside hospitals, the coding of the cause of death is likely to be less accurate. Because mortality data is a proxy measure of the community incidence rather than the hospital incidence, these data gives information which the NPR-data do not contain.

This study therefore uses AMI admissions to hospitals and the crude numbers of PCI-treatment as data on actual consumption. Mortality data is included in the regression analysis to control the results based on actual consumption with the community incidence (need).

Mortality data on IHD for the counties per year in Norway is included in the analysis as an independent variable which is analysed for its effect on the probability of PCI. The number of deaths per 100 000 population per county is used as a measure of the need for PCI-treatment. If the probability of getting PCI is high in geographical areas where the mortality is high, and lower in areas where mortality is lower, there might be evidence of relative differences in need being reflected by the same relative differences in supply and consumption.

## 3.5 Supply side independent variables

### 3.5.1 Travel distance

In studies of general consumption and access to health care services in Norway (Nerland & Hagen 2008) the effect of the distance to treatment centre is negative, meaning that the consumption of health care services decreases with an increase in the travel distance to hospital. Especially emergency and out-patient treatments are affected by the distance from the patients' home municipality to the nearest hospital. Following this, the distance to PCI-treatment centre is included in the analysis. Table 3.1 shows the HTs offering PCI-treatment and their geographical location (municipality).

The catchment areas to the PCI-centres for the years 1999 – 2002 are outlined in Figure 3.3.

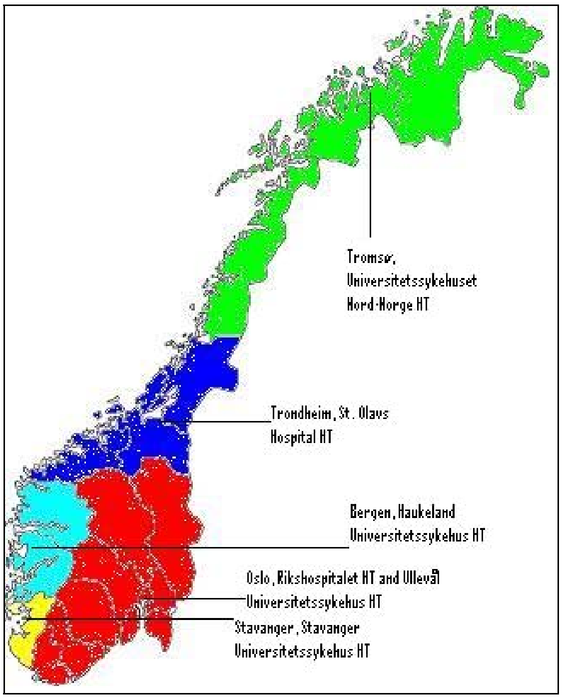



*Figure 3.3 Catchment areas for PCI-centres, 1999 – 2002.*

The establishment of a PCI-centre in Arendal in 2003 changed the catchment area of the PCI-centres in South (South-East) Norway RHA. The new catchment areas for the years 2003 – 2007 are implemented in the analysis and are outlined in Figure 3.4.

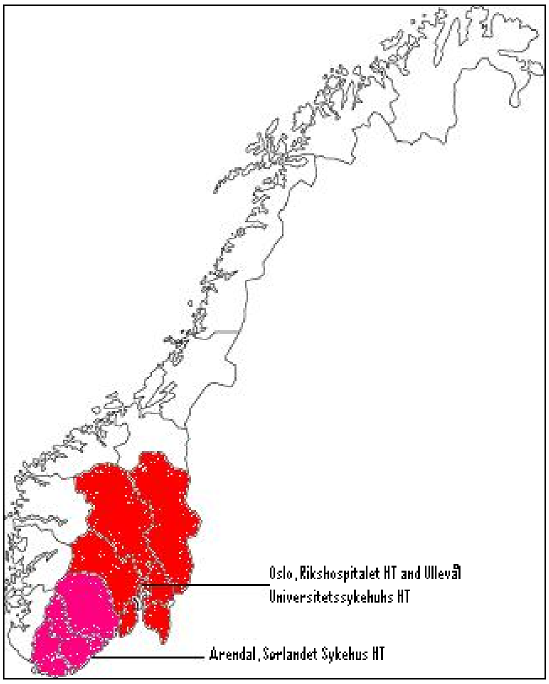



*Figure 3.4 Catchment areas for PCI-centres in South (South-East) RHA, 2003 – 2007.*

The guidelines describing which hospital the patients are to be treated at for the different RHAs are followed in the analysis with the following simplification/adjustment:

- The West Norway RHA operates with different catchment areas due to helicopter weather and day, or day-and-night services at the different hospitals offering PCI treatment. In the analysis this is not taken into account because of the complications this will lead to in the analysis. The catchment areas are stated as if the hospitals are open at all times and that there are always helicopter weather, see Table 3.4.

*Table 3.4 Catchment areas for the hospitals offering PCI treatment in West Norway RHA used in the analysis.*

| Hospital | Catchment area |
|---|---|
| Stavanger Universitetssykehus HT | All municipalities within Rogaland county |
| Haukeland Universitetssykehus HT | All municipalities within Hordaland and Sogn og Fjordane counties |

The distance in overhead line in km from the centre of each municipality to the centre of the municipality with a HT giving PCI-treatment is included in the analysis as an independent variable. According to medical guidelines (see chapter 2.4) patients living far from PCI-treatment centre are in many cases administered thrombolytic therapy instead of PCI-treatment. It is therefore expected to find evidence for a negative effect of the distance, meaning that with increasing distance to PCI-treatment centre there are decreasing probability of PCI.

### 3.5.2 HT and year dummy variables (fixed effects)

As shown in Figure 3.1 the consumption rate can be influenced or restricted by the supply and availability of health care services. As long as the demand for treatment is larger than the supply, supply side differences will affect the consumption rates. Access to resources, efficiency, organising and leadership are typical supply side factors that may differ between the HTs and between the RHAs because of different organising, geographical adjustments, patient mix etc. Differences in these factors may lead to different supply side effects between the HTs.

The danger of erroneous inference due to supply side effects is most present when the level of a consumption analysis coincides with the level of the supply side. Analyses of aggregated consumption rates per HT would to a large extent coincide with the county of residence for the patients and the HT treatment area, and such analyses are thus in danger of getting results influenced by unwanted supply side effects. The supply side effects, in this study the supply side effects from the HTs in the secondary care services, are handled both by bringing the analyses down to a lower level than the level of the HTs and by including HT dummies. Using small-areas (municipalities) or individuals as the level of analysis give a larger number of observations and more precise estimates of the variables, and in addition reduce the danger of level fallacy (Smith 2007).

The analysis of consumption of PCI-treatment is executed at individual level. The estimates are presented at both individual, municipality, county and HT-level. Hierarchic aggregation of the results is used to aggregate the data from individual level and up to higher levels (municipality, county, HT). This enables the estimates at higher levels to explain variations at lower levels. In this way, hierarchic aggregation reduces unwanted supply side effects from the HTs and at the same time enables comparisons at HT level.

Possible supply side differences between the HTs are also tried avoided in the analysis by excluding the variation between the HTs and using the variation between consumption and the need variables within the HTs to calculate the estimates. This is done by including HT dummies (HTNR1 – HTNR24) which captured the effect of unequal supply side effects *between* the HTs. (NOU 2008:2 2008). HTNR = 24 is used as reference unit, table 7.1 in the appendix gives an overview over the HTs.

Investigating the change in probability of PCI across the years is done in a similar way by including dummies for years (T1999 – T2007), with year = 2007 as reference unit.

## 3.6 Summary

Chapter 3 describes both the institutional and the financial framework laying premises for equal supply and access to PCI-treatment for all patients in Norway. The need/demand side variables and the supply side variables included in the analysis and investigated for their influence on the dependent variable, the probability of PCI, are also described. The need/demand side variables include both individual variables and municipality variables. The individual variables age and gender are expected to affect the probability of getting PCI in favour of middle aged men, disfavouring women and very old persons. Municipality variables indicating low SES (low education level, low income, high share of unemployed and high share of disabled) are expected to have a negative impact on the consumption rate and probability of getting PCI for AMI. Such results would indicate inequalities in the probability of PCI. The results are controlled for need, measured as mortality from IHD per 100 000 population per county. The supply side variables include travel distance to PCI-treatment per municipality, which is expected to have a negative estimate, and HT dummies which are included in the analysis to avoid that the estimates are influenced by supply side differences between the HTs. Table 3.5 defines and sums up the independent variables included in the analysis.

*Table 3.5 Definition of independent variables*

| **Variable** | **Definition** |
|---|---|
| Age | From NPR-data: individual age on AMI-patients |
| $(Age)^2$ | Age * Age |
| Gender | From NPR-data: individual gender on AMI-patients |
| Share 45 - 66 | Number of citizens 45 - 66 years/number of citizens |
| Share 67 - 79 | Number of citizens 67 - 79 years/number of citizens |
| Share 80+ | Number of citizens 80 years and above/number of citizens |
| Distance PCI | Distance from home municipality to PCI-treatment centre |
| Share disabled | Number of disabled/number of citizens |
| Mean income | Sum personal income for all citizens/number of citizens |
| Share low education | Number of citizens with low education/number of citizens |
| Share unemployed | Number of unemployed/number of citizens |
| Mortality IHD | Number of deaths from IHD per 100 000 population |
| HTNR | HTNR24=dummy (value=0) |
| T | T2007=dummy (value=0) |

The institutional set up, the financing of the RHAs and the estimates for the independent variables are the background for insight and answers to the research questions presented in chapter 1:

1) Is there significant evidence for unequal access, measured as varying probability of PCI, in Norway in the period of analysis?

2) Is there significant evidence for an unequal probability of PCI between those patients living in the catchment area of HTs *with* PCI-treatment and those living in the catchment area of HTs *without* PCI-treatment?

3) Is there significant evidence for an unequal probability of PCI within the group of HTs *with* PCI?

4) Is there significant evidence for an unequal probability of PCI within the group of HTs *without* PCI?

5) Are demographical variables, SES-variables and geographical location independently associated with the probability of PCI?

# 4. Data and method

## 4.1 Ethical considerations

The study has been ethically reviewed and approved by “Personvernombudet for forskning”, “Regional komité for medisinsk og helsefaglig forskningsetikk Sør-Øst (REK Sør-Øst)” and ”Helsedirektoratet (Norwegian Directorate of Health)” to ensure that personal information protection, ethical guidelines and obligations to maintain secrecies are followed and that the research are done in accordance with the law.

## 4.2 NPR-data

Chapter 2 describes the medical aspects of AMI, treatment alternatives and the medical guidelines for the treatment alternatives. Figure 2.1 and Figure 2.2 show the number of reported AMIs during the period of analysis in crude number and per 100 000 population. The basis for these numbers is NPR-data for the years 1999 – 2007 which represents a register over all HT admissions in the given period of time. Using NPR-data for analysis purposes require knowledge about how the data came in to being, its contents and certain limitations connected to the data material.

Each HT registers all admissions in a system where each patient is assigned a patient number from a number series administered by the hospital. Information about the patient is registered on the patient number: personal number, name, gender, address, home municipality, diagnosis, treatment, length of stay and so on. Different coding practice for the same diagnose and treatment lower the quality of the data. This is not very likely to be the case for AMI (see chapter 6.4 for discussion about this). Every tertian the HTs report these data over admissions and hospital activity to NPR. Because of laws restricting the use of personal identification until recently (Fornyings- og administrasjonsdepartementet 2009;Helse- og omsorgsdepartementet 2009a;Justis- og politidepartementet 2009), the data stored and made available from

NPR used in this study is without personal identification information. Without personal identification, a patient who visits several hospitals can not be identified by the NPR-data. The NPR-data contains number of hospital admissions/stays, independent of the actual number of patients.

As described in chapter 3.5.1, not all hospitals offer PCI-treatment. A patient experiencing AMI will in some cases be sent directly to a hospital offering PCI-treatment, in other cases to a hospital not offering PCI-treatment. If the investigation of the patient reveals the need for PCI-treatment, the patient admitted to a hospital without PCI-treatment is sent further on to a hospital offering PCI-treatment. After the invasive surgery (PCI-treatment), some patients may experience being sent back to the local hospital for recovery instead of staying at the HT with PCI-treatment. Regarding the registered admissions in the case where the patient has to be referred to another hospital for PCI-treatment, one AMI case generates two, possible three, AMI admissions and one PCI-treatment. If the initial hospital had offered PCI treatment, the registered admissions would have shown one AMI admission and one PCI-treatment. Thus, the probability of getting PCI-treatment, calculated as the number of PCIs divided on the number of AMIs, for municipalities within the catchment area of a hospital not offering PCI-treatment may show a false low rate because of a higher AMI number than is the case. This is a problem following the use of NPR-data and if possible should be corrected for. The use of HT dummies in this analysis corrects for some of this variation between the HTs, but still the results should be interpreted carefully with this problem in mind.

## 4.3 Dependent variable: Probability of PCI

Before the dependent variable is calculated from the NPR-data, all AMI admissions coded with an age less than 15 years are excluded from the data used in the analysis. Because AMI very rarely occur at young age, the admissions coded with an age less than 15 are most likely results of code error or other registration error. The number of excluded admissions because of code/registration error is insignificant for the results of the analysis.

The descriptive statistics for the dependent variable, probability of PCI, shows an increasing trend for the whole of Norway during the period of analysis 1999 – 2007, see Table 4.1. In 1999 only 3% of the AMI admissions are treated with PCI. In 2007 24% of all AMI admissions are treated with PCI. The probabilities differ greatly between the HTs, both between the HTs with PCI-treatment and between the HTs without PCI treatment, see chapter 5.

## 4.4 Other data sources

Individual variables describing age and gender of the patients are gathered from the NPR-data. The variables describing municipality age structure, number of persons with low education level, gross mean income, number of unemployed and number of disabled persons are gathered from Statistics Norway (SSB) and Norwegian Social Science Data Services (NSD) and are only available at municipality level. County mortality data for IHD is gathered from Statistics Norway (SSB) for the period 1999 - 2006. Data from 2007 is not available (see chapter 4.5 for description of extrapolation). The data is only available on county level because of patient safety concerns connected to the data. The matrix over the distances in kilometres from each municipality centre to the centre of the hospital municipality is prepared and calculated by InfoMap Norge AS  (Iversen & Kopperud 2002b;Kopperud 2002).

## 4.5 Extrapolation: centered moving average

The variables “Mortality IHD” and “Mean income” are extrapolated to fill in missing values for the year 2007. This is done in SAS (Statistical Analysis System) by using PROC EXPAND and CMOVAVE statements. PROC EXPAND replaces missing values at the beginning or at the end of input series (SAS Institute Inc. 2009). CMOVAVE means centered moving average and can be referred to as a “smoothing technique" designed to reduce or eliminate short-term instability in the data. A smoothed series is preferred to a non-smoothed one because it may capture changes in the underlying trend instead of capturing insignificant changes due to for instance one special measurement varying from the others.

Centered moving average consolidates the yearly data points of "Mortality IHD" and "Mean income" into longer units of time so that an average of several years is created based on the middle value of the data and thus gives a value for the year 2007 based on the average of several year's data. The downside by using this technique is that some of the variable's timeliness is lost. For this reason, a "weighted" moving average is used in this analysis, putting more importance on the more current values (the last three years) (Federal Reserve Bank of Dallas 2009). The extrapolated values for the years 1999 – 2007 are used in stead of the real values for the years 1999 – 2006 and the extrapolated value for 2007.

## 4.6 Statistical analysis tool

Performing the regression analysis with several variables (municipalities, age groups, individual age and gender, SES-variables, distances to treatment centre, HF and year dummies) on the NPR-data consisting of 147 396 admissions is done with SAS. SAS enables analyses of large amounts of data and handles dummy variables in a good way. The drawback is the complexity of the system and the need for a person with programming skills within SAS.

## 4.7 Empirical model

The study is designed as a pooled cross-sectional study. This is the same as repeated cross-sectional, or trend design. A "cross-section" – a slice that cuts across an entire population – is used to see all parts, or sections, of that population. In a pooled cross-sectional study, the data is collected over time so that the relationship between cause (independent variables) and effect (dependent variable) can be investigated (Chambliss and Schutt 2006).

The basic empirical model should capture the effects the independent variables have on the probability of PCI (dependent variable). The need/demand side variables include individual patient specific variables, municipality specific variables and a county specific variable. The supply side variables include a municipality specific variable and a HT specific variable. The multiple linear regression model where the probability of getting PCI for patient *i* in municipality *j* and county *k* per year is given by

$$Y_{ijk} = \beta_0 + \beta_1 x_{1ij} + \beta_2 x_{2i} + \beta_3 x_{3j} + \beta_4 x_{4k} + \beta_5 x_{5j} + \beta_6 D + e_{ijk} \qquad (1)$$

where footprint for year $t$ is suppressed. $\beta_0$ is a constant term, $x_{1ij}$ denotes patient *i*s age and also the three age groups at municipality level included in the analysis. $x_{2i}$ denotes patient *i*s gender, value 1 assigned male patients, value 2 assigned female patients. Independent variables taking only two values are called dummy variables and in most cases the values 0 and 1 are assigned the variables (Newbold et al. 2006). The values assigned (1 and 2, instead of 0 and 1) affect the intercept by moving the intercept along the x-axis from the x value = 0 (men) to the x value = 1 (men) so that a new intercept is created. The regression line stays the same (the regression estimates are not affected) and thus for the purpose of this analysis, it does not matter whether values 0 and 1, or values 1 and 2 are used. Male, value 1, is defined as the reference unit with the estimate for gender defining the difference female patients have on the probability of PCI compared with male patients. $x_{3j}$ denotes SES-variables at municipality level, $x_{4k}$ denotes mortality from IHD at county level and $x_{5j}$ denotes travel distance to PCI-treatment centre at municipality level. $e_{ijk}$ is the error term for all levels. *D* is a vector for hospital trust specific (*H*) and year specific (*T*) dummy variables. Equation (2) expresses this alternative specification for the dummies in (1)

$$D = \beta_7 H + \beta_8 T \quad (2)$$

The hospital trust specific *H* and year specific *T* dummy variables work as "fixed effects". The estimate of the impact of HTNR24 (hospital area number 24) is assigned the reference value 0. The estimate of the impact of year 2007 is also assigned the reference value 0. The estimates for the other *H* and *T* dummies show if there are significant differences between the different HTs and years compared to the reference values. The fixed effects capture both observed and unobserved time-constant variables. Additionally, the control for fixed effects make it possible to study the *within* effects of the time-varying variables, for example SES-variables (Martinussen and Hagen 2009). The estimates of the SES-variable "Share low education" tell how much "Prob PCI" changes as "Share low education" changes, within the specific HTs.

## 4.8 Assumptions

### 4.8.1 Statistical

The population sample used in this study – pooled cross-sectional population sample (NPR-data from 1999 - 2007) – ensures that the generalisability is good and that the results are applicable to similar populations. The relatively large sample size (147 396 patients with AMI) ensures that the probability of type I and type II errors are minimized. The power is adequate to show significant results and the estimates are likely to be precise. The validity of the instrument (multiple regression) and the accuracy of the results are dependent on the data quality, which is considered to be good.

The independent variables are tested for normality and as anticipated, all of them are normally distributed. The error term is assumed to have a normal distribution.

The standard assumptions for multiple regressions (homoscedasticity, heteroscedasticity and multicollinearity) (Newbold, Carlson, & Thorne 2006) are checked and the only assumption not fulfilled is the requirement of no linear relationship between two of the explanatory variables (multicollinearity). The procedure CORR in SAS is used to compute Pearson product-moment correlation on the independent variables. Pearson correlation is a parametric measure of a linear relationship between two variables (SAS Institute Inc. 2009) which if being correlated, may disturb the results of the main analysis. The variable “Low education level” is strongly correlated with “Mean income” (Pearson correlation of -0,77) and having to choose which one of the variables to keep in the analysis, “Mean income” is excluded and “Low education level” is kept due to the stronger explanatory power of this variable. Also, studies argue for the level of education as an explanatory factor for health status and survival from diseases in comparison with the average income (Kravdal 2006;Lovasi et al. 2008;NOU 2008:2 2008).

Significant explanatory variables not included in the analysis are a general problem for regression analyses. In this study local variables explaining AMI incidence or PCI demand, may be examples of such variables. The fixed effects included in this analysis (HT-dummies and year-dummies) capture most of the effect of potential variables not included, but probably not all effects.

### 4.8.2 Methodical

To simplify the analysis, the assumption that patients always are within their home municipality when having an AMI, is set. This is done because the distance between home municipality and HT with PCI-treatment is included in the analysis as an independent variable. Thus, if patients to a large extent are not within their home municipality when having AMI (work, vacation etc.) the distance variable looses its explanatory power.

PCI treatment of AMI is assumed always to be executed as emergency treatment, not as an elective treatment. Thus, the free choice of hospital is eliminated as an unwanted effect on the distance variable. CABG-treatment was initially considered included in the analysis but since this treatment to a large extent is given elective, this treatment is excluded from the analysis.

## 4.9 Descriptive statistics

Descriptive statistics for the variables included in the analysis are presented in Table 4.1. The variable "ProbPCI" shows the percentage probability of PCI, calculated from number of PCI divided on number of AMI (NPR-data). The variables "Age", "$(Age)^2$" and "Gender" show values calculated on the basis of the AMI admissions (NPR-data). The age variables are given in years. The gender variable assigns the value 1 to male and 2 to females. The variables describing share of age groups and SES show the calculated values of their percentage share of the population per municipality. The variable "Mortality IHD" are given in number of deaths per 100 000 population per county. The variable "Distance PCI" is given in km.

*Table 4.1 Descriptive statistics of variables, 1999 – 2007.*

| | **Mean** | **Std Dev** | **Minimum** | **Maximum** |
|---|---|---|---|---|
| **1999 (Valid N=11771)** | | | | |
| ProbPCI | 0,03 | 0,17 | 0,00 | 1,00 |
| Age (AMI) | 70,97 | 13,18 | 18,00 | 103,00 |
| $(Age)^2$ (AMI) | 5210,16 | 1775,92 | 324,00 | 10609,00 |
| Gender (AMI) (2=female) | 1,37 | 0,48 | 1,00 | 2,00 |
| Share 45 - 66 | 0,24 | 0,02 | 0,18 | 0,33 |
| Share 67 - 79 | 0,10 | 0,02 | 0,05 | 0,18 |
| Share 80+ | 0,04 | 0,01 | 0,02 | 0,12 |
| Share low education | 0,28 | 0,06 | 0,14 | 0,53 |
| Share unemployed | 0,01 | 0,00 | 0,00 | 0,05 |
| Share disabled | 0,06 | 0,02 | 0,02 | 0,14 |
| Mortality IHD | 192,89 | 31,20 | 133,08 | 244,33 |
| Distance PCI (km) | 142,56 | 170,02 | 0,00 | 1017,90 |
| **2000 (Valid N=11776)** | | | | |
| ProbPCI | 0,05 | 0,22 | 0,00 | 1,00 |
| Age (AMI) | 70,76 | 13,45 | 19,00 | 100,00 |
| $(Age)^2$ (AMI) | 5187,29 | 1809,71 | 361,00 | 10000,00 |
| Gender (AMI) (2=female) | 1,37 | 0,48 | 1,00 | 2,00 |
| Share 45 - 66 | 0,25 | 0,02 | 0,19 | 0,32 |
| Share 67 - 79 | 0,10 | 0,02 | 0,05 | 0,18 |
| Share 80+ | 0,04 | 0,01 | 0,02 | 0,12 |
| Share low education | 0,27 | 0,06 | 0,14 | 0,54 |
| Share unemployed | 0,01 | 0,00 | 0,00 | 0,06 |

| | | | | |
|---|---|---|---|---|
| Share disabled | 0,06 | 0,02 | 0,03 | 0,14 |
| Mortality IHD | 188,37 | 30,96 | 131,41 | 241,43 |
| Distance PCI (km) | 143,89 | 172,38 | 0,00 | 1017,90 |

| **2001 (Valid N=14617)** | | | | |
|---|---|---|---|---|
| ProbPCI | 0,08 | 0,27 | 0,00 | 1,00 |
| Age (AMI) | 71,19 | 13,62 | 20,00 | 107,00 |
| $(Age)^2$ (AMI) | 5253,47 | 1839,57 | 400,00 | 11449,00 |
| Gender (AMI) (2=female) | 1,37 | 0,48 | 1,00 | 2,00 |
| Share 45 - 66 | 0,25 | 0,02 | 0,19 | 0,32 |
| Share 67 - 79 | 0,10 | 0,02 | 0,05 | 0,17 |
| Share 80+ | 0,05 | 0,01 | 0,02 | 0,12 |
| Share low education | 0,27 | 0,05 | 0,14 | 0,52 |
| Share unemployed | 0,01 | 0,00 | 0,00 | 0,05 |
| Share disabled | 0,07 | 0,39 | 0,03 | 43,12 |
| Mortality IHD | 180,61 | 29,77 | 127,94 | 234,08 |
| Distance PCI (km) | 144,63 | 166,95 | 0,00 | 1017,90 |

| **2002 (Valid N=15626)** | | | | |
|---|---|---|---|---|
| ProbPCI | 0,13 | 0,33 | 0,00 | 1,00 |
| Age (AMI) | 70,97 | 13,89 | 19,00 | 104,00 |
| $(Age)^2$ (AMI) | 5229,56 | 1888,13 | 361,00 | 10816,00 |
| Gender (AMI) (2=female) | 1,37 | 0,48 | 1,00 | 2,00 |
| Share 45 - 66 | 0,25 | 0,02 | 0,20 | 0,33 |
| Share 67 - 79 | 0,09 | 0,02 | 0,05 | 0,16 |
| Share 80+ | 0,05 | 0,01 | 0,02 | 0,12 |
| Share low education | 0,26 | 0,05 | 0,14 | 0,52 |
| Share unemployed | 0,05 | 0,01 | 0,03 | 0,11 |
| Share disabled | 0,07 | 0,51 | 0,03 | 42,93 |
| Mortality IHD | 174,46 | 30,27 | 120,41 | 234,21 |
| Distance PCI (km) | 140,64 | 164,06 | 0,00 | 1017,90 |

| **2003 (Valid N=17844)** | | | | |
|---|---|---|---|---|
| ProbPCI | 0,17 | 0,37 | 0,00 | 1,00 |
| Age (AMI) | 70,55 | 14,05 | 18,00 | 103,00 |
| $(Age)^2$ (AMI) | 5175,13 | 1899,69 | 324,00 | 10609,00 |
| Gender (AMI) (2=female) | 1,38 | 0,48 | 1,00 | 2,00 |
| Share 45 - 66 | 0,26 | 0,02 | 0,20 | 0,33 |
| Share 67 - 79 | 0,09 | 0,02 | 0,05 | 0,17 |
| Share 80+ | 0,05 | 0,01 | 0,02 | 0,13 |
| Share low education | 0,26 | 0,05 | 0,14 | 0,50 |
| Share unemployed | 0,02 | 0,01 | 0,01 | 0,07 |
| Share disabled | 0,07 | 0,49 | 0,03 | 44,66 |
| Mortality IHD | 165,34 | 28,87 | 114,00 | 224,71 |
| Distance PCI (km) | 129,90 | 162,39 | 0,00 | 1017,90 |

| **2004 (Valid N=18141)** | | | | |
|---|---|---|---|---|
| ProbPCI | 0,20 | 0,40 | 0,00 | 1,00 |
| Age (AMI) | 70,49 | 13,98 | 19,00 | 104,00 |
| $(Age)^2$ (AMI) | 5164,11 | 1898,45 | 361,00 | 10816,00 |
| Gender (AMI) (2=female) | 1,36 | 0,48 | 1,00 | 2,00 |
| Share 45 - 66 | 0,26 | 0,02 | 0,20 | 0,34 |

| | | | | |
|---|---|---|---|---|
| Share 67 - 79 | 0,09 | 0,02 | 0,05 | 0,16 |
| Share 80+ | 0,05 | 0,01 | 0,02 | 0,14 |
| Share low education | 0,26 | 0,05 | 0,14 | 0,48 |
| Share unemployed | 0,02 | 0,01 | 0,01 | 0,06 |
| Share disabled | 0,07 | 0,26 | 0,03 | 21,97 |
| Mortality IHD | 150,98 | 26,87 | 104,00 | 204,61 |
| Distance PCI (km) | 128,66 | 162,69 | 0,00 | 1017,90 |

| **2005 (Valid N=18570)** | | | | |
|---|---|---|---|---|
| ProbPCI | 0,22 | 0,42 | 0,00 | 1,00 |
| Age (AMI) | 70,05 | 13,91 | 18,00 | 103,00 |
| $(Age)^2$ (AMI) | 5100,36 | 1890,77 | 324,00 | 10609,00 |
| Gender (AMI) (2=female) | 1,35 | 0,48 | 1,00 | 2,00 |
| Share 45 - 66 | 0,27 | 0,02 | 0,21 | 0,35 |
| Share 67 - 79 | 0,09 | 0,02 | 0,05 | 0,16 |
| Share 80+ | 0,05 | 0,01 | 0,02 | 0,12 |
| Share low education | 0,25 | 0,05 | 0,14 | 0,49 |
| Share unemployed | 0,02 | 0,01 | 0,00 | 0,05 |
| Share disabled | 0,08 | 0,54 | 0,03 | 22,56 |
| Mortality IHD | 139,14 | 23,91 | 97,20 | 179,89 |
| Distance PCI (km) | 132,60 | 165,06 | 0,00 | 1017,90 |

| **2006 (Valid N=19561)** | | | | |
|---|---|---|---|---|
| ProbPCI | 0,24 | 0,43 | 0,00 | 1,00 |
| Age (AMI) | 69,66 | 14,23 | 18,00 | 107,00 |
| $(Age)^2$ (AMI) | 5054,40 | 1923,35 | 324,00 | 11449,00 |
| Gender (AMI) (2=female) | 1,35 | 0,48 | 1,00 | 2,00 |
| Share 45 - 66 | 0,27 | 0,02 | 0,22 | 0,35 |
| Share 67 - 79 | 0,09 | 0,02 | 0,04 | 0,16 |
| Share 80+ | 0,05 | 0,01 | 0,02 | 0,12 |
| Share low education | 0,25 | 0,05 | 0,14 | 0,48 |
| Share unemployed | 0,01 | 0,00 | 0,00 | 0,05 |
| Share disabled | 0,07 | 0,23 | 0,03 | 18,44 |
| Mortality IHD | 133,01 | 23,78 | 91,36 | 171,60 |
| Distance PCI (km) | 130,15 | 158,89 | 0,00 | 1017,90 |

| **2007 (Valid N=19490)** | | | | |
|---|---|---|---|---|
| ProbPCI | 0,24 | 0,43 | 0,00 | 1,00 |
| Age (AMI) | 69,73 | 14,07 | 18,00 | 103,00 |
| $(Age)^2$ (AMI) | 5060,59 | 1913,03 | 324,00 | 10609,00 |
| Gender (AMI) (2=female) | 1,34 | 0,47 | 1,00 | 2,00 |
| Share 45 - 66 | 0,27 | 0,02 | 0,23 | 0,36 |
| Share 67 - 79 | 0,09 | 0,02 | 0,04 | 0,16 |
| Share 80+ | 0,05 | 0,01 | 0,02 | 0,12 |
| Share low education | 0,25 | 0,05 | 0,14 | 0,50 |
| Share unemployed | 0,01 | 0,00 | 0,00 | 0,04 |
| Share disabled | 0,06 | 0,02 | 0,02 | 0,13 |
| Mortality IHD | 130,09 | 22,56 | 89,28 | 165,96 |
| Distance PCI (km) | 130,54 | 160,37 | 0,00 | 1017,90 |

Table 4.1 shows an increasing mean value for the probability of PCI from 1999 to 2007. In 1999 only 3% of the AMI admissions are treated with PCI. In 2007 24% of

all AMI admissions are treated with PCI. The mean age of patients admitted with AMI is 70 years and has been steady in the period of analysis. When it comes to gender, about two thirds of the AMI patients are men. The mortality from IHD is steadily decreasing from a mean of 193 deaths per 100 000 population in 1999 to 130 deaths in 2007. The mean distance to PCI-treatment centre is decreasing from a peak in 2001 at approximately 145 km, to approximately 130 km in 2006/2007.

Table 4.2 shows descriptive statistics for AMI and PCI per 10-year age groups from 60 years and above. Number of AMI-admissions per age group, number of PCI-treatments per age group and the probability of PCI per age group are calculated from the NPR-data.

*Table 4.2 Descriptive statistics of AMI and PCI per 10-year age group, 1999 – 2007.*

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|---|---|---|
| **Age 60 - 69** | | | | | | | | | |
| AMI | 2113 | 2034 | 2526 | 2670 | 3127 | 3263 | 3891 | 4011 | 4190 |
| PCI | 97 | 138 | 304 | 498 | 759 | 899 | 1129 | 1265 | 1250 |
| ProbPCI | 5 % | 7 % | 12 % | 19 % | 24 % | 28 % | 29 % | 32 % | 30 % |
| **Age 70 - 79** | | | | | | | | | |
| AMI | 3656 | 3477 | 4109 | 4114 | 4589 | 4602 | 4463 | 4568 | 4595 |
| PCI | 63 | 110 | 245 | 413 | 664 | 873 | 974 | 1097 | 1089 |
| ProbPCI | 2 % | 3 % | 6 % | 10 % | 14 % | 19 % | 22 % | 24 % | 24 % |
| **Age 80 - 89** | | | | | | | | | |
| AMI | 3120 | 3164 | 4151 | 4389 | 4838 | 4830 | 4659 | 4862 | 4692 |
| PCI | 14 | 19 | 74 | 114 | 258 | 345 | 460 | 552 | 611 |
| ProbPCI | 0 % | 1 % | 2 % | 3 % | 5 % | 7 % | 10 % | 11 % | 13 % |
| **Age 90 +** | | | | | | | | | |
| AMI | 451 | 485 | 707 | 838 | 973 | 1027 | 1064 | 1066 | 1139 |
| PCI | 0 | 1 | 0 | 4 | 12 | 19 | 9 | 23 | 36 |
| ProbPCI | 0 % | 0 % | 0 % | 0 % | 1 % | 2 % | 1 % | 2 % | 3 % |

A distinct treatment pattern showing a decreasing probability of PCI with higher age is evident. Figure 4.1 is a graphic representation of the probability of PCI per age group. The curves of the age groups 60 – 69 years and 70 – 79 years seem to slightly flatten off from 2006 to 2007, but whether this is a starting trend or only small adjustments are uncertain.

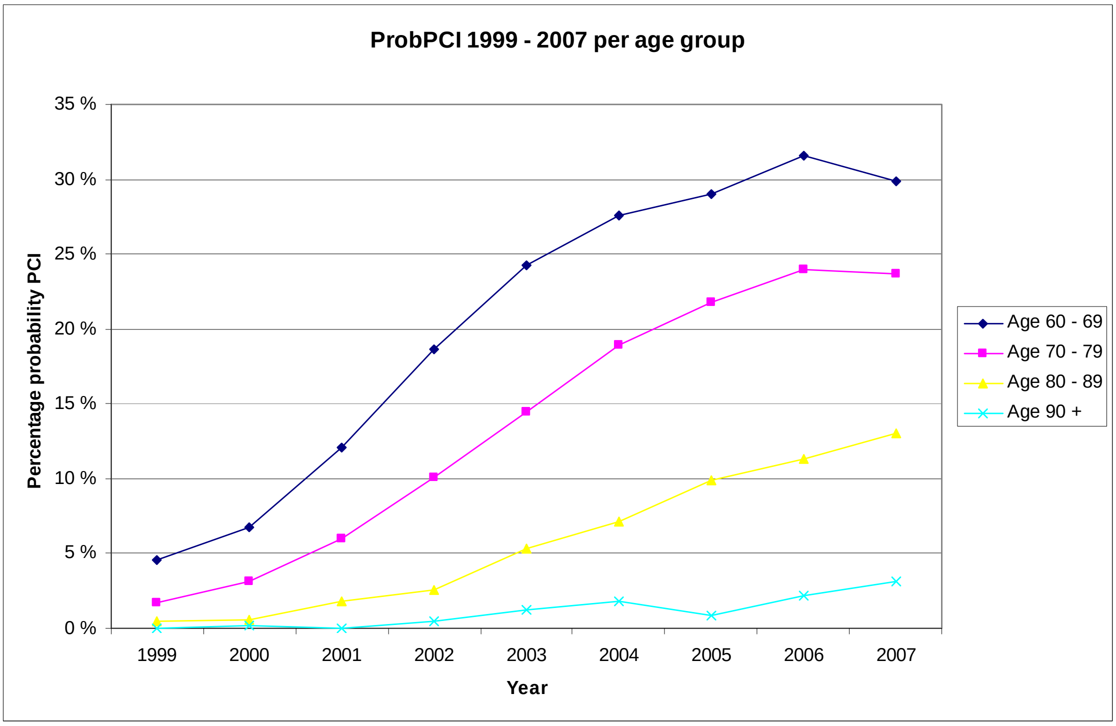



*Figure 4.1 Probability of PCI per age group, 1999 – 2007.*

# 5. Results

Approximately 148 000 admissions are registered with AMI as main diagnosis between 1999 and 2007. Due to suspicion of errors in the coding of some of the admissions (age < 15 year) and because of missing data (municipality number), the data set used in the analysis consists of 147 396 AMI admissions.

The basic model, equation (1), is estimated via multiple linear regression analysis, and the results are reported in Table 5.1. The regression estimates are then commented and applied in the answers to the research questions. Additional analyses on differences between and within the HTs *with* PCI-treatment centre and the HTs *without* PCI-treatment centre are carried out to answer some of the research questions.

*Table 5.1 Results obtained from the regression analysis, 1999 – 2007.*

| Variable | Estimate | Standard error | t-value | p-value |
|---|---|---|---|---|
| **Intercept** | 0,0427 | 0,0357 | 1,2000 | 0,2315 |
| **Age** | 0,0096 | 0,0006 | 16,9800 | <,0001 |
| **(Age)$^2$** | -0,0001 | 0,0000 | -27,9700 | <,0001 |
| **Gender** | -0,0190 | 0,0020 | -9,5700 | <,0001 |
| **Share 45 - 66** | 0,1020 | 0,0867 | 1,1800 | 0,2395 |
| **Share 67 - 79** | 0,0910 | 0,1243 | 0,7300 | 0,4644 |
| **Share 80+** | -0,4682 | 0,1558 | -3,0100 | 0,0027 |
| **Distance PCI** | -0,0001 | 0,0000 | -6,3500 | <,0001 |
| **Share disabled** | -0,0020 | 0,0026 | -0,7600 | 0,4486 |
| **Share low education** | -0,0025 | 0,0286 | -0,0900 | 0,9315 |
| **Share unemployed** | -0,1000 | 0,1800 | -0,5600 | 0,5788 |
| **Mortality IHD** | 0,0015 | 0,0001 | 12,6500 | <,0001 |
| **HTNR1** | -0,0865 | 0,0114 | -7,6200 | <,0001 |
| **HTNR2** | 0,0006 | 0,0130 | 0,0500 | 0,9603 |
| **HTNR3** | 0,0141 | 0,0132 | 1,0700 | 0,2853 |
| **HTNR4** | -0,1501 | 0,0114 | -13,1300 | <,0001 |
| **HTNR5** | -0,0025 | 0,0151 | -0,1600 | 0,8710 |
| **HTNR6** | -0,0757 | 0,0133 | -5,6900 | <,0001 |
| **HTNR7** | -0,0936 | 0,0122 | -7,7000 | <,0001 |
| **HTNR8** | -0,1031 | 0,0123 | -8,4000 | <,0001 |
| **HTNR9** | -0,0794 | 0,0115 | -6,9400 | <,0001 |
| **HTNR10** | -0,1410 | 0,0120 | -11,7500 | <,0001 |
| **HTNR11** | -0,0068 | 0,0109 | -0,6200 | 0,5345 |
| **HTNR12** | 0,0902 | 0,0131 | 6,8800 | <,0001 |
| **HTNR13** | -0,0291 | 0,0122 | -2,3900 | 0,0168 |
| **HTNR14** | 0,0927 | 0,0125 | 7,3900 | <,0001 |

| | | | | |
|---|---|---|---|---|
| **HTNR15** | -0,0547 | 0,0117 | -4,6600 | <,0001 |
| **HTNR16** | -0,0846 | 0,0102 | -8,2900 | <,0001 |
| **HTNR17** | -0,0852 | 0,0112 | -7,5900 | <,0001 |
| **HTNR18** | 0,0287 | 0,0121 | 2,3700 | 0,0179 |
| **HTNR19** | -0,0985 | 0,0117 | -8,4500 | <,0001 |
| **HTNR20** | -0,0016 | 0,0103 | -0,1500 | 0,8799 |
| **HTNR21** | -0,0266 | 0,0094 | -2,8200 | 0,0048 |
| **HTNR22** | -0,0399 | 0,0100 | -3,9800 | <,0001 |
| **HTNR23** | 0,2269 | 0,0127 | 17,8900 | <,0001 |
| **HTNR24** | 0,0000 | , | , | , |
| **T1999** | -0,3065 | 0,0089 | -34,5000 | <,0001 |
| **T2000** | -0,2795 | 0,0084 | -33,4500 | <,0001 |
| **T2001** | -0,2327 | 0,0073 | -31,8200 | <,0001 |
| **T2002** | -0,1722 | 0,0101 | -17,0400 | <,0001 |
| **T2003** | -0,1207 | 0,0058 | -20,8900 | <,0001 |
| **T2004** | -0,0684 | 0,0047 | -14,4500 | <,0001 |
| **T2005** | -0,0284 | 0,0040 | -7,0700 | <,0001 |
| **T2006** | -0,0018 | 0,0036 | -0,4900 | 0,6212 |
| **T2007** | 0,0000 | , | , | , |

** HTNR3 includes Rikshospitalet HT, Ullevål Universitetssykehus HT and Aker Universitetssykehus HT due to a subdivision of Oslo in districts. Data on the home district of the patients from Oslo municipality is not available. HTNR3 is therefore not directly comparable to the results from the other HTs.*

The independent need/demand side variables “Age”, “$(Age)^2$”, “Gender”, “Mortality IHD” ($p < 0,0001$) and “Share 80+” ($p < 0,001$) are significantly correlated to probability of PCI. Need/demand side variables with no significant results are “Share 45 – 66”, “Share 67 – 79”, “Share disabled”, “Share low education” and “Share unemployed”. Of the supply side independent variables, “Distance PCI” is significantly correlated to the probability of PCI ($p < 0,0001$). Eighteen of the HT variables (twenty three in total), compared to the dummy variable, are significant at the 5% level. The variables explaining the differences between the years, compared to the dummy variable, are significant from 1999 to 2005 (2007 dummy).

The estimate for a given independent variable indicates the percentage change in probability of PCI for a one unit increase in the independent variable, while controlling for the simultaneous effect of the other independent variables (Newbold, Carlson, & Thorne 2006). The interpretation of the estimate (0,0096) for “Age” is that for each increase of one year in the age of an AMI-patient the probability of PCI increases with approximately 1%. The older the patient, the higher is the probability of PCI. “(Age)$^2$” with its estimate of -0,0001 together with the estimate for “Age” show that the probability increases until a certain age where the probability starts decreasing instead, see Figure 5.1. The estimates indicate a turning point around 50 years.

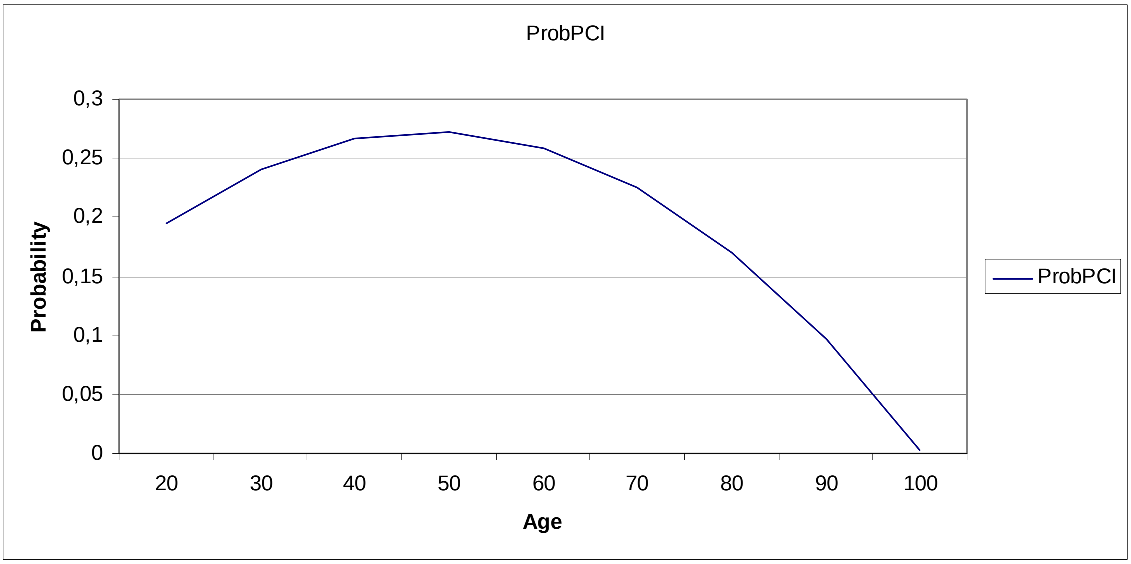



*Figure 5.1 Probability of PCI as a function of “Age” and “(Age)$^2$”.*

The probability of PCI decreases with approximately 2% if the AMI-patient is a woman (-0,0190) indicating that in the period of analysis, men are more often given PCI for AMI than women.

If the share of people in age group 80 years and above increases with one unit (1%), the probability of PCI decreases with 0,46% (-0,4682). This may indicate what Nerland & Hagen (Nerland & Hagen 2008) call a “crowding-effect”. Their study of general access to health care services in Norway during the period 1999 – 2005 established the existence of an effect they called the “crowding-effect”. In municipalities with large demand for health care services, waiting lists for treatment become longer and the longer the waiting lists, the less consumption per citizen. Simplified, larger demand reduces the consumption of health care services because of supply side restrictions. If a larger share of the population is in the age group 80 years and above there are most likely more patients in need of general hospital treatment. This may generate a lower consumption of treatment due to the “crowding-effect”. The negative estimate of the variable “Share 80+” indicates that the consumption of also PCI-treatment decreases with increasing need/demand.

The negative effect of distance to treatment centre (-0,0001) means that if the distance increases with 1 km, the probability of PCI decreases with 0,01%. This means that longer distance to treatment leads to lower consumption of PCI-treatment, ceteris paribus. The estimate for “Mortality IHD” (0,0015) indicates that the probability increases with 0,15% with a one unit increase in mortality from IHD.

## 5.1 Research question 1 and 2

The results support a positive answer to the first research question: Is there significant evidence for unequal access, measured as varying probability of PCI, in Norway in the period of analysis? Significant estimates are found for several of the explanatory variables included in the regression analysis, both among the need/demand side variables and the supply side variables (see answer to research question 5).

The HT variables for the whole period of analysis indicate that there are significant differences between the probabilities of PCI in some HTs compared to others. HT number 24 is chosen as a dummy (value = 0) as the SAS system automatically choose the highest variable number as reference unit. Out of the rest 23 HT dummies, five are not significant at a 5% level ($p > 0,05$). Of those HT dummies with a significant estimate, the probability of PCI ranges from 0,2269 (HTNR23) to -0,1501 (HTNR4) compared to HTNR24. The estimates for the HTs are interpreted as the percentage change in probability of PCI compared to the reference unit. Patients living in the catchment area of HTNR23 (Universitetssykehuset i Nord-Norge HT) have approximately 23% higher probability of PCI than the patients living in the catchment area of HTNR24 (Helse Finnmark HT). Patients living in the catchment area of HTNR4 (Sykehuset Asker og Bærum HT) have approximately 15% lower probability of PCI than the patients living in catchment area of the reference unit. Three HTs distinguish them selves with very high probabilities of PCI; HTNR23 (Universitetssykehuset i Nord-Norge HT), HTNR14 (Helse Bergen HT) and HTNR12 (Stavanger Universitetssykehus HT), see table Table 5.1.

The estimates from the analysis reveal a clear tendency: The patients living in the catchment area of a HT with PCI-treatment have a higher probability of PCI than patients living in the catchment areas of a HT without PCI-treatment. This hypothesis is tested by including the variable “PCIcentre” in the regression analysis. The variable “PCIcentre” includes the HTs *with* PCI-treatment centre, so that their joint effect on the probability of PCI can be distinguished from the effect HTs *without* PCI-treatment centre have on the probability of PCI. The results show that the probability of PCI is 12,5% higher (0,1249, $p < 0,0001$) for a patient living in the catchment area of a hospital *with* PCI-treatment centre, than for a patient living in the catchment area of a hospital *without* PCI-treatment for the whole period. This analysis is repeated for the year 2007 separately, and the result gives an estimate of 16% higher probability (0,1604, $p < 0,001$) for a patient living in the catchment area of a hospital *with* PCI-treatment centre.

## 5.2 Research question 3 and 4

The same regression analysis is performed for the whole period once more but this time the HTs *without* PCI-treatment centre are excluded from the analysis. The analysis would then provide results showing whether or not there is unequal probability of PCI within the group of HTs *with* PCI-treatment centre, controlled for all other effects. HTNR23 (Universitetssykehuset i Nord-Norge HT) is chosen as a dummy. The results are presented in Table 5.2 .

*Table 5.2 Results from test of effects within the group of HTs* ***with*** *PCI-treatment centre, 1999 – 2007.*

| Variable | Estimate | Standard error | t-value | p-value |
|---|---|---|---|---|
| **HTNR3** | -0,1350 | 0,0139 | -9,7100 | <,0001 |
| **HTNR11** | -0,1873 | 0,0117 | -15,9900 | <,0001 |
| **HTNR12** | -0,0236 | 0,0144 | -1,6400 | 0,1016 |
| **HTNR14** | -0,0789 | 0,0117 | -6,7300 | <,0001 |
| **HTNR18** | -0,1633 | 0,0104 | -15,7400 | <,0001 |
| **HTNR23** | 0,0000 | , | , | , |

Four out of five HTs have significant estimates ($p < 0,001$). The estimates show that for the whole period there are significant variations in probability of PCI within the group of HTs *with* PCI-treatment centre. Compared to the reference unit, the probability ranges from -16,3% to -2,4% lower than the reference.

Further, all years except the latest year, 2007, are excluded from the analysis. The results are presented in Table 5.3.

*Table 5.3 Results from test of effects within the group of HTs* ***with*** *PCI-treatment centre, 2007.*

| Variable | Estimate | Standard error | t-value | p-value |
|---|---|---|---|---|
| **HTNR3** | -0,2463 | 0,1205 | -2,0400 | 0,0410 |
| **HTNR11** | -0,0794 | 0,0599 | -1,3300 | 0,1848 |
| **HTNR12** | -0,0014 | 0,1177 | -0,0100 | 0,9902 |
| **HTNR14** | -0,0780 | 0,0785 | -0,9900 | 0,3206 |
| **HTNR18** | -0,1806 | 0,1057 | -1,7100 | 0,0875 |
| **HTNR23** | 0,0000 | , | , | , |

Two out of five HTs have significant estimates at a 10% level ($p < 0,1$). This is interpreted as a sign of less variation in the probability of PCI in 2007 than in the whole period of analysis, since three out of five do not significantly differ from the reference unit.

Again, the same regression analysis is performed for the whole period, this time the HTs *with* PCI-treatment centre are excluded from the analysis. The analysis would then provide results showing whether or not there is unequal probability of PCI within the group of HTs *without* PCI-treatment centre, controlled for all other effects. HTNR24 (Helse Finnmark HT) is chosen as a dummy. The results are presented in

Table 5.4.

*Table 5.4 Results from test of effects within the group of HTs **without** PCI-treatment centre, 1999 – 2007.*

| Variable | Estimate | Standard error | t-value | p-value |
|---|---|---|---|---|
| **HFNR1** | -0,0399 | 0,0122 | -3,2800 | 0,0011 |
| **HFNR2** | -0,0011 | 0,0134 | -0,0800 | 0,9371 |
| **HFNR4** | -0,0901 | 0,0126 | -7,1700 | <,0001 |
| **HFNR5** | -0,0089 | 0,0157 | -0,5700 | 0,5720 |
| **HFNR6** | -0,0454 | 0,0138 | -3,2800 | 0,0010 |
| **HFNR7** | -0,0507 | 0,0129 | -3,9300 | <,0001 |
| **HFNR7** | -0,0627 | 0,0131 | -4,8000 | <,0001 |
| **HFNR9** | -0,0575 | 0,0120 | -4,7900 | <,0001 |
| **HFNR10** | -0,0809 | 0,0129 | -6,2700 | <,0001 |
| **HFNR11** | -0,0342 | 0,0111 | -3,0800 | 0,0021 |
| **HFNR13** | -0,0237 | 0,0127 | -1,8700 | 0,0613 |
| **HFNR15** | -0,0240 | 0,0123 | -1,9500 | 0,0507 |
| **HFNR16** | -0,0788 | 0,0103 | -7,6800 | <,0001 |
| **HFNR17** | -0,0712 | 0,0115 | -6,1800 | <,0001 |
| **HFNR19** | -0,0611 | 0,0123 | -4,9700 | <,0001 |
| **HFNR20** | -0,0094 | 0,0101 | -0,9300 | 0,3498 |
| **HFNR21** | -0,0138 | 0,0091 | -1,5100 | 0,1311 |
| **HFNR22** | -0,0210 | 0,0102 | -2,0700 | 0,0387 |
| **HFNR24** | 0,0000 | , | , | , |

Thirteen out of eighteen HTs have significant estimates ($p < 0,05$). The estimates show that for the whole period there are significant variations in probability of PCI within the group of HTs *without* PCI-treatment centre. Compared to the reference unit, the probability ranged from -9% to -2% lower than the reference.

Also for this group, all years except the latest year, 2007, are excluded from the analysis. The results are presented in

Table 5.5.

*Table 5.5 Results from test of effects within the group of HTs* ***without*** *PCI-treatment centre, 2007.*

| Variable | Estimate | Standard error | t-value | p-value |
|---|---|---|---|---|
| **HFNR1** | 0,0297 | 0,0393 | 0,7500 | 0,4504 |
| **HFNR2** | 0,0319 | 0,0561 | 0,5700 | 0,5697 |
| **HFNR4** | -0,0655 | 0,0403 | -1,6200 | 0,1044 |
| **HFNR5** | 0,0381 | 0,0619 | 0,6200 | 0,5380 |
| **HFNR6** | -0,0135 | 0,0448 | -0,3000 | 0,7639 |
| **HFNR7** | -0,0041 | 0,0422 | -0,1000 | 0,9236 |
| **HFNR8** | -0,0294 | 0,0411 | -0,7100 | 0,4754 |
| **HFNR9** | 0,0094 | 0,0397 | 0,2400 | 0,8133 |
| **HFNR10** | -0,0449 | 0,0416 | -1,0800 | 0,2806 |
| **HFNR13** | 0,0150 | 0,0467 | 0,3200 | 0,7475 |
| **HFNR15** | 0,0024 | 0,0433 | 0,0500 | 0,9566 |
| **HFNR16** | -0,0597 | 0,0361 | -1,6500 | 0,0982 |
| **HFNR17** | -0,0395 | 0,0393 | -1,0000 | 0,3151 |
| **HFNR19** | -0,0148 | 0,0403 | -0,3700 | 0,7134 |
| **HFNR20** | -0,0078 | 0,0331 | -0,2400 | 0,8134 |
| **HFNR21** | 0,0094 | 0,0303 | 0,3100 | 0,7564 |
| **HFNR22** | -0,0220 | 0,0324 | -0,6800 | 0,4971 |
| **HFNR24** | 0,0000 | , | , | , |

None of the HTs have significant estimates. This is interpreted as a sign of only insignificant variation in the probability of PCI in 2007 between the HTs *without* PCI-treatment centre.

The results from the tests within the groups of HTs for the whole period indicate that there are significant variations in the probability of PCI both within the group of HTs *with* PCI and within the group of HTs *without* PCI. The largest variation is found within the group of HTs *with* PCI. The analyses on 2007 data separately, indicate that the variation in the probability of PCI within the HTs *with* PCI seems to be less in 2007 than for the whole period. For the group of HTs *without* PCI there are only insignificant variations in the probability of PCI in 2007 within the group.

## 5.3 Research question 5

The positive estimate for “Age” indicates an increase in the probability of PCI with older age. The negative estimate for “$(Age)^2$” shows that this trend is declining, meaning that the probability increases until a certain age where the probability starts decreasing instead. The negative estimate for “Gender” shows that women in less extent than men get PCI-treatment. The probability of PCI decreases for a higher share of the population being 80 years or older, indicating a lower consumption of PCI-treatment due to a “crowding-effect”. The negative effect of distance to PCI-treatment indicates that longer distance to treatment leads to a lower probability of PCI, ceteris paribus. The positive estimate for “Mortality IHD” indicates that the probability increases with higher mortality from IHD.

# 6. Discussion

## 6.1 Topic and problem statement

Inequality in the probability of PCI for AMI in Norway during the years 1999 to 2007 is investigated in this study. This study aimes to assess whether consumption of PCI varies with need, or whether the consumption varies with other factors such as age, gender, SES, distance to treatment centre and geographical location.

## 6.2 Main findings

Significant estimates ($p < 0,001$) for the independent variables "Age", "$(Age)^2$", "Gender", "Share 80+", "Mortality IHD" and "Distance PCI" are found. Eighteen "HTNR" dummies and seven year dummies are significant at the 5% level. These results are used as evidence for claiming that there are significant differences in the probability of PCI during the period of analysis.

In addition, estimates from additional analyses on the whole period indicate that patients living in the catchment area of a HT *with* PCI-treatment have a higher probability of PCI than patients living in the catchment areas of a HT *without* PCI-treatment. This difference seems to increase from 1999 – 2007.

Significant variations in the probability of PCI both within the group of HTs *with* PCI and within the group of HTs *without* PCI are found. The largest variation is found within the group of HTs *with* PCI. The variation in the probability of PCI within the two groups decreases from 1999 – 2007.

## 6.3 Discussion of results

The estimates for the variables “Age”, “(Age)$^2$” and “Gender” are as anticipated. The results from “Age” and “(Age)$^2$” presented in Figure 5.1 indicate that the probability decreases after an age of 50 years. One possible explanation is that having an AMI before the age of 50 generates more extensive treatment methods than an AMI case where the patient is older. Cost-utility analysis favours resources spent on young patients compared to older patients, number of QALYs[7] being higher for younger patients. There might also be that those experiencing an AMI before the age of 50 have a more serious AMI and therefore are in greater need of PCI than patients older than 50 years with less serious AMI cases. Another explanation might be that the risk of complications is higher for older patients and therefore PCI-treatment are given in less extent to older patients. More research is needed to draw any conclusions about the explanation.

The estimate for “Gender” shows that women are more seldom given PCI-treatment than men. The fact that women have a lower probability of PCI is not necessarily a signal of inequality. Since women with AMI often experience a more diffuse disease where PCI is not the best treatment method, a lower probability for women may not indicate inequality after all. Further investigation of the medical aspects of differences in treatment between men and women due to differences in AMI disease factors is outside the scope of this study.

The estimate for “Share 80+” is as anticipated negative. This result can be interpreted as a “crowding-effect” where higher demand is not met by a correspondingly higher supply and inequalities arise. The descriptive statistics (see chapter 4.9) for age groups, however, shows that there is a larger percentage in older age groups getting PCI in 2007 than in 1999.

[7] Quality-adjusted life years (QALYs) is a measure of disease burden, including both the quality and the quantity of life lived.

As anticipated, the estimate for “Distance PCI” is negative. Some of this effect is assigned to the medical guidelines (see chapter 2.4) recommending thrombolytic treatment if there is more than 90 minutes travel time to a hospital with PCI-treatment. Whether some of this effect should also be assigned differences in medical practice due to for instance distance to treatment centre is discussed in connection with the HT-variables.

The positive estimate for “Mortality IHD” means that areas with a higher demand for PCI have a higher probability of PCI, indicating a better supply than in areas with less demand. This must be interpreted as a “healthy” sign for the health care sector in Norway, indicating that the health policy makers, the responsible for prioritizing within health care and those responsible for resource allocation to a certain extent manage to establish a better supply of health care services in areas with higher need/demand.

The regression analyses run on the two groups of HTs (with and without PCI-treatment centre) reveal a significant difference in the probability of PCI for patients living in the catchment area of a HT *with* PCI-treatment compared to patients living in the catchment area of a HT *without* PCI-treatment. The result is controlled for the other variables included in the analysis, which means that there must be some unidentified explanatory factors affecting the probability of PCI. As mentioned in 4.2 there may be generated more AMI admissions than is the case in HTs without PCI-treatment. The result may be that the difference between HTs *with* and HTs *without* PCI-treatment in reality is not as significant as this analysis shows. The trend of larger differences over time may thus be a sign of increasing division of in-patient stays. Instead of recovering at the PCI-treatment centre, the patients may experience being sent to another local hospital for recovery. Another explanation of the difference may be different medical practice, for example in referrals for PCI and use of thrombolytic treatment between the HTs. If the difference is caused by the latter, inequality in the access to PCI treatment is found. Further investigation is needed before a final conclusion can be made about the reasons for these differences.

Analysing the differences within the two groups of HTs reveal differences also within each group. The largest difference in probability of PCI is found within the group of HTs *with* PCI-treatment. This result is mainly caused by HTNR23 (Universitetssykehuset i Nord-Norge HT) and HTNR12 (Stavanger Universitetssykehus HT) which stand out with the significant highest probabilities of PCI. Again, differences in medical practice may explain the findings. Such differences should be investigated further, especially the possibility of different treatments for the same AMI severity. Evidence for medical practice including PCI-treatment for lower severity cases of AMI in some HTs compared to others would indicate inequality in the probability of PCI between the HTs. Another possible cause is a trend including healthier lifestyle. If this is a trend spreading across the country, starting in the main cities and perhaps being correlated to high SES, results of this may be less serious and fewer AMI cases in the areas where the population are more health conscious. Areas not reached by this trend yet, may experience more serious AMI cases and a higher number of AMI.

Noticing that the HT with the highest probability of PCI is HTNR23 (Universitetssykehuset i Nord-Norge HT) draws the attention towards the financing of the North Norway RHA mentioned in chapter 3.2. Due to need based analyses this region is assigned more resources than the analyses have found need based evidence for. Whether or not this has established a better supply of health care services, in this case PCI-treatment, in this region when compared to other regions is not known for certain. But favourable financing of the North Norway RHA may be a possible explanation of the differences in probability of PCI found in this study.

Looking at the analyses of the two groups of HTs for the year 2007 separately, differences within the two groups seem to decrease until almost no difference in the probability of PCI because very few of the variables significantly differed from the reference unit.

## 6.4 Limitations

The results must be interpreted with several reservations. Significant explanatory variables not included in the analysis are a general problem for regression analyses. The independent variables included in this analysis are chosen on the basis of available research and earlier findings on this field. There might however, exist some significant explanatory variables that should have been included, but is not. Local variables explaining AMI incidence or PCI demand within a small area may be examples of such variables. These possible effects are tried captured by dummies (fixed-effects) for HTs and years.

Researchers should bear in mind that the NPR-data is constructed mainly for financial purposes (reimbursements due to ABF). Medical information gathered from NPR-data should therefore be interpreted carefully with this in mind. Choosing the diagnosis AMI and the treatment PCI as the field of investigation minimized the chances of systematic errors due to differences in coding praxis from year to year or from HT to HT. The coding praxis at this field is very clear and has not been changed considerably during the period of analysis. The use of NPR-data in analyses is briefly discussed in chapter 4.2 where the problem with double/triple registration of AMI cases is mentioned. This means that the probability of PCI for municipalities within the catchment area of a hospital not offering PCI-treatment may show a false low rate because of a higher AMI number than is the case. HT dummies are included in the analysis to capture some of these effects. An additional analysis between the HTs not offering PCI and between the HTs offering PCI is executed to investigate the differences between the two groups further.

The lack of direct information about the need for PCI-treatment in the different municipalities constitutes a problem. Variations in probability of getting PCI-treatment can be difficult to interpret since they may be justified if associated with variations in incidence. Mortality data on IHD is included in the analysis as an independent variable and analysed for its effect on the probability. In this way the estimates from the analysis are controlled for need, measured as mortality from IHD.

Exact information about the incidence would have lead to an even better and more reliable result.

# 7. Conclusion

Significant evidence for inequality in the probability of PCI is found in this study. Differences between the HTs and a decreasing probability with increasing distance to PCI-treatment centre indicate that place (geographical location) do matter when looking at inequality in the access to PCI-treatment. No significant estimates are found for the SES-variables, indicating that SES does not matter for the probability of PCI. Differences in probability of PCI are also found for age, gender, share above 80 years, mortality from IHD and years. The differences are relatively large in the beginning of the period. Due to decreasing differences with time, the differences are relatively small in the end of the period of analysis.

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# Appendix

*7.1 HT numbers, name and PCI-centre*

| HTNR | Name Hospital Trust/area | PCI-centre |
|---|---|---|
| 1 | Sykehuset Østfold HT | |
| 2 | Akershus Universitetssykehus HT | |
| 3 | Oslo* | Yes (Rikshospitalet, Ullevål). No (Aker). |
| 4 | Sykehuset Innlandet HT | |
| 5 | Sykehuset Asker og Bærum HT | |
| 6 | Ringerike Sykehus HT | |
| 7 | Sykehuset Buskerud HT | |
| 8 | Blefjell Sykehus HT | |
| 9 | Sykehuset i Vestfold HT | |
| 10 | Sykehuset Telemark HT | |
| 11 | Sørlandet Sykehus HT | 1999: No. 2007: Yes. |
| 12 | Stavanger Universitetssykehus HT | Yes |
| 13 | Helse Fonna HT | |
| 14 | Helse Bergen HT | Yes |
| 15 | Helse Førde HT | |
| 16 | Helse Sunnmøre HT | |
| 17 | Helse Nordmøre og Romsdal HT | |
| 18 | St. Olavs Hospital HT | Yes |
| 19 | Helse Nord-Trøndelag HT | |
| 20 | Helgelandssykehuset HT | |
| 21 | Nordlandssykehuset HT | |
| 22 | Hålogalandssykehuset HT | |
| 23 | Universitetssykehuset Nord-Norge HT | Yes |
| 24 | Helse Finnmark HT | |

** HTNR3 includes Rikshospitalet HT, Ullevål Universitetssykehus HT and Aker Universitetssykehus HT due to a subdivision of Oslo in districts. Data on the home district of the patients from Oslo municipality is not available.*