The Coordination Reform: Potential for substitution between primary- and specialist health care in Norway.

Analysis of the relationship between municipal health care supply and number of hospital admissions for selected diagnosis groups in Norwegian municipalities, 1999-2007.

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Abbreviations and acronyms

RHA	Regional Health Authorities/Regionale Helseforetak
GP	General Practitioner
ABF	Activity based financing
DRG	Diagnosis-related group
GDP	Gross domestic product
OECD	Organisation for Economic Co-operation and Development
NIS	National Insurance Scheme
ICT	Information and Communication Technology
R&D	Research and Development
NOK	Norwegian kroner
SSB	Statistics Norway/Statistisk sentralbyrå
ICD-10	Tenth revision of the International Classification of Diseases
HT	Health Trust/Helseforetak (HF)
WHO	World Health Organization
WLS	Weighted least squares
GPH	General practitioner hospital (sykestue)

Abstract

BACKGROUND: In June 2009, the Norwegian government presented a proposal for one of the most central health reforms in Norway during the last decades, white paper (St.melding) no. 47, The Coordination Reform. The intention is to improve coordination between the primary- and specialist health care sector. More specifically, the strategy is to transfer responsibility from specialist- to municipal health care services in order to improve quality and counteract the growth in health expenditures. To achieve the stated objectives, organisational, legislative and financial means are planned implemented.

OBJECTIVE: To analyse the impact of supply of health care in Norwegian municipalities on use of specialist health care services, hereunder number of hospital admissions for specific diagnosis groups that are believed to hold a potential of being treated within municipal health care services to a larger extent.

METHOD: The method used is a weighted least square regression incorporating “fixed effects” for health trust and year, analysing how number of hospital admissions for four main diagnosis groups are affected by supply of health care services in 427 Norwegian municipalities between 1999 and 2007. The thesis is based on diagnosis data that also form the basis for a separate thesis by Alejandra Palacio Perez, performing similar analyses with other relevant diagnosis groups.

RESULTS: We find statistically significant and rather strong positive effects of number of municipal physicians and negative effects for general practitioner hospitals (sykestuer) on number of hospital admissions. In addition, we find negative effects of coverage of institutions for elderly. The results indicate that the number of hospital admissions increase with a higher number of man years of physicians. This finding is contrary to one of the means suggested in the white paper of increasing the number of GPs, hereby decreasing the pressure on specialist health care. Further, we find that municipalities that are covered by general practitioner hospitals have fewer admissions to somatic hospitals. Our analyses also indicate that high coverage of institutions within municipalities, results in reduced number of hospital admissions for elderly.

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1. INTRODUCTION

The Norwegian health care system is considered to be among the best in Europe. Compared to other countries Norway is on top when considering both life expectancy and percentage of gross domestic product (GDP) spent on health (Norwegian Directorate of Health 2006). According to Johnsen (2006), the key strengths of the Norwegian system include provision of health care services for all based on need (regardless of personal income), local and regional accountability, public commitment and political interest in improving the health care system (Johnsen 2006). Health care is organised on three levels; national, regional and local levels formed by the state, regional health authorities and municipalities. According to the Norwegian Board of Health Supervision (2006), the system of health care provision is based on a decentralised model, where the state, through the Ministry of Health and Care Services, holds the responsibility for policy design, overall capacity and quality of health care through legislation and budgeting (Norwegian Board of Health Supervision 2006). The regional level is managed through four regional health authority entities (RHA) owned by the state. Inside the regional health authorities, somatic and psychiatric hospitals, and some hospital pharmacies, are organised as health trusts. Within the limits of legislation and available economic resources, the regional health authorities and municipalities are formally free to plan and run public health services as they wish (ibid.). In practice however, their freedom to act independently is limited by access to recourses.

The high costs for health care in Norway has paved way for a debate considering how recourses better can be allocated and spent more efficiently. Lack of coordination between health care entities and within the system has often been emphasised, resulting in a white paper, The Coordination Reform, presented in 2009 and planned to be implemented from 2012. The main purpose presented in the white paper is to transfer more responsibility from specialist health services to municipalities with the intention of reducing pressure on the former.

1.1 Aims and objectives of the study

The intention of this study is to investigate the relationship between the amount of- and access to health care services in Norwegian municipalities, and the use of specialist health care services through number of hospital admissions for selected main diagnosis groups. We wish to uncover to what extent a potential for substitution between the two levels exists. Similar studies have been conducted by Carlsen (unpublished), Holmås, Kjerstad, Kristiansen and Lurås (2007), Nerland and Hagen (2008) and Hagen (2009). The most recent study (Hagen 2009) uncovered some effects of level of municipal supply, especially for elderly. This study however, will be based on a larger dataset and will investigate the effects of supply within 427 Norwegian municipalities in relation to number of admissions for four specific main diagnosis groups (diabetes mellitus, heart diseases, chronic lower respiratory diseases and other diseases of intestines) over a time period of nine years (1999-2007). In the first section, we will describe the Norwegian health care structure briefly. In section two we discuss the most important strategic tools suggested in white paper no. 47, The Coordination reform, before we describe the theoretical foundation in section three. In section four we describe data and methods in our analyses followed by results in section five.

1.2 Structure and organisation of Norwegian health care

"The Ministry of Health and Care Services outlines national health policy, prepares major reforms and proposals for legislation, monitors their implementation and assists the government in decision-making (…) and is responsible for primary health care, specialised health care, public health, mental health, medical rehabilitation, dental health, pharmacies and pharmaceuticals, emergency planning and coordination, policies on molecular biology and biotechnology and nutrition and food safety" (Johnsen 2006, 16). The 431 municipalities are responsible for primary health care, including both preventive and curative treatment and for providing reasonable, high-quality health care and social services to everyone in need of them, regardless of age or diagnosis (Ministry of Health and Care Services 2010). The Norwegian health care system is primarily funded through taxes. While the municipalities have the right to levy proportional income taxes on their respective populations, the regional health authorities must rely on transfers from the central government (Johnsen 2006). The municipalities receive most of the funding from the state in the form of block grants. For some specific prioritised areas however, such as the population of elderly, the municipalities receive earmarked grants. The municipalities mainly provide all social services themselves, but there are examples of inter-municipal cooperation, and some municipalities buy services from private organisations (Norwegian Board of Health Supervision

2006). Figure 1 (adapted from Johnsen 2006) provides an overview of the structure of the Norwegian health care system.

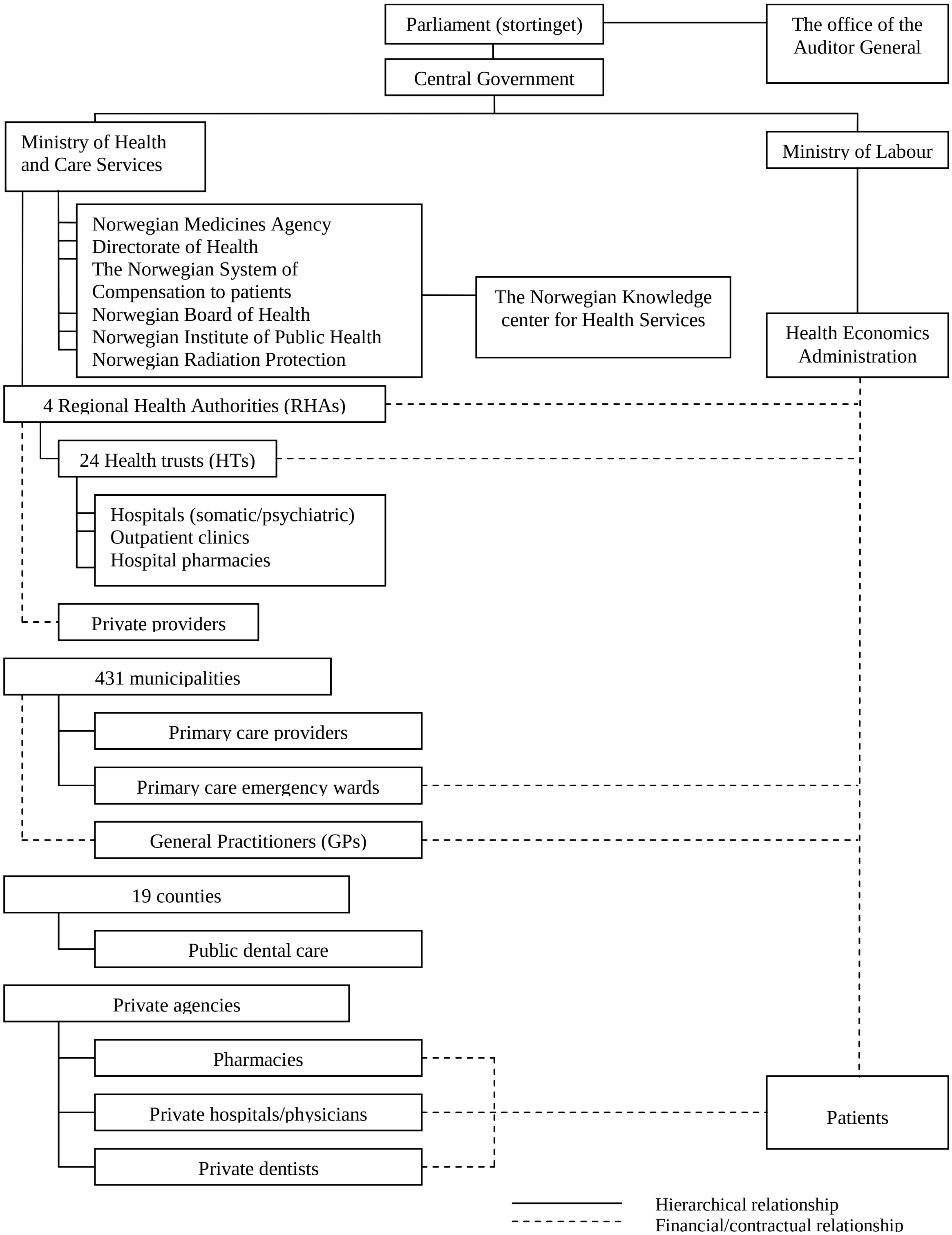


Figure 1: Overview of the Norwegian health care system (adapted from Johnsen 2006).

“The aim of the primary health care in Norway is to improve the general health of the population and to treat diseases and deal with health problems that do not require hospitalisation. Much of the spending in the municipalities is directed towards nursing, somatic health care and mental health care” (Johnsen 2006, xiv). The financing of GPs is divided in three; a basis subsidy from the municipalities based on the magnitude of the patient list, reimbursement from The Norwegian Health Economics Administration (HELFO) and patients’ out-of-pocket payment (Helse- og omsorgskomiteen 2010). The regional health authorities provide the basis for specialist health care, hereunder planning the development and organisation of specialist health care according to the needs of the regional population and services are provided by the regional health authorities’ health enterprises (Johnsen 2006). Their responsibility also includes services provided by other entities, such as private agencies. “Tertiary-level specialized health care is delivered in accordance with regulations set out by central government” (ibid., xiv). After the central state took over ownership of the hospitals from the counties with the hospital reform in 2002, private supply of specialist health care has increased, but all in all, private suppliers of specialist health care still play a minor role in the Norwegian health care system (Midttun 2006; Tjerbo 2009, 56). “The majority of health care providers are publicly owned and, therefore, health care personnel are mainly salaried employees, with the exception of GPs” (Johnsen 2006, xiv).

1.3 Policies

The Norwegian health care system has undergone several important reforms during the last decades, which can help describe the current structure and organisation.

“The main purpose of the Municipalities Health Services Act (1982) was to improve the coordination of the health and social services at local level, to strengthen those services in relation to institutional care and preventive care, and to pave the way for better allocation of health care personnel. The act provides the municipalities with a tool to deliver comprehensive health services in a coordinated way. In 1988 the Municipalities Health Services Act was further expanded and county nursing homes were transferred to the municipalities” (ibid., xiv-xv).

Year	Reform	Purpose
1984	Municipalities health care reform	Better local coordination of primary health care and social services
1992	HVPU	Downsize institutions for people with development disabilities
1997	Activity based financing (ABF)	Give economic incentives to increase the patient flow
1998	Action plan for elderly	Strengthen the housing and services to elderly locally
1999	Escalation plan for metal health	Strengthen and transform mental health services both locally and regionally
2001	New health legislations	Strengthen patients' rights
2001	The medical overseas project	Decrease hospitals waiting times by sending patients abroad
2001	Liberalisation of the pharmacy market	Increase availability of pharmacies and medicines
2001	The Regular General Pracitioners' scheme	Improve the quality of the local medical service and the patient to doctor relationship
2001	Individual plan	A tool to improve coordination of patients in need of long-term care services
2002	Reorganisation of central government	Increase the efficiency and the coordination of national central bodies
2002	The hospital reform	Improve specialist health care services by reorganization and change of ownership
2003	A Broad Policy for Public Health, White Paper	Increase and strengthen public health
2004	Substance abuse treatment reform	Strengthen the treatment and accessibility to specialist health care for substance abusers

Table 1: Selection of Norwegian health care reforms implemented during the last decades (adapted from Johnsen 2006).

In 1997, Norway introduced an activity-based financing scheme based on the DRG system for somatic inpatient activity. The Norwegian government's argument for introducing the system was to achieve an increased number of elective treatments that was considered necessary to fulfil the waiting list guarantee adopted by the parliament. In addition to this, one assumed that the leakage to other sectors for which the county councils are responsible would make an increase in the block grant insufficient (Biørn et al. 2002). “By introducing a matching grant to the county councils, the government intended to influence their cost of hospital treatment relative to other services, and hence, shift the county councils’ properties in the direction of hospitals” (ibid., 272). “The reimbursement of a DRG point is consistent throughout the country, but the regional health authorities are allowed to change these reimbursement rates to their health enterprises” (Johnsen 2006, xv).

The Regular General Practitioner scheme was implemented in 2001 and introduced a list system where patients were assigned to one GP. The patients were given the right to decide if they wanted to participate in the scheme, to choose another physician as their GP (twice a year) as well as the right to get a second opinion from another GP. The aim of the reform was to improve the quality of the local medical services, to improve continuity of care and ensure a more personal patient–physician relationship. The Regular General Practitioner reform also provided a new model for employing GPs, based on contracted physicians in private practice where capitation, fee-for-service and out-of-pocket payments form the income of GPs (ibid.).

In 2002, to counteract the problems of long waiting lists for elective treatment, lack of equity in supply of services and lack of responsibility and transparency which led to a blaming-game between the counties and the state, the Norwegian government took over responsibility for, and ownership of, public hospitals. Hospitals were now organised as enterprises, with the general manager and executive board responsible for running it. According to Hagen and Kaarbøe (2004), the hospitals became separate legal subjects and thus not an integrated part of the central government administration, although ownership remained public (Hagen and Kaarbøe 2004). The country was divided into five regional health authorities and the hospitals were part of the health enterprises. At present there are four entities after merging the southern and eastern authorities into South-Eastern Norway Regional Health Authority in 2007.

1.4 Primary- and specialist health care services

Figure 2 (adapted from Iversen and Kopperud 2005), describes the patient flow in primary- and specialist health care in Norway.

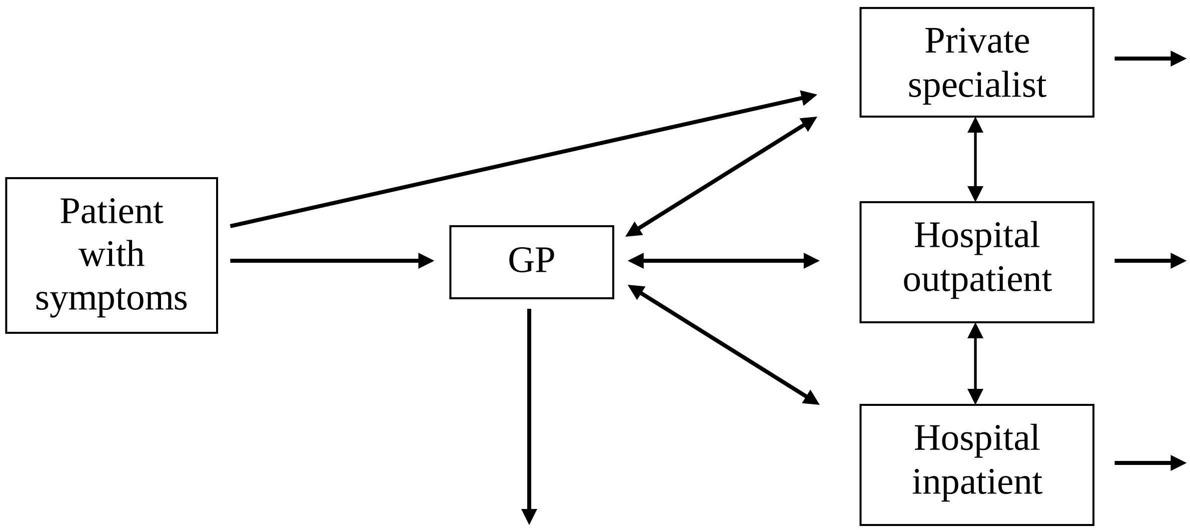


Figure 2: Patient flow in the Norwegian health care system (adapted from Iversen and Kopperud 2005).

The arrows pointing out of the figure indicates that the patient is discharged. First, the patient will decide whether to consult a general practitioner or a private specialist. Consulting a GP entails relatively low costs for the patients as out-of-pocket payments plays a minor role. The GP is responsible for either referring the patient for further evaluation in specialist health care or treating the patient within primary health care, if treatment is required at all. After treatment in specialist health care, the patient will either be discharged, or returned to primary services. This entails a role as gatekeepers for the GPs in that they decide if patients are to be referred to the specialist health services for further investigation. Hence, number of general practitioners and their incentives for carrying out this role is important when considering referrals to specialist treatment. It has been argued that the Norwegian system, where GPs are partly paid by the magnitude of their patient list parallel with the patient's right to choose their GP, provides incentives that strengthens the competition between GPs and in turn weakens their role as gatekeepers as their income is partly dependent on keeping their patient list (Carlsen and Norheim, 2003).

The four regional health authorities are responsible for the following number of inhabitants and hospital trusts (hospital pharmacy HTs included);

- South-Eastern Norway Regional Health Authority (Helse Sør-Øst): approximately 2,6 million inhabitants, 11 hospital trusts.
- Western Norway Regional Health Authority (Helse Vest): approximately 1 million inhabitants, 5 hospital trusts.
- Central Norway Regional Health Authority (Helse Midt-Norge): approximately 650 000 inhabitants, 6 hospital trusts.
- Northern Norway Regional Health Authority (Helse Nord): approximately 464 000 inhabitants, 5 hospital trusts.

The system for resource allocation from the state to the four RHAs can be divided in two. Revenues in the basic granting are independent of activity, while revenues via activity based financing and outpatient clinic are dependent on activity (NOU, 2008:2, 12). In 2008 the total granting allocated by the regional health authorities amounted to approximately 83 billion NOK (ibid.).

Table 2 (adapted from SINTEF 2010) describes number of inpatient stays in hospitals in the four regional health authority areas in 2006 and 2007 per 1000 inhabitants and total.

RHA		**Inpatient stays, total**		**Elective inpatient stays**		**Acute care, inpatient stays**		**Acute care, inpatient stays, medical DRG**	
		2006	**2007**	**2006**	**2007**	**2006**	**2007**	**2006**	**2007**
South-east	per 1000	966	937	293	285	569	549	430	411
	total	2 509 699	2 468 228	762 385	749 986	1 479 347	1 446 723	1 118 492	1 082 175
West	per 1000	956	913	290	269	577	561	419	401
	total	925 162	896 570	280 671	264 079	558 210	550 594	404 939	393 975
Central	per 1000	1 023	958	243	225	677	625	505	467
	total	668 329	632 091	158 948	148 391	442 587	412 362	330 049	307 927
North	per 1000	1 072	1 039	305	286	677	661	491	487
	total	495 538	480 082	140 777	132 161	312 790	305 297	227 009	225 006
All regions	per 1000	982	945	287	273	597	573	444	424
	total	4 598 728	4 476 971	1 342 781	1 294 617	2 792 934	2 714 976	2 080 488	2 009 083
Total (non-Norwegian visitors included)		4 612 052	4 493 214	1 343 578	1 295 621	2 805 068	2 729 488	2 087 523	2 018 163

Table 2: Use of specialist health care services in region of residence, by type of stay, type of admittance and DRG-type. Days of hospitalisation per 1 000 inhabitants and number of days of hospitalisation in total (adapted from SINTEF 2010).

The number of inpatient stays decreased between 2006 and 2007 in all regions. This can be explained by an increase in outpatient treatment of 4,4 percent. When taking both inpatient- and outpatient treatment into consideration, there was a total increase of 0,7 percent. Still, this increase is lower than the trend the previous years.

1.5 Financing of health care services

As mentioned earlier, the Norwegian health care system is primarily funded through taxes and transfers from the central government. "The municipalities and counties have the right to levy taxes on their respective population which, together with the government transfer, provide funding for primary health care. Regional health authorities depend on central government's transfer and do not have the right to levy taxes" (ibid., 34). There is element of out-of-pocket payments, but these are mainly subsidised by the Health Economics Administration (HELFO). Figure 3 (Johnsen 2006) delineates the financial flow in Norwegian health care.

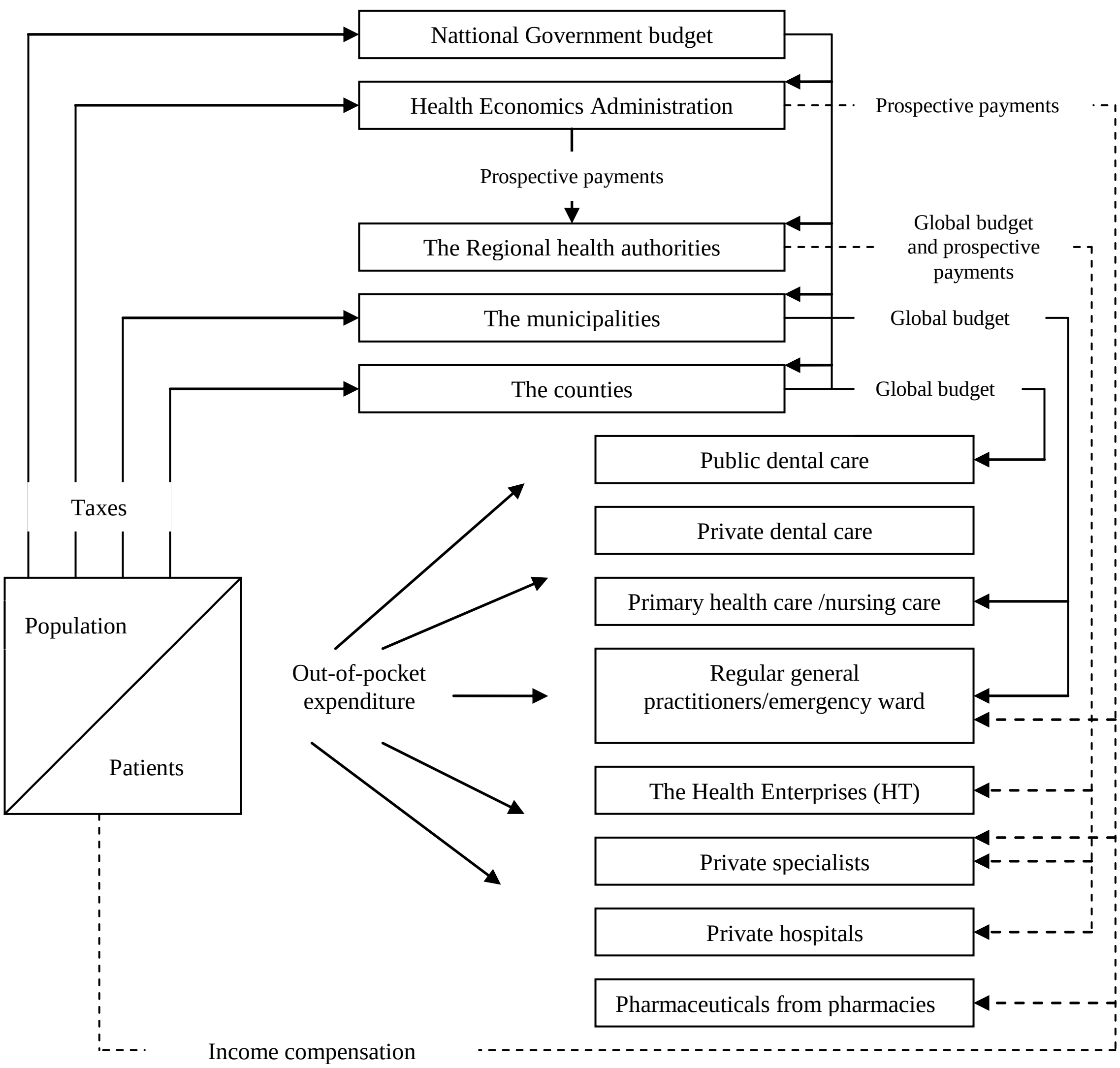


Figure 3: Financial flow chart (adapted from Johnsen 2006).

From 2009, the administration of individual reimbursements of patients, payment of different health care providers and responsibility for the regular GP scheme, was transferred from The Norwegian Labour and Welfare Service (NAV) to The Norwegian Health Economics Administration (HELFO), a sub-ordinate institution linked to the Directorate of Health.

In 2007, Norway's total health expenditure, public and private, was 203 billion Norwegian kroner. Norway has one of the largest shares of public financing of health services per capita in the world (Norwegian Directorate of Health 2009). The Norwegian per capita health expenditure ranked second among the OECD countries with USD 4,520 (adjusted for purchasing power parity) in 2006. The period between 1997 and 2006 saw a variation in the health expenditure as GDP ratio ranging from 8,4 percent to 10 percent, peaking in 2003, decreasing to 8,7 percent in 2006 (Norwegian Directorate of Health 2009). "The growth in health expenditure in Norway is similar to that in other western countries and can be explained by several reasons, such as the increasing number of elderly people, higher expectations, growth in the real GDP and increasing implementation of new technology in the health sector" (Johnsen 2006, 34).
Figure 4 (adapted from European Health for All database 2010) presents total health expenditure as percentage of gross domestic product in Norway, Denmark, Finland, Sweden and the EU between 1999 and 2007. Norway had a more rapid increase than the other countries from 8,4 percent in 2000 to 10 percent in 2003. During the last four years, Norway's expenditures decreased to 8,9 percent of GDP in 2007, which is lower than both Denmark and Sweden (9,8 and 9,1 percent, respectively). However, when only including Norway's mainland GDP, the percentage is relatively stable between 11 and 12,5 percent, which is substantially higher than the other countries. Finland had the lowest percentage over the nine years, a trend that can partly be explained by lower payment for health care personnel (Kittelsen et al. 2009).

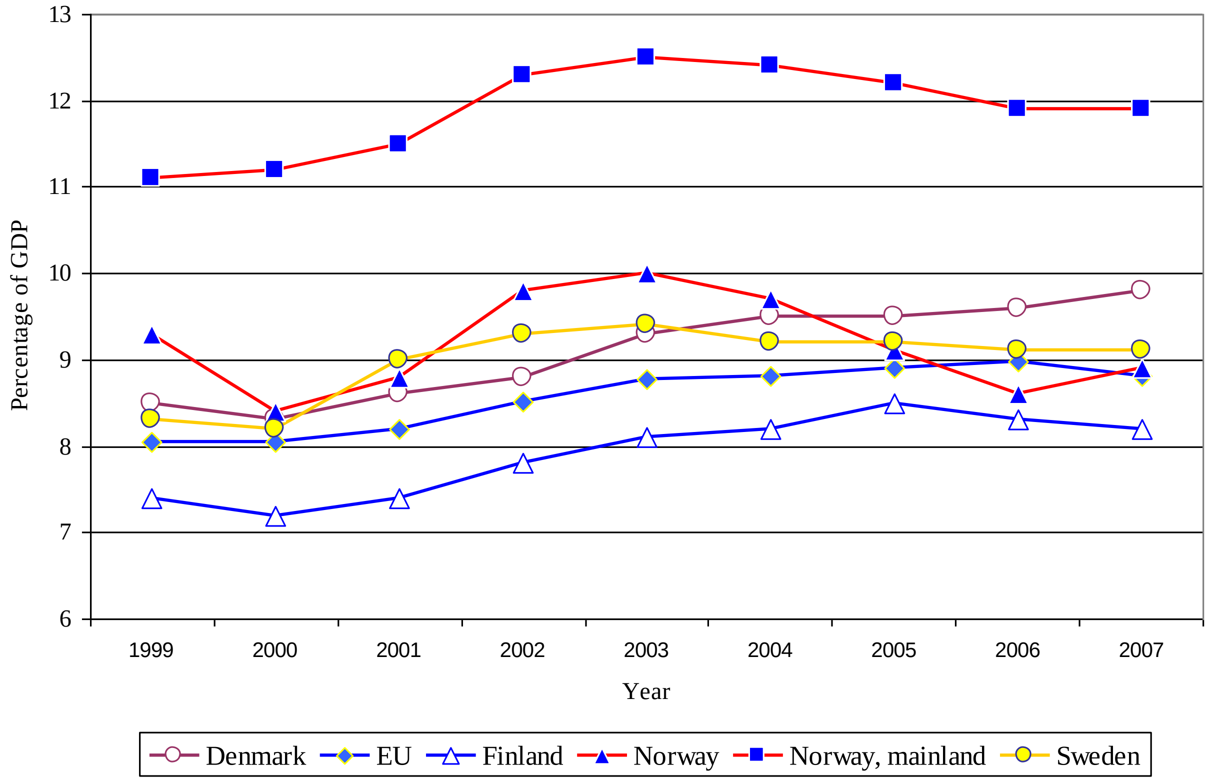


Figure 4: Trends in health expenditure as a share (percentage) of GDP in Norway and selected countries, 1999-2007 (European Health for All database January 2010).

It is important to notice that international comparisons considering health care expenditure will not necessarily give a correct picture due to definition- and measurement problems. According to Jensen, Østre and Hagen (2010), to get a true picture of use of resources, one has to make sure that health expenditures are defined and delimited in the same way between the countries and that difference in wages and level of costs are adjusted for (Jensen, Østre and Hagen 2010). The authors also underline problems when using the numbers from OECD that are often used for such comparisons;

- That the numbers are not corrected for differences in real income between countries.

- Problems related to how health care expenditures are defined. Jensen, Østre and Hagen (2010) stresses the problem of precise definitions considering if long time care should be registered as health care expenditures or social expenditures. Some countries define a large part of such expenses as social costs, not health care expenditures. As an example, according to OECD's numbers for 2007, Norway had five times as high expenditures per capita for long time care compared to Sweden and three times as high costs as Finland (ibid.).

- Problems regarding measurements of personnel. The authors underlines two issues with the OECD data in relation to this; that definitions of health personnel varies between countries and that personnel are counted, not calculated as man years (ibid.).

2. THE COORDINATION REFORM

2.1 Background for the reform

In June 2009, the Norwegian government presented a proposal for one of the most central health reforms in Norway during the last decades, white paper (St.melding) no. 47, The Coordination Reform. The reform was initiated by former minister of health and care services, Bjarne Håkon Hanssen (The Norwegian Labour Party), in order to meet the following challenges;

- Patient's needs for coordinated services are not sufficiently met in Norwegian health care at present.
- There is too little initiative aimed at limiting and preventing disease in the services.
- The challenges of population development and the changing range of illnesses among the population.

"Even though there are many systems which involve the various partial services, few systems are oriented towards cohesion that should meet patients' needs for coordination between them. There are also differing perceptions as to the goal of the different services; while the specialist health care entities are largely concerned with the goal of medical healing, the municipal health services typically focus more on patient functioning and coping" (Norwegian Ministry of Health and Care Services 2009a, 4). The health system in Norway does not provide local communities and municipalities with economic incentives to carry out preventive health care measures and health promoting efforts as these are financed by the local governments themselves. Treatment in specialist health care on the other hand, is fully financed through the state. This results in a system where local governments will gain financially by letting diseases and afflictions develop to a stage that demands treatment in hospitals, rather than taking preventive measures into use. Thus, prevention and early intervention often lose out in the battle for recourses.

There are ongoing changes in both demographics and epidemiologic patterns with an increasing number of elderly and changes towards more chronic and complex illnesses such as chronic obstructive pulmonary disease (COPD), diabetes, dementia, cancer and mental disorders. Without new solutions, the Ministry of Health and Care Services draws two possible outcomes; a development that threatens society's sustainability or that makes it necessary over time to take prioritising decisions that conflict with the basic values of the Norwegian welfare model (Norwegian Ministry of Health and Care Services 2009).

According to the white paper, the objective is to give proper treatment, at the right place, at the right time. The reform aims at meeting the increasing challenges of chronic diseases, a larger proportion of elderly, increased health costs and the problem of patients with complex set of diagnoses falling in between the different health service entities.
A chronic disease such as diabetes mellitus affects an increasing number of Norwegians. According to The Norwegian Diabetes Association there are approximately 200 000 people living with diabetes in Norway and 6000-7000 new cases each year (The Norwegian Diabetes Association 2010). Approximately 175 000 of the cases are type II, which is affected by lifestyle. Several other chronic life- and age related diseases are also increasing rapidly.
200 000 Norwegians are suffering from COPD, a disease that is expected to be the third largest cause of death in the world by 2020, surpassed only by cardiovascular and cerebrovascular disorders (Carré et al. 2008).
In 2005 there were 66 000 patients with dementia in Norway. The number is expected to be twice as high by 2035. "It is likely that 50 percent of patients suffering from dementia are dependent on treatment in nursing homes, which will amount to 50 percent more than the total capacity of 40 000 residents available at present" (Norwegian Ministry of Health and Care Services 2009b, 43). The rising number of chronic cases is likely to escalate in the future due to a larger proportion of elderly. According to Statistics Norway's population projections, the number of Norwegians aged 67 and over will increase from 617 000 in 2009 to around 1.6 million in 2060 (Statistics Norway 2009). Elderly patients are more susceptible to a complex set of afflictions where both the diseases and treatments affect each other mutually. According to the Ministry of Health and Care Services, patients older than 75 have an average of 3 different diagnoses and 25 percent in this age group have 6 diagnoses (Norwegian Ministry of Health and Care Services 2009b).

2.2 Strategy

The white paper suggests a number of steps to meet these challenges;

- A clearer role for the patient.
- A new municipal role emphasising prevention, early intervention efforts, low threshold initiatives and interdisciplinary measures.
- Changing the funding system so that municipal co-funding of the specialist health care services is a vital element.
- Developing the specialist health care services to enable them to apply their specialised competence to a greater extent.
- Facilitating better-defined priorities.
- Additionally; ICT, R&D, competent health professionals (Norwegian Ministry of Health and Care Services 2009a).

To provide a clearer role for patients is a tool to counteract the lack of cohesive patient pathways. According to the white paper, more involvement from patients and their organisations should be encouraged in efforts to implement structures and systems for the patient pathways to be more cohesive. Further, the pathway approach will help to orient all systems and services toward assisting the individual with coping with life or restoring functioning (ibid.). To succeed in this, the Ministry suggests measures such as maintenance and development of patients' involvement and participation, a contact point for all services within municipalities and a review of the statutory framework to determine how patients and their organisations should assume a clearer role in patient pathways (ibid).

The Coordination Reform has often been called a municipality reform as these will play the largest role in meeting the new challenges in Norwegian health care. According to the white paper; "the municipalities should ensure that the patient receives the best effective health care service through cohesive patient pathways. The municipalities must view the health and care sector in context with other areas of society – and coordinate services that take into account the distinctive features and characteristics of various personnel groups" (ibid., 6).

Further, some of the recommendations of the white paper are; to transfer and establish new tasks for the municipalities, to create a binding system between municipalities and health authorities, to reinforce preventive health work and improve medical health care in the municipalities. To enable municipalities to implement preventive health strategies and programs, the ministry has proposed a total of 230 million NOK in the municipalities' unrestricted income in the national budget for 2010 for these services (Prop. 1 S 2009-2010).

2.2.1 Financial incentives

The most important financial instruments are municipal co-financing of the specialist health care service and municipal financial responsibility for patients ready for discharge. The intent is for the financial schemes to encourage municipalities to assess whether positive impacts on health can be achieved with different financial strategies (Norwegian Ministry of Health and Care Services 2009a). More specifically, the Norwegian Ministry of Health and Care Services have suggested that 20 percent of the funds that are transferred from the state to the Regional Health Authorities at present should be transferred to the municipalities and thus, enable them to acquire more of the tasks. In addition, the white paper suggests that money that are spent on keeping patients that are ready for discharge in hospitals due to lack of municipal rehabilitation entities and nursing homes, should be transferred to the municipalities if they are able to provide such services. This means that municipalities will be provided with incentives to generate cost effective services for treatment and rehabilitation of patients that have been treated in specialist care services. Today these incentives are rather weak as the regional health authorities are allowed to demand municipal payment for patients ready for discharge not sooner than 10 days (7 days for hospitals in Oslo) after the municipality have been notified about the patient (Norwegian Ministry of Health and Care Services 1998). As a result of the increased focus on prevention and early intervention efforts, reducing the activity-based financing rate from 40 to 30 percent is suggested in the white paper.

2.2.2 Increased municipal responsibility

By transferring parts of the responsibility from specialist- to municipal health care, the ministry wishes to pave way for the former to focus its strengths on treatment that demands its expertise. The suggested strategy for this to happen is to establish administrative systems that can control the rising costs in specialist health care services, to enhance and develop the administrative systems between the ministry, the regional health authorities and the individual health authorities, to ensure contribution from the specialist health care in the build-up of expertise in municipal health and to implement and follow up pilot hospital projects.

Due to inadequate cohesion, the authorities do not have a sufficiently coordinated decision-making system for the health and care services. According to the white paper, efforts must be made to focus more prioritising decisions on cohesion in the patient pathways, rather than partial services (Norwegian Ministry of Health and Care Services 2009a). Further, development of ICT systems, research, education and competent personnel to make the system more eligible for the changes delineated in the white paper, are suggested. The ministry also emphasise municipal collaboration in development of local medical centres (lokalmedisinske sentra) to treat patients locally and by this help secure observation, treatment and posterior treatment on the most efficient health care level, to inhibit hospital admissions and to contribute to closeness to- and satisfaction with the supply of health care services.

2.2.3 Increased number of General Practitioners

To limit the pressure on specialist health services in Norway, the white paper suggests an increase in number of general practitioners (GPs) of 50 percent. This, however, is one of the most controversial proposals in the white paper. The hypothesis is that by increasing the amount of GPs, the number of referrals to specialist health care will decrease. The ministry has met critique from various expert groups for basing this decision on a limited foundation of research, as both Norwegian and international studies on the effect of general practitioner capacity on referrals to specialist health care are inconclusive. Some studies indicate that an increase in the number of GPs leads to increased consumption of specialist health care, while other studies conclude with the opposite, or no significant effects. Both Godager, Lurås and Iversen (2007), Carlsen and Norheim (2003, 2005) and Iversen and Ma (2009) found that increased number of GPs and thereby increased competition, weakened the GPs role as gatekeepers as it made them more prone to referring patients to specialist health services in fear of losing patients to other GPs. In accordance with these results, Nerland and Hagen (2008) found that a high coverage of general practitioners increased referrals to specialists and gave two possible explanations for the positive relationship; that a higher physician-to-population ratio increases the willingness to refer to specialists as a result of increased competition for patients, or that a higher ratio of physicians results in more consultations which in turn increases the number being referred for further clarification in specialist health services (Nerland and Hagen 2008). Iversen and Kopperud (2002) found significant effects of supply-side variables measured by GP density and the accessibility indices for specialist care on the utilisation of private specialists, but not on hospital visits and inpatient stays (Iversen and Kopperud 2002).

Tjerbo (2009) on the other hand, found that high GP spare list capacity at the municipal level resulted in less spending on specialist health care, but only for ambulatory care. The author stressed that the more general implication of the results was the acknowledgement of the complex and multileveled nature of the health care system, and how variables at either level could have significant external effects (Tjerbo 2009, 67). From the international literature, Croxson, Propper and Perkins (2001) and Dusheiko et al. (2006) found positive effects of physician density on admissions, while Gravelle et al. (2003) and Morris, Sutton and Gravelle (2005) found no significant relationship. In accordance with the results of Tjerbo (2010), Laditka, Laditka and Probst (2005) found a negative relationship between physician density and hospitalisation for ambulatory care sensitive conditions in urban areas.

2.3 A potential for substitution?

For municipal health care services to be able to reduce some of the pressure on specialist health care services, a potential for substitution between the two must exist. A potential for substitution entails that there is coherence between the level of municipal health care services and the use of specialist services. This means that if primary health care services are provided with more funds and thus, treat more patients, the hospitals should experience a decrease in number of patients relative to the extent of the increase in treatment in the municipalities. This, however, is not a given relationship and can result in an alteration of risk sharing between the two. If this potential does not exist, an expansion of municipal services would not have the desired effect on specialist services. Consequently, if hospitals get 20 percent less funds than they do at present due to the implementation of municipal co-funding, as it has been suggested in the white paper, but does not manage to reduce treatments and costs, the strategy is likely to lead to increased total costs over both services. Further, if the municipalities react to their new role without evaluating their capacity, implementation of services that are not cost effective might be an unintended effect. If a potential for substitution between the two do exist, the next question would be if a shift to more services in municipal health care is more cost effective than offering the services in specialist health care. Further, the potential for desirable effects such as quality improvement, reduced waiting lists, travel time and reduced burden on family and relatives, would have to be considered.

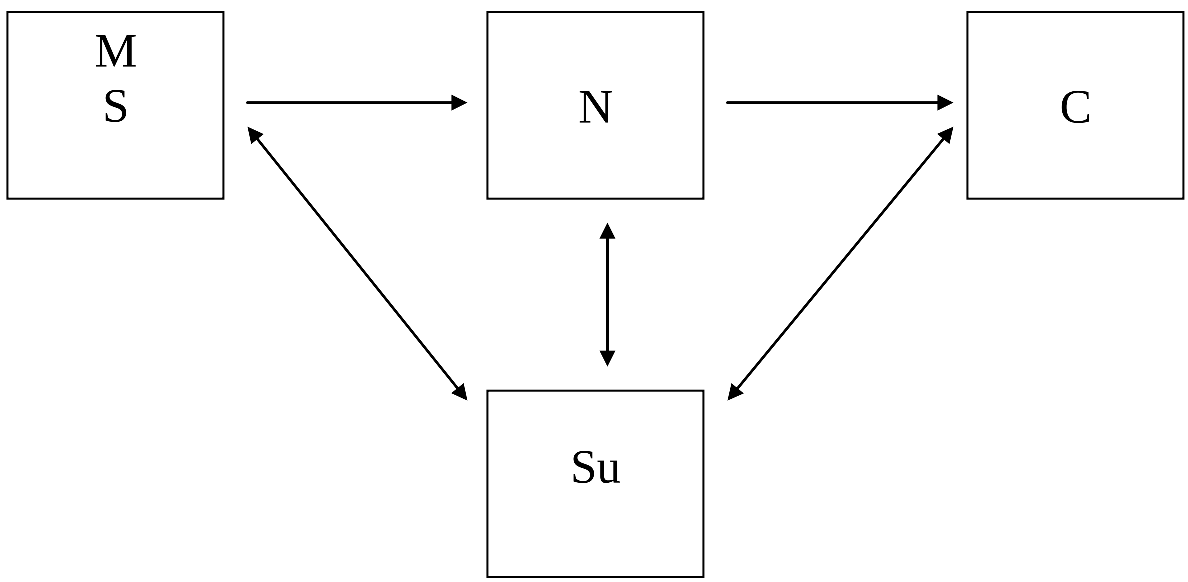
2.4 Experiences from Denmark

Denmark introduced a new municipal reform from 2007, with many similarities with the new reform suggested in Norway through white paper no. 47. The reform implemented structural changes within the health care sector, hereunder a new distribution of responsibility between municipalities, regional level and national level, a reduction from 14 entities into 5 health regions and 98 municipalities and a new financing scheme with municipal co-funding as a central method (Agenda/Implement 2009). The municipal structure is thus different from Norway, in that Denmark have larger municipalities with an average of 55 000 inhabitants and relatively few municipalities with population below 20 000. The preliminary experience from the new reform is that the municipalities have too little impact on hospital admissions as well as general practitioners to fulfil the tasks they were intended to acquire. This has led to a debate considering a more targeted approach for municipal co-funding within areas the municipalities are able to influence to a larger extent. So far, the experience is that municipal co-funding has not had the desired effects in Denmark. However, the new reform is still relatively recent, and it might be too early to make any conclusions concerning the effects of the reform.

3. THEORETICAL FOUNDATION

3.1 Need, demand and consumption

When measuring the need for health care services in a region, individual need is the main component. However, individual need is subjective, and thus difficult to measure. A common prerequisite is that individual need is dependent on current health status which, joint with the current available medical technology, determines their ability/possibility to utilise health services (Sutton 2002, cited in NOU 2008:2). Figure 5 shows the relationship between health- and socioeconomic status, need, demand and supply of health care services.



M: Measurements of health

S: Socioeconomic characteristics (including gender and age)

N: Need (unobserved)

C: Consumption of health care services

Su: Supply side characteristics

Figure 5: The coherence between health status, socioeconomic characteristics, need, consumption of health care services and supply side characteristics (adapted from NOU, 2008:2).

Need for health care services (N) arise as a result of diseases, injuries or other afflictions. Thus, health status (M) will be an explanatory variable when considering needs and the basis from which the need of these services is developed. Age, gender and socioeconomic factors (S) will affect need, either indirectly if they affect health status, or directly if they affect the need for health care services through person characteristics such as increased need with increased age. Further, the need for health care services can help explain the consumption (C) of such services. The need may affect the demand for certain services, and if the demand is greater than the supply (Su), consumption is restricted by the level of supply. Supply side variables will also affect the consumption of services indirectly, through its effect on needs. Through preventive- and curative care, the health service can contribute to reducing needs, but a large and well constructed system of health care services alongside with development of new medical technology may also contribute to uncover needs or create new needs, alternatively new demands (NOU 2008:2, 42). Needs may also arise from variance in epidemiology and demography as well as change in which afflictions that are treated or lowering of boundaries for treatment. This can also be affected by available resources in that one is more likely to follow the technological imperative, to use available technology and resources “to be safe”, even when such treatment is not necessarily medically induced.
A simplified manner to interpret the relationship between the variables is as follows (NOU 2008:2);

Need = demand, if no supply side restrictions (and perfect information).
Demand = consumption, if supply > demand

Thus, in cases with no restrictions in supply side variables, the need can be observed through consumption of services. However, when considering health care services, consumption as a measure of need does not take the fact that consumers of these services are not necessarily the ones in most need of them, into account. An additional problem is the possibility of groups in the population that systematically over- or under consumes health care services when compared to their need. Given that need is not directly observable, there are two ways to approach the need for health care services in a population; by measuring health status or by measuring consumption (ibid.).

Epidemiological data provides an overview of the health status in the population through the occurrence of various diseases and afflictions. This is not necessarily linked to actual consumption, and hence, it is considered more precise than measures of consumption when studying actual need (ibid.). However, with epidemiological health surveys in a population, problems such as selection- and sampling bias, measurement bias, intervention bias as well as cultural or geographical differences in measures may arise. In addition, self reporting may provide problems related to interpretation of survey questions. When measuring the relationship between extent of- and access to municipal health services and hospital admissions for specific diagnosis groups as we do in this analysis, patient registry data appears as the most adequate measure.

3.2 Distribution of responsibility

The municipalities and specialist health care services share the responsibility of supply when individuals are in need of health care. While the municipalities are responsible for the broadly oriented health care supply, the health trusts offers specialised treatment (NOU 2005:3, 49). Within family- and social networks, voluntary sector is included with different tasks spanning from self care to municipal health services (ibid., 49). Critique is often pointed at specific levels within health care supply, e.g. lack of adequate supply within hospitals. However, supply of health care at community level arises from interaction between the different actors. Figure 6 describes the distribution of responsibility between the various actors within health care service supply.

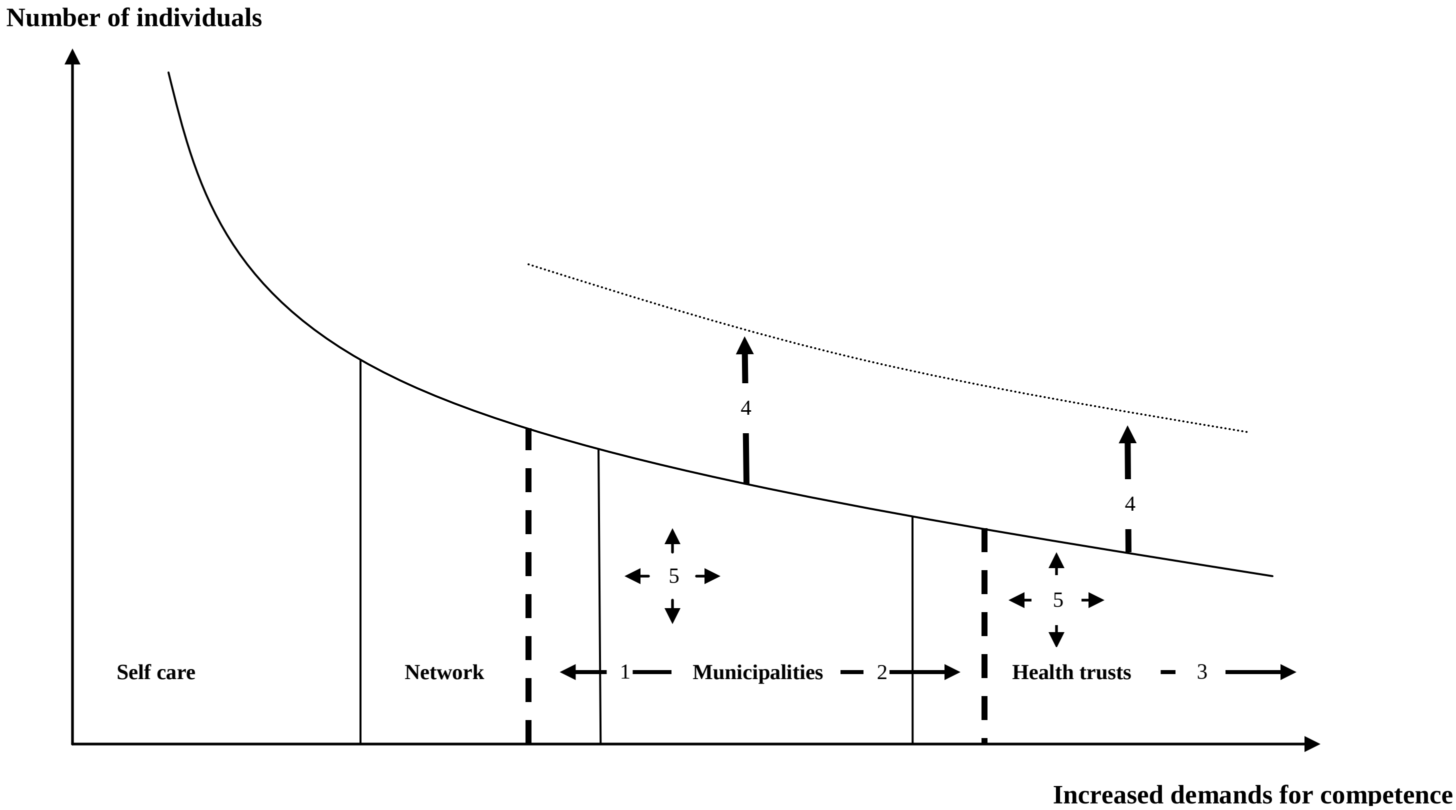


Figure 6: Distribution of responsibility between the various levels of health care supply (adapted from NOU 2005:3).

The distribution of responsibility is fluent, for instance it is widely accepted that the capacity of care in individual networks has declined as a consequence of changes in family structure, hereunder the increased amount of women pursuing careers (ibid.). Arrow 1 illustrates this movement as municipal health care services have taken over a larger proportion of the responsibility due to diminished support from personal networks. Arrow 2 illustrates the rise in patient groups that are treated within the municipalities as a consequence of among others the increased responsibility resting on GPs that formerly belonged to specialist services. Health- and care services within the municipalities are also assigned more responsibility for patients using respirators, advanced pain care and care for mentally ill patients (ibid., 50). The borderline for which tasks to be solved in municipal- or specialist health care sector is furthermore dependent on economic facilities, local collaboration between municipalities and hospitals, as well as changes in the hospital structure following the hospital reform in 2002 (ibid.). Arrow 3 describes how new knowledge affects hospitals and subsequently the municipalities. Development of technology and new methods for treatment followed by the possibility to treat new groups of patients expands the area of responsibility for the actors.

Demographic changes within the population along with increased focus on patient rights also increase the pressure on both primary- and specialist health care, illustrated by arrow 4. This is especially caused by an increase in supply of treatment for persons over 80, but also for younger age groups. In addition, even though the growth in supply is partly requested by- and decided within the political sphere, some of it is likely to be a consequence of increased professional ambitions among health care personnel (ibid.). This development is perceived positively among most patients and relatives. However, it might be a problem that a considerable share of the prioritisation of the overall resources is initiated by personnel, outside the political debate (ibid., 50). This is illustrated by arrow 5.

The figure can help describe a complex and fluent system with continuous changes in responsibility between the different sectors of health care supply. In our analyses we will try to examine to what extent the access to municipal health care services effects the use of specialist services, in other words if there exists a potential for substitution between the two levels.

4. DATA AND METHODS

4.1 Study design

We use a repeated cross-sectional study design on two levels; health trusts and municipalities in Norway during the time period between 1999 and 2007. We include fixed effects on two levels; health trust and year. In addition we implement a similar design for a separate population group; inhabitants aged 80 and above. The design captures variation over time as well as variation in population dynamics.

In the analyses we will compare the extent of relevant variables that can describe municipal health care services and the access to these in 427 municipalities in Norway, with the number of hospital admissions for eight groups of diagnoses from the Tenth revision of the International Classification of Diseases, ICD-10. The five groups within chapter IX: Diseases of the circulatory system (I00-I99) are merged into one main group, “Heart diseases, total”. Hence, we will perform analysis on four dependent variables (main diagnosis groups). In addition to the dependent variables, we take social factors such as socioeconomic status, age distribution in the population and number of disabled within the municipalities into consideration. We use each diagnosis group as dependent variable in a weighted-least-squares regression analysis along with relevant variables explaining supply of municipal health care services. Variables explaining need is also included in the analyses. All variables are standardised per 1000 inhabitants. In accordance with a study by Hagen (2009), who found effects for patients over 80 years of age, we will analyse this age group separately. We also include a separate analysis concerning local medical centres, as the white paper suggests expansion of these entities as an important mean for the stated challenges to be met.

The main diagnosis groups are selected by the joint trait that they are relatively widespread in the population and that they normally will not demand specialist- or acute care, thus we expect that these afflictions could to a larger extent be treated in primary health care if access to such treatment is available. The four main diagnosis groups we perform analyses on are diabetes mellitus, heart diseases, chronic lower respiratory diseases and other diseases of intestines.

In addition we perform a separate analysis on the effect of local medical centres.

4.2 Data sources and limitations

The diagnosis data are gathered from the Norwegian Patient Registry (NPR), while the municipal data are gathered from Statistics Norway (SSB) and Norwegian Social Science Data Services (NSD). Preferably, the diagnosis data would be obtained on individual patient level. Due to restrictions however, this was not possible and consequently, the analyses are based on aggregated patient level data, describing total number of hospital admissions per year in each municipality for the various main diagnosis groups.

The municipal data are collected from a total of 439 municipal units. However, due to merger of the municipals 0716 Våle and 0718 Ramnes into 0716 Re in 2002, 1154 Vindafjord and 1159/1214 Ølen into 1160 Vindafjord in 2006, 1569 Aure and 1572 Tustna into 1576 Aure in 2006 and 1842 Skjerstad into 1804 Bodø in 2005, all of these data were deleted. In addition, 1505 Kristiansund was deleted due to change in municipal code and 0815 Kragerø was deleted due to an unnatural increase in number of diagnoses in year 2007, which made our analysis consist of 427 Norwegian municipalities where data for all nine years were available within a geographical area that remained constant. For the variable "Disabled", due to lack of data from 2007 for all municipalities, we transposed the data from 2006 for this year.

Originally, we intended to include five diagnosis groups considering diseases of the circulatory system. However, due to a rather small number of admissions for each group except ischaemic heart diseases, we decided to merge this into one variable in our analysis; "Heart diseases, total". The diagnostic groups included in this variable are still described in the descriptive statistics.

4.3 Statistical analysis tool

We analyse various variables describing supply of municipal health care services' effect on admissions for four main diagnosis groups describing use of specialist health care. In addition we include variables describing need for health care services. To do this we use a weighted least squares (WLS) regression in Statistical package for social sciences (SPSS) 16.0.

4.4 Weighted least squares (WLS) regression

A critical assumption for an ordinary least squares regression (OLS) is homoscedasticity; that the variance of residuals is constant across values of the predicted values. In our data we analyse Norwegian municipalities with a large variation in number of inhabitants. Thus, the variation within the municipalities is likely to differ in relation to the size of each municipality. Using WLS regression, we give the more precise observations (those with less variability as a consequence of larger population) greater weight in determining the coefficients. Analysing without taking this method into use, would give each municipality the same influence on our results, independent of the fact that a small change in number of diagnoses for instance, in a small municipality, would have a large impact on the standardised number of cases. To avoid a potential fallacy, we have weighted the population in each municipality against the average total population of all municipalities over the nine years of analysis. Thus, in addition to standardising each variable per 1000 inhabitants, we give the trends within the municipalities with large population size greater weight and influence in our data than those with smaller population size. When using this method it is essential that the weights can be estimated precisely relative to one another. We believe that the weights used in our analyses are precise as they are weighted relative to population size, based on population data for each municipality over nine years, divided by the average total population for all municipalities in the dataset (per year). Consequently, the largest municipality in the dataset, Oslo, is given a weight estimate of approximately 0,121 in 2007 due to a population size of 548 617 inhabitants of a total average of 4 525 269 inhabitants over the nine year period analysed.

As in ordinary least squares, the unknown values of the parameters, β_0, β_1,…, in the regression function are estimated by finding the numerical values for the parameter estimates that minimize the sum of the squared deviations between the observed responses and the functional portion of the model (NIST/SEMATECH e-Handbook of Statistical Methods 2003). However, weighted least squares differ in that each term in the WLS criterion includes an additional weight, w_i, that determines how much each observation influences the final parameter estimates. The weighted least squares criterion that is minimised to obtain the parameter estimates is

$$Q = \sum_{i=1}^{n} w_i \left[y_i - f\left(\vec{x}_i : \vec{\hat{\beta}} \right) \right]^2$$

4.5 Empirical model

The empirical model should capture the effects of the independent variables describing supply and need on the dependent variables; hospital admissions for four diagnosis groups.
The weighted least squares regression model where the dependent variable (Y) are constituted of four main diagnosis groups on municipal level (j) is given by;

$$Y_j = w_i \left[\beta_0 + \beta_1 SUPPLY_j + \beta_2 NEED_j + \beta_3 D_k + \beta_4 D_y + e_j \right]$$

,where w_i composes the weight estimate, β_0 is a constant term, $SUPPLY_j$ denotes supply side variables at municipal level (physicians, nurses, places, residents and recipients) and $NEED_j$ denotes need variables at municipal level (elderly, mortality, disabled, unemployment, income, immigrants, low education, temperature and travel distance). D_k and D_y are vectors of dummy variables (fixed effects) of health trusts and year, while e_j is the error term for all levels (residuals).

4.6 Fixed effects

In addition to the variables included in our analyses describing need and supply, other factors not included in the models such as access to resources, internal culture, efficiency and routines may affect number of admissions and differ between geographical areas. The most potent method to exclude supply side variation is then to include the health trusts as dummy variables. Consequently, we include the 24 HTs as dummies, with health trust number 2, Akershus Universitetssykehus HT, as reference unit (see appendix I for overview of all health trusts). By doing this, we implement a “fixed-effects”-analysis, utilising the heterogeneity between municipalities within each health trusts’ catchment area. The “fixed-effect” variables capture supply-side variation and omitted need variables (Hagen 2009, 10). In addition, we include dummies for years, capturing the variation between the years (1999-2007), with 2003 as reference unit.

4.7 Statistical assumptions

A large enough sample size is important to ensure generalisability of the results. We include 427 Norwegian municipalities (of 431 in total) over 9 years in our analysis, resulting in a large data set which is expected to ensure the generalisability. All dependent variables are checked for normal distribution. The variables "Diabetes mellitus" (skewness of 5,209, kurtosis of 61,816), "Diabetes mellitus, 80+" (skewness of 3,100, kurtosis of 17,017) and "Chronic lower respiratory diseases, 80+" (skewness of 3,841, kurtosis of 39,387) are all positively skewed indicating scores clustered to the left at the low values and with rather high 'peakedness' (high positive kurtosis). In accordance with the central limit theorem however, the sample size is large enough to indicate that the mean will be approximately normally distributed. Multicollinearity arises when selected independent variables are strongly correlated and might lead to biased results, while singularity indicates that the independent variables are perfectly correlated and one variable is a combination of one or more of the other variables. We have checked for this by using Pearson correlation and set the limit for exclusion of variables at 0,7. As a result, some variables have been removed from the various models, which we return to when describing results. In addition to these assumptions, we have checked for outliers. One municipality, 0815 Kragerø, was removed due to an unnatural increase in number of diagnoses between 2006 and 2007. We avoid the problem of heteroscedasticity by using weights and including fixed effects in our analyses.

4.8 Variables

4.8.1 Main diagnosis groups (dependent variables)

- *Diabetes Mellitus (ICD-10 code: E10- E14)*

“Diabetes mellitus is a syndrome with disordered metabolism and inappropriate hyperglycemia due to either a deficiency of insulin secretion or to a combination of insulin resistance and inadequate insulin secretion to compensate” (McPhee et al. 2008, 1032). The diagnosis group E10-E14 covers insulin-dependent diabetes mellitus (type I), non-insulin-dependent diabetes mellitus (type II), malnutrition-related diabetes mellitus, other specified- and unspecified diabetes mellitus (WHO 2007). Between 1999 and 2007 a total of 53 291 patients were diagnosed within group E10-E14, diabetes mellitus, in Norway. During the same period the number increased rather steadily, from 5520 in 1999, to 6457 in 2007. 12,7 percent of the patients were more than 80 years of age. In accordance with Statistics Norway, this age group composed 4,7 percent of the total population in Norway in 2007, which make the group of patients over 80 years overrepresented within the diagnosis group (Statistics Norway, 2007).

- *Chronic rheumatic heart diseases (I05-I09)*

“Chronic rheumatic heart disease results from single or repeated attacks of rheumatic fever that produce rigidity and deformity of valve cusps, fusion of the commissures, or shortening and fusion of the chordae tendineae” (McPhee et al. 2008, 359). The diagnosis group includes rheumatic mitral valve diseases, rheumatic aortic valve diseases, rheumatic tricuspid valve diseases, multiple valve diseases and other rheumatic heart diseases (WHO 2007). 1476 patients were diagnosed within ICD-10 codes I05-I09. The number of diagnoses decreased steadily from 387 cases in 1999, to 98 cases in 2007. 15,2 percent of the diagnosed patients were 80 year and older.

- *Hypertensive diseases (I10-I15)*

“Elevated arterial blood pressure is a major cause of premature vascular disease, leading to cerebrovascular events, ischaemic heart disease and peripheral vascular disease” (Kumar and Clark 2009, 798). The group comprises essential (primary) hypertension, hypertensive heart disease, hypertensive renal disease, hypertensive heart and renal disease and secondary hypertension (WHO 2007). A total of 7910 patients were diagnosed within the group over the nine years. 2095 patients (26,5 percent) of the total number were more than 80 years of age, thus, a large overrepresentation compared to the 4,7 percent this age group constitutes in the total population. The yearly number of diagnoses remained relatively constant, with a decrease from 1195 patients in 1999 to 849 patients in 2007.

- *Ischaemic heart diseases (I20-I25)*

"Ischaemic heart disease or myocardial ischemia occurs when there is an imbalance between the supply of oxygen (and other essential myocardial nutrients), and the myocardial demand for these substances" (ibid. 743). The diagnosis group covers angina pectoris, acute myocardial infarction, subsequent myocardial infarction, certain currant complications following acute myocardial infarction, other acute ischaemic heart diseases and chronic ischaemic heart disease (WHO 2007). Between 1999 and 2007, a total of 446 601 Norwegians were diagnosed with various disorders within the diagnosis group. The number increased from 44 848 to 52 536 patients over the nine year period. 20, 6 percent of the total number of patients were aged 80 or older.

- *Diseases of veins, lymphatic vessels and lymph nodes, not elsewhere classified (I80-I89)*

Diagnosis group I80-I89 includes among others phlebitis and thrombophlebitis, other venous embolism and thrombosis, varicose veins of lower extremities, haemorrhoids and oesophageal varices (see appendix II for all diagnoses). In total, 68 957 patients were diagnosed within diagnosis group I80-I89 over the nine years. From 1999 to 2007 the number of diagnoses decreased from 7215 to 6892 after reaching a top level of 8710 in 2003. 9730 patients, or 14,1 percent of the total, were 80 years or older.

- *Other and unspecified disorders of the circulatory system (I95-I99)*

Diagnosis group I95-I99 in ICD-10 contains hypotension, postprocedural disorders of circulatory system not elsewhere classified, other disorders of circulatory system in diseases classified elsewhere and finally, other and unspecified disorders of circulatory system (WHO 2007).
This is a relatively small group with a total of 6218 patients diagnosed within the group between 1999 and 2007 in Norway's municipalities. However, 2579 (41,5 percent) of the diagnoses were

among persons over 80 years of age which makes this group highly overrepresented when compared to the 4,7 percent this age group constitutes of the population in total. In addition, the number of diagnoses was almost doubled, from 491 in 1999, to 954 in 2007.

- *Heart diseases, total (I05-I99)*

Consists of diagnosis groups I05-I09 (chronic rheumatic heart diseases), I10-I15 (hypertensive diseases), I20-I25 (ischaemic heart diseases), I80-I89 (diseases of veins, lymphatic vessels and lymph nodes, not elsewhere classified) and I95-I99 (other and unspecified disorders of the circulatory system).

- *Chronic lower respiratory diseases (J40-J47)*

The diagnosis group for chronic lower respiratory diseases covers diagnoses like bronchitis, not specified as acute or chronic, emphysema, asthma and other chronic obstructive pulmonary disease (see appendix II for all diagnoses). 129 800 patients were diagnosed with these disorders in Norway between 1999 and 2007, in which 20 586 (15, 9 percent) were more than 80 years of age. The number remained rather stable during the nine years with 16 244 diagnoses in 1999, decreasing to a low of 12 804 in 2002, then rising again to 15 573 in 2007.

- *Other diseases of intestines (K55-K63)*

The diagnoses K55-K63 includes among others vascular disorders of intestine, paralytic ileus and intestinal obstruction without hernia, diverticular disease of intestine, irritable bowel syndrome and abscess of anal and rectal regions (see appendix II for full list of diagnoses).
A total of 117 993 patients were diagnosed within this group between 1999 and 2007, 22,1 percent in age group 80 years and older. The data shows a gradual increase from 10 576 diagnoses in 1999, to 15 659 diagnoses in 2007.

4.8.2 Variables describing supply

- *Physicians*: number of man years of municipal physicians, per year, per 1000 inhabitants. The variables include all physicians employed within municipalities, with GPs constituting the largest share. Due to the potential of substitution we assume that more municipal physician man years will decrease number of admissions to specialist health care. However, as mentioned in section 2.2.3, some studies indicate a positive correlation between number of physicians and hospital admissions.

- *Social and nursing care*: number of man years of municipal social and nursing care, per year, per 1000 inhabitants. Due to the potential of substitution we assume that more man years within social and nursing care in municipalities will decrease number of hospital admissions.

- *Places in institution*: number of municipal institutional places, per year, per 1000 inhabitants. This variable provides a picture of the supply within the municipalities and we assume that a high level of supply might decrease number of admissions to hospital. This is in accordance with Hagen (2009), who found negative (but insignificant) effects of places in institution and nursing care.

- *Places in nursing care*: number of municipal nursing care places, per year, per 1000 inhabitants. We assume the same as for "Places in institution".

- *Home residents*: number of home residents in municipalities receiving nursing services, per year, per 1000 inhabitants. We assume that a high number of home residents will result in an increased number of admissions. Residents within health care services meet health personnel on a regular basis, which one would expect increased the likeliness of detection of diseases and afflictions. In addition, these variables are likely to give a picture of the age structure in the population, the more residents in home care and institutions as well as recipients of municipal care services, the more elderly, thus more admissions.

- *Institutional residents*: number of residents in municipal institutions with nursing services, per year, per 1000 inhabitants. As for home residents, we expect that a high number of institutional residents will lead to more admissions to specialist health care services.

- *Recipients*: number of recipients of municipal nursing care services, per year, per 1000 inhabitants. We assume that a high number of recipients will lead to a raise in number of admissions.

- *Travel distance (km)*: average travel distance from the municipality's centre to nearest hospital, in kilometres. In accordance with the findings of Nerland and Hagen (2008), we assume that longer distance equals less consumption and thus fewer admissions.

4.8.3 Variables describing need

- *Population 67-79*: number of people between 67 and 79 years of age, per year, per 1000 inhabitants. In accordance with the findings of Nerland and Hagen (2008), we assume that a higher ratio of people within this age group will increase the number of admissions.

- *Mortality*: number of deaths, per year, per 1000 inhabitants. In accordance with the findings of Hagen (2009), we assume that a higher ratio of deaths results in a higher number of admissions.

- *Disabled*: number of disabled, per year, per 1000 inhabitants. Hagen and Nerland (2008) found that number of disabled is positively correlated with use of specialist health care. We assume that number of hospital admissions will increase with a higher ratio of disabled.

- *Unemployment*: number of unemployed, per year, per 1000 inhabitants. We assume that a high share of unemployment will increase number of admissions.

- *Income*: average gross income of inhabitants in 10 000 NOK, per year. Carlsen (2006) found that expenses for specialist health care increased with a higher number of inhabitants with low income. We assume that a higher average income will result in fewer admissions to hospital.

- *Low education*: number of persons with no more than primary and secondary school level education, per year, per 1000 inhabitants. In accordance with Carlsens (2006) findings, we assume that a higher number of people with low education will increase number of admissions.

- *Immigrants, non-European*: number of first- and second generation immigrants from countries outside Europe, per year, per 1000 inhabitants. We assume that a high number of non-European immigrants results in an increased number of admissions, especially for some diseases such as diabetes mellitus. However, we know from the literature (Ingebretsen and Nergård 2007) that there is a certain degree of underconsumption within this population group, especially among elderly.

- *Temperature*: average temperature, during summer. In accordance with Carlsen (2006), we assume that lower average temperature will increase use of health care services and thus increase number of hospital admissions.

4.8.4 Variables describing local medical centres

- *Sykestuer*: general practitioner hospitals ("sykestuer") describe intermediate entities between municipal- and specialist health care, primarily located in rural areas in northern Norway. A total of 25 municipalities are located within areas covered by these centres.

- *Sjukestugu*: Hallingdal sjukestugu, located in Ål, organised within Ringerike hospital covering 6 municipalities and approximately 20 000 inhabitants.

- *Ørland*: located at Brekstad in Sør-Trøndelag, covering inhabitants within six municipalities and approximately 21 000 inhabitants.

4.9 Descriptive statistics

All variables are standardised as number per 1000 inhabitants to exclude differences in population size between the municipalities, with the exception of income, travel distance and temperature. The mean describes the average numbers per year between 1999 and 2007 in 427 Norwegian municipalities. For variables where all data are complete, N = 3843 (427 municipalities x 9 years).

4.9.1 Descriptive statistics, total population

Diagnosis groups							
	N	Mean	Min.	Max.	Std. dev.	Skewness	Kurtosis
Diabetes mellitus	3843	1,527	0,000	30,700	1,468	5,209	61,816
Chronich rheumatic heart diseases	3843	0,037	0,000	3,120	0,157	8,892	109,522
Hypertensive diseases	3843	0,197	0,000	7,960	0,367	6,176	81,124
Ischaemic heart disesases	3843	12,890	0,000	48,750	5,923	1,613	4,522
Diseases of veins, lymphatic vessels and lymph nodes	3843	1,745	0,000	13,000	1,051	1,486	6,317
Other circulatory diseases	3843	0,176	0,000	10,490	0,327	9,908	262,118
Heart diseases, total	3843	15,045	0,000	52,200	6,126	1,565	4,370
Chronic lower respiratory diseases	3843	3,096	0,000	24,570	1,839	2,030	11,086
Other diseases of intestines	3843	3,088	0,000	14,450	1,491	1,395	4,776

Table 3: Descriptive statistics for diagnosis groups analysed, 1999-2007. All variables are standardised as number of admissions per 1000 inhabitants.

From the descriptive statistics for the diagnosis groups in our analysis, we see that the most widespread affliction for hospital admissions is ischaemic heart disease with a mean of 12,890 admissions per 1000 inhabitants. The skewness value provides an indication of the symmetry of the distribution. Positive skewness values indicate scores clustered to the left at the low values, while negative skweness values indicate a clustering of scores at the high end (Pallant 2007, 56). Kurtosis, on the other hand, provides information about the ‘peakedness’ of the distribution. Positive kurtosis value indicate that the distribution is rather peaked (clustered in the center) (ibid., 56).

Supply side- and need variables							
	N	Mean	Min.	Max.	Std. dev.	Skewness	Kurtosis
Physicians	3829	1,116	0,000	4,867	0,417	1,776	6,131
Social and nursing care	3837	28,209	0,000	113,907	9,915	1,638	7,237
Places in institution	3288	12,005	0,000	46,377	5,771	0,931	1,585
Places in nursing care	3286	10,757	0,000	38,278	5,202	1,042	2,118
Home residents	3270	13,169	0,000	78,394	6,559	1,071	4,761
Institutional residents	3395	11,676	0,000	61,100	5,777	0,859	3,202
Recipients	3306	55,867	0,000	129,930	17,503	0,480	0,449
Population 67-79	3843	100,047	43,550	183,311	20,933	0,164	0,025
Inhabitants, 80+	3843	53,358	16,022	136,106	15,984	0,253	0,310
Mortality	3629	10,878	2,217	29,010	3,374	0,805	1,426
Disabled	3843	67,603	17,167	129,97	18,409	0,377	-0,380
Unemployment	3843	18,875	2,041	111,021	15,649	2,228	5,082
Income	3843	23,761	15,110	49,460	3,698	0,959	2,374
Immigrants, non-European	3843	15,664	0,000	171,020	14,822	3,457	21,773
Low education	3843	293,682	136,250	541,940	59,606	0,601	0,429
Temperature	3843	12,919	6,270	15,97	1,737	-0,494	0,291
Travel distance	3780	57,354	2,000	353,000	56,713	1,750	3,793

Table 4: Descriptive statistics of supply- and need variables, 1999-2007. All variables, except temperature and travel distance (km) are standardised as number per 1000 inhabitants. The numbers encompasses the time period 1999-2007 and are presented per year.

The minimum value of all diagnosis- and supply variables as well as the variable concerning number of immigrants is zero. This is caused by zero-values in some of the smallest municipalities in our dataset resulting in the same number when standardised per 1000 inhabitants. However, this will not affect our results as we weight each municipality's population size against the total population within the study.

4.9.2 Descriptive statistics, population 80 and over

In the separate analysis where we use data for the population over 80 years of age, we have standardised the variables where specific data for this age group is available per 1000 inhabitants within this age group. This includes all diagnosis groups as well as number of home- and institutional residents. Thus, the variables "80+", describes the number of cases (admissions or residents) aged 80 and over, per 1000 inhabitants within the same age group.

Variables, 80+							
	N	Mean	Min.	Max.	Std. dev.	Skewness	Kurtosis
Inhabitants, 80+	3843	53,358	16,022	136,106	15,984	0,253	0,310
Diabetes mellitus , 80+	3838	3,610	0,000	58,824	5,488	3,100	17,017
Chr. rheum. Heart dis., 80+	3838	0,134	0,000	42,553	1,140	20,387	604,915
Hypertensive diseases, 80+	3838	0,925	0,000	80,247	2,791	9,678	197,167
Ischaemic heart dis., 80+	3838	49,792	0,000	232,558	27,451	1,419	4,963
Diseases of veins., 80+	3838	5,329	0,000	62,500	6,478	2,611	12,126
Other circ. dis., 80+	3838	1,241	0,000	29,412	2,758	3,619	18,759
Heart diseases, tot., 80+	3838	57,421	0,000	232,558	28,719	1,242	3,972
Chr. low. resp. dis., 80+	3838	9,294	0,000	179,739	10,706	3,841	39,387
Oth. dis. of intestines, 80+	3838	14,170	0,000	142,857	11,588	1,993	9,756
Home residents, 80+	3287	119,854	0,000	411,110	64,487	0,393	0,289
Institutional residents, 80+	3389	187,842	0,000	1263,160	101,747	1,895	8,280

Table 5: Descriptive statistics of variables 80+, 1999-2007. The variables describe the number of cases for persons over 80 years of age per 1000 inhabitants over 80 years of age. The numbers encompasses the time period 1999-2007 and are presented per year.

The maximum value for "Institutional residents, 80+" appears to be erroneous as it exceeds 1000 residents. The source of this number is the 2001 data for municipality number 1252, Modalen with 24 residents in institution aged 80 and above parallel with a total of 19 inhabitants in the same age group. This may be explained by residents that are registered in other municipalities as the municipality has a rather high ratio for all nine years. The impact of the numbers however, is very low as the municipality is one of the smallest in our dataset and therefore weighted at a low ratio.

5. RESULTS

5.1 Diabetes mellitus (E10-E14)

5.1.1 Diabetes mellitus, total population

The average number of yearly hospital admissions of patients diagnosed with diabetes mellitus in Norwegian municipalities between 1999 and 2007 was 1,53 per 1000 inhabitants, with a variation from 0 patients to 30,7 patients per 1000 inhabitants.

	Model 1: Personnel		**Model 2: Places**		**Model 3: Residents**	
Variable	Estimate	Std. error	Estimate	Std. error	Estimate	Std. error
Diabetes (constant)	0,241	0,434	0,461	0,437	0,615	0,437
Physicians	0,283***	0,075				
Social and nursing care	0,004	0,003				
Places in institution			0,022***	0,006		
Places in nursing care			--	--		
Home residents					-0,003	0,003
Institutional residents					0,022***	0,006
Recipients					--	--
Population 67-79	0,003**	0,002	0,003	0,002	0,003	0,002
Population 80+	-0,002	0,003	-0,002	0,003	-0,002	0,003
Mortality	0,031***	0,011	0,031***	0,011	0,032***	0,011
Disabled	0,007***	0,002	0,006***	0,002	0,006***	0,002
Unemployment	0,003	0,002	0,004*	0,002	0,004	0,002
Income	-0,001	0,009	-0,002	0,010	-0,007	0,010
Immigrants, non-European	0,002**	0,001	0,003***	0,001	0,003***	0,001
Low education	0,002***	0,000	0,002***	0,001	0,002***	0,001
Temperature	-0,066***	0,018	-0,065***	0,019	-0,065***	0,019
Travel distance (km)	-0,001**	0,000	0,000	0,000	0,000	0,000
Fixed effects (HT and year)	Included		Included		Included	
R square (explanatory power)	0,293		0,320		0,321	

*** = P<0,01   ** = P<0,05   * = P<0,10

In the first model (personnel) we look at supply side variables in the municipalities by including the independent variables for number of municipal physicians (man years) and number of man years of social and nursing care personnel. In the second model we look at supply by including the two variables describing availability of places.

In the personnel analysis the variables “Physicians”, “Population 67-79”, “Mortality”, “Disabled” , “Immigrants, non-European”, “Low education”, “Temperature” and “Travel distance (km)” are significantly correlated to number of admissions for diabetes mellitus. The estimate for independent variables indicates the change in number of admissions for diabetes per one unit change in the independent variable. The analysis indicates a rather strong and positive effect of number of municipal physicians on number of admissions for diabetes mellitus to specialist health care. The variable “Physicians” is highly significant (P<0,01) with an estimate of 0,283. Thus, if number of municipal physicians per 1000 inhabitants is increased with one unit (man years), number of hospital admissions within diagnosis group diabetes mellitus would increase with approximately 0,28 per 1000 inhabitants. This result is surprising if one assume a potential for substitution between primary- and specialist health care services, but is in accordance with a study by Nerland and Hagen (2008), mentioned in section 2.2.3. The finding conflicts with the strategy of increasing number of general practitioners by 50 percent to limit the pressure on specialist services, suggested in the white paper.

As expected “Immigrants, non-European” (P<0,05) is correlated with admissions for diabetes. However, we would expect a higher implication of the variable for this specific diagnosis group. The estimate (0,002), indicates that if number of non-European immigrants per 1000 inhabitants increase with one, the number of admissions for diabetes mellitus will increase with 0,002 per 1000 inhabitants. The low effect might be a result of underconsumption of health care services within this population group. As assumed, “Population 67-79” (P<0,05, estimate = 0,003), “Mortality” (P<0,01, estimate = 0,031), “Disabled” (P<0,01, estimate = 0,007) and “Low education” (P<0,01, estimate = 0,002) are highly significant with positive effect, while “Temperature” (P<0,01, estimate = -0,066) and “Travel distance (km)” (P<0,05, estimate = -0,001) has a negative effect on number of admissions for diabetes mellitus. The explanatory power of the model is acceptable (R square = 0,293) and calls for more detailed investigations. Still, some of the variables are highly significant and the strong positive effect of number of physicians remains interesting.

Originally, the variable “Places in nursing care” was included in model 2 analysing places, but this variable is strongly correlated with “Places in institution” (Pearson correlation of 0,893), thus “Places in institution” was kept due to the stronger explanatory power in relation to diabetes.

The supply variable “Places in institution” is highly significant (P<0,01) with an estimate of 0,022. The interpretation of this result is that if number of places in municipal care institutions increase with one per 1000 inhabitants, the number of admissions for diabetes mellitus will increase by approximately 0,02 per 1000 inhabitants. Thus, the effect is relatively small.

The variables describing need remains significant with approximately the same effect as in the first model, with the exception of share of population aged 67-79 and travel distance which is not significantly correlated with diabetes mellitus related hospital admissions in the model analysing municipal places and unemployment which is significant (P<0,10, estimate = 0,004) in model 2. Share of population over 80 years of age is insignificant in both models with negative estimates, which is in conflict with our hypotheses for this variable. However, the number of patients in this age group with diabetes is relatively low, which might help explain the results. The explanatory strength of the model is relatively strong (R square = 0,320).

In model 3 we analyse independent variables concerning number of home residents with nursing services, residents in institution and recipients of municipal nursing care services.

Due to a strong correlation between the variables “Institutional residents” and “Recipients” (Pearson correlation of 0,710), the latter variable was removed as it had a weaker correlation with the dependent variable. “Mortality” and “Population 67-79” is also correlated (Pearson correlation 0,682), but is still kept in the analysis. “Institutional residents” is highly significant (P<0,01), while “Home residents” is insignificant. We assumed that these variables would have a positive correlation with the dependent variables, the more residents in home care and institutional care, the more hospital admissions. However, only “Institutional residents” have a significant and positive correlation with an estimate of 0,022. Thus, the effect of number of institutional residents on admissions for diabetes mellitus is relatively weak. All need variables show the same level of significance and estimates as in model 2. The explanatory strength of the model is relatively strong (R square = 0,321).

5.1.2 Diabetes mellitus, population 80 and over

The average number of hospital admissions for patients aged 80 and over diagnosed with diabetes mellitus, was 3,6 per 1000 inhabitants within the same age group per year (1999-2007).

	Model 1: Personnel		**Model 2: Places**		**Model 3: Residents**	
Variable	Estimate	Std. error	Estimate	Std. error	Estimate	Std. error
Diabetes, 80+ (constant)	10,493***	2,202	9,858***	2,214	10,595***	2,236
Physicians	-0,388	0,319				
Social and nursing care	-0,006	0,013				
Places in institution			--	--		
Places in nursing care			-0,039	0,029		
Home residents, 80+					0,000	0,001
Institutional residents, 80+					0,000	0,001
Recipients					--	--
Population, 80+	0,001	0,011	0,006	0,011	-0,003	0,010
Mortality	0,035	0,046	0,026	0,047	0,023	0,047
Income	-0,128**	0,051	-0,132***	0,051	-0,147***	0,051
Immigrants, non-European	0,009	0,006	0,009	0,006	0,009	0,006
Low education	-0,001	0,002	0,000	0,002	-0,002	0,002
Temperature	-0,225***	0,083	-0,181**	0,084	-0,186**	0,083
Travel distance (km)	-0,006***	0,002	-0,007***	0,002	-0,007***	0,002
Fixed effects (HT and year)	Included		Included		Included	
R square (explanatory power)	0,067		0,068		0,069	

*** = P<0,01   ** = P<0,05   * = P<0,10

In the analysis for population aged 80 and over, we remove the variables disabled (only for population in working-age, 16-67 years) and unemployment as these variables are not relevant for this specific age group. When comparing admissions for patient group 80+ with variables providing supply of personnel and places, we get significant results for the need variables "Income" (P<0,01, estimate = -0,128 and -0,132), "Temperature" (P<0,01, estimate = -0,225 for personnel, P<0,05, estimate = -0,181 for places) and "Travel distance" (P<0,01, estimate = -0,006 and -0,007). Both temperature and travel distance seems to have a stronger (negative) effect on admissions for this age group for diabetes compared to the population in total investigated in the former analyses. The variable describing average income is highly significant, which was not the case in the analyses of the population in total. In contrast with the analysis for total population, the personnel variables have negative estimates for this age group. This means that number of admissions for diabetes within age group 80 and above would decrease as number of personnel increases. However, the effects are not significant. The variable providing the proportion of population 80+ in the total population is not significant and shows a diminishing effect on number of admissions. This is likely caused by the relatively low number of cases of diabetes (mean = 3,610) and that this age group is not overrepresented among patients with diabetes mellitus to the same extent as is the case for some other diagnosis groups.

It is important to emphasize that the models' explanatory power is weak (R square of 0,067 and 0,068). The cause of this may be that the independent variables are not accounting for this specific age group, but the population in total due to lack of age specific data. Preferably, all variables would be age specific and standardised as proportion among inhabitants over 80 years of age.

For model 3: Residents on the other hand , data for number of residents in institution and home residents are age specific for the age group 80 and above. The variable "Recipients" is withdrawn from the analysis due to a strong correlation with the variable "Population 80+".

None of the variables describing residents are significant and both have low estimates, suggesting that the proportion of residents aged 80 and above within home- and institutional care are not correlated with number of admissions for diagnose group diabetes mellitus for the same age group. Again, it is important to stress the weak explanatory power of the model and the relatively small number of cases with diabetes mellitus. The variables describing income, temperature and travel distance remains significant with approximately the same estimates as in model 1 and 2 for hospital admissions for diabetes, patients over 80 years of age.

5.2 Heart diseases (I00-I99)

5.2.1 Heart diseases, total population

	Model 1: Personnel		**Model 2: Places**		**Model 3: Residents**	
Variable	Estimate	Std. error	Estimate	Std. error	Estimate	Std. error
Heart diseases (constant)	5,286***	1,838	7,758***	1,912	7,695***	1,871
Physicians	1,522***	0,265				
Social and nursing care	-0,017	0,011				
Places in institution			--	--		
Places in nursing care			-0,041*	0,025		
Home residents					0,033**	0,014
Institutional residents					0,025	0,024
Recipients					0,022***	0,008
Population 67-79	0,071***	0,007	0,071***	0,007	0,071***	0,007
Population 80+	0,026**	0,010	0,043***	0,011	--	--
Mortality	0,044	0,039	0,049	0,041	0,070*	0,038
Disabled	0,050***	0,007	0,049***	0,007	0,046***	0,007
Unemployment	0,052***	0,011	0,053***	0,012	0,056***	0,012
Income	0,062	0,043	0,044	0,045	0,040	0,043
Immigrants, non-European	0,000	0,005	-0,002	0,005	0,000	0,005
Low education	0,012***	0,002	0,011***	0,002	0,010***	0,002
Temperature	-0,440***	0,070	-0,518***	0,074	-0,493***	0,074
Travel distance (km)	-0,016***	0,002	-0,014***	0,002	-0,015***	0,002
Fixed effects (HT and year)	Included		Included		Included	
R square (explanatory power)	0,496		0,487		0,487	

*** = P<0,01   ** = P<0,05   * = P<0,10

The dependent variable "Heart diseases (I00-I99)" include the five diagnosis groups within diseases of the circulatory system in ICD-10; chronic rheumatic heart diseases, hypertensive diseases, ischaemic heart diseases, diseases of veins, lymphatic vessels and lymph nodes and other and unspecified disorders of the circulatory system. On average, 15,045 patients per 1000 inhabitants were referred to specialist health care within these diagnosis groups yearly between 1999 and 2007 in Norwegian municipalities. Ischaemic heart diseases constitute the largest part of this group, with an average of 12,89 yearly hospital admissions per 1000 inhabitants.

As for diabetes, the number of man years of municipal physicians has a strong positive correlation (P<0,01) with number of admissions, the opposite of our assumptions of a potential for substitution. This means that if number of man years of municipal physicians per 1000 inhabitants increases with one, the number of admissions for heart diseases increases with approximately 1,5 per 1000 inhabitants. Thus, the effect of increasing the number of physicians in municipal health care services would be an increase in number of admissions to specialist health services, the opposite of the intent of the proposals in the white paper. The need variables "Population 60-79" (P<0,01, estimate = 0,071), "Population 80+" (P<0,05, estimate = 0,026), "Disabled" (P<0,01, estimate = 0,050), "Unemployment" (P<0,01, estimate = 0,052) and "Low education" (P<0,01, estimate = 0,012) are all significant and positively correlated with heart diseases. The strongest effect is for population aged 67-79 with an increase of 0,071 admissions per 1000 inhabitants per 1 unit increase in inhabitants within this age group (per 1000 inhabitants). The explanatory power of the model is rather strong (R square of 0,496).

Due to correlation between the variables "Places in institution" and "Places in nursing care" (Pearson correlation of 0,893), the former is removed from model 2 as a result of slightly lower correlation with the dependent variable (heart diseases). When analysing "Places in nursing care", the variable is significant at the 10 % level with a negative estimate of -0,041. The need variables describing share of population aged 67-79, share of population aged 80 and over, disabled, unemployment, low education, temperature and travel distance remains significant with approximately the same estimates as in model 1 analysing personnel. The explanatory power is rather strong with an R square value of 0,487.

As a result of correlation between the variables "Recipients" and "Population 80+" (Pearson correlation of 0,717), we keep the former variable due to stronger correlation with the dependent variable. In accordance with our assumptions, the variables explaining residents, "Home residents" (P<0,05) and "Recipients" (P<0,01) are positive and significantly correlated with number of admissions for diabetes with estimates of 0,033 and 0,022, respectively. Thus, if number of residents in nursing homes and recipients of municipal care services increases with one unit per 1000 inhabitants, the number of admissions for heart diseases will increase with 0,033 and 0,025 per 1000 inhabitants, respectively. Despite significant correlations, the effect is rather small. The variables describing need remains significant with approximately the same estimates as in model 1 and 2, with the exception of mortality which is significant in model 3. The explanatory power is strong with R square value of 0,487.

5.2.2 Heart diseases, population 80 and over

	Model 1: Personnel		**Model 2: Places**		**Model 3: Residents**	
Variable	Estimate	Std. error	Estimate	Std. error	Estimate	Std. error
Heart diseases, 80+ (const.)	101,287***	11,165	110,419***	11,506	112,713***	11,527
Physicians	4,160***	1,618				
Social and nursing care	-0,065	0,068				
Places in institution			-0,389***	0,141		
Places in nursing care			--	--		
Home residents, 80+					-0,006	0,007
Institutional residents, 80+					-0,006	0,007
Recipients					--	--
Population, 80+	-0,217***	0,054	-0,138**	0,059	-0,174***	0,052
Mortality	0,529**	0,233	0,638***	0,244	0,426*	0,241
Income	-0,508**	0,257	-0,517*	0,266	-0,522**	0,264
Immigrants, non-European	0,117***	0,030	0,109***	0,032	0,088***	0,031
Low education	0,022**	0,011	0,026**	0,012	0,018	0,012
Temperature	-1,753***	0,419	-2,287***	0,441	-2,140***	0,426
Travel distance (km)	-0,124***	0,011	-0,125***	0,012	-0,140***	0,012
Fixed effects (HT and year)	Included		Included		Included	
R square (explanatory power)	0,140		0,145		0,150	

*** = P<0,01   ** = P<0,05   * = P<0,10

An average of 57,4 patients within age group 80+ were admitted to hospital with one of the five diagnoses included in the variable "Heart diseases", per 1000 inhabitants within the same age group per year (1999-2007).

For variables describing personnel, we find significant results for number of physician man years compared to the dependent variable share of heart diseases for age group 80+. Number of municipal physicians (man years) is positively correlated to heart diseases for this age group with a rather large effect (P<0,01, estimate = 4,160). Thus, if number of man years is increased with one per 1000 inhabitants (in total), number of admissions for age group 80+ with heart diseases will increase by 4,160 per 1000 inhabitants within this age group. Share of population aged 80 and more has a highly significant (P<0,01) negative correlation with number of admissions for the same age group in relation to heart diseases. This means that municipalities with a high share of elderly (more than 80), have fewer admissions within this age group. More specifically, the results are interpreted in the way that if the share of the total population aged 80+ increases with one (per 1000), the number of admissions for the same age group for heart diseases will decrease with approximately 0,22 admissions per 1000 inhabitants aged 80 and more. This result may indicate what Nerland and Hagen (2008) called a "crowding-effect", meaning that municipalities with a high share of elderly and thus higher demand for health services, have longer waiting lists for treatment resulting in a decline in number of hospital admissions (relative to the share of population within the age group). All the need variables are significant with estimates in accordance with our assumptions.
The variable describing places in nursing care is removed as it correlates with places in institution (Pearson correlation of 0,893) which has a higher correlation with heart diseases.
The remaining variable "Places in institution" is significant at the 1% level with a negative estimate of -0,389. Thus, for each unit increase in available municipal places in institutions per 1000 inhabitants, the number of admissions for heart diseases within age group 80+ decreases with 0,389 per 1000 inhabitants aged 80 and above. The explanatory power of the models is relatively low with R square values of 0,140 and 0,145, respectively.

As for the analysis of diabetes mellitus, share of home- and institutional residents aged 80 and older is insignificant for number of admissions for heart diseases for the same age group, suggesting that number of elderly residents does not affect number of admissions for the same group. The explanatory strength of the model is relatively weak (R square = 0,150).

5.3 Chronic lower respiratory diseases (J40-J47)

5.3.1 Chronic lower respiratory diseases, total population

	Model 1: Personnel		**Model 2: Places**		**Model 3: Residents**	
Variable	Estimate	Std. error	Estimate	Std. error	Estimate	Std. error
Chronic lower respiratory diseases (constant)	2,210***	0,697	2,239***	0,710	2,132***	0,698
Physicians	0,189*	0,100				
Social and nursing care	-0,010**	0,004				
Places in institution			-0,017**	0,009		
Places in nursing care			--	--		
Home residents					0,000	0,005
Institutional residents					-0,032***	0,009
Recipients					-0,006*	0,003
Population 67-79	0,012***	0,003	0,010***	0,003	0,009***	0,003
Population 80+	-0,017***	0,004	-0,012***	0,004	--	--
Mortality	0,059***	0,015	0,055***	0,015	0,044***	0,014
Disabled	0,021***	0,003	0,020***	0,003	0,020***	0,003
Unemployment	0,009**	0,004	0,009**	0,004	0,009**	0,004
Income	-0,034**	0,016	-0,025	0,017	-0,016	0,016
Immigrants, non-European	0,007***	0,002	0,007***	0,002	0,007***	0,002
Low education	0,000	0,001	0,001	0,001	0,001*	0,001
Temperature	-0,051*	0,027	-0,074***	0,028	-0,080***	0,028
Travel distance (km)	-0,005***	0,001	-0,006***	0,001	-0,005***	0,001
Fixed effects (HT and year)	Included		Included		Included	
R square (explanatory power)	0,228		0,227		0,228	

*** = P<0,01   ** = P<0,05   * = P<0,10

The average number of yearly hospital admissions for patients diagnosed with chronic lower respiratory diseases in Norwegian municipalities between 1999 and 2007 was 3,096 per 1000 inhabitants, with a variation from 0 patients to 24,6 patients per 1000 inhabitants.

Unlike in the other analyses, social and nursing care personnel (P<0,01, estimate = -0,014) gives a significant correlation compared to number of admissions for chronic lower respiratory diseases. The estimate is negative, meaning that if number of man years within nursing increase with one unit (one man year per 1000 inhabitants), the number of admissions regarding chronic lower respiratory diseases will decrease with 0,014 per 1000 inhabitants. Number of physicians remains positive as in the former analyses, (P<0,10, estimate = 0,189). All need variables are significant and in accordance with our assumptions with the exception share of population aged 80 and more which is negative, a trend that we suspect is the result of a "crowding-effect", and low education which is insignificant.

The variable "Places in nursing care" is removed from the second model due to correlation with "Places in institution" and lower explanatory value in relation to the constant.

Number of places in institution is significant at the 5% level with a negative estimate of -0,017. Thus, if number of places per 1000 inhabitants is increased by one unit, number of admissions for chronic lower respiratory diseases will decrease with 0,017 per 1000 inhabitants, a relatively small effect. The need variables remain significant with approximately the same effects as in the personnel analysis, with the exception of income which is insignificant in model 2.

The explanatory strength of model 1 and 2 is acceptable with R square values of 0,228 and 0,227, respectively.

In the third model we remove the variable describing share of population aged 80 and over as a result of correlation with the variable "Recipients" (Pearson correlation of 0,717).

The variables "Institutional residents" (P<0,01, estimate = -0,032) and "Recipients" (P<0,10, estimate = -0,006) are significant, while "Home residents" is insignificant. The negative estimates in relation to chronic lower respiratory diseases conflicts with the findings for diabetes and heart diseases where the significant variables describing residents/recipients were positive. However, the effect is rather low with a decrease of 0,032 hospital admissions within the diagnosis group per 1000 inhabitants for each one unit increase in institutional residents per 1000 inhabitants and 0,006 fewer admissions per 1000 inhabitants for each one unit increase in recipients of municipal nursing care services per 1000 inhabitants.

The explanatory power of model 3 is acceptable (R square = 0,228).

5.3.2 Chronic lower respiratory diseases, population 80 and over

On average, approximately 9,3 patients aged 80 and over per 1000 inhabitants within the same age group were admitted to hospital diagnosed with chronic lower respiratory diseases per year between 1999 and 2007 in Norwegian municipalities.

	Model 1: Personnel		**Model 2: Places**		**Model 3: Residents**	
Variable	Estimate	Std. error	Estimate	Std. error	Estimate	Std. error
Chronic lower respiratory diseases, 80+ (constant)	10,088**	4,372	10,635**	4,515	13,105***	4,584
Physicians	0,505	0,634				
Social and nursing care	-0,011	0,027				
Places in institution			-0,189***	0,055		
Places in nursing care			--	--		
Home residents, 80+					0,003	0,003
Institutional residents, 80+					-0,008***	0,003
Recipients					--	--
Population, 80+	-0,084***	0,021	-0,046**	0,023	-0,072***	0,021
Mortality	0,322***	0,091	0,342***	0,096	0,258***	0,096
Income	0,160	0,100	-0,179*	0,104	0,142	0,105
Immigrants, non-European	0,040***	0,012	0,034***	0,012	0,043***	0,012
Low education	-0,004	0,004	0,000	0,005	-0,002	0,005
Temperature	-0,149	0,164	-0,248	0,173	-0,256	0,169
Travel distance (km)	-0,034***	0,004	-0,034***	0,005	-0,037***	0,005
Fixed effects (HT and year)	Included		Included		Included	
R square (explanatory power)	0,099		0,103		0,105	

*** = P<0,01 ** = P<0,05 * = P<0,10

None of the personnel variables are significant for admissions of patients with chronic lower respiratory diseases aged 80 and over. The need variables “Population, 80+” (P<0,01, estimate = -0,084) and “Travel distance” (P<0,01, estimate = -0,034) are both significant at the 1 % level with negative correlations with number of admissions, while “Mortality” (P<0,01, estimate = 0,322) and “Immigrants, none-European” (P<0,01, estimate = 0,040) are positively correlated within the same level of significance. Again, we find that municipalities with a high share of inhabitants aged 80+, have fewer admissions within this age group, which we suspect is caused by what Hagen and Nerland (2008) called a “crowding-effect”, due to longer waiting lists for treatment in hospital as a consequence of a larger share of elderly.
In “model 2 we remove the variable “Places in nursing care” due to correlation with “Places in institution” and lower explanatory value in relation to the constant.
In accordance with earlier findings, the variable describing places in institution is negatively correlated with number of admissions within this age group. The need variables remain significant with approximately the same estimates as in model 1. In addition, “Income” is significant at the 10 % level, with a negative estimate of -0,179.
The explanatory power is relatively low for both models (R square, model 1 = 0,099, R square, model 2 = 0,103).
Due to correlation between the variables describing share of population aged 80+ and recipients of municipal nursing care services (Pearson correlation of 0,717), the latter is removed from model 3. Number of institutional residents aged 80 and over is significant at the 1% level with a negative estimate of -0,008. Consequently, if number of residents aged 80 and older increase with one per 1000 inhabitants aged 80 and older, the number of admissions for chronic lower respiratory diseases decreases with 0,008 per 1000 inhabitants within this age group, thus a small effect. Number of home residents is not significantly correlated with number of admissions.
The need variables describing share of population within the age group, mortality, immigrants and travel distance remains highly significant with estimates within the same range as in the former models. It is important to emphasise the relatively weak explanatory power for all three models (R square, model 3 = 0,105).

5.4 Other diseases of intestines (K55-K63)

5.4.1 Other diseases of intestines, total population

The average number of yearly hospital admissions for patients diagnosed with other diseases of intestines in Norwegian municipalities between 1999 and 2007 was 3,088 per 1000 inhabitants, with a variation from 0 patients to 14,45 patients per 1000 inhabitants.

	Model 1: Personnel		**Model 2: Places**		**Model 3:Residents**	
Variable	Estimate	Std. error	Estimate	Std. error	Estimate	Std. error
Other diseases of intestines (constant)	1,453***	0,471	1,743***	0,489	1,737***	0,489
Physicians	0,309***	0,081				
Social and nursing care	-0,002	0,003				
Places in institution			--	--		
Places in nursing care			0,002	0,007		
Home residents					0,003	0,003
Institutional residents					0,013*	0,007
Recipients					--	--
Population 67-79	0,005***	0,002	0,006***	0,002	0,005***	0,002
Population 80+	0,015***	0,003	0,017***	0,003	0,015***	0,003
Mortality	-0,002	0,012	-0,002	0,012	-0,003	0,012
Disabled	0,011***	0,002	0,011***	0,002	0,011***	0,002
Unemployment	0,004	0,003	0,003	0,003	0,004	0,003
Income	0,001	0,010	0,002	0,011	0,003	0,011
Immigrants, non-European	0,001	0,001	0,001	0,001	0,001	0,001
Low education	0,000	0,001	0,000*	0,001	0,000*	0,001
Temperature	-0,040**	0,020	-0,053***	0,021	-0,052**	0,021
Travel distance (km)	-0,003***	0,001	-0,003***	0,001	-0,003***	0,001
Fixed effects (HT and year)	Included		Included		Included	
R square (explanatory power)	0,335		0,326		0,325	

*** = P<0,01 ** = P<0,05 * = P<0,10

As for the personnel analysis of admissions for diabetes mellitus, heart diseases and chronic lower respiratory diseases, number of physicians is significant with a positive correlation (estimate = 0,309) with number of hospital admissions within diagnosis group “Other diseases of intestines”. The estimate is interpreted in the way that if number of municipal physicians increase with one man year per 1000 inhabitants, the number of admissions to hospital within this diagnosis group will increase with 0,309 per 1000 inhabitants. Of the need variables, “Population 67-79” (P<0,01, estimate = 0,005), “Population 80+” (P<0,01, estimate = 0,015) and “Disabled” (P<0,01, estimate = 0,011) are significant and positively correlated with number of hospital admissions for the diagnosis group. Temperature and travel distance again shows negative correlation.

In the analysis of places, we remove the variable “Places in institution” as a result of correlation with the variable describing places in nursing care and less explanatory value.

The remaining variable, providing number of places in nursing care, is insignificant. The need variables remain significant with approximately the same effects as in model 1. In addition, the variable “Low education” is significantly correlated with number of admissions, but with no effect (estimate = 0,000).

The explanatory power of model 1 and 2 is relatively strong with R square values of 0,335 and 0,326, respectively.

We remove the variable “Recipients” from model 3 as a result of correlation with the variable “Population 80+” (Pearson correlation of 0,717).

For the variables describing residents, “Institutional residents” (P<0,10, estimate = 0,013) is significantly correlated with number of admissions with a positive estimate, which is in accordance with our assumptions. However, the effect is relatively low with 0,013 more admissions per 1000 inhabitants per one unit increase in number of residents in nursing care institutions.

All need variables remain significant with approximately the same estimates as in model 2. The explanatory power of model 3 is relatively strong (R square = 0,325).

5.4.2 Other diseases of intestines, population 80 and over

An average of 14,2 patients aged 80 and over, per 1000 inhabitants within the same age group were admitted to hospital diagnosed within diagnosis group "Other diseases of intestines" per year between 1999 and 2007.

	Model 1: Personnel		**Model 2: Places**		**Model 3: Residents**	
Variable	Estimate	Std. error	Estimate	Std. error	Estimate	Std. error
Other diseases of intestines, 80+ (constant)	17,846***	4,092	21,383***	4,240	21,281***	4,254
Physicians	2,456***	0,708				
Social and nursing care	0,003	0,027				
Places in institution			--	--		
Places in nursing care			0,024	0,064		
Home residents, 80+					-0,002	0,003
Institutional residents, 80+					0,003	0,003
Recipients					0,018	0,016
Population, 80+	-0,010	0,022	0,010	0,023	--	--
Mortality	0,079	0,099	0,102	0,104	0,089	0,084
Income	-0,125	0,087	-0,136	0,091	-0,139	0,089
Immigrants, non-European	0,027***	0,009	0,029***	0,009	0,028***	0,009
Low education	-0,013***	0,004	-0,014***	0,004	-0,014***	0,005
Temperature	-0,068	0,166	-0,199	0,175	-0,205	0,176
Travel distance (km)	-0,016***	0,004	-0,014***	0,005	-0,017***	0,005
Fixed effects (HT and year)	Included		Included		Included	
R square (explanatory power)	0,137		0,137		0,141	

*** = P<0,01   ** = P<0,05   * = P<0,10

As with the personnel analysis for heart diseases, population over 80, the variable describing number of municipal physicians is positive and significant at the 1% level with an estimate of 2,456, meaning that if number of physicians increase with one man year per 1000 inhabitants, the number of admissions for patients aged 80 and over within diagnose group "Other diseases of intestines" will increase with 2,456 per 1000 inhabitants in the same age group. The need

variables “Immigrants, none-European” (estimate = 0,027), “Low education” (estimate = -0,013) and “Travel distance (estimate = -0,016) are all significant at the 1% level. The negative estimate for number of persons with no more than primary and secondary school level education (“Low education”) is contrary to our assumption for this variable. This means that number of hospital admissions for diseases of intestines for age group 80+ will decrease slightly if number of persons with low education increases. However, the effect is relatively low.
For model 2, the variable “Places in institution” is removed due to correlation with “Places in nursing care” (Pearson correlation of 0,893).
The remaining variable describing number of places within municipal nursing care has a positive estimate, but is insignificant. The need variables for number of immigrants, low education and travel distance remains significant with approximately the same estimates as in model 1. The explanatory strength of model 1 and 2 is relatively weak, with R square values of 0,137.
The variable “Population, 80+” is removed from the analysis in model 3, due to correlation with the variable “Recipients” (Pearson correlation of 0,717) and less explanatory value compared to the constant. None of the variables are significantly correlated to admissions for diseases of intestines for age group 80+. The need variables remain significant with approximately the same effects as in the two supply-side models.

5.5 Local medical centres

5.5.1 Local medical centres, total population

In the last analysis we look at the effect of supply of intermediate health care by including local medical centres. More specifically, we include variables describing general practitioner hospitals (“Sykestuer”), Hallingdal sjukestugu (“Sjukestugu”) and Ørland medical centre (“Ørland”).
There are 25 general practitioner hospitals (GPHs) in Norway, most of them located in the north, mainly as a consequence of the geographical structure with long distances to nearest hospital. Hallingdal sjukestugu is located at Ål in Buskerud as a collaboration to provide local treatment to inhabitants in six municipalities and a population of approximately 20 000. Ørland medical centre is located at Brekstad in Sør-Trøndelag, covering inhabitants within six municipalities and a

population of approximately 21 000. All three variables describe intermediate entities in rural areas for patients in need of treatment but not demanding specialist hospital treatment. The objective of this analysis is to try to uncover the effect of local intermediate supply, which has been underlined as an important strategic tool in the white paper. The largest diagnosis group, "Heart diseases, total" is used as dependent variable in the analyses of local medical centres.

	Model 1: Personnel		**Model 2: Places**		**Model 3:Residents**	
Variable	Estimate	Std. error	Estimate	Std. error	Estimate	Std. error
Heart dis., tot. (constant)	4,883***	1,855	7,112***	1,930	7,115***	1,893
Sykestuer	-2,917***	0,599	-3,517***	0,628	-3,124***	0,630
Sjukestugu	-0,864	0,972	-0,572	1,035	-0,346	1,032
Ørland	-0,935	0,657	-0,640	0,688	-0,608	0,685
Physicians	1,464***	0,265				
Social and nursing care	-0,017	0,011				
Places in institution			--	--		
Places in nursing care			-0,042*	0,025		
Home residents					0,032**	0,014
Institutional residents					0,023	0,024
Recipients					0,021***	0,008
Population 67-79	0,070***	0,007	0,070***	0,007	0,071***	0,007
Population 80+	0,025**	0,010	0,042***	0,011	--	--
Mortality	0,036	0,039	0,042	0,041	0,064*	0,038
Disabled	0,052***	0,007	0,052***	0,007	0,049***	0,007
Unemployment	0,058***	0,011	0,060***	0,012	0,062***	0,012
Income	0,063	0,043	0,048	0,045	0,043	0,043
Immigrants, non-European	0,001	0,005	0,000	0,005	0,001	0,005
Low education	0,012***	0,002	0,011***	0,002	0,010***	0,002
Temperature	-0,434***	0,071	-0,502***	0,074	-0,479***	0,074
Travel distance (km)	-0,012***	0,002	-0,010***	0,002	-0,011***	0,002
Fixed effects (HF and year)	Included		Included		Included	
R square (explanatory power)	0,499		0,492		0,491	

*** = P<0,01 ** = P<0,05 * = P<0,10

In all the three models we find highly significant effects on the 1% level for GPHs (“Sykestuer”). The estimate varies from -2,917 to -3,517, meaning that municipalities covered by these clinics have approximately 3,25 fewer admissions within the five diagnosis groups included in the dependent variable “Heart diseases, total”, per 1000 inhabitants.

The explanatory power is rather strong for all three models (R square values ranging from 0,491 to 0,499).

16 of 25 of the municipalities covered by these clinics are located in the county of Finnmark with a total of 19 municipalities. With the exception of Hammerfest, Kvalsund and Sør-Varanger, all municipalities are covered by GPHs in the county. Thus, to avoid a potential fallacy, we merge the dummy variables for the health trusts covering Troms and Finnmark (HTNR 23 and 24) in a separate analysis, to include more variation through municipalities that are not covered by GPHs. The effect remains significant within two of the models (model 2 and model 3). However, both significance level and estimates are lower (model 2; P<0,10, estimate = -1,108 and model 3; P<0,10, estimate = -1,252).

We do not find any significant effects considering Hallingdal sjukestugu and Ørland medical centre.

5.5.2 Local medical centres, population 80 and over

When analysing the effect of local medical centres for population aged 80 and above, we find similar results as for the population in total, with highly significant (P<0,01) and strong effects of GPHs (“sykestuer”). The effect however, is larger when considering this population group with estimates varying from -11,700 (model 1) to -19,312 (model 3). Consequently, the lowest effect we find within municipalities covered by these entities compared to other municipalities, is a decrease in approximately 12 hospital admissions for heart diseases among inhabitants aged 80 and older, per 1000 inhabitants within the same age group.

As for the total population we include a separate analysis where the dummy variables for HT 23 and 24 are merged. The variable “sykestuer” remains highly significant in all three models at the 1 % level, with a minor decrease in the estimates (model 1; estimate = -10,923, model 2; estimate = -12,570, model 3; estimate = -13,939).

We do not find any significant effects for the other two variables describing supply of intermediate health care services analysing the population aged 80 and older.

	Model 1: Personnel		**Model 2: Places**		**Model 3:Residents**	
Variable	Estimate	Std. error	Estimate	Std. error	Estimate	Std. error
Heart diseases, 80+ (constant)	98,017***	11,278	106,038***	11,628	107,837***	11,613
Sykestuer	-11,700***	3,640	-14,285***	3,797	-19,312***	4,136
Sjukestugu	4,048	5,942	5,607	6,294	8,072	6,164
Ørland	-2,906	4,021	-1,193	4,185	-1,248	4,071
Physicians	3,838**	1,622				
Social and nursing care	-0,061	0,068				
Places in institution			-0,405***	0,141		
Places in nursing care			--	--		
Home residents, 80+					-0,005	0,007
Institutional residents, 80+					-0,006	0,007
Recipients					--	--
Population, 80+	-0,224***	0,054	-0,145**	0,059	-0,183***	0,052
Mortality	0,517**	0,233	0,631***	0,244	0,426*	0,241
Income	-0,488*	0,257	-0,492*	0,266	-0,488*	0,264
Immigrants, non-European	0,122***	0,031	0,114***	0,032	0,093***	0,031
Low education	0,025**	0,011	0,030**	0,012	0,021*	0,012
Temperature	-1,634***	0,422	-2,123***	0,445	-1,952***	0,429
Travel distance (km)	-0,112***	0,012	-0,111***	0,013	-0,126***	0,013
Fixed effects (HF and year)	Included		Included		Included	
R square (explanatory power)	0,143		0,149		0,157	

*** = P<0,01   ** = P<0,05   * = P<0,10

6. DISCUSSION

6.1 Study objective

The intention of the study is to investigate the relationship between supply of municipal health care services and use of specialist health care after controlling for need, in Norway over a time period of nine years. The background for this study objective is the intentions of the white paper (St.meld.nr.47) “The Coordination Reform”, planned to be implemented in 2012. The white paper aims at transferring parts of the responsibility from specialist health care to municipal health care services. For the strategy to succeed, we assume that there has to exist a potential for substitution between the two levels, meaning that the pressure on specialist services will be lowered if more tasks are implemented in the municipalities. The method used is a weighted least squares regression based on data describing number of admissions in hospital for four main diagnosis groups and other variables related to supply and need of health services in 427 Norwegian municipalities. In the analyses we standardise all variables per 1000 inhabitants (for total population or age group 80 and over), we use population size of the municipalities as weights and we include “fixed effects” for health trust and year.

6.2 Main findings

The number of man years of municipal physicians, is significantly correlated with number of hospital admissions for all diagnosis groups. The effect is positive in all analyses and varies from 0,189 for chronic lower respiratory diseases, to 0,283 for diabetes, 0,309 for diseases of intestines and 1,522 in the analysis of the largest diagnosis group, heart diseases. The interpretation of these results is that for each increase of one man year of municipal physicians per 1000 inhabitants, the number of hospital admissions will increase with approximately 1,5 admissions per 1000 inhabitants for heart diseases, 0,3 for diabetes and diseases of intestines, and 0,2 for chronic lower respiratory diseases. The findings are in conflict with our assumption of substitution effects as well as the strategy of increasing the number of GPs by 50 percent to reduce pressure on specialist health care services, suggested in the white paper. However, it is in accordance with previous studies by Carlsen and Norheim (2003, 2005), Godager et al. (2007), Hagen and Nerland (2008) and Iversen and Ma (2009). The payment structure for GPs in Norway, depending partly on magnitude of patient list, is a possible explanation for the effect, in that increased number of GPs results in more competition, increasing the willingness to refer patients to specialists. An alternative explanation is that increased number of GPs leads to more consultations, resulting in more referrals to specialists. If we assume an increase in number of municipal physicians of 50 percent, as suggested in the white paper, our analyses indicates an increase in hospital admissions of approximately 65 percent for diabetes mellitus, 16 percent for heart diseases, 5 percent for chronic lower respiratory diseases and 12 percent for diseases of intestines, when controlled for the various need variables included in the models. It is important to stress that the percentage is based on numbers providing man years of municipal physicians in total, not only GPs. Still, most of the municipal physician man years are constituted by GPs and the delineated increase in number of admissions will consequently provide a fairly accurate picture. Of comparable studies, Hagen (2009) found rather weak effects of physicians on use of specialist care. The study indicated negative effects of physicians within nursing homes on use of long term inpatient stays and positive effects on use of rehabilitation and total consumption of specialist health care services. The study indicated no effects of coverage of GPs (Hagen, 2009). Further, when analysing the effects of number of municipal physicians for age group 80 years and older, we find significant and strong effects for two of the diagnosis groups (heart diseases and other diseases of intestines). The estimates indicates 4,160 more admissions for heart diseases and 2,456 for diseases of intestines per 1000 inhabitants aged 80 and over, for each unit increase in man years of physicians per 1000 inhabitants (of total population). Again, if we assume an increase in number of municipal physicians of 50 percent, number of hospital admissions for heart diseases and diseases of intestines among inhabitants aged 80 and over will increase with approximately 2,3 percent and 8 percent, respectively, when controlled for need variables included in the models.

For number of man years of nursing personnel, we find no significant effects in relation to hospital admissions for the diagnosis groups investigated, with the exception of chronic lower respiratory diseases. The effect is negative, meaning that more nurses results in less admissions. However, the effect is rather small with a decrease of 0,010 admissions per 1000 inhabitants for each unit increase in man years of nursing personnel per 1000 inhabitants.

In the analyses of elderly (80+), we find no significant effects of number of man years of nursing personnel.

For the second model analysing supply through the inclusion of places in institution/nursing care, we find significant effects in relation to three of the diagnosis groups (diabetes, heart diseases and chronic lower respiratory diseases). The effect is relatively small and positive for diabetes (0,022), while it is negative for heart diseases (-0,041) and for chronic lower respiratory diseases (-0,017). The significant results for three of the analyses indicate that even though number of municipal nursing- and institutional places might have an effect on number of hospital admissions, the effect is relatively small and uncertain.
Analysing age group 80+, we find a different pattern, with places in institution/nursing care being significant within two diagnosis group, heart diseases and chronic lower respiratory diseases. The analyses indicates rather strong and negative effects, with estimates of -0,389 (heart diseases) and -0,189 (chronic lower respiratory diseases). The interpretation is that for each unit increase in number of municipal institutional places per 1000 inhabitants (of total population), number of admissions diagnosed with heart disease and chronic lower respiratory disease among inhabitants aged 80 and older will decrease by approximately 0,4 and 0,2 admissions per 1000 inhabitants within the same age group, respectively. The indication of negative effects of coverage of institutional places on admissions for elderly patients, are in accordance with the findings of Hagen (2009), Holmås et al. (2007) and Carlsen (unpublished).

When considering variables describing residents/recipients (model 3), home residents is insignificant in all analyses except for heart diseases ($P<0,05$, estimate = 0,033). Institutional residents is highly significant in three of the analyses, but the effect is rather small and uncertain with positive estimates for diabetes (0,022) and diseases of intestines (0,013), and negative for chronic lower respiratory diseases (-0,032). It is also positive in the analysis of heart diseases, however, it is insignificant. Number of recipients of municipal services is significant in both analyses where included, positively correlated with the dependent variable (number of hospital admissions) in the analysis of admissions for heart diseases (0,022) and negative in the analysis of chronic lower respiratory diseases (-0,006). The interpretation of the results of model 3 for total population is that while number of residents within institution and home care and number of recipients of municipal health care services have significant effects on number of admissions for the diagnoses investigated, the effects are rather small and uncertain. Hagen (2009) found negative, but insignificant effects of residents on use of rehabilitation, use of long term inpatient stays and total use of specialist health care services.

In the analyses of residents for inhabitants aged 80 and older, we find significant effect in only one analysis regarding institutional residents; a negative correlation between number of institutional residents aged 80 and older and number of admissions for chronic lower respiratory diseases within the same age group. The estimate indicates a reduction of 0,008 hospital admissions per 1000 inhabitants for each increase in places per 1000 inhabitants within the age group, thus a small effect.

When analysing the effect of local medical centres, a type of medical unit that is suggested as a tool in the white paper to meet some of the stated challenges, we find highly significant and relatively strong effects on number of hospital admissions (for heart diseases) for municipalities covered by GPHs (sykestuer). In the analysis of the total population, we find significant correlations at the 1% level, with effects varying from -2,917 (model 1) to -3,517 (model 2). This indicates a strong effect, with a decline of approximately 3,25 hospital admissions per 1000 inhabitants within municipalities that are covered by these services, compared to those that are not. However, due to the potential effect of HT24 (Helse Finnmark HT), where 16 of 19 municipalities holds GPHs, we merged HT 24 with HT23 (Universitetssykehuset Nord-Norge HT) covering Troms, in a separate analysis. The effects remained negative in all models and significant within model 2 and 3, but with lower values (model 2; $P<0,10$, estimate = -1,108 and model 3; $P<0,10$, estimate = -1,252). Thus, some of the effect found in the first analysis might be caused by the situation in HTnr 24 covering the county of Finnmark, where most municipalities are covered by GPHs. Still, the results indicate fewer admissions within municipalities with clinics, even when a potential "Finnmark effect" is ruled out.

For the population over 80 we find even stronger and highly significant effects varying from a decrease of approximately 12 (model 1) to 20 (model 3) hospital admissions for heart diseases per 1000 inhabitants aged 80 and more, within municipalities covered by GPHs. When merging HT 24 and 23, we find the same effect within the age group, however with a small decrease in the effects. The potential of travel distance as a cause for these trends are taken into account, as we include this variable in our analyses. Thus, we find a relatively strong and negative effect when analysing the effect of GPHs (sykestuer) on number of hospital admissions (for heart diseases), indicating that the clinics might help lower the pressure on specialist services, as suggested in the white paper. The findings are in accordance with studies by Aaraas (1998) and Aaraas, Førde, Kristiansen and Melbye (1998).

6.3 Limitations

Using patient registry data on municipal level provides a description of the use of specialist health care through hospital admissions within Norwegian municipalities. However, the patient data from NPR describes the total number of admissions within each diagnosis group, without personal identification. Thus, individuals that are treated in several hospitals will not be identified in the data. Personal identification data would likely increase the validity of the study.
In addition, different coding practice between hospitals and potential misdiagnoses might affect the patient numbers for the four main diagnosis groups analysed. Finally, the analyses are based on a rather large data set describing selected variables for 427 Norwegian municipalities over a time period of nine years. For some variables, the data were not complete for all municipalities and years, presenting a limitation for the analyses.

7. CONCLUSION

The study indicates effects on number of hospital admissions for supply side variables describing number of man years of municipal physicians and places in institution/nursing care. The effect of physicians is rather strong and positive, indicating an increase in number of admissions with increased number of physicians. The effect of municipal supply of institutional care and nursing care on the other hand, proves to be significant, but with small and uncertain effects. The results indicates a stronger effect within age group 80 and over, with a strong positive effect of number of municipal physicians and negative effects of places in nursing care and institutions, suggesting that number of hospital admissions within this age group increases with number of physicians and decreases with supply of institutional- and nursing care places.

In the separate analysis considering local medical centres (intermediate health care entities), we find strong and negative effects of the variable describing GPHs (sykestuer), indicating that municipalities covered by these services have a lower number of hospital admissions, particularly for inhabitants aged 80 and over.

Our conclusion is that while municipal health care supply can lower pressure on specialist health care services through increased supply of institutional- and nursing care places, especially for elderly patients, the effect of increasing the number of municipal physicians will have the opposite effect and lead to increased pressure on hospitals. Intermediate health care entities (sykestuer) on the other hand, seem to have positive effects if the intention is to decrease hospital admissions, particularly for elderly. However, other factors, such as size of municipalities, access to personnel, geography and economy should be taken into consideration when evaluating strategies for decreasing pressure on specialist health care services. Further, the potential for desirable effects such as quality improvement, reduced waiting lists, travel time and reduced burden on family and relatives, would have to be considered.

The effects of municipal physicians as well as intermediate health care entities and coverage of institutions indicated in this study calls for further investigation, preferably based on individual level patient data.

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APPENDIX I

HTno.	Health Trust (Helseforetak)
1	Sykehuset Østfold HT
2	Akershus Universitetssykehus HT
3	Oslo Universitetssykehus HT
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
12	Stavanger Universitetssykehus HT
13	Helse Fonna HT
14	Helse Bergen HT
15	Helse Førde HT
16	Helse Sunnmøre HT
17	Helse Nordmøre og Romsdal HT
18	St. Olavs Hospital HT
19	Helse Nord-Trøndelag HT
20	Helgelandssykehuset HT
21	Nordlandssykehuset HT
22	Hålogalandssykehuset HT
23	Universitetssykehuset Nord-Norge HT
24	Helse Finnmark HT

APPENDIX II

Tenth revision of the International Classification of Diseases, ICD-10

Chapter IV: Endocrine, nutritional and metabolic diseases (E00-E90):

Diabetes mellitus (E10-E14)

E10: Insulin-dependent diabetes mellitus
E11: Non-insulin-dependent diabetes mellitus
E12: Malnutrition-related diabetes mellitus
E13: Other specified diabetes mellitus
E14: Unspecified diabetes mellitus

Chapter IX: Diseases of the circulatory system (I00-I99):

Chronic rheumatic heart diseases (I05-I09)

I05: Rheumatic mitral valve diseases
I06: Rheumatic aortic valve diseases
I07: Rheumatic tricuspid valve diseases
I08: Multiple valve diseases
I09: Other rheumatic heart diseases

Hypertensive diseases (I10-I15)

I10: Essential (primary) hypertension
I11: Hypertensive heart disease
I12: Hypertensive renal disease
I13: Hypertensive heart and renal disease
I15: Secondary hypertension

Ischaemic heart diseases (I10-I25)

I20: Angina pectoris
I21: Acute myocardial infarction
I22: Subsequent myocardial infarction
I23: Certain current complications following acute myocardial infarction
I24: Other acute ischaemic heart diseases
I25: Chronic ischaemic heart disease

Diseases of veins, lymphatic vessels and lymph nodes, not elsewhere classified (I80-I89)

I80: Phlebitis and thrombophlebitis
I81: Portal vein thrombosis
I82: Other venous embolism and thrombosis
I83: Varicose veins of lower extremities
I84: Haemorrhoids
I85: Oesophageal varices
I86: Varicose veins of other sites
I87: Other disorders of veins
I88: Nonspecific lymphadenitis
I89: Other noninfective disorders of lymphatic vessels and lymph nodes

Other and unspecified disorders of the circulatory system (I95-I99)

I95: Hypotension
I97: Postprocedural disorders of circulatory system, not elsewhere classified
I98: Other disorders of circulatory system in diseases classified elsewhere
I99: Other and unspecified disorders of circulatory system

Chapter X: Diseases of the respiratory system (J00-J99):

Chronic lower respiratory diseases (J40-J47)

J40: Bronchitis, not specified as acute or chronic
J41: Simple and mucopurulent chronic bronchitis
J42: Unspecified chronic bronchitis
J43: Emphysema
J44: Other obstructive pulmonary disease
J45: Asthma
J46: Status asthmaticus
J47: Bronchiectasis

Chapter XI: Diseases of the digestive system (K00-K93):

Other diseases of intestines (K55-K63)

K55: Vascular disorders of intestine
K56: Paralytic ileus and intestinal obstruction without hernia
K57: Diverticular disease of intestine
K58: Irritable bowel syndrome
K59: Other functional intestinal disorders
K60: Fissure and fistula of anal and rectal regions
K61: Abscess of anal and rectal regions
K62: Other diseases of anus and rectum
K63: Other diseases of intestine