Associations between Primary Health Care- and Hospital Utilization among Elderly People in Norway

A dissertation for the degree of Philosophiae doctor

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2013

Acknowledgements

This study was carried out between 2006 and 2013 at the Department of community medicine, Faculty of Health Sciences, University of Tromsø and at the Center of Clinical Documentation and Evaluation (SKDE). The work was funded by the Regional Health Authority of Northern Norway, National Centre for Rural medicine, the research umbrella FORSAH (Forskning på samhandling i helsetjenesten). The last period as research fellow I have been working at SKDE.

Many people have been important for me to realize and complete this thesis.
First; my three supervisors: Toralf Hasvold, you were my first inspirator and mentor. Our initial goal was to create a regional database to describe the activity in and content of general practice. For many reasons we did not succeed, but as co-advisor you have been a valuable discussion partner. We share both experiences and perspectives from the general practice (GP) standpoint, and you have contributed with highly relevant input to the present project. Gro Berntsen, my main supervisor, thank you for never giving up the ambition of teaching me research and finishing this project. I have learned a lot from your skills and perspectives. We started out as optimists in register data research, and met several obstacles well recognized by more experienced researchers. We learned that the right question would be "What is wrong with the data?" indicating that systematic doubt and focus on detail is a source of knowledge. In periods with frustration, your enthusiasm and sense of humour have been important; what a difference a good laugh can make!
Olav Helge Førde, my second co-advisor and also part-time colleague at SKDE: Thank you for your supportive corrections and critics! I am impressed of your insights and clear thought.

Trine Magnus, as the leader of SKDE in the later period of this project, you gave me the opportunity to finish this thesis, and I am deeply grateful for your patience. Erik Sund, thank you for daily inspiring conversations, friendship and fun while we shared office at SKDE. The methodical discussions lead us to collaborate on paper 3. I have learned a lot- and have still a lot to learn- in the field of multilevel analyses and social epidemiology. Thank you for introducing me to Andy Jones from University of Norwich, who became a valuable co- author on our paper. I hope we can collaborate further in the future. I am also grateful to my colleagues at SKDE for discussions and fun over the last years. Without our company, finishing this thesis would have been even more demanding!

Most of these years I have been doing research, I also have worked part time as GP. I am deeply indebted to colleagues and friends at “Nordbyen legesenter” for your willingness to let me finish the thesis. I recognize the burden I have put on your daily work through these years. Special thanks to Unni Ringberg, who also contributed to one of my articles and to Lise Zimowski Johansen for taking care of many of my list patients during the last years.
Special thanks to Tom Wilsgaard at Department of community medicine for valuable statistical advice in the beginning t of this project. I also learned to know Nils Fleten, Georg Høyer and Ragnar Hotvedt as good colleagues.
At the General practice section I had inspiring discussions during several phases of the project. Thank you to Hasse Mellbye at the General Practice Research Unit and Svein Steinert Per Baadnes, Peder Halvorsen and Ivar Aaraas at the National Centre of Rural Medicine for their support, travel companions and help during these years.

Finally and most of all, I want to thank my love and life companion Sameline for your faith in me and this project. Your support has been essential. Also many thanks to Jakob, Regine and Johannes for your patience and encouraging support! Our family life has been the best contrast to up and downs in this project- which took too much time.

Contents

Summary

Background: Geographical variations in health-care utilization in many countries have been an area of debate. Health-care supply factors, population and/or environmental need factors might explain the so-called small-area variations (SAVs). Demographic forecasts indicated a significant increase in the elderly population over the next few decades, with a resulting increased need for health services. The Norwegian Coordination reform and health policies in many western countries suggested that a strengthening of primary health care (PHC) could improve the sustainability of health-care budgets and decrease pressure on hospital services. Studies were however inconsistent in their conclusions regarding whether a higher PHC-utilization can reduce hospital utilization.

Aims and study designs: In three papers we have aimed to explore the association between PHC-utilization and utilization of specialized health care (SHC) among elderly people in Norway. In papers 1 and 2 we used a linear multiple regression model, whereas in paper 3 we used a multilevel model. We adjusted for variables known to influence health-care use.

Results: We found no or a weak positive association between PHC and SHC use in all three papers. Age, sex, mortality, and a composite of hospital status and municipality population size were identified as effect modifiers, whereas travel time to a local hospital was an important confounder. Socioeconomic variables had little influence on the associations studied. In the multilevel study we found that higher municipality LTC volume was associated with less unplanned medical admissions among the oldest, whereas we found a modest geographical variability in risk for unplanned medical admissions at both the municipality level and the local hospital area level.

Conclusions: In a universal health-care system with well-functioning PHC it was not obvious that increased PHC utilisation alone will reduce the pressure on hospital services.

List of papers

1. Trygve S Deraas, Gro R Berntsen, Toralf Hasvold and Olav H Førde. 2011. Does long-term care use within primary health care reduce hospital use among older people in Norway? A national five-year population-based observational study. *BMC Health Services Research* **11**:287 doi:10.1186/ 1472-6963-11-287
2. Trygve S Deraas, Gro R Berntsen, Toralf Hasvold, Unni Ringberg, Olav Helge Førde 2013. Is a high level of general practitioner consultations associated with low outpatients specialist clinic use? A cross-sectional study. *BMJ Open* **3**:e002041.
3. Trygve S Deraas, Gro R Berntsen, Andy Jones, Erik Sund et al. Associations between primary health care and unplanned medical admissions in Norway. A multilevel analysis of the total population above 64 years of age [Submitted Health & Place; under review].

List of abbreviations

ACSC	ambulatory care sensitive conditions
ADL	activities of daily life
CR	Coordination reform
DRG	diagnosis-related group
EH	emergency hospitalization
EPR	electronic patient record
GP	general practitioner
HDs	hospital days
HRQoL	health-related quality of life
HRR	hospital referral region
HSA	hospital service area
HT	hospital trust
KP	Kaiser Permanente
LOS	length of stay
LTC	long-term care
NPR	Norwegian Patient Registry
NSDM	National Centre of Rural medicine
OECD	Organisation for Economic Co-operation and Development
OPC	outpatient clinic
PCC	Pearson's correlation coefficient
PCP	primary care physician
PCP ratio	number of primary care physicians compared with number of specialist health-care physicians
PHC	primary health care
RHA	regional health authority
SAV	small-area variations in health care utilization
SES	socioeconomic status
SHC	specialized health care
UMA	unplanned medical admission
UA	unplanned admission

1 Introduction

A report from the regional health authority of northern Norway demonstrated, in 2005, a threefold rate difference in municipality utilization of outpatient clinics (Hansen 2005). This demonstrated municipality variation could challenge the long-standing Norwegian goal of equity (Norwegian Ministry of Health 2003) . The municipalities with the lowest outpatient clinic (OPC) utilization were consistent with those previously designated 'lighthouse municipalities' by the National Centre of Rural Medicine (NSDM), based loosely on their comprehensive and high-quality primary health care (Bliksvær and Olsen 2003). Did this indicate that local primary health care influenced the utilization of specialized health care? This awakened my interest in exploring the relationship between primary health care (PHC) and specialized health care (SHC), and this was the start of this project.

A literature review demonstrated that so-called 'small-area variations' in health care utilization (SAV) had been an international focus for decades (Wennberg and Gittelsohn 1973;Health Services Research Group 1992;Rohrer 1993;). Although these were variations by type of illness and between countries, an almost equal SAV for the same disease had been demonstrated in such different countries as Norway, England and the USA (McPherson 1982).

John Wennberg and his colleagues at Dartmouth Medical School, Vermont, USA had documented variations in hospital utilization and spending for decades, which in some cases had contributed to a greater harmonization of practices or even led to system changes (Wennberg et al. 1977). The observed SAV might be random or systematic. As summarized by Folland, the systematic SAVs are probably influenced by complex and often interrelated variables such as those listed below (Folland 1990):

1. Specialist health-care practice and supply, and geographical factors
2. Primary health-care practices
3. Population characteristics
4. Morbidity
5. Socioeconomic factors.

In other words, did the variation stem from supply or need differences – or both? The supply variables in 1 and 2 in the list might be studied either at an individual level or as aggregated data. The data for need variables (3.–5. in the list above) were available for us at individual patient level, practitioners' level or different aggregated levels inside the health-care system. The five items are described in more detail below.

1.1 Specialist health-care practice and supply, and geographical factors

Five decades ago Roemer's law stated that 'a built bed is a filled bed', indicating the tendency for higher availability of beds to lower the threshold for use (Shain and Roemer 1959). Generally speaking, if utilization of health services were linked to high capacity, this could lead to inappropriate health care for some patients. If, on the other hand, high utilization were due to higher morbidity in the population, the high capacity could be seen as an adaptation to need.

Wennberg and his colleagues argued early on that geographical variation in health-care utilization and spending mainly derived from different health-care service capacity and medical practice rather than from population need factors. On their way they defined three categories of health care as an analytic framework: effective care, preference-sensitive care and supply-sensitive care (Fisher 2000;Wennberg 2002;Fisher 2003). The largest variation in spending and utilization was found for discretionary conditions. This was conditions where evidence base was weak with little consensus on the preferred response. As capacity was often operationalized through measures such as bed supply, which according to Roemer's law also relates to utilization, a strong correlation could be expected.

Findings from the Veterans Administration (VA) hospital system, an American public hospital system, indicated, in line with the findings of Wennberg, that geographical variation between areas was largest for supply-sensitive care of 'discretionary' conditions (Ashton et al. 1999). In these discretionary cases it was argued that local practice style had a big influence on treatment, diagnostics and follow-up. However, it was unclear whether physicians or local hospitals practice differed more in these cases than overall. A Canadian study found that the proportion of hospitalized cases with discretionary conditions was higher for physicians who were most likely to refer. However, the difference between the physicians most likely and those least likely to admit patients to hospital was smaller with regard to discretionary conditions than it was for conditions overall. This could indicate that the decision whether to admit a patient was a complex process in which physician practice style was just one of several dimensions (Roos 1992). Other authors also questioned the basis for the idea that a high rate of 'discretionary hospitalizations' was the reason for their overall high admission rate (Green 1994;Restuccia et al. 1996;Porell 1999).

An American (Goodman 1997) and a Canadian study (Veugelers 2003) showed that the short distance to urban centres with hospitals was linked to higher utilization of hospital services. A Norwegian report, from 2002, estimated an availability index for specialized health care services based on geography and capacity measure (travel time/distance and number of beds per 10,000 inhabitants in the municipalities). They found the lowest availability index in northern Norway, especially in Finnmark (Kopperud 2002). Furthermore, greater utilization was demonstrated in municipalities with private specialists and hospitals (Fylkesnes 1993a;Iversen and Kopperud 2005;Nerland and Hagen 2008), whereas large municipalities (>5000 inhabitants) with proximity to local hospitals or private specialists had higher use of outpatient health services in northern Norway (Hansen 2005). In the Norwegian studies, urbanized municipalities had the highest rates of multiple admissions, and increased travel time was associated with falling utilization (Nerland & Hagen 2008).

1.2 Organization and practice of municipality primary health

Important aspects of the international literature and organizational features of Norwegian health care and municipality PHC were described in the first two papers. Below I discuss some issues about the municipality PHC and its association with SHC.

A Danish study utilizing registry data without risk adjustment found no association between Danish municipalities' utilization rates of hospital stays and GP consultations, although there was a significant variation between the municipalities for both services (Thomsen and Barner-Rasmussen 1992). Inside countries with 'gate keeping', wide variations in referral rates were shown and different studies demonstrate the influence of patient, doctor and practice characteristics; in addition a large proportion of the variation remained unexplained (Wilkin and Smith 1987;Franks et al. 2000;Roos 1992;). In Norway, the gate-keeping GPs, in principle, were the main referrers to specialist services and should ideally ensure the quality of outpatient referrals and hospital admissions. However, gate keeping might conflict with GPs' role as an advocate for their patients (Carlsen 2006a). Most inhabitants met a GP annually, because 76% of the population had at least one GP consultation in 2006 (Norwegian Labour and Welfare Administration 2007). How the patient list system reform in 2001 influenced hospital utilization rates during the following years was unclear, because the public Norwegian hospital sector was restructured through a major reform a half years later. Whether or not the variation in referrals from GPs represents a quality problem is unclear. It could be expected that different knowledge, working style, experience and personality across doctors could result in different referral rates for multifaceted problems in general practice, for which there is seldom *one best* solution (Davis et al. 2002;Mabeck and Kragstrup 1993;Wilkin & Smith 1987).

Before the GP-reform about 80 % of the patients reported that they had regular contact with the same GP over time (Hasvold and Johnsen 1996). A Norwegian study of effects of continuity showed that knowing the patient increased the chance of referring the patient (Hjortdahl and Borchgrevink 1991).

Most GPs were (and still are) self-employed with a mixed income from capitation (30%) and fee for service (Norwegian Research Council 2006). The introduction of capitation as a financial component when the patient list system was introduced lowered the fee-for-service payment, and was, as a theoretical model, expected to lower the threshold for referrals (Iversen and Luras 2000).

In Norway, the municipality LTC inpatient emergency capacity has been minimal, with exceptions for the municipalities with cottage hospital beds in Finnmark County (Aaraas 1998). Hence, although the gate-keeping GPs have free access to specialist health care, they have traditionally had few opportunities to refer to an emergency bed, or even a regular bed, in the LTC service.

Although some literature focused on the association between GPs and hospital utilization, there was less research on the association between the utilisation of LTC and the utilization of specialist health care. Unclear boundaries between the different levels of LTC, and lack of activity data from different levels of services, could explain some of this lack. A review of home and community services demonstrated a mixed effect on hospital use (Weissert et al. 1988).

The activity of Norwegian municipality PHC including LTC might relate to the municipality's economy, which is influenced by tax income, government remittances and income from local enterprises. Whether these economic issues influence the daily practice or give rise to different services for people in municipalities that were better off than those with a tighter economic situation was unclear and not an issue in these papers.

1.3 Composition of the population

Age is a marker for several biological, social and environmental factors influencing health (Bhopal 2008a). Health-care use varies with age and sex (Schulz 2005;Australian Institute of Health and Welfare 2008;Broemeling, 2008). Older people, especially during the last phase of life, are major users of hospital services (Lagoe et al. 1999;Wanless 2006), and take up a significant part of the total health-care expenditures (Anderson and Hussey 2000). Although women are heavy users in their fertile period, men seem to make more use of SHC than women, who seem to make more use of PHC (Juel and Christensen 2007).

In Norway, age has been the main criterion for the funding of specialist health services since the hospital reform, although this proportion has been reduced (Norwegian Ministry of Health 2003;Norwegian Ministry of Health and care services 2008). How variations in specialist utilization between municipalities have been influenced by different population ages and sex structures, and how age and sex eventually interacted with other explanatory variables affecting utilization, were unclear. An American study showed an interaction of age with socioeconomic status (Hofer et al. 1998).

Demographic forecasts indicated higher life expectancy and a higher proportion of elderly people in the coming decades, but whether this would result in higher health-care utilization was-and still is- unclear. The so-called 'school of red herring' argued for a 'compression of morbidity', expecting most life-years to be added free of morbidity and an almost negligible effect of increased life expectancy on future health-care expenditure (Dormont et al. 2006). Opposite to this, the 'extension of the morbidity' view proposed that increased life expectancy would lead to more years with illness and disability (Olshansky et al. 1991). Between these counter-hypotheses, the 'relative compression of morbidity' view promoted a relative growth in both the years without illness and the years with illness, where the distribution of illness years depended on type of morbidity (Bronnum-Hansen et al. 2006;Manton 1991).

Whether or not preventive medicine focusing on lifestyle risk factors such as smoking, inactivity, being overweight and diabetes would succeed, and affect both fatal and non-fatal diseases and health-care use of elderly people, was unclear (Hubert et al. 2002;Olshansky et al. 2005).

1.4 Morbidity

How differences in morbidity and self-perceived health influence utilization of health care was controversial (see section 1.1). Although some authors argued that only a minor part of the SAVs could be explained by different needs (Wennberg 2002), others argued that large morbidity differences across geographical areas were the main explanation for SAVs (Shwartz 2005). Furthermore, regions or hospitals with a more advanced diagnostic armamentarium or more specialists may identify more disease compared with other areas with similar population morbidities. Different access to primary care, especially for chronically ill individuals, might also bias the prevalence estimates, which are often derived from SHC registries.

It is challenging to obtain good measures of morbidity, and several indices have been developed to estimate the total individual or population disease burden, including comorbidity (Charlson 1987; Starfield 1991;Elixhauser 1998;).

In many epidemiological studies mortality has been used as a proxy for morbidity, and was judged to be a better indicator than socioeconomic status as a need measure (Mays 1987). In Norway, there are historical mortality data for the total population, whereas other morbidity measures are more fragmented. Self-rated health correlated with a whole range of more objective measures of health, such as mortality. One Norwegian panel study (*n* = 3449; mean age 46 years) demonstrated that poor or very poor health led to higher public SHC use, but not to higher private SHC use (Iversen and Kopperud 2002), in line with a Nordic study on SHC use in Norway and Finland (Suominen-Taipale et al. 2004).

A report from 2001 claimed that various disease burdens over many years in different parts of the country have led to different regional division of the health service, and hence different utilization (Huseby 1991). But, to attribute causation based on such a correlation is difficult and it could be argued that the opposite is just as likely, or that there is no association. Thus, it was not clear in the literature to what extent morbidity contributed directly to the different health-care utilization.

1.5 Socioeconomic factors

It was widely recognized that morbidity was associated with socioeconomic status (SES), and relative social inequalities in health have been reported higher in Norway than several other European countries, despite a Scandinavian welfare model (Krokstad et al. 2002;Mackenbach 1997). However, a comparative study from eight European countries, including Denmark and Finland, demonstrated different associations between education level and morbidity for several common chronic disorders (Dalstra et al. 2005). How socioeconomic factors such as education, unemployment, income distribution and poverty ratio, influenced utilization of health-care services, given the same morbidity level, was unclear. Two US studies reported that aggregated SES did not explain the variations in hospital utilization in the USA (Fisher 2000;Wennberg 1977), while several other studies from the USA and Canada were inconclusive (Gittelsohn and Powe 1995;McMahon 1993;Veugelers 2003).

Education has often been used as a marker of socioeconomic status, and has been believed to have direct and indirect effects on individual health (Mæland et al. 2009). Education gives varying opportunities to select work and thus the level of income potential. It has been assumed that education makes it easier to understand information about health issues and hence improves health-related lifestyle habits (Elstad 2008).

Adjustment for socioeconomic status by education has several advantages: First; public statistics include most people, also elderly and unemployed. Second; education can be seen as less influenced of health conditions in later life preventing reverse causal explanation (that poor health might lead to low education), although it might be influenced by poor health in adolescence and young adulthood, which in turn may be related to poor health in later years. Third; it is easy to categorize education into relatively few groups with clear boundaries between them. Fourth; education changes little over time for the population over 25 years-30 years who mostly have finished their education {Huisman, 2005 326 /id}. The latter might also be a disadvantage as it might not precisely capture the socioeconomic position among elderly individuals.

Approximately 84 000 Norwegians were job-seekers in 2006, and 30% of these were long-term unemployed (job seeker over 26 weeks) (Statistics Norway 2006). Unemployment has been regarded as a health risk and job- seekers probably have increased morbidity. A Canadian study showed that long-term unemployed had higher consumption of hospital services than the general population, even when they had no history of mental illness prior to unemployment (Kraut et al. 2000)

Income has been widely used as indicator of social class by influencing varying degrees of self-esteem and self-realization, opportunity to improve living conditions through food, place of residence and participation in activities. (Mæland, Elstad, Næss, Westin, & et al 2009). Income level might be influenced by poor health (reverse causal explanation). The European Union has defined a cut-off level for "risk of poverty" as below 60% of the median national income (Atkinson 2004). In Norway nearly 10 % of the working population had a disposable household income below 60% of the median national income in 2007 (Enes 2010). The municipality level of income below this threshold could be regarded as a measure of municipality level of deprivation.

The international literature has shown conflicting results with regard to whether the aggregated socioeconomic data for a given geographical area were representative of people who used hospital services from that area. One American and one Spanish study documented that the area-based socioeconomic indicators corresponded well with the individually based indicators, and therefore were well suited for use in measurement of social inequality {Hofer, 1998 142 /id;Dominiquez-Berjon, 2004 319 /id}. However, three studies from the USA, Canada and Australia showed a more uncertain context, requesting moderation in the interpretation of the findings if aggregate figures were used (Demissie et al. 2000;Soobader et al. 2001;Walker and Becker 2005).

Higher physician utilization among the most affluent layer of the population has been shown in 21 OECD countries and one Australian study, in line with Hart's 'inverse care law', which states that 'the availability of good medical care tends to vary inversely with the need for it in the population served' (Hart 1971;Van Doorslaer et al. 2006;Walker et al. 2006). Although unskilled and lower blue collar workers had higher hospitalization rates decades ago (Nord 1988), access to public outpatient health services was later found to be reasonably evenly distributed, and independent of SES (Iversen and Kopperud 2005). Others demonstrated that fewer patients from lower socioeconomic classes were referred to SHC, indicating a social gradient in the referral process (Fylkesnes 1993).

One Canadian multilevel study found a higher referral rate to SHC for affluent individuals (Chan 2003). In one British study, patient sociodemographic factors explained up to 45% of the total variation in hospital emergency admissions, whereas general practice organizational characteristics explained only a tiny part (Reid et al. 1999). In another British study there was only a 1.2-fold variation between GP practices' admission rates after adjustment indicating that patients' SES was most important (Duffy et al. 2002).

2 Aims of the study

In this study we have focused the association between municipality PHC utilisation and SHC utilization. We considered adjusting for variables known to affect both types of health-care use, many of which were described in the introduction. Influenced by the demographic forecasts stating a substantial growth of the elderly in the coming decades, we were especially interested in the health care utilization of the elderly. Furthermore, we assumed that different elements of Norwegian PHC related differently to various elements of the SHC, depending on their respective roles in the overall provision of health care for the elderly.

The 'Coordination reform' (CR), presented in 2009, was a national political headline. To improve the sustainability of health care budgets and ease the pressure on the hospitals, it proposed increased PHC volume, improved cooperation and strengthening of chronic care (Norwegian Ministry of Health and Care services 2009). Although the assumptions and evidence underpinning the proposed actions were controversial, it contributed to our project becoming even more policy relevant, also our choice to focus the elderly.

In the three papers we studied the relationship between primary health-care and specialized health-care utilization among elderly people in Norway using three different observational approaches, with assessment of relevant interactions and adjustment of relevant confounders:

1. How long-term care use was associated with hospital use

2. The associations between general practice and outpatient clinic consultation rates

3. The association between two municipality constructs, LTC and GP utilization, and an individual's likelihood of being hospitalized as an unplanned medical admission.

3 Material and methods

3.1 Material

Data from the national data sources – Norwegian Patient Register (NPR) and Statistics Norway (SSB) – for all elderly Norwegians (aged ≥67 years in paper 1; ≥65 in papers 2 and 3). Data were grouped according to sex, individual age (paper 3), 5-year age groups, municipality of residence or municipality of GP practice. In all papers Norwegian municipalities made up the smallest geographical unit for several reasons:

1. The municipality represented the formally, organizationally, socioeconomically, democratically and culturally linked smallest entity (although the population in the municipalities can obviously be divided into smaller units with special features)
2. The local authorities were well-defined population units that were well characterized in official statistics and self-organized the municipal primary care
3. PHC was a municipality responsibility in which differences at the local level provided important information to decision-makers.

In the final analyses municipalities were grouped by criteria such as travel time, population size and hospital status, partly to reduce the effect of small numbers and partly to achieve a manageable number of groups in analyses.

3.1.1 Variables common to papers 1–3

Most geographical, demographic and socioeconomic variables were common to all three papers, but some aspects about them have to be mentioned.

Hospital status; a municipality's hospital status was determined by whether it hosted the service of interest as defined by the outcome in the analysis in the single papers (see below).

Travel time to hospital; was measured from the town hall of each municipality to the nearest hospital, with the service defined by the outcome variable. The geographical position coordinates for these localities were collected from cartographic databases manually, and thereafter Statistics Norway merged the information with detailed road data. Hence, travel by air was not included in 'travel time'. In paper 1 we used information about the structure of the hospitals in 2004, which was in the middle of the analytical period. We included hospitals that have at least surgical, medical and radiographic departments, corresponding to the possibility of inpatient stays, and hence hospital days (HDs), and the HD rate.

For paper 2 we used information on hospitals with at least medical and surgical outpatient services for the year 2008. We were aware that the health authority of south-east Norway had also restructured the geographical area of a few of their hospitals by July 2009, which had a minor impact on a few municipalities. We found it likely that these changes would have influenced the PHC referral practice gradually over the second half of 2009. However, we judged the influence on the analyses to be small and therefore did not change the travel time for these municipalities.

In paper 3 we defined the hospital municipalities with regard to the hospitals responsible for acute admissions to a medical department for each municipality in 2008. Based on local hospitals' statistics for unplanned medical admissions, we defined which hospital municipalities situated halfway between two hospitals 'belonged' in this context.

Municipal population size; this was collected from the population database of Statistics Norway (Statistics Norway 2013b). For paper 1 this was the average population size by the end of each of the 5 years 2002–6. For papers 2 and 3 this was the population size at the end of 2009.

Municipality education level; when examining the educational data we obtained from Statistics Norway in the first phase of the project we found several interactions between educational level, age and place of residence when using three or four educational categories. According to official statistics 47.3 % aged 67 years and older in 2005 had Primary School (7-year) as highest education and approximately 12 % had college or university education, mostly men (Jorgensen 2006). It has been shown that the largest mortality difference between four educational level in younger age groups was between the lowest and second lowest level of four education groups (Rognerud and Zahl 2006) . The most relevant contrast of educational level in this age span was thus considered to be between those with only primary school and those with higher educational level. In papers 1 & 2 education was available for each analytic unit (municipal 5-year age and sex groups). In Article 3, we treated education as a municipal characteristic; the mean proportion with only primary school in the municipal population aged 25 years or more, because the individual education level was unavailable.

3.1.2 Population weighting and creation of percentiles

We made an a priori assumption, based on earlier information, that both individual and system factors would influence the association between the main exposure and outcome variables. In papers 1 and 2 we constructed a pseudo-individual level by 5-year age and sex groups. A crude analysis, unweighted by the population in each row, would give all municipalities the same influence on the results. By weighting the analyses by population in each row every person counted equally in the analysis result, and rows representing few people counted less than rows representing many people. In papers 1 and 2 the main explanatory variables had a non-linear relationship with the outcome, hence they were ranked in percentiles and included in a factor analysis. The percentiles were created by weighting the population in each row, to ensure that the population was equal in each *n*-tile and that each person had the same weight in the analyses.

3.1.3 **Correlation**

Adjustment variables with too high correlation will cause the model to become too unstable. Thus, for variables which were highly correlated, we must either choose one of the two, or try to make new combined variables. When evaluating the correlations between the different explanatory variables in papers 1 and 2, we defined high correlation as Pearson's correlation coefficient (PCC) ≥0.7. If a high correlation between the variables was revealed, the variables were merged into one combination variable to prevent instability in the model. The variables 'municipality population size' and 'hospital municipality' were highly correlated. In paper 1 PCC was 0.7 and we constructed the following combination variables:

		Municipality	
		Non-hospital	Hospital
		Population (%) (no. of municipalities)	Population (%) (no. of municipalities)
Municipality population size group	0	3.5 (95)	0
	2000	12.1 (141)	0 (1)*
	5000	13 (81)	2 (9)
	10,000	12 (44)	4 (12)
	20,000	11.1 (19)	10 (15)
	50,000	3 (3)	29 (10)

* Lærdal was defined as a hospital municipality and belonged to the yellow group in the analyses.

By combining population size and hospital in the municipality, we constructed three different categories: (1) small municipalities without a hospital (green; n = 317), (2) medium-to-large municipalities without a hospital (blue; n = 66); and (3) hospital municipalities (yellow; n = 47, including Lærdal). Travel time did not correlate with the variables population size and hospital in the municipality (0.43/0.47).

In paper 2 the PCC was 0.7 between the 'municipality population size' and 'hospital municipality' variables and were merged into a combined variable as in paper 1. When we tested the correlation between the combined variable and travel time, the correlation was 0, 66 (weighted for population), which allowed us to include both variables in the analyses. However, since the correlation is high, it is fair to note that we were not interested in these variables as independent predictors, only as adjustment variables for the main association. The high correlation between two adjustment variables did not influence our final judgement of the main association. In this paper we constructed five different categories of the combined variable; see paper 2 for categorization details.

In paper 3 using multilevel methodology we chose 'travel time' as the primary explanatory variable; thereafter we included 'hospital municipality' and 'population size'. The PCC was 0.5 between 'travel time' and 'hospital municipality', indicating moderate correlation. We tested and found a low correlation (<0.3) between GP- and LTC-rate.

3.2 Confounding

In epidemiological terms a confounder is a covariate/explanatory variable that can be associated with both the outcome and the main explanatory variable (Bhopal 2008b). The word originates from Latin, meaning 'mix together', and is seen as a factor that can confuse the result. The confounder might partially or fully influence the relationship.

We examined several variables known to influence health and hence health-care utilization during the analyses. A common strategy to examine for confounding is to compare the estimate of the crude association with the association adjusted for the variable being focused on. If the difference between the unadjusted and adjusted analyses was higher than a preanalytic defined limit, the variable was included in the further analyses as a confounder. In papers 1 and 2, a confounder was defined when the change in the predicted least square means of the model with and without the confounding factor was >10% in two points (quartiles).

In paper 3, models were fitted in a sequential manner whereby potential confounders were initially adjusted for, before adding the exposures of interest, and their association with our outcome was tested both with and without adjustment for the confounders. Finally we examined cross-level interaction terms between age and the two primary predictors.

3.3 Paper 1

3.3.1 Study population

All Norwegians (59% women) aged >66 years (n = 605,676) (13.2% of total population) in 2002–6.

3.3.2 Outcome variable: Rate of hospital days

In paper 1 we expected that LTC mainly addressed needs arising from functional limitations due to ill health. Such help could be provided at both hospital and municipal levels. If LTC services were unavailable due to capacity issues, one would expect the same services to be delivered at a hospital level and prolong a hospital stay. If LTC service capacity was better, a LTC substitution for hospital would be possible, but could also induce in- and outpatient hospital utilization by identifying health needs at an early stage. LTC might substitute for hospital stays or at least HDs, especially for patients who have received the recommended in-hospital treatment. Both the number of stays and the HDs might be appropriate measures for the relationship of interest. As the municipality mean of HDs is a product of the number of days in one stay and the total stays, and one of the most costly measures of hospital utilization, we chose this as an outcome measure. The mean national distribution of rate of hospital days for the years 2002-2006 is depicted in figure 3.2.2 below.

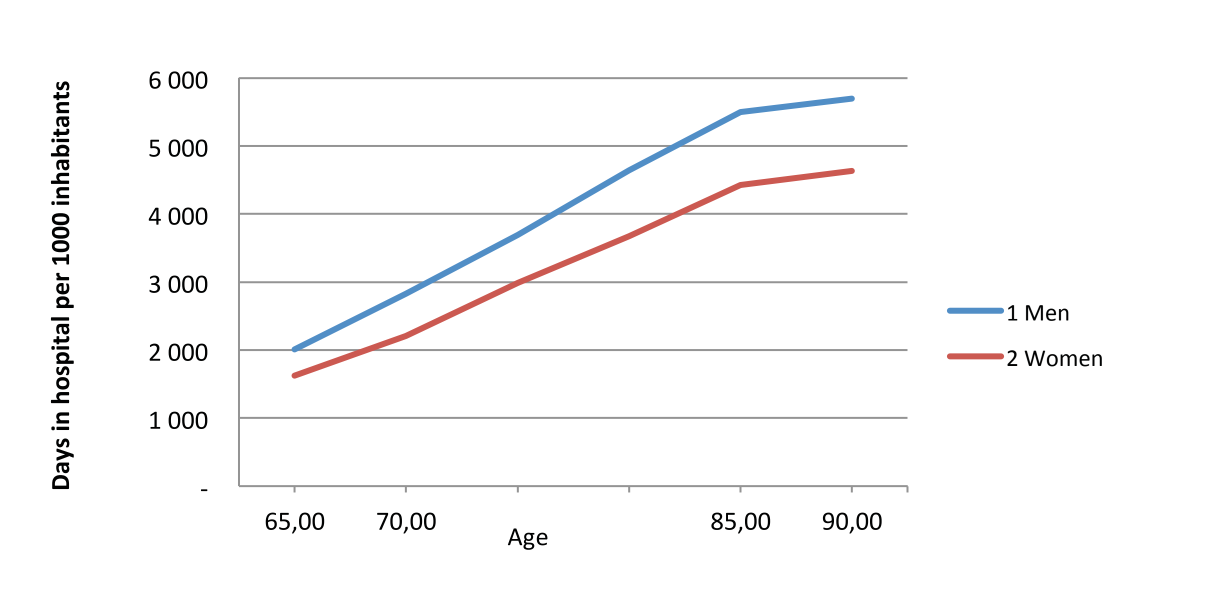

Figure 3.2.2: Rate of hospital days by age and sex, Norwegian population (mean 2002-2006)

3.3.3 Definition of the main explanatory variable, long-term care

We argued that the total LTC volume, comprising both community care and institutional care as a 'package', was the best way to address LTC use, and is described in detail in the paper. We considered that institutional and community care were overlapping. The number of users was counted on a specific day every year, which could give raise to deviations from the average use throughout the year, which would be our ideal measure. However, we assumed that a 5-year mean would reduce such errors due to random variation.

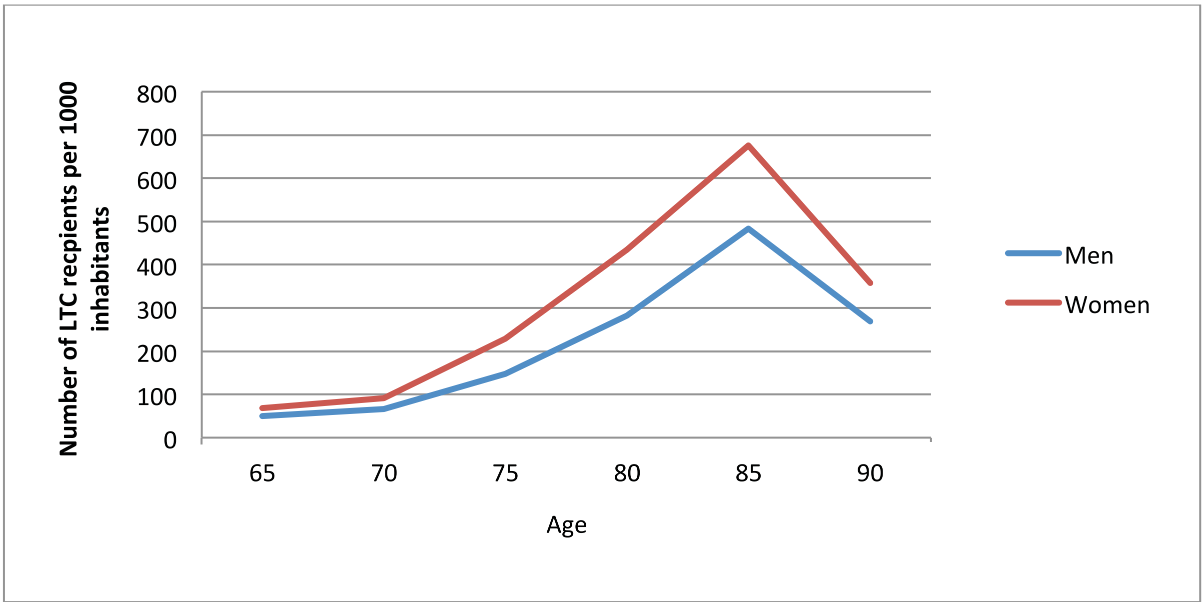

Figure 3.2.3: Rate of users of long term care, Norwegian population (mean 2002-2006).

Hence, the main explanatory variable, LTC rate, consisted of the number of recipients of municipal LTC (both at home and in institutions) per 1000 inhabitants in each unit of analysis. It included the total number of recipients of LTC counted on a specific day each year in the age groups 67–74, 75–79, 80–84, 85–89 and 90–105 years (source 2).

3.3.4 **Statistical methods**

The statistical methods were described in detail in the method section of the paper.

3.4 Paper 2

3.4.1 **Study population**

All Norwegians aged ≥65 years (n = 721,915; 56% women – 15% of the total population) in 2009.

3.4.2 **Outcome variable**

The primary care–specialist interface is a key organizational feature of many health-care systems. Patients are referred to specialist health care when investigation or therapeutic options in primary care are exhausted and more specialized investigations, diagnostic procedures or treatment is needed. The referrals to an OPC have considerable implications for patients, the health-care system and health-care costs. Hence, our outcome variable of interest was the total specialised care OPC consultations per 1000 inhabitants (OPC rate). About 2% of the total dataset from the NPR regarding OPC consultations among private specialists missed data about patients' sex. By using the same national sex distribution as in the rest of the data, we imputed the sex of the missing values.

3.4.3 **Main explanatory variable**

In a 'gate-keeping' system, the GPs' referrals to the outpatient clinics have a large impact on the entire hospital system. GPs refer to both out- and inpatient services, but to a much larger degree to out-patient services. The specialist out-patient examination may in turn result in a secondary hospital admission. Thus the gate-keeper role of GPs has mainly been exercised through the means of the out-patient referrals. Hence, in paper 2 we wanted to study the association between GP consultations and OPC consultations.

Our main predictor of interest was the complete general practitioner consultation activity inside municipality PHC. As this included both regular and emergency services, and also home visits, the total number of municipality GP consultations per 1000 inhabitants (GP rate) included all GP consultations.

3.4.4 **Statistical methods**

The statistical methods used were described in detail in the method section of the paper.

3.5 Paper 3

3.5.1 **Study population**

All individuals aged ≥65 years in Norway (n = 722,464) in 2009.

3.5.2 **Definition of the outcome variable**

The Coordination reform focused a reduction of emergency hospitalizations, especially for medical conditions through a strengthening of PHC. Both the utilisation of the GP-services and volume of the LTC-services might prevent emergency admissions, and this is argued for in paper 3.

We decided to investigate the relationship between the emergency admissions and the volume of LTC, GP utilisation and total PHC volume. At the time that we initiated this part of the study, we had access to patient data at the individual level, which allowed us to utilize a multilevel framework.

The outcome variable, unplanned medical admission (UMA), was defined by a) the definition of "unplanned" by NPR, which was defined opposite to "planned", and b) medical by the opposite of surgical- hence her "non- surgical" = medical. We created UMAs at an individual level by linking the UMAs provided by the NPR, with census information for the entire Norwegian population aged ≥65 years (722,464 individuals). By implementing this procedure, our dataset consisted of 120,846 individuals which were hospitalized at least once in 2009, and for whom we had information about sex, age group and municipality of residence.

3.5.3 **Main explanatory variables**

When initiating the work we acknowledged that the GP-, LTC- and SHC utilization were all linked to one-another and that GP and LTC-service could be seen as one unit of first line entity. Hence, both the GP and the LTC capacity were important for emergency hospitalizations through different mechanisms. The total number of GP consultations/1000 inhabitants per year, including both daytime and out-of-hours service (GP rate), and the number of recipients of municipality LTC (both at home and in institutions) per 1000 inhabitants (LTC rate) were counted on a specific day each year. The PHC variables were introduced into the model separately and as an entity.

3.5.4 **Other variables**

At the municipality level (level 2) (n = 428) we utilised travel time in three categories and municipality hospital status (whether the municipality hosts a hospital). Furthermore mortality and municipality rate of disability pension were both utilized as proxies for morbidity. Educational level (percentage with only primary school as education among residents aged ≥25 years), municipality level of unemployment and low income were utilised as proxies for municipality deprivation.

3.5.5 **Statistical methods**

The analyses in the cross-sectional study of paper 3 were done within a multilevel statistical framework.

Whether the variations in health-care utilization rates found in other aggregate studies were due to differences between individuals (case-mix) or the individuals' environment (system level) was unclear because the analyses do not separate variation between individual and system levels.

The multilevel model that we utilized made it possible to investigate the distribution of variation across the individual and system levels. It required data at the individual level. We created an outcome at the individual level, utilizing variables measured at individual, local and hospital levels. Individual level variables can explain variance at all levels, whereas variables at the system level (contextual variables) explain only the variance at its own level and that above. In general, this means that the variation is distributed between the levels in the analyses.

The PHC variables were introduced into the model separately and as an entity.

4 Main results and conclusions

We conducted three studies with different approaches to see how the utilisation of PHC was associated with utilization of SHC.

4.1 Paper 1

For all men and women aged <80 years we found an overall, weakly positive, statistically significant, but still not clinically important, relationship between rates of LTC and HDs. For women aged ≥80 years the weakly negative association was neither statistically significant nor clinically important. Travel time to hospital was a stronger confounder than mortality in the final analyses.

4.2 Paper 2

Among elderly people aged ≥65 years we found a moderately positive association between GP consultation rates and rates of OPC use in Norway in 2009. There was an effect modification by age, mortality, and a composite of hospital status and municipality population size on the association between the GP-rate and the OPC-rate. When we adjusted for the two confounding variables – sex and travel time to hospital – the positive association remained except in the oldest age group with the highest mortality in medium-to-large municipalities. Socioeconomic variables did not influence the association and were not included in the final analysis.

4.3 Paper 3

In a mixed-model analysis we found no general association between the individual likelihood for a UMA and the municipality GP or LTC utilization rates. However, when including an interaction term between age and LTC rate, LTC seemed to be associated with fewer UMAs (non-surgical) among people aged ≥80 years. We found a modest geographical variability in UMAs at both the municipality level and the local hospital area level.

5 General discussion – methodology

To discuss the ability to generalize the results we need to discuss different aspects with regard to internal and external validity.

5.1 Internal validity

Internal validity concerns confounding and different types of bias. Bias could be conceptualized as an 'error that applies unequally to comparison groups' (Bhopal 2008). Hence, different types of bias must always be considered when study results have been validated for the population focused on.

5.1.1 Selection bias and study design

Selection bias is the term for errors or skewedness in the choice of population, and hence is essential for interpretation of the study results. All three studies in this thesis analysed associations between different aspects of the utilization of SHC and municipality PHC for the entire Norwegian population aged ≥65 years. In this aspect our studies were highly representative of our elderly population in Norway in the given time period. All studies were population-based observational studies. Although study 1 was for a 5-year period and could be seen as a population case-series study, papers 2 and 3 cover 1-year data and have a cross-sectional design.

5.1.2 Information bias

Choice of outcome and explanatory variables

The data on GP consultations related to the consultations at the GP practice site municipality, which was not necessarily the same as the patients' residence municipality. In general, we would expect some people to have their GP in the municipality in which they were employed or were students, and this might differ from their registered home municipality. We assumed that this bias was less important among patients aged ≥65, which we expected to have their GP in their home municipality because most of them no longer worked, and very few were students. However, some patients could conceivably keep their GP in their previous work community. With regard to acute admissions to OPC or inpatient activity (paper 3), we believed that most patients would be referred by a GP in their home municipality. Accidents and acute cases while travelling or on holiday could happen randomly and therefore not give rise to any systematic misclassification.

Bias of population migration

According to Statistics Norway 1% of elderly people aged ≥ 70 years migrated between two municipalities in 2004, and the tendency was similar in more recent statistics (Forgaard 2005;Statistics Norway 2013a). As the relocations happen all year long while the number of inhabitants was counted only once a year, this could lead to slight over- or under- estimations of the municipalities' population size. As 1 % of the population aged > 70 years represent slightly more than 2000 inhabitants out of more than 700 000 persons in the material (0,3 %), this will have a small influence on the rates in the analyses. Further we have no reason to believe that the over- and under estimations of population size was systematically related to neither the main explanatory nor the outcome variables in the three studies. Since explanatory and outcome variables use the same population denominator, any misclassification would not distort the relationship between the two within municipalities. Thus this source of misclassification was judged to be non-systematic and its influence of minor importance.

Quality of registry data (Hospital Episode Statistics data)

The outcome data in all papers were delivered from the NPR, which receives national data on all hospital activity, delivered primarily for financial reimbursement purposes. Hence, their accuracy for research use can be discussed. Probably, this indicates that the activity data should be almost complete. However, it can also lead to strategic coding, where the hospitals of varying degrees maximise the activity, i.e. the number of hospital days in paper 1. For paper 1 we used 5-year data from NPR, and in addition calculated a 5-year mean of hospital activity by which we reduced the effect of any outliers. The NPR have documented how they control the activity data by checking the completeness of coding in most variables (Norwegian Ministry of Health and Care services 2007).

The data for the private outpatient consultations in paper 2 were produced by the NPR and included 91.8% of the specialists' consultations. The private specialists had roughly 30% of the total OPC consultations. If we assume that private specialists who did not deliver data have had the same number of consultations compared with private specialists who did deliver data, the missing data represent about 3% of the total OPC-consultations. Again, we have no reason to believe that such a misclassification was systematic related to GP-utilization rates. This indicated a slight influence on the total data.

The data about LTC for the years 2002–6 (paper 1) was provided by Statistics Norway. These data were primarily collected by the municipality administration for local administrative reasons, not research. No data on individual LTC-users was available. These data were checked for consistency with the previous years' data for the same municipality. We do not know of any documentation that streamlines registration procedures between municipalities. In 2007, the old data-collection routines on LTC-use were changed by law to individual LTC-user level registration by LTC-personnel. The data for 2007 and 2008 therefore had several quality issues (personal communication Statistics Norway). In 2009 these problems were overcome, so the LTC-data for 2009 (paper 3) were assumed to be of sufficiently quality for research.

5.1.3 **Confounding**

The formal requirements for inclusion as confounders in the analyses were met by several variables. In paper 1 we discussed in detail the fact that we utilized mortality as a proxy for morbidity. Other studies related to SHC utilization vary with regard to adjustment for morbidity. Studies with aggregated data have indirectly adjusted for morbidity, e.g. a US study adjusted for morbidity by using mortality as a proxy (Kravet et al. 2008) and a British study (Gulliford 2002) adjusted for the proportion of the population with the variable 'limiting long-term illness'. Studies with available individual data adjusted for morbidity by utilizing individual administrative data in respect of diagnostic codes (Forrest and Starfield 1996;Mark et al. 1996). There will probably be residual confounding by morbidity, because none of our proxy variables for morbidity (mortality, age and sex) covers morbidity completely. These issues are discussed in paper 1 and 2. The ideal study should have compared groups of patients with the same morbidity experience, who had high and low LTC and GP utilization rates respectively. The impact of better morbidity data on the analysed relationship between care levels is an important research question for further research. Furthermore, in most countries, as well as in Norway, differences in health status are shown at the municipality or county level.

Another confounder was travel time to hospital. We grouped the variable differently in papers 1 and 2 versus paper 3. In paper 1 we found a crude negative association between LTC and HD rates. Including travel time as a confounder turned the association into a moderately positive one, illustrating that low HD rates and high LTC rates in rural districts distorted the crude results. In paper 2 travel time was also a confounder, but did not change the crude, significantly positive association in three strata. However, the non-significant association for the oldest patients with highest mortality, who were close to a hospital, turned into a non-significant negative association when adjusting for travel time. In paper 3, the odds of UMAs decreased by increasing travel time to hospital. Education was a significant confounder in paper 1, but not in the other papers.

5.1.4 Effect modification

Our criteria for defining a variable as an effect modifier might seem strict. Using a less strict definition we would be able to identify a high number of interacting variables, and possibly understand differences in the population better. However, a less strict definition of the criteria would indicate an increased risk of identifying random variation as an interaction. We believed that, if interactions were not evident in visual representations, they were not convincing interactions, but more likely represented random variations. Furthermore, a softer definition of interactions would require a stratification of the material into more and smaller groups, which again would make interpretation difficult Even though we had a relatively strict definition of the interaction in paper 2, we still had to the stratify into five strata. For instance, the smallest stratum ‘age 85+, medium and large municipalities, highest mortality’ which included only 0.65% of the total study population. The results for this group were possibly an artefact of the small numbers involved in each GP quintile within the group. It illustrated that a softer threshold for effect modification could result in interpretation challenges.

5.1.5 Analytical models

In papers 1 and 2 we studied the relationship between a main exposure variable and a primary endpoint. Therefore, the models were developed carefully around the association between the two variables of interest. All interactions and relevant confounders known to affect health-care use, were reviewed with respect to the main association studied.

5.1.6 External validity

In addition to assessing the validity of the results for the studied population, I will discuss the ability to generalize to other populations. This thesis covers the entire population aged >66 years in paper 1 and >64 years in papers 2 and 3, and is thus not influenced by a random selection process, which is a major strength of our study. This indicates a high ability to generalize to Norwegians in this age group. As discussed above random error may still occur in the form of measurement error. Acceptance of these measurements as valid and sufficiently reliable means that we have presented the best possible estimates for the associations between PHC and SHC utilization, in the elderly population, for the studied time periods.

As part of preparing the dataset for paper 1, we examined whether the ranking of utilization measures in both primary and secondary care changed significantly over time. The annual PHC and specialist utilization measure correlation across years was >0.9 for all possible year-on-year combinations, within the same age, sex and municipality groups. Therefore, although use did increase in the period, the ranking did not change. Thus we concluded that time was not an interactive factor and we did not need to split the material by time period. Paper 1 included a 5-year dataset, and papers 2 and 3 only 1-year datasets. This could decrease their representative nature for longer time periods.

Different countries have their own sociocultural, political, economic and organizational history in which the health-care system has developed (Kringos et al. 2010). Also, as the health systems are open systems, and their interlinked components interact with the local and national context (Atun 2004), one can argue that differences in health-care systems and history might exclude generalization of the findings for other countries. However, we think that the conclusions are probably reliable for elderly populations in other Scandinavian and northern European countries that have health-care system with universal coverage and fair access to GPs, who are gate-keepers to secondary care.

6 General discussion – results

The principal finding was that a higher utilization of PHC was associated with a moderate increased utilization of SHC. However, in paper 3, high LTC seemed to lower the risk for a UMA in the oldest age groups.

In Norway, the National Health Plan has introduced legislation mandating that municipalities create emergency beds in their own or in cooperating neighbouring municipalities before 2016 (Norwegian Ministry of Health and Care services 2011). Although promising alternatives to hospitalizations in the municipalities, or in units in cooperation with the hospitals, have been demonstrated (Garasen et al. 2007;Lappegard and Hjortdahl 2012), a recent report showed that the cottage hospital beds in the municipalities in the county of Finnmark have more of a complementary than a substitution effect on hospital utilization (Heiberg 2012). However, the question of adequate adjustment for differences in morbidity was an issue in this report also.

6.1 Primary Health Care

In papers 1 and 2 we argued for global measures of LTC and GP utilization respectively. This complicates comparison of our findings with other studies in the field, because fewer studies utilize LTC and GP utilization in the same manner.

To define the necessary medical treatment or level of care among elderly people is challenging, because their diffuse symptomatology is dominated more by functional deficit than illness presentation. Both LTC and GP utilisation, the coordination and communication between GPs and LTC nurses or specialists, or all, and finally the supply of hospital services are all factors that might influence hospital use. Regular follow-up in PHC tailored to patients' individual needs might prevent hospital use if unrecognized needs can be handled in primary care, and such handling prevent or postpones need for specialist services. But, if these uncovered needs necessitate hospital services, the effect might be higher hospital use. A Canadian, 1-year, randomized controlled trial did not show an effect of a broad home-based primary care intervention on hospital admissions or emergency room use (Ploeg et al. 2010).

A review of studies on the effect of nursing homes on hospitalizations showed inconsistent results, with various study designs and classifications, and the studies had not included important adjustment variables (Grabowski et al. 2008). This might indicate that good PHC quality measures have been difficult to define.
A recent Norwegian study found, by using quantile regression, that higher numbers of municipality home care and nursing home receivers per 1000 inhabitants aged >80 years moderately reduce length of stay (LOS) for patients with the longest stays, especially for elderly people aged >67, in the four largest cities in Norway (Holmaas et al. 2012). The study was limited to the 16 most frequent diagnoses, utilized individual patient record data and adjusted for case-mix including the number of comorbidities. We found that adjusting for travel time turned a negative crude association into an adjusted positive association in paper 1, and in paper 3 reduced the propensity for a UMA. However, this Norwegian study did not adjust for travel time. The outcome, LOS, was different from the outcomes that we examined in this thesis. They did not report what correlations existed between the explanatory variables nor did they describe if they checked for effect modification. However, the moderately negative relationship found in home care with emergency admissions points in the same direction as our findings in paper 3, where higher LTC-rate among the oldest individuals was associated with a lower propensity for emergency hospitalization. To conclude, the small differences between these studies can stem from different outcomes, aggregation levels and adjustments. The identified association between LTC and lower hospital use could be causal, indicating a possible substitution effect of LTC among the oldest old. But, the association could also to some degree be a marker of age, indicating that among the oldest old the need for acute treatment or hospital treatment can be regarded as less even in the face of serious disease , and/ or proper care for people near the age of dying is LTC. A Finnish study supported the latter (Murphy and Martikainen 2013).
General practitioners are the cornerstone of municipality PHC services. In paper 2 we demonstrated that a high total GP consultation rate in 5-year age and sex groups was related to increased utilisation rate of the outpatient specialist services, whereas the municipality GP utilisation did not seem to influence the individual likelihood for an unplanned medical hospitalization, shown in paper 3.
One British study showed that a higher supply of GPs was associated with a decrease in hospital admission rates for acute and chronic conditions. However, the GP supply was considerably lower than in Norway, with a mean of 1724 patients per GP (range 1408–2325)

(Gulliford 2002), whereas in 2009 the mean number of patients per GP in Norway was 1185 (Gaardsrud 2012), indicating a higher access to GPs compared to Britain. A Norwegian study based on data from a representative telephone survey sample (n = 6465) indicated that increased volume of GPs did not reduce referrals to SHC (Godager et al. 2012) . Although this study included people aged ≥18 years, with overrepresentation of middle-aged women, the findings were in line with our findings in paper 2.
The decision to refer is a result of complex assessments with many interrelated variables. Patient morbidity was reported to be most important in a British multilevel study (Sullivan et al. 2005). A recent Norwegian study demonstrated that doctors' gender and experience influence the decision to refer (Ringberg et al. 2013), which was largely consistent with an American patient study demonstrating that a physician's propensity to refer is highly influenced by his or her training, experience and practice setting (O'Neill and Kuder 2005). However, in a pseudo-multilevel study (Rossdale et al. 2007) the practice level did not influence hospitalization rates, in accordance with the results in paper 3.

Previous research on the linkage between proxy measures of GP-utilization and secondary care utilization did not differentiate between components of Primary Health Care physicians' work (Starfield et al. 2005; Kravet et al. 2008). As our study sought to examine these relationships at a system level in a Norwegian setting, we originally wished to include all GP-consultations into our exposure measure. Hence, our GP data in papers 2 & 3 consist of all GP consultations inside municipality PHC.
Although we had distinct components of GP-work in current datasets, we had no information on the content, time spent and quality of the GP consultations in the different municipalities during daytime and at the Casualty Clinics (CC) respectively. As shown in a sentinel survey from 2007, 66 % of consultations at the CC for the elderly above 70 years were classified as "regular" GP-work, with no acute characteristics, and 5 % was classified as "red response" (Hansen et al. 2009). This indicated that the degree of emergency in CC-consultations was not as different from day-time work as might have been expected. This underpinned our choice of lumping all types of GP-consultations together.
However, there are components of GP work which might have independent impact on OPC-rates. For instance it is possible that the continuity in the patient – GP relationship is better taken care of at daytime than at the Casualty Clinics. A recent Norwegian study indicated that

longitudinality with a GP at daytime (>2 years) was associated with a lower probability for OPC utilization, while high GP consultation rate was associated with a large increase in probability for OPC visit. In paper 2 we did had information on total frequency, but not on longitudinality. We neither did know how many patients at the CC who had consultations with their "list doctor".

As we failed to reproduce the findings of previous studies on GP-capacity and measures of secondary care, it becomes an interesting question whether the separate components of GP-care may have other and independent relationships with OPC-rates. However, this is a research question which has grown out of our current work, and is a fundamentally different question than the one we originally put to ourselves. Hopefully, the data needed to answer these questions will be available.

From the start we wanted to study each part of PHC services separately. When starting with paper 3 we acknowledged that the GP-, LTC- and SHC utilisation were all linked to one-another, and that GP and LTC-service could be seen as one unit of first line entity. In this light both GP-rates and LTC-rates were relevant confounders when examining the link between PHC and secondary care. With hindsight it is possible that we should have included both services for the analyses in the two first papers as well.

6.2 Practice and/or geographical variation

Our results indicated that PHC utilization rates either had no association or were weakly associated with more hospital use. An American study showed that physicians in high-spending areas tended to follow their patients up and recommended other services more often, indicating a local ecology of care (Sirovich et al. 2008). This finding was in line with recent studies on small-area variations from Dartmouth Institute (Fisher et al. 2003b) However, the recent Dartmouth studies were questioned because they divided the USA into 306 heterogeneous hospital referral regions (HRRs) with between 150,000 and 10.5 million inhabitants (Cooper 2010). In a study of the less aggregated hospital service areas (HSAs) (n = 3436), a substantial heterogeneity of utilization of medical services inside the HRRs was revealed among the Medicare population aged ≥65 years (Zhang et al. 2012). The author asked whether the geographical variation was too inconsistent even in the HSAs and suggests studying variations in even smaller areas.

Our work studied smaller geographical areas than these studies. In papers 1 and 2 we used municipal 5-year age and sex groups as the lowest analytical unit. We included a mix of age-and sex-specific variables and municipal-level variables in our analyses. To account for the correlation within the municipalities for age- and sex-specific variables, we also adjusted analyses for municipality as a random effect factor. These analyses did not allow distinction between variation attributable to the age- and sex-specific variables and that attributable to municipal-level variables. In paper 3 we carried out a multilevel analysis, in which the unexplained variation was formally divided between individual and system level factors. In this paper, most of the unexplained variability was found to be at the individual level, whereas some minor variance could be ascribed to variation between municipalities and hospital regions. These findings were consistent with a US study in which most of the geographical variation between counties diminished when individual characteristics, including health status, were taken into account (Reschovsky et al. 2011). A Swedish mixed-model study reports similar results (Merlo et al. 2005).

Interestingly, when the Dartmouth Atlas studies were repeated by the US Institute of Medicine with broader risk and price adjustment, variations were reduced but still existed, and the ranking between geographical areas changed (Newhouse and Garber 2013). In line with Zhang they found that the variation between areas with regard to costs and quality of care was incongruent, probably indicating that some of the variation relates to the behaviour of hospitals and individual physicians. Hence, they propose that further investigations on variation have to look beyond geography and into practice variations at a less aggregated level.

Last, but not least, the statistics methods used to discriminate real variations from variations by chance influence the interpretation of the SAV findings. A Spanish study validating different measures of geographical variations demonstrated that a mixed-model applying empirical Bayesian statistics was better than other more traditional methods for defining variation, because to a much lesser degree it was dependent on procedure rate and the underlying variability (Ibanez et al. 2009).

6.3 Travel time to hospital

We found in all studies that the distance to hospital was inversely related to hospital use. In Norway about 10% of the population live with a travel time to hospital of more than 1 hour. In paper 1, the distance to hospital was the most important confounder, which in fact turned the negative crude association between LTC and HD rate into a positive association. In paper 2, distance did not influence the association between the outcome and the main explanatory variable. However, in both paper 1 and paper 2 the hospital utilization rate was significantly lower in the most distant municipalities. In paper 3, the odds for UMAs were 13% lower for individuals living in municipalities with travel time to hospital of >60 minutes compared with those with travel time <20 minutes. In summary, this indicates that travel time had an influence on the use of SHC, but did not consistently influence the associations between PHC and SHC utilization.

6.4 Composite variable "Municipality population size and Hospital status"

Although the composite variable 'Municipality population size and hospital status' was a confounder in paper 1, it was an effect modifier in paper 2. We found in all papers that hospital utilization was higher in municipalities hosting a hospital. In paper 1 HD rates in hospital municipalities were higher than in all other municipality types; in paper 2 the OPC rates were highest for people aged 65–84 years in large hospital municipalities. This is in line with one Norwegian study reporting higher hospital use in municipalities with a hospital (Fylkesnes 1993). However, the study did not test for effect modifiers or adjust for possible confounders. In paper 3 we found in bivariate analysis that municipalities with a hospital had higher UMA rates than municipalities without (174/1000 versus 160/1000). However, in the full multivariate model there was no difference. This suggests that not having a hospital in the municipality indicate lower hospital use, but the lower use did not seem to be explained by higher GP- or LTC rates in the non-hospital municipalities.

6.5 Age and mortality

The influence of age and interactions with age has not been reported by others because age- and sex-standardized rates have been used in most studies. In paper 1 we stratified by both age and sex, whereas in paper 2 we found interaction only by age, indicating different associations between PHC and hospital use for the oldest individuals. In paper 3, due to the different methodology, we defined the age groups based on earlier findings.

In all the papers we found relatively little impact of the adjustment for mortality as a proxy for morbidity. In paper 3, use of the municipality level of disability pension as a proxy for morbidity did not influence the results. When adjusted for mortality in paper 1, increasing LTC seemed to reduce HD levels among the oldest populations. Similarly, in paper 3 high LTC volume in the municipality corresponded with lower individual propensity to be admitted as a UMA for the oldest individuals (80+), whereas for the younger age groups we found the opposite tendency. In paper 2 age had an influence only for the tiny group of oldest individuals with the highest mortality, which we questioned as a possible artefact. In summary, our proxies for morbidity had a minor influence on the associations in all papers. As we found only relatively small effect sizes, one might discuss whether the adjustment for morbidity was insufficient or whether morbidity was in fact not an important confounder because the differences in mortality at municipality level were moderate, and had random fluctuations from year to year. However, in papers 1 and 2 we used 5-year and 3-year mortality means to reduce the impact of year-to-year variation.

6.6 Socioeconomic status

Socioeconomic inequalities in health status increased with age in the UK where people of lower SES were found to have a faster decline in physical health (Chandola et al. 2007). The Norwegian government decided, in 2008, that the criteria for funding the hospital regions should also include SES within the area (Carlsen 2006b;Ministry of Health and Care services 2008). A small Norwegian population survey study indicated that the proportion of people who use PHC and specialist services increases with improved SES, with the exception of the subgroup of men aged 67+ with coronary heart disease, among whom those with low income made the greatest use of GPs (Jensen 2009). While one Norwegian study indicated that more affluent patients made less use of GPs and were more often referred to SHC (Hansen et al. 2012) another population study found no SES gradient in use of the GPs or inpatient care, but demonstrated that affluent people (measured by educational level and income) had higher utilization of hospital and private out-patient specialist services (Vikum et al. 2013). An interesting study utilizing the 2201 GP lists (all lists of Norwegian GPs with specialty in family medicine) showed that the lowest quintile SES level list had a 13% higher consultation rate than the highest quintile (Hetlevik and Gjesdal 2012). Altogether, these survey studies indicated that higher educational level was associated with higher outpatient use. In paper 2 we demonstrated that educational information in 5-years age and sex groups did not fulfil the criteria to be included as a confounder indicating that educational level did not influence the association between GP-rates and use of out-patient clinic in our aggregated analyses. Whether this would hold true if we had individual data is open for discussion.

In this thesis, age group or municipality-specific SES, employment, income and education had little influence on the studied associations. Educational level was a significant confounder in paper 1, but inclusion of education in the final model did not change the sign of the association, indicating a small effect (data not shown in the paper). However, it can be questioned whether SES data at individual level and/ or GP lists level together with municipality specific level would have altered the picture if the data had been available.

7 Future perspectives

Demographic forecasts indicate that a growing proportion of elderly people might threaten the sustainability of future health-care budgets. However, these assumptions are still controversial. We found that 15% of the elderly population receive LTC, which corresponds roughly to the findings in the UK (Bardsley et al. 2012), the USA (Spillman 2004) and Canada (Worrall and Knight 2004). Far more people aged >65 provide informal care than receive formal care (Organisation for Economic Co-operation and Development 2011). Hence, elderly people are a heterogeneous group where many people are healthy and independent in old age.

Second, elderly people in the future may live longer with fewer disabilities than previously, and their impact on future hospital utilization might be less than that assumed (Breyer et al. 2010;Christensen et al. 2009). However, reduced hospital need among elderly people might be compensated for by an increased need for LTC for the very oldest individuals (Murphy & Martikainen 2013).

Third, a belief that most health needs of elderly people can be met in municipality PHC can lead to suboptimal elderly health care (Aaraas 2012;McCloskey and van den Hoonaard 2007), if elderly people's needs are not clarified by a comprehensive geriatric assessment at admission (Samaras et al. 2010). Especially at a stage of life when terminal palliation in a local setting is best practice, emergency admissions should be avoided. Although a small Norwegian study indicated that local palliative competence could have substituted for some admissions, these admissions represented a very small proportion (0.2%) of the total admission volume (von Hofacker S. et al. 2010;Wyller 2010), in line with the proportion found in a recent Canadian study (Jensen et al. 2009).

It is well recognized that the prevalence of multi-morbidity, defined as having two or more long-term conditions, increases with age (Barnett et al. 2012;Starfield 2010). Even if this increase might partly result from a lower diagnostic threshold in a specialized, disease-oriented, health-care system, rather than from factual growth (Starfield 2011), patient multi-morbidity and disabilities complicate treatment pathways of chronically ill elderly people. A Commonwealth study from 11 countries including Norway demonstrated poor coordination of care for patients with complex needs, who also experienced more medical errors (Schoen et al. 2011). A report of GP activity in 22 European countries in 2009–10 evaluated efficiency in structure and process related outcomes (Pelone et al. 2013). It demonstrated a low score for

Norwegian GPs' cooperation with specialists (Kringos et al. 2013a). Hence, content of and cooperation between services within and between care levels, which is challenging in Norway for several reasons, might have more impact on SHC- utilisation than increased PHC volume. However, if GPs are foreseen as having a more coordinating and team-leading role within and between today's two care levels, this might reduce their consultation capacity to such an extent that it will require more GPs in the municipalities than the government has planned recently (Norwegian Directorate of health 2013).

It is argued that the strong economic focus of the Coordination reform hampers the development of integrated care, especially for multi-morbid patients, and instead reinforces power games between two separate financial and administrative bodies at organizational, hospital and practitioner levels (Romoren et al. 2011). Also, the contrast between a single disease-based perspective dominant in a state-owned and -run specialist health service and the often patient-centred care perspective in a fragmented and decentralized, municipality, generalist PHC can lead to suboptimal patient pathways and care (Rosstad et al. 2013).

Most list doctors are organized into group practices with an electronic patient record (EPR) system, which has gradually been connected to the specialist sector through the Norwegian Health Network. As shown in a Commonwealth Fund study and highlighted in several government reports, there is a need for enhanced, technologically integrated, health-care information exchange and integration (Holmboe O et al. 2009;Norwegian Ministry of Health and Care services 2012a). This must include improving communication means across GP, LTC and hospital services. To improve cooperation and integration of care, better understanding of the different cultures and better interprofessional attitudes are needed and should be a focus of future education and training of health personnel and administrators. But, as demonstrated in a 4-year project from Australia, this is a difficult task (Braithwaite et al. 2013).

8 Suggestions for further research

In spite of our findings, we cannot exclude important effect of PHC for hospital use. Further research has to concentrate more deeply on the role of LTC in acute cases and the role of GPs, look more into patient trajectories and finally evaluate the content and quality of the It has been argued that it is a paradox that the major health-care reforms such as the CR can be implemented based on political and economic assumptions more than on scientific evidence, whereas the introduction of a new drug demands several clinical trials, even if the impact on patients' morbidity and mortality of health service changes might be greater (Hillman 1998). At least, for the CR, an on-going evaluation is planned – mainly at the organizational level, with attention to the administrative changes and the economic endpoints (Norwegian Ministry of Health and Care services 2012b). It will be important to observe whether the legislated introduction of municipality emergency beds will influence the rates of hospital emergency admissions and readmissions. This must be followed closely in the years to come (Norwegian Ministry of Health and Care services 2011). The evaluation requires individual data on utilization of all LTC services including use of the acute beds. Also the role of informal care and individual data on SES and marital status among elderly people should be included.

Multilevel studies with individual and system level data, and other statistical methods like empirical Bayesian Statistics have to be considered for future studies.

8.1 GP data

It will be essential to include data from PHC use and terminal care activities in future studies on variations of health-care utilization, quality and costs. In Norway almost all GPs and have had EPRs for many years. This unique and huge data source includes reasons for encounters, diagnoses, prescriptions, sick leave, laboratory tests and referrals. Given appropriate safeguards, these data can be utilized to investigate population disease prevalence and variation, and patient management, and to study variations – also between countries (Kroneman et al. 2010;Simpson et al. 2010;Westert et al. 2006). Simultaneously, the GPs can extract and analyse their own practice data as part of local quality improvement.

Better adjustment for morbidity and multi-morbidity is important to enhance the quality of the research. There are several challenges to capturing morbidity data from patient registries. The use of discharge diagnoses without including information at admission might lead to misclassifications and erroneous conclusions about inappropriate admissions (Pronovost and Lilford 2011;Raven et al. 2013). Furthermore, even if the discharge diagnostic coding practice accuracy seems to improve (Burns et al. 2012), it might be influenced by financial interests (Lægreid and Neby 2012) and vary as a result of organizational factors (Santos et al. 2008). Hence, other approaches to better identify morbidity are of interest. The prevalence of disease, especially chronic disease, is generally higher in self-reporting than in GPs' patient journals, which should be a good indicator of disease prevalence because about 80% of the population visit their GP annually (Westert, Jaabaaij, & Schellevis 2006). One British study demonstrates a high predictive value for utilization of GPs via the number of prescribed drugs compared with other morbidity measures (Brilleman and Salisbury 2013). Another British study showed that the number of chronic diseases was equivalent to the Charlson index for predicting 1-year mortality, and had a better explanation for variation between GP practices in a multilevel study (Carey et al. 2013).

8.2 Patient trajectories

Given better data for morbidity and data from primary care, it is relevant to study patient trajectories of chronically ill elderly patients for better understanding of the dynamics between the services both within PHC and between different levels of care. These studies might also include quality-of-care aspects and outcomes of care. In a recent publication from Manitoba, different patient trajectories were compared by different quality-of-care measures in respect of both process (vaccination, prescription consultations) and outcome (stroke, myocardial infarction, amputation) (Katz et al. 2013). Possibly, measures for health-related quality of life (HRQoL) –and 'activities of daily living' (ADL) can be beneficial for such studies. A recent publication from Norway showed that elderly people who were hospitalized had better health 1 year after, when assessed as the ability to cope with everyday activities (Helvik et al. 2013).

Not to forget, patient trajectories inside hospitals must be focused on, because hospital organizational changes can have a huge influence on patient quality-of-care outcomes and long-term costs, as demonstrated in a 10-year Spanish study (Corbella 2013).

8.3 Coordination and cooperation

A clinically integrated, one-level, health-care delivery system such as Kaiser Permanente (KP) in the USA has fewer doctors, fewer inpatient bed days, and better preventive and integrated chronic care compared with Danish health care, but higher spending (Frolich et al. 2011). A recent European study indicated that, although there were favourable effects on population health and hospital use, the overall health-care spending was higher in countries with a strong PHC, demonstrating that future studies must take into account the total health-care costs (Kringos et al. 2013b). It has been a matter of debate whether the Norwegian health care's 'two-level' finance system is an important cause of problems with fragmentation, power games, coordination and cooperation, especially for chronically ill (and often multi-morbid) patients. The time is ripe to study whether the positive experiences from systems like the insurance-based KP in respect of one care level, integrated and preventive care, are transferable into a Scandinavian universal health-care setting. In a research project where, for example, one to three hospitals and their associated municipalities' PHC are financially, organizationally and clinically integrated in the same health delivery organization, one could examine effects of a large whole-system change in the Norwegian setting. Whether medical care in such a system will give better and more patient- centred care must be examined with a broad and multidisciplinary research focus. Important factors to study are implementation, system and care integration, interprofessional cultures and attitudes, patient outcomes and satisfaction, and finally total health-care utilization and spending.

9 Conclusions of the thesis

In a universal health-care system with well-functioning primary health care, increased PHC utilization alone does not seem to reduce the pressure on the hospital services. Further research should focus on the content of services and cooperation within and between service levels.

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PAPER I

Trygve S Deraas, Gro R Berntsen, Toralf Hasvold and Olav H Førde

Does long-term care use within primary health care reduce hospital use among older people in Norway? A national five-year population-based observational study. *BMC Health Services Research 2011, 11:287*

PubMed**:** PMID: 22029775

PAPER II

Trygve S Deraas, Gro R Berntsen, Toralf Hasvold, Unni Ringberg and Olav H Førde
Is a high level of general practitioner consultations associated with low outpatients specialist clinic use? A cross-sectional study. *BMJ Open 2013;3:e002041.*
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PAPER III

Trygve S. Deraas, Gro R. Berntsen, Andy P. Jones, Olav H. Førde, Erik R. Sund.

Associations between Primary Health Care and Unplanned Medical Admissions in Norway. A multilevel analysis of the entire elderly population.

Health & Place (Under review)

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ISBN xxx-xx-xxxx-xxx-x