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Lena Janita Skarshaug

Patients' use of general practitioners in Norway

Doctoral thesis

NTNU
Norwegian University of Science and Technology
Thesis for the Degree of
Philosophiae Doctor
Faculty of Medicine and Health Sciences
Department of Public Health and Nursing

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Trondheim, December 2020

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Fastlegekonsultasjoner i Norge

Før sykehusinnleggelse, over tid, og når fastlegen plutselig blir utilgjengelig.

Hvorfor har vi forsket på dette?

I mange land blir allmennpraksis sett på som en hjørnestein i helsetjenesten. Norge innførte fastlegeordningen i 2001 med mål om å sikre kontinuitet i allmennlegetjenestetilbudet ved å gi alle innbyggere rett til én fast lege over tid; fastlegen. Forsking har vist at pasienter som opplever kontinuitet i behandlingen fra fastlegen har bedre helse og mindre behov for spesialisthelsetjenester, f.eks. i form av sykehusinnleggelser.

I de senere år har Norge, i likhet med mange andre land, ønsket å redusere presset på spesialisthelsetjenesten ved å øke forebyggende behandling i primærhelsetjenesten, og flytte oppgaver fra spesialisthelsetjenesten til allmennpraksis. I tillegg blir det stadig flere eldre i befolkningen. For å finne eventuelle fallgruver og potensialer for forebygging, er det behov for mer kunnskap om hvordan pasientene bruker fastlegetjenester, og da spesielt de som går ofte til fastlegen; eldre og kronisk syke. Vi ønsket derfor å undersøke pasienters kontakt med fastlegen og hvordan bruken av helsetjenester eventuelt endres 1) før akutte sykehusinnleggelser, 2) i en periode med oppgaveoverføring fra spesialisthelsetjenesten til fastlegene og 3) når pasienter plutselig ble utsatt for en situasjon der deres opprinnelige fastlege var utilgjengelig i lengre tid.

Hva har vi funnet?

Resultatene fra alle tre artiklene i denne avhandlingen understreker fastlegenes viktige rolle i befolkningen – i forebygging av innleggelser, oppfølging av risiko og som kontinuitetsbærer.

I den første artikkelen fant vi en generell økning i fastlegekonsultasjoner frem mot innleggelse for vanlige akutte tilstander som akutt hjerteinfarkt, hoftebrudd, hjerneslag, hjertesvikt og lungebetennelse hos trøndere over 50 år. Utviklingen var forskjellig mellom pasientgrupper med ulike diagnoser, og med en spesielt uttalt økning i legekontakter fram mot innleggelse for hjertesvikt. Selv om flertallet var i kontakt med lege i forkant av innleggelsen fant vi også at en betydelig andel av pasientene *ikke* var til lege (fastlege eller legevakt) måneden før sykehusinnleggelse, særlig 50-64 år gamle menn. Denne pasientgruppen kan representere et mål for forebygging, selv om de kan være utfordrende å nå.

I den andre artikkelen fant vi økt bruk av fastlegekonsultasjoner (men ikke legevakt) i perioden 2007-2016 blant befolkningen nord i Trøndelag. Økningen så ut til å være spesielt fremtredende hos den friskere delen av befolkningen, og gjaldt ikke i samme grad pasienter med etablert sykdom (høyt blodtrykk og psykisk lidelse). Det at befolkningen går oftere til fastlegen kan tyde på bedre forebygging, oppfølging og behandling. Men, siden det er et betydelig kapasitetspress på fastlegetjenestene, bør prioriteringsprinsipper og oppfølging av pasienter med ulike behov studeres videre.

Samlet sett tyder våre resultater fra den tredje artikkelen på at pasienter i den norske fastlegeordningen får tilgang til den hjelpen de behøver også når en stabil fastlege plutselig blir borte for en periode på over to måneder. En liten og forbigående nedgang i konsultasjoner initialt ble dels kompensert av en tilsvarende økning i bruk av legevakt, mens det ikke var noen større endringer i akuttinnleggelser for de fleste aldersgrupper. Likevel så vi en økning i potensielt forebyggbare innleggelser hos de aller eldste etter at fastlegen ble borte, og dette bør studeres videre.

Hvordan gjorde vi det?

For å komme frem til resultatene våre, har vi kombinert data fra flere norske helseundersøkelser og registre for å studere bruk av legetjenester hos enkeltindivider over tid. I den første artikkelen var studiepopulasjonen alle innbyggere på 50 år og eldre i de fire kommunene Trondheim, Malvik, Melhus og Midtre Gauldal som ble akuttinnlagt i perioden 2012-2013. Vi registrerte kontakter med helsetjenesten hver måned i året før innleggelse for akutt hjerteinfarkt, hoftebrudd, hjerneslag, hjertesvikt eller lungebetennelse.

I den andre artikkelen tok vi utgangspunkt i de som deltok i Helseundersøkelsen i Nord-Trøndelag i 2006-2008 (HUNT3). Vi kombinerte informasjon fra spørreskjema og kliniske målinger (fra HUNT3) med nasjonale registerdata om fastlegetilhørighet og legekonsultasjoner. Vi registrerte legekonsultasjoner hver måned og hvert år i perioden 2007-2017 for grupper med ulik helsestatus (relatert til høyt blodtrykk og psykiske plager) og for pasienter som tilhørte ulike fastlegelister.

I den tredje artikkelen tok vi utgangspunkt i fastlegeregisteret og nasjonale registerdata på fastlegeaktivitet i perioden 2007 til 2017 for å identifisere stabile fastleger (minst 12 måneders stabil praksis) med et plutselig praksisbrudd som varte i to eller flere måneder. Pasienter tilknyttet disse legene 12 måneder før bruddet ble fulgt med månedlige registreringer av helsetjenestebruk (fastlege, legevakt, sykehusinnleggelser) før, under og etter bruddet.

I alle artiklene brukte vi binomiale generaliserte estimeringsmodeller med en logit-funksjon for å sammenligne repeterte målinger av helsetjenestebruk over tid og mellom grupper. I tillegg benyttet vi flernivåmodeller i artikkel 2 og vurderte om det var tegn til opphopning av ulik konsultasjonspraksis på legenivå ved å se på intraklassekorrelasjon.

Kandidat: **lege Lena Janita Skarshaug**

Institutt: **Institutt for samfunnsmedisin og sykepleie**

Hoved veileder: **førsteamanuensis og lege Kristine Pape**

Biveileder: **professor Johan Håkon Bjørngaard**

Finansieringskilde: **Forskningsrådet og NTNU**

Ovennevnte avhandling er funnet verdig til å forsvares offentlig

for graden PhD i samfunnsmedisin.

Disputas finner sted digitalt,

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Table of Contents

Summary

Background:

General practice (GP) medicine is a cornerstone in many countries' health services. In Norway, the establishment of the regular general practitioner (GP) scheme in 2001 introduced a structural emphasis on gatekeeping and continuity of GP care by entitling all inhabitants (more than 99%) to a regular GP within a list-based system. General practitioners providing continuity of care for their patients has been suggested to be beneficial for patients' health and reduce the need for secondary health care treatment.

As in many other European countries, the current Norwegian policy is to reduce pressure on specialist health care by increasing preventive care and shifting tasks from secondary to primary health care. These recent developments and the expected increase in the number of older people in the years to come call for new knowledge on patients' use of GP services to identify pitfalls and potentials for prevention, especially in the elderly and chronically ill. We wondered how patients consulted their GP before hospital admission and over time during the last decade. We also wondered how the patients were affected if suddenly exposed to a situation where their regular GP was unavailable for a longer period of time; could we detect a spill over to out-of-hours services or increased acute hospital admissions?

Aims:

To investigate patients' contact with GPs and how the use of health care services changes 1) prior to acute hospital admissions, 2) in a period when GPs' responsibilities for health care services increased and 3) when patients are suddenly exposed to a situation where the regular GP was unavailable for a longer period of time.

Methods:

In Paper I, we used a longitudinal design, linking person-level national register data on use of health services (GP and out-of-hours (OOH)) and municipal health care services for inhabitants aged 50 and older admitted to hospital for acute myocardial infarction, hip fracture, stroke, heart failure or pneumonia in four municipalities (Trondheim, Malvik, Melhus and Midtre Gauldal) in 2012-2013, covering a population of 214,722 persons. We used binomial generalised estimation equation models with a logit function to investigate the percentage with GP/OOH contacts before the hospital admission; per month during the year

before the admission; and per triplet of days (2–4, 5–7, …., 29–31 days) the month before the admission. We performed the analysis separately for each of the selected patient groups.

In Paper ll, we used survey data and clinical measurements from the Norwegian HUNT3 study (2006-2008) linked with national administrative data on the GP list assignment and consultations with GP services. We grouped participants aged 40-59 years according to sex and their baseline status regarding hypertension and anxiety/depression symptoms. We registered GP consultations in 2007-2016 and used general estimation equation models to estimate the percentage with monthly GP consultations each year during follow-up. We used multilevel models with participants nested in their assigned regular GP to calculate GP level intra-class correlation coefficients, reflecting to what extent patients' consultation patterns could be attributed to the individual GP.

In Paper lll, we used a longitudinal design, linking person-level national register data on the use of health services (GP and OOH) and GP affiliation for 2,529,311 Norwegians assigned to the patient lists of 2,501 regular GPs who, after 12 months of stable practice, had a sudden discontinuity of care lasting two or more months between 2007 and 2017. Patient follow-up with monthly registrations of health care use were analysed during the same time periods before (2 to 7 months before), during (1 month before to 1 month after) and after (2 to 13 months after) the episode of discontinuity. Logistic regression models compared monthly GP consultations, out-of-hours consultations, acute hospital admissions and Ambulatory Care Sensitive Conditions (ACSC) admissions in periods during and after the discontinuity to the period before the discontinuity, for five age groups separately.

Results:

In Paper l, we identified 66,952 participants, of whom 720 were admitted to hospital for acute myocardial infarction, 645 for hip fracture, 740 for stroke, 399 for heart failure and 853 for pneumonia in the two-year study period. The majority of these acutely admitted patients had contact with general practitioners each month before the emergency hospital admission, especially contacts with a regular GP. A general increase in GP contacts was observed towards the time of hospital admission, but development differed between the patient groups. Patients admitted with heart failure had the steepest increase of monthly GP contacts. A sizable percentage did *not* contact their regular GP or OOH services the month before admission, in particular men aged 50-64 admitted with myocardial infarction or stroke.

In Paper II, we identified 47,550 HUNT3 participants that were registered with 102 different GPs in Nord-Trøndelag County, Norway, in 2007. Adjusted for age, we observed an overall increase in GP consultations in 2007-2016, particularly in those with a better health status at baseline. About 2% of the variance of patient consultations could be attributed to differences between GPs and 10% to the use of lengthy consultations. Out-of-hours consultations did not change much in the study period 2007-2016.

In Paper III, we found that all age groups had a 3-5% decreased odds of monthly regular GP consultations during the discontinuity, followed by normalisation. The odds of monthly out-of-hours consultations increased 3-6% during the discontinuity for all adult age groups. The odds of hospital admissions increased during and after the discontinuity in those older than 65 years, particularly for ACSC admissions.

Conclusion:

The results from all three papers in this thesis point to the important role of the regular GP in the population. Most people saw their GP on a regular basis, both before an acute hospital admission (Paper I) and overall (all three papers). Nevertheless, in Paper I, a substantial percentage of the patients did *not* see their GPs the month before a hospital admission. This group of patients could represent a possible target for prevention, although they cannot be easily reached. We found indications of an increased use of GP services (but not OOH use) in Norway partly due to changes in help-seeking behaviour among the healthier part of the population (Paper II). More frequent consultations could indicate better prevention, monitoring and treatment. However, as GP services are under considerable capacity pressure, prioritisation principles and following-up of patients with varying needs are topics for further scrutiny. Overall, patients seem to access help when faced with a sudden discontinuity of care from their regular GP (Paper III). However, the increase in acute hospital admissions for ambulatory care sensitive conditions in the older age groups after such a discontinuity suggests a crucial role of the GP and warrants attention and further research.

Acknowledgements

The studies for this thesis were approved by the Regional Committee for Medical and Health Research Ethics in Central Norway (2011/2047).

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I would like to thank the consultants at the HUNT Data Bank for preparing and providing data from the HUNT database; the Norwegian Directorate for Health for preparing data from the Control and Payment of Health Reimbursement (KUHR) database; the Norwegian Directorate for e-Health for preparing data from the Norwegian General Practitioner Register; Statistics Norway for preparing data on education and demography for my studies; and Professor Aslak Steinsbekk, who provided all the data for my first paper.

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Mum and Dad: for always being there for me, wherever life has taken me. Always supportive, loving and kind, giving room for me to never stop growing and evolving as a person. Yes, I am approaching 40; no, I still don't know what I want to be when I "grow up"!

My dear Håkon: husband, soul mate, and best friend. For all the big and little things along the way. I love you with all my heart.

My beloved daughters Vita and Evienne: You make me strive to be a better person each day, teach me more than any PhD ever will and make me remember what is important in this brief time of ours called life.

Norway, the social democratic state with accessible education and health care services for all: You made my journey possible.

List of papers

Three papers are included in this thesis, hereafter referred to as Paper I, Paper II and Paper III respectively.

Paper I: Contact with primary health care physicians before an acute hospitalisation.

Lena J. Skarshaug, Ellen R. Svedahl, Johan H. Bjørngaard, Aslak Steinsbekk & Kristine Pape

Scandinavian Journal of Primary Health Care. 2019 Jul 09; 1-11 Doi:10.1080/02813432.2019.1639900

Paper II: Changes in General Practitioners' consultation frequency over time for patients with hypertension or anxiety/depression symptoms: a ten-year follow up of the Norwegian HUNT study.

Lena J. Skarshaug, Silje L. Kaspersen, Johan H. Bjørngaard & Kristine Pape

Family Practice. 2019 Nov 06; 1-7 Doi: 10.1093/fampra/cmz070

Paper III: General practitioner discontinuity and health care utilisation in 2.5 million Norwegians

Lena J. Skarshaug, Silje L. Kaspersen, Johan H. Bjørngaard & Kristine Pape

In review, Family Practice.

List of abbreviations

ACSC	Ambulatory Care Sensitive Conditions
CI	Confidence interval
COPD	Chronic obstructive pulmonary disease
GP	General practitioner [Norwegian: Fastlege]
GDP	gross domestic product = bruttonasjonalprodukt (BNP)
HADS	Hospital Anxiety and Depression Scale
HELFO	Helseøkonomiforvaltningen, Norwegian Health Economics Administration
HUNT	Helseundersøkelsen I Nord-Trøndelag, The Nord Trøndelag Health Study
HUNT3	The Nord-Trøndelag Health Study, third wave (2006-2008)
ICD-10	International Classification of Diseases and Related Health Problems, 10th edition[1]
ICPC	The International Classification of Primary Care[2]
KUHR	Control and payment of health reimbursement [Norwegian: Kontroll og utbetaling av helserefusjoner]
NTNU	Norwegian University of Science and Technology
OOH	Out-of-hours services [Norwegian: Legevakt]
OR	Odds ratio
SSB	Statistisk sentralbyrå, Statistics Norway

1 Introduction

General practice (GP) medicine is a cornerstone in many countries' health services. In recent years, the services of GPs have been under scrutiny and debate. Nevertheless, it may be argued that specialised health care services have received more research attention than primary care, in general, and GPs, in particular. This forms the background for this thesis, where we aimed to investigate patients' contact with GPs, and how the use of health care services changes 1) prior to acute hospital admissions, 2) in a period when GPs' responsibilities for health care services increased and 3) when patients are suddenly exposed to a situation where their regular GP was unavailable for a longer period of time.

Over the last few decades, there have been demographical changes in Norway and most western countries towards an older population with a more complex disease burden[3-5], putting the health care systems under pressure. The ideal allocation of tasks and resources between primary and secondary health services has been debated in most health care systems, regardless of finance and organisation. In Norway, the challenge is to provide good services within the welfare state (that is available for all and publicly financed mostly through income taxes). Most patients, on the other hand, are mainly concerned about getting proper help when they need it without too much inconvenience, both financially and time.

Even though North European countries organise their primary health care sectors differently, they all emphasise the importance of general practice and primary care when discussing the public health challenges of an ageing population[6]. Primary care will, in many settings, be more cost-efficient[7] and may reduce pressure on secondary care. This has led many western countries to shift responsibilities from secondary to primary health care[8]. This shift, however, may have increased pressure on primary health care.

As a medical doctor in Norway, I am interested in the role and importance of GPs, as well as the GPs' and the system's effect on the patients. During the time period that I worked on this thesis, there was increased media attention on recruitment and retention problems with Norwegian GPs, as well as increased workload. However, updated research within the field was lacking. Hence, the current research felt both timely and inspirational to do.

Due to the shifts of tasks from secondary to primary health care, we wondered how this has affected the patients' contact with their GPs. With special emphasis on the elderly and chronically ill, we wondered if there was a difference in GP contacts between different patient groups and over time. We also wondered how the patients were affected when they suddenly could not access their regular GP at all for some time; could we detect a spill over to out-of-hours services or increased acute hospital admissions?

This thesis consists of three empirical papers investigating the above-mentioned issues using a rich source of register-based and population-based data in the intersection between health services research and epidemiology. For this thesis, I chose to compare my and other Norwegian research mainly to Denmark, Sweden and England, as their health care systems are most like the Norwegian health care system, and they (particularly England) have recently done a lot of research on GPs. Where not stated otherwise, I am referring to the Norwegian system/context/studies.

1.1 Outline of the thesis

Chapter 2 outlines the Norwegian health care system, describing relevant descriptive and research literature on which this thesis was built. Chapter 3 describes the aims of the studies. Chapter 4 deals with ethics, study designs, variables and statistical analysis. Chapter 5 presents the results from the studies. Chapter 6 discusses the results and their implications against the literature. Chapter 7 presents the overall conclusion. Then follows the reference list and, lastly, the three papers with their respective supplementary materials.

2 Background

In this chapter, I will first describe the Norwegian health care system for context, with emphasis on the parts relevant for this thesis. Then I will briefly describe three other health care systems that can be logically compared to the Norwegian health care system before describing the relevant statistics and literature to frame the three papers.

2.1 The Norwegian health care system

Norway has a public health care system based on the classic Scandinavian welfare model, which finances and provides universally available services that are (ideally) affordable for all inhabitants. The health care system is built on the principle of equality— the right to equal access to health services regardless of background or life situation [9].

All health care services are free for children under the age of 16, whereas older patients pay an out-of-pocket fee for GPs (both regular and OOH), psychologists, outpatient clinic (hospital), radiology department, patient travel, medicines and equipment on the "blue prescription", with a maximum sum per person per calendar year (the sum is adjusted yearly in the regulation on limit of patient charge; in 2020, the limit is 2460 NOK[10]). Hospital stays and ambulance services are free of charge for all.

Norway spends a substantial amount of money on health services and medical treatment, in 2017 representing 10.4% of the GDP, which was higher than the OECD average of 9% in 2016[11]. In 2015, 257 billion NOK was spent on individual health care services and medical treatment; 14% of this was paid by the individual patient out of pocket and the rest by the public administration[12].

Whereas secondary health care services are organized and financed by state and regional health trusts, each municipality is responsible for providing primary health care services, including general practice services, to its inhabitants[13]. Since this thesis is about the use of GP services and the intersection between primary and secondary health care services, these will be the focus of the following description of the Norwegian health system. Figure 1 shows the main pathways for a patient who experiences a health problem—with general practitioners

as the first-line service and gatekeepers to secondary health care. It is important to notice that this is a simplification—in practice, there is much complexity with other possible pathways, including other primary and secondary services, but with less relevance for this thesis.

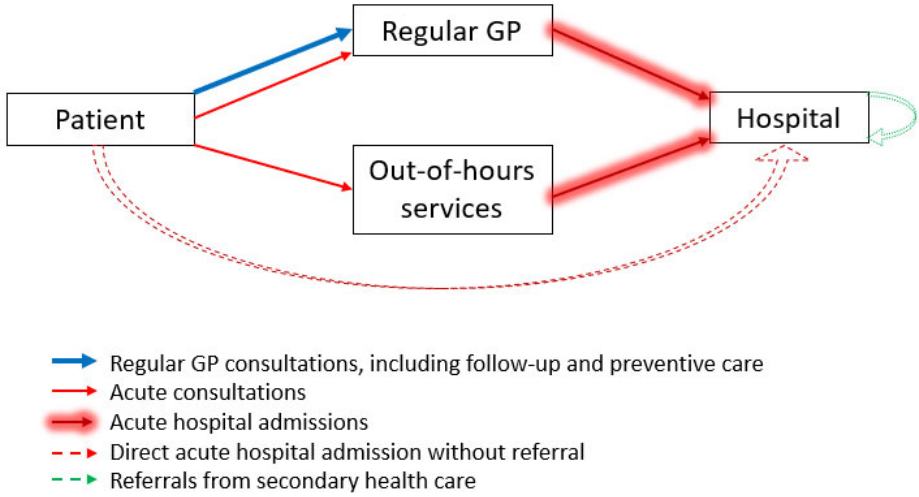

Figure 1: Different trajectories for patients to primary care (consultations) and secondary care (acute hospital admissions, direct hospital admissions, and (usually planned) references from secondary health care). Figure by me, Skarshaug

2.1.1 Authorities and important reforms

Norway has four regional health authorities[14]: Helse Nord (northern Norway), Helse Midt Norge (central Norway), Helse Sør-Øst (south-eastern Norway) and Helse Vest (western Norway)[15]. They are in charge of their respective health authorities, which run the hospitals[16].

Dentists and complementary and alternative medical providers are usually organised outside the public system and are most often fully paid by adult patients[17].

The Regular General Practitioner Scheme

The regular general practitioner scheme was introduced in 2001 to meet several primary health care service challenges, like the lack of standardised GP operations (which led to large differences in patients' own payments[18]) and a growing concern of so-called "doctor

shopping" (defined as "seeing multiple treatment providers, either during a single illness episode or to procure prescription medications illicitly"[19]) in more central areas. Through the Ordination of the Municipal Regular General Practitioner Scheme, the municipality organises the regular GP scheme and ensures that persons who wish to do so will be offered a place on the GPs' lists[20]. Through the same ordination, the regular GPs are obliged to provide both acute and non-acute medical care for their patients during office hours[20]. In addition, the municipality must provide out-of-hours emergency medical care (OOH services) that ensure the immediate needs of the population, through at least one doctor being available for emergency care throughout the day in form of consultations, home visits and callouts, all regulated through the Regulation on organization of emergency services[14].

The Coordination Reform

The Norwegian Coordination Reform was introduced in 2012 to meet several health service challenges, such as fragmented services, a lack of preventive care, and demographical and epidemiological changes, forcing a change in economic priorities[21]. This reform systemised a shift towards increased responsibility and follow-up of severely ill patients in primary care [21]. The aim of the Coordination Reform was to improve cooperation and coordination between primary and secondary health care; as such, the municipalities were to take responsibility for more patients, avoiding hospital admissions and receiving discharged patients at an earlier stage[21]. The net result would be more responsibility for the course of treatment for each GP, but, in return, the patient lists were supposed to get shorter, as the number of GPs was supposed to rise. However, from 2012 to 2018, the number of GPs increased by only 551[22]; the average GP list decreased by 67 (6%) patients[23], while the population increased by almost 310,000[24].

2.1.2 Specialised health care services

Norwegian specialised health care services are run by the state and regulated through the Specialised Health Services Act[25]. Norway has a strict gatekeeping system, where access to secondary health care usually is based upon referral from a doctor working in primary or secondary health care. Hospital admissions are divided into acute/emergency (when the patient needs help within 24 hours) and planned/elective (when the patient can wait). In 2019, there were nearly 2 million unique patients in Norwegian hospitals, and the majority of

treatments were given in an outpatient setting[26] (see Figure 2[27]). Despite the Coordination Reform[21] and an increase in secondary outpatient treatment, the number of hospital stays has remained relatively stable in recent years (see Figure 3)[28]. Most hospital admissions are acute, and there is little difference between the sexes (women utilise all modalities slightly more than men[27]). In 2018, 530,000 patients spent about 3.4 million days hospitalised, an average of 6.3 days per hospitalised patient[29]. In reality, 5% of the hospitalised patients accounted for 34% of the days in hospital, the majority of whom were found among the older age groups[29].

Specialised health care services use the ICD-10[1] when classifying hospital stays and other contacts. The most common causes for hospital stay across all age groups in Norway during 2012-2018 were circulatory diseases (ICD-10 chapter IX), external causes (ICD-10 chapter XX) and pregnancy/childbirth (ICD-10 chapter XV)[27].

Out of the 803,628 inpatient stays in 2019, 69% were acute inpatient stays[30]. The number of acute inpatient stays slowly increased from 662,294 in 2008 to 788,692 in 2019; females constituted about 52% of the stays each year[30], and the age group 71-80 years had the steepest increase from 62,008 acute inpatient stays in 2008 to 87,848 in 2019 (see the light grey line, Figure 4)[30].

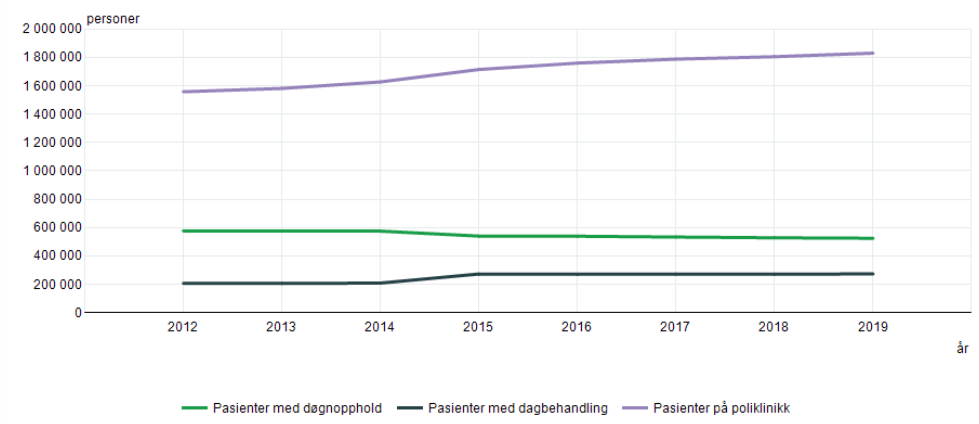

Figure 2: Number of patients receiving treatment in Norwegian somatic hospitals by year; inpatient stays (green line), day treatment (black line) and outpatient treatment (purple line). Both sexes and all ages combined, each individual patient can receive several kinds of treatment. Figure generated by me, data source: Statistics Norway[27]

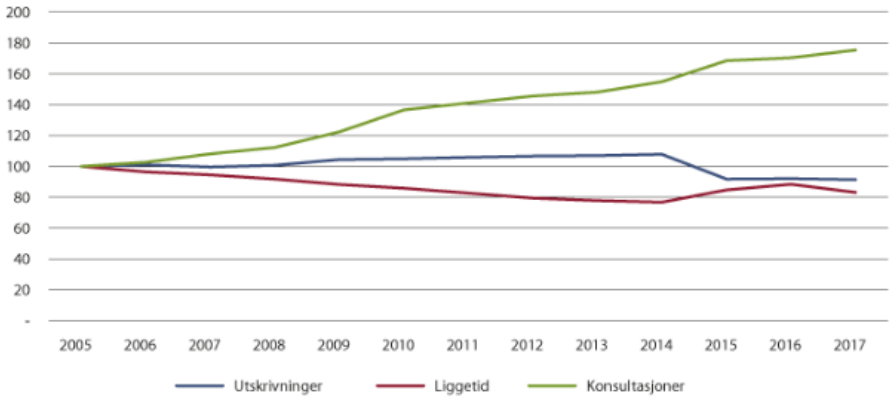

Figure 3: Development in number of somatic hospital stays (blue line), number of days in hospital (red line) and outpatient consultations (green line). 2005-2017. Y-axis: the levels compared to the levels in 2005 (=100). Figure by Statistics Norway/Magnussen et al., 2019[28]

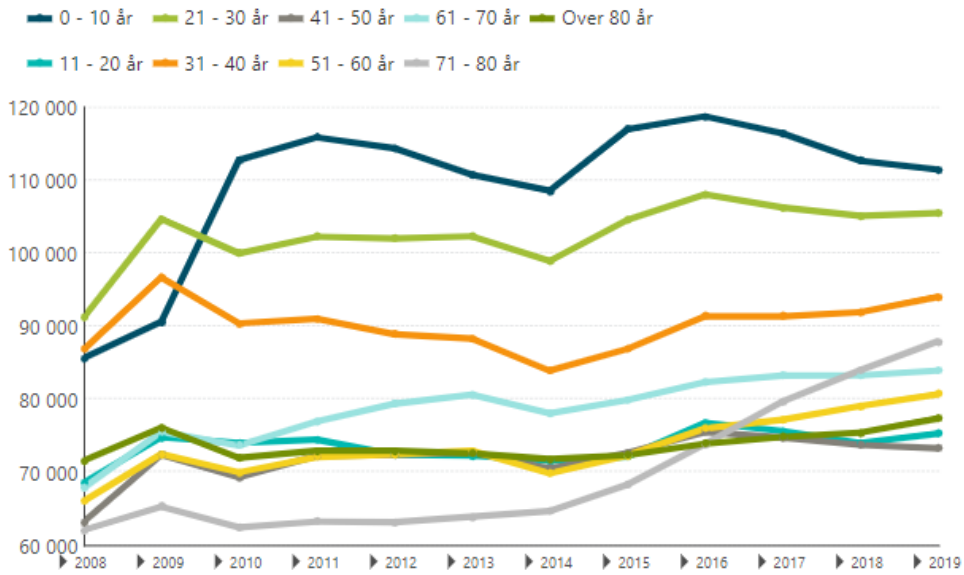

Figure 4: The number of patients with acute admissions to Norwegian hospitals by age group from 2008 to 2019. Figure generated by me, data source: NPR[30]

2.1.3 General Practitioners

General practitioners (GPs) are key service providers in primary care, encouraging health and function, as well as preventing, treating and monitoring illness and function loss[31]. They are responsible for the coordination of services, adequate preventive care, referral of patients to

secondary health care when needed, follow-up and monitoring after secondary health care treatment[20, 32]. GPs play an important role in the management of patients with chronic conditions[33]. Furthermore, adequate access to GP services and continuity of care from GPs have been suggested to prevent deterioration of several medical conditions[33-36] and decrease visits to emergency departments in children[37, 38], the elderly[39], and the general population[40-42] across different health care systems[43].

One of the cornerstones of the Norwegian health care system today is the GPs who treat their patients in all eras of life. They act as gatekeepers, referring to secondary health care when needed and, at the same time, serving as a professional ally to their patients (not necessarily an easy combination[44]).

Organisation and renumeration

The GP services are organised by each municipality[13] and regulated through the ordination of the Municipal Regular General Practitioner Scheme[20]. The GP reimbursement system is based on a combination of payment per capita on their patient list (paid by the municipalities) and fee for services (paid by the state), in addition to the out-of-pocket payments from patients[45]. Many GPs choose to organise their medical practice in group practice. This is done either by self-employed doctors operating group practices in office communities or by group practices operating in the form of a company or through a joint operating company[46]. An alternative to this is the GP working for the municipality with a fixed salary. By December 2019, there were 4,884 GP lists operated by regular GPs in Norway (not operated by locums or shared lists), and 14.0 % of them had a fixed salary [47]. This share has had a steady increase since 11.8 % in January 2018, but it is difficult to see trends over a longer period, as the data on fixed salary from before 2018 is of poor quality[47].

Out-of-hours service

Out-of-hours (OOH) service is the emergency medical treatment programme in primary care, designed for acute conditions outside of normal office hours. It is organised by each municipality[13] and regulated by the regulation of emergency services[14]. Regular GPs participate in OOH services by obligation through the Ordination of the Municipal Regular General Practitioner Scheme[20]. Other doctors (like interns or other non-GP specialists) can participate if they meet professional requirements or have access to a GP specialist on call, regulated through the Regulation on organization of emergency services[14]. Per December

2018, there were 97 OOH (phone) centrals and 177 OOH offices in Norway, the OOH offices being organised as either single-municipal operations (75 offices) or in inter-municipal cooperation (102 offices)[48].

2.1.4 Use of GP services

Almost all Norwegians were included in the Regular General Practitioner Scheme from 2001-2018[22]. In 2018, Norwegians consulted their GPs on average 2.7 times[49], which is in the lower third of the spectrum when compared to other OECD countries[50]. As seen in Figure 5, there is a gradient of more consultations with increasing age[51], and the number of GP consultations has increased the last decade, as seen in Figure 6[52].

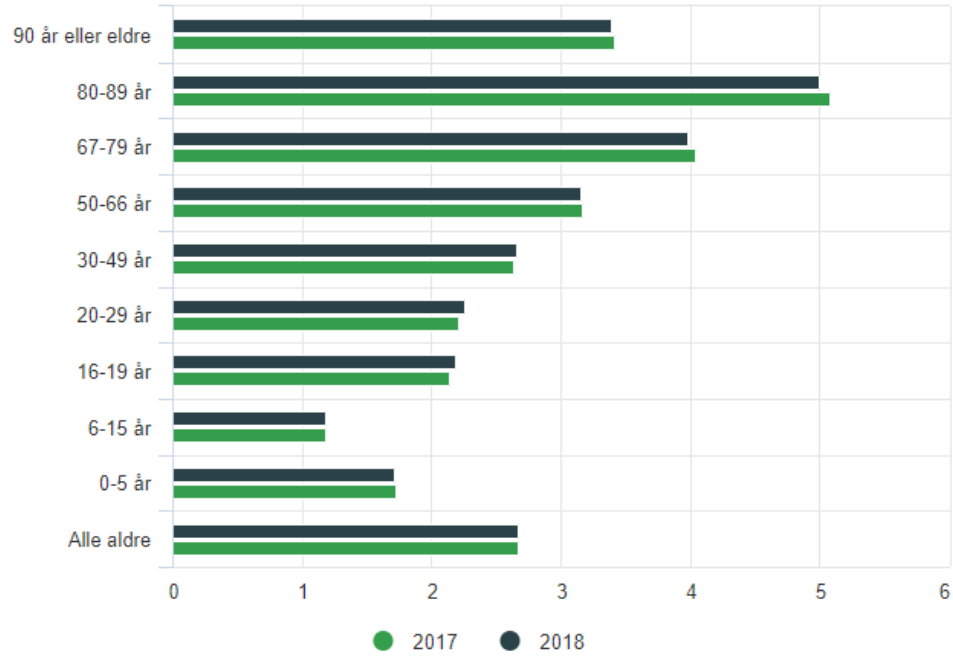

Figure 5: The average number of general practitioner consultations in a year by age in Norway, 2017 and 2018. Figure by Statistics Norway[51].

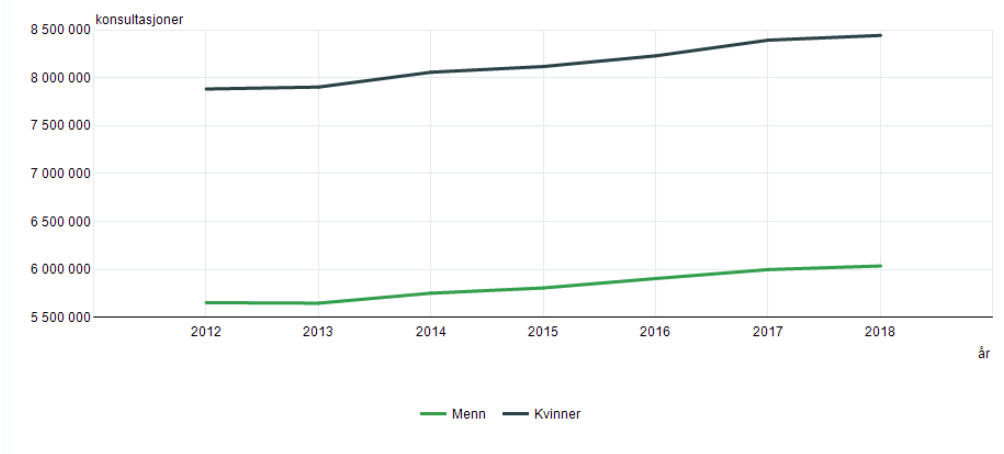

Figure 6: Number of Norwegian general practitioner consultations, by sex (green line = men, black line = women). Figure generated by me, data source: Statistics Norway[52].

The reasons for contact with a regular GP are often complex and will, in many cases, not involve a specific diagnosis or a medical cause of a visit. In addition, patients tend to address several concerns per consultation[53]. This implies that the diagnostic code according to the ICPC-2[2], which the GP registers after each visit, has low accuracy [54]. Also, GP reimbursement is based on codes related to activity (regulated by the Norwegian Directorate for health[55]) and not to diagnosis.

In general, younger age groups contact their GPs for acute/transient conditions and preventive measures, while older age groups contacted their GPs for chronic conditions (increasingly with increasing age)[56]. The most important registered causes for contact (all ages combined) were the diagnosis groups of psychological disease or complaint; respiratory infections, including otitis/ear infection; and localised pain and inflammation[52] (Diagnosis groups by NOMESKO (Nordic Medical Statistics Committee) that correspond to but do not completely overlap with ICPC-2 codes[56]).

When assessing specific diagnoses, the most common ICPC-2 diagnosis for women after seeing their GP was "P76: Depressive disorder" followed by "K86: Hypertension uncomplicated"; whereas the most common diagnoses in men are "K86: Hypertension uncomplicated" followed by "P76: Depressive disorder"[56]. This is not special to Norway. For Paper ll, we chose the diagnoses hypertension and anxiety/depression, as they are both common in the general population worldwide[57, 58] and, to a large extent, managed within

primary health care services. Otherwise, these conditions differ in most aspects. While prevention and follow-up of hypertension have been standardised and regulated through guidelines to which GPs are expected to adhere[59], no direct recommendations exist regarding anxiety/depression.

Regarding OOH consultations, Norwegians had, on average, 0.24 OOH consultations in 2018[52]. The most important registered causes for OOH consultations (all ages combined) were the diagnosis groups of respiratory infections, including otitis/ear infection; accidents/ injuries; and localised pain and inflammation[52] (Diagnosis groups by NOMESKO (Nordic Medical Statistics Committee) that correspond to but do not completely overlap with ICPC-2 codes[56]).

Where can patients turn for help

Within office hours, the public is encouraged to contact their regular GP or the office where their GP works. If on holiday or outside office hours, the public is encouraged to call 116117; the national OOH number (since 01 Sept 2015; prior to then, different local numbers were used)[60]. However, in the case of an acute medical emergency, the public must call 113 to get hold of the emergency medical communication centre (AMK – Akutt medisinsk kommunikasjon, also regulated through the Regulation on organization of emergency services), which guides and provides the help at the proper level and orders an ambulance if necessary[14]. These centrals are governmental, organised by four regional health authorities[14].

2.1.5 Other health care systems, in comparison with the Norwegian system

The Nordic welfare model, aiming for equal access to health care services for all residents, is the basis of the political structures and health care systems in Nordic countries. However, none of the systems are identical. In addition, it is natural to compare the Norwegian system to the English system, as there are a lot of similarities and a lot of research has been executed on English general practice. A brief summary of the Danish, Swedish and English health care systems are summarised below.

Denmark [61]

Denmark has a national health care system that is regulated, planned and funded by the national government (through earmarked income tax) and provided by regional and municipal authorities. With some exceptions, there are no caps on cost-sharing but rather

decreased co-payments with higher out-of-pocket drug spending. Primary care is private and engages in gatekeeping. Registration with a GP is required, and payment consists of an approximately 70% fee for services and 30% for capitation. Almost all hospitals are public, and payments are mainly global budgets and case-based payments[61].

Sweden [61]

Sweden has a national health care system that is regulated and supervised, with some funding by the national government (mainly through general tax revenue raised by county councils and some national tax revenue). Responsibility for most financing and purchasing/provisions is devolved to county councils. There are caps on cost-sharing and some cost-sharing exemptions. Primary care is a mix of ~40% private and ~60% public. There is no gatekeeping, but registration with a GP is required (for all counties except Stockholm). Payment is a mix of capitation (~80% of total) and fee-for-service/limited pay-for-performance (~20%). Almost all hospitals are public, and payment is through global budgets (~66% of total) and case-based payment/limited pay-for-performance[61].

England [61]

England has the National Health Service (NHS), which is publicly financed through general tax revenue. With some exceptions, there are no general caps on cost-sharing. Out-of-pocket payments apply almost exclusively to prescription drugs and medical appliances. Primary care is mainly private with a limited number of NHS-owned practices with salaried physicians; they engage in gatekeeping, and registration with a GP is required. Payment is a mix of capitation/fee-for-service/payment-for-performance, while a minority has salary payments (salaried GPs are employees of private group practices, not the NHS). The hospitals are mostly public, and payment is mainly case-based (60%) with budgets for mental health, education, and research and training[61].

2.2 General practitioners and prevention

The regular GP has an important role in promoting heath and preventing disease in the list population. Adequate prevention and follow-up by the regular GP could also reduce the need for specialised health services. The GP often has important knowledge of their list patients,

such as medical history, medications, family and care arrangements. Such knowledge might be crucial to avoid unnecessary hospital admissions.

According to Ordination of the Municipal Regular General Practitioner Scheme §20, the GPs are to have a key part in individual preventive medicine[20]. The modern comprehension of preventive medicine is more concerned with risk factors and, through reducing their effects, reducing the likelihood and consequences of subsequent illness[62]. Regular GPs have a unique access point for both primary prevention (reducing incidence (number of new cases)[63]), secondary prevention (reducing prevalence (number of existing cases)[63]) and tertiary prevention (reducing sequelae (direct and indirect effects)[63]).

The structural aspects of the GP service promote prevention by ensuring access and continuity for all. Depending on how the GPs arrange their practice, patient follow-up can be preventive in general (e.g. lifestyle recommendations) and more specific with actions related to recommendations and guidelines (e.g. certain patient groups, such as those with cardiovascular risk[64]).

Ideally, proper GP-initiated preventive care could prevent health problems in both the short- and long-term. However, some argue that it is hard to tell who will actually benefit from preventive treatment[65], that it is difficult to measure the effect of preventive treatment and that evidence for large preventive interventions is lacking (particularly among the elderly[66]). It is also difficult to discern preventive activities from other activities in the GP setting, where one consultation often has several functions (see Section 2.1.4 Use of GP services).

The GP also has an important role in preventing or reducing the need for emergency medical care, such as OOH service visits and emergency hospital admissions. This could be done both by preventing acute illness in the first place but also by providing services that would be a better alternative to, for instance, acute hospital admission. With a growing number of hospital admissions worldwide, a relevant question is whether these could have been prevented or avoided. Certain diagnoses and conditions have been identified as causes of potentially preventable admissions—these conditions are often called Ambulatory Care Sensitive Conditions (ASCS)[67]. ACSCs are conditions for which hospitalisation is thought to be avoidable with the application of preventive care and early disease management, usually delivered in the ambulatory setting[67].

ACSCs have been studied internationally with framework and definitions[67] and adapted to the Norwegian context[68]. Studies from many countries[34, 35, 69] point to the role of GPs in preventing these ACSC hospital admissions, while Norwegian results have been inconclusive[68, 70]. In addition, an English study concluded that the drivers of ACSC admissions were complex (including population, practice and hospital factors), and the most important drivers were largely beyond the control of GPs[71].

2.3 Changes in general practitioners' responsibilities and tasks

Almost 20 years have passed since the regular GP scheme was introduced. Even if this scheme has remained largely unchanged, it is likely that general practice and the use of GPs over time have changed. The Coordination Reform starting in 2012 formalised a transfer of many tasks from specialised care to primary care (see Section 2.1.1 The Coordination Reform). Such a transfer of tasks is likely to have considerably changed the GP's work[72]. In this section, I will describe some changes in GP services over time, acknowledging that there is presumably substantial practice variation between GPs at any given time.

Norwegian GPs' responsibilities are given through regulations[20], although the way GPs serve their patients is not controlled in detail but more so up to their individual preferences. This way, GPs have kept a high degree of autonomy even after the implementation of the regular GP scheme, and there is evidence of substantial differences between the way different GPs practice[73], such as participation in meetings[74], carrying out practical procedures like IUD (contraceptive) insertion[75] and referral to secondary health services[76, 77]. Such a variation in GPs' referral patterns has also been seen in many other countries[78], including England[79] and Denmark[80].

Differences in working patterns could be related to GP characteristics, such as sex, age and experience. Prior studies have, for example, indicated that female physicians treat fewer patients than male doctors [81] and refer more frequently to secondary care[76].

A GP's practice will depend on the composition of patients on his or her list, e.g. age, sex, socioeconomic status and morbidity. This is one of the challenges when comparing GPs' practice patterns to each other. List populations with a lower socioeconomic status use GP services more without using more of their GP's time or laboratory tests [82]. An English study

found socioeconomic differences in consultation rates among elderly people (highest among the elderly living alone or in communal establishments)[83].

People seek help from their doctor for different reasons. It has long been known that women see their GP more often than men; while psychological predisposition has traditionally been a more important predictor of health service use for women, health status and social role are more important to men[84]. The decision to actually consult a GP is, however, based on a complex mix of physical, psychological and social factors, where both health status and consultation rates are impacted by socioeconomic and demographic characteristics[85]. However, most symptoms are dealt with outside the GPs office[86]. It is likely that health-seeking behaviours have changed, resulting in Norwegian GPs experiencing a lower threshold for GP consultation over time [72].

A Norwegian study found that patients' age and sex influenced their expectations in how their GP could help them, with the elderly having the highest expectations[87]. Moreover, Norwegian GPs tended to overestimate to what degree their patients would see them for several medical problems, particularly psychosocial problems[87]. Another study found that Norwegian home-dwelling elderly individuals with moderate to severe dementia consulted their GP less frequently than their counterparts with mild or no dementia[88].

When asking Norwegian "not critically ill" patients why they used the OOH services instead of their GP, the most common reason was becoming ill after GP office hours, and some had no desire to wait for the GP office to open the following day[89]. In addition, a large number of patients considered their medical problems as more serious than the health care workers did[89]. As the Norwegian OOH system is somewhat special, studies from other countries are not directly transferable. However, English studies have found that 26.5% of unplanned emergency department visits were due to failed attempts to access primary care[90], and the users of OOH services were mainly children under 5 years old and the poor[91].

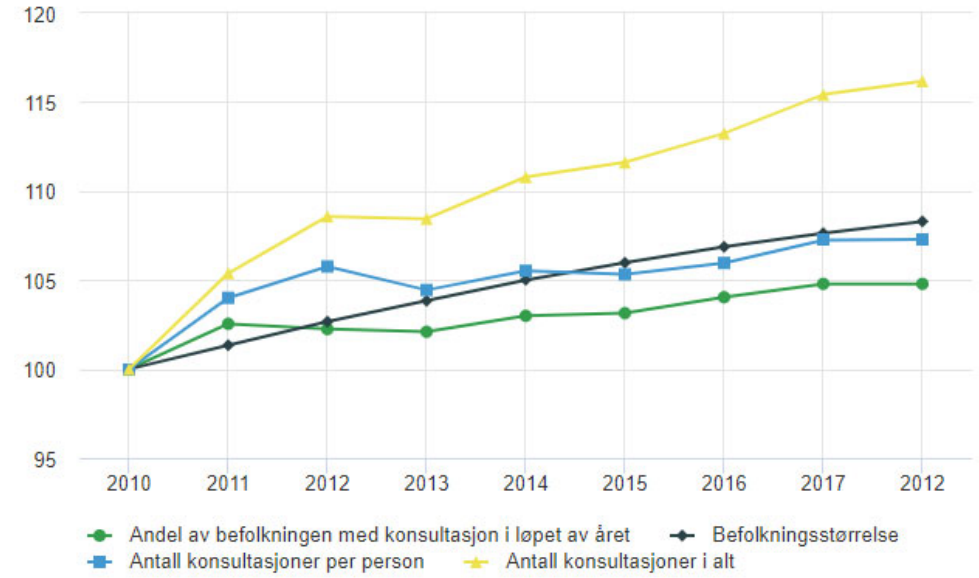

Figure 7: Development in GP consultations and population size. 2010-2018. Y-axis: the levels compared to the levels in 2010 (=100). Green line: share of the population with a GP consultation during the year. Blue line: number of consultations per person. Black line: population size. Yellow line: total number of consultations. Figure by Statistics Norway[51]

The number of GP consultations has increased during the last decade (see Figure 6)[52]. Figure 7 illustrates that this increase, which cannot be fully explained by an increase in population size, is related to both an increase in the percentage of the population who consulted a GP and in the number of consultations per person[51]. During this same period, there has been an increase in the number of working GPs[22] and a decrease in the average number of patients on each GP list[23]. Despite this, there are indications of an increased amount of work for Norwegian GPs and increased work per patient[92]. Among suggested explanations for this are an ageing and more medically complex population, a shift of responsibilities from secondary to primary health care and increased public expectations about health and health services[72]. In a 2016 study of GPs in 26 EU member states, 76% of the states found the GP workload both unreasonable and unsustainable[93]. GP workload is currently a hot topic, as it may influence not only GP job satisfaction[94] but also patient outcomes[95-97].

2.4 Continuity of care

Continuity of care lies in the heart of the regular GP scheme. Ideally, having a dedicated primary physician would provide knowledge on important aspects of the patient's life, together with accumulation of knowledge over time. In this section, I will define continuity of care and present some of the research literature documenting the positive effects for patients. However, conclusions regarding causal relationships between continuity of care and patient outcomes must be drawn with caution due to some fundamental methodological limitations, which also will be presented.

The American Academy of Family Physicians has defined continuity of care as the process in which the patient and the physician are cooperatively involved in the ongoing health care management toward the goal of high quality and cost-effective medical care[98].

Three types of continuity of care can be identified [99]:

1. Informational continuity—The use of information on past events and personal circumstances to make current care appropriate for each individual
2. Management continuity—A consistent and coherent approach to the management of a health condition that is responsive to a patient's changing needs
3. Relational continuity—An ongoing therapeutic relationship between a patient and one or more providers[99].

The establishment of the Norwegian regular GP scheme in 2001 introduced a structural emphasis on the continuity of GP care by entitling all inhabitants (more than 99%[22]) to a regular GP within a list-based system. This system aims for relational, informational and management continuity[99] for the patients: Relational continuity being between patients and their GP; informational continuity consisting of the GP keeping track of and coordinating most information regarding the patient; and management continuity as in the GP practicing a consistent and coherent approach to the patient's changing health needs. This system has shown the ability to provide a high degree of personal GP continuity to patients, even if differences exist, for instance, between larger and smaller municipalities. A Norwegian study from 2012 found that 78% of all consultations were with the usual GP but also that this personal continuity was lower in smaller municipalities[100]. The average length of a GP contract (indicating continuity) in Norway during the period 2001-2014 was almost six years, but it

varied with municipality size, disfavouring the less populated municipalities[101]. Also, 2.5% of patient lists did not have a responsible GP in 2019, steadily increasing from 1.6% in 2012[47]. Most Norwegian GPs work in group practices[47, 102], where common access to patients' journals (shared within the practice) also ensures informational and management continuity in the absence of the regular GP.

A more primary care-oriented health system is assumed to enhance continuity and the coordination of information regarding the patient and management continuity, with regard to access to secondary health care[103]. Strategies to improve continuity of care in general practice might reduce secondary care costs (particularly for "heavy users") and possibly give better experiences to both the patients and GPs themselves[33, 104].

There is extensive literature suggesting that high continuity of care in general practice reduces hospital admissions[33, 35, 43, 105-108], elective[109] and unplanned admissions[110], readmissions[111], out-of-hours service visits[39, 112, 113], mortality[114-117], use of outpatient secondary health care services[106], use of complementary and alternative medical providers[118] and health care costs[119].

The GP who provides interpersonal continuity is valued by most patients[120-122], especially by the most vulnerable patient groups, such as those with multimorbidities[123] and more serious conditions[124]. Patients value their GPs' knowledge of them[121, 124], although some patients (and situations) prefer availability and a fresh perspective[122].

However, there are challenges when comparing patients with a high degree of continuity of care from their GPs to patients with a lower degree of continuity of care. One might end up comparing rather different patient groups and, hence, introducing confounding due to potential underlying differences in the patient groups regarding age, sex, education, level of (co)morbidity, etc. (See Section 6.2.2 Confounding). In the practical aspect of measuring continuity of care, measuring the regularity of GP contacts at the patient level might reflect the patient's underlying characteristics (including morbidity). In addition, results may depend on the measuring index used[125]. One can even ask the question: What is really measured when measuring continuity of care? Is it a characteristic of the GP who calls his/her patients to an appointment, the individual patient (who makes an appointment), the system (including guidelines or standardised patient trajectories) or a mix of everything? If continuity of care is

a trait associated with practice, it may again reflect the composition of the patients belonging to the practice. An Italian outpatient study found high levels of continuity of care to be associated with the elderly, females, higher levels of education, and having better health[126]. (Furthermore, most studies we came across compared patient groups with either high or low level of continuity of care regarding one or several outcomes).

Cessation of continuity of GP care

Due to the advantages of continuity of care, it seems likely that cessation of continuity of care would be unfortunate. Compared to the immense body of research on continuity of care, not much has been researched on the cessation of GP care. A review of physician turnover from 2004 mentions the risk of patient dissatisfaction[127], but it was specific to general internal medicine practices in Boston, USA[128].

3 Aims

3.1 General objective

The general objective of this thesis was to investigate patients' contact with GPs and how the use of health care services changes 1) prior to acute hospital admissions, 2) in a period when GPs' responsibilities for health care services increased and 3) when patients are suddenly exposed to a situation where their regular GP was unavailable for a longer period of time. These aims were analysed within the context of patients with expected close follow-up and need of attention from both primary and secondary health care.

3.2 Specific aims

The aims of the studies were:

Paper I

- To investigate the extent and timing of contacts with GPs (both regular and out-of-hours (OOH)) among adults aged 50 years and older during the year before emergency hospital admission for five common acute diagnoses (acute myocardial infarction; hip fracture; stroke; heart failure; and pneumonia).

Expecting a gradual increase in contacts as patients got closer to the time of hospital admission, we investigated the extent and timing of contacts according to diagnosis and type of GP contact (regular GP vs. OOH services). If an increase in GP contact could be observed over a longer period (e.g. several months), indicating a gradual health deterioration culminating in the acute or subacute situation causing the emergency hospital admission, this could point to both a preventive potential and the role of close monitoring of vulnerable patients in primary care.

For acute myocardial infarction and stroke, we also wanted to explore whether these groups had a more stable level of GP contacts over time before an acute incident leading to their admission, or if there was any indication of increased contact in the weeks or months before admission—indicating a potential for prevention or early detection in primary care.

Paper ll

- To investigate contacts with primary physicians after participation in a large population-based survey (The HUNT study). Participants with baseline known hypertension or anxiety/depression or risk profiles for hypertension or anxiety/depression (indicating an increased need for GP contact) were compared to participants without known disease/risk profiles and followed for a period of 10 years (2007-2017).

We aimed to explore whether follow-up changed for patients with chronic conditions during this period in which GPs experienced a gradual increase in responsibilities and, in particular, after the initiation of the Norwegian Coordination Reform (1 January 2012).

Our hypothesis was that the different patient groups would show different GP consultation patterns over time, and that consultations for those with chronic conditions would increase after the Coordination Reform.

We also wanted to investigate the extent to which consultation patterns differed between GPs and whether this had changed with time, hypothesising that major changes like the Coordination Reform would either increase or decrease the differences.

Paper lll

- To Investigate how a sudden discontinuity of GP care affects their list patients' regular GP consultations, out-of-hours consultations and acute hospital admissions, including admissions for ambulatory care sensitive conditions (ACSC). Starting out with the entire Norwegian population from 2006-2016, access to administrative registry data allowed us to identify and follow all patients experiencing discontinuity of GP care, hence comparing the patient population to itself before and after discontinuity.

We wanted to analyse the use of primary and specialist health care services in list patients exposed to GPs who suddenly stopped seeing patients for two or more months, hypothesising that this discontinuity would decrease patients' use of any regular GP but increase their use of the OOH services and potentially the need for acute hospital admission. We believed that an increase in the OOH services both could be due to a lack of access to the regular GP during office hours but also potentially because patients wait longer before seeing a doctor and develop acute conditions. In the latter case, one would expect acute hospital admissions to

increase. Furthermore, we also hypothesised that not being able to see the regular GP could lead to an increase in avoidable hospital admissions, as the regular GP would be better suited to do a proper assessment of both the medical conditions and the patient's total situation, including alternatives to hospital admission.

4 Materials and methods

In this section, I will present our ethical considerations and disclaimer before giving detailed presentations on data provision, study designs and populations, study variables and statistical analysis.

4.1 Ethical considerations

The project was approved by the Regional Committee for Medical and Health Research Ethics in central Norway (2011/2047 (Paper I) and 2016/2158/REK midt (Papers II and III)). When participating in the Nord-Trøndelag Health Study/HUNT (ref 2018/13051/TRS), each participant signed a written consent for the data to be used in future research. We conducted the studies in accordance with the Helsinki Declaration on ethical principles for medical research involving human subjects, including research on identifiable human data. Only anonymous case numbers were used to link data from the different data sources, and the key was made and kept by an independent third party (The Department of Computer Science (IDI) at NTNU for Paper I; Statistics Norway for Papers II and III). All analyses were on either aggregated or anonymised subsets of data.

4.2 Disclaimer

For this thesis, data from the following registers were used: Municipal Health Care Data (from four different Norwegian municipalities), the Norwegian Control and Payment of Health Refunds (KUHR), the Norwegian Patient Register (NPR), the Nord-Trøndelag Health Study (HUNT3), the General Practitioner Register and Statistics Norway (The National Education Register (NUDB) and Demographics (The National Population Register)).

The interpretation and reporting of these data are the sole responsibility of the authors, and no endorsement by the different registries is intended nor should be inferred.

4.3 Data provision (and variables)

Paper I is based on a linkage between routine patient administrative data from St. Olav's University Hospital (the same data that the hospital reports to the Norwegian Patient Register), Municipal Health Care Data (from four different Norwegian municipalities) and individual-level data on primary health care use (The Norwegian Control and Payment of Health Refunds (KUHR)); all data were from 2012 through 2013.

Paper II is based on a linkage between the third wave of the Nord-Trøndelag Health Study (HUNT3), individual-level data on primary health care use (the Norwegian Control and Payment of Health Refunds (KUHR)), GP affiliation and GP characteristics (the Norwegian General Practitioner Register), education and demographic information (Statistics Norway); data were from 2007 through 2016.

Paper III is based on a linkage between the Norwegian Patient Register NPR, individual-level data on primary health care use (The Norwegian Control and Payment of Health Refunds (KUHR)), GP affiliation and GP characteristics (the Norwegian General Practitioner register), education and demographic information (Statistics Norway); data were from 2006 through 2016/2017.

For all papers, the linkages between the different data sources were built on the 11-digit Norwegian personal identification number; all data were de-identified before being handled by us. An overview of the data sources for the different papers and their respective time periods is given in Table 1, followed by a description of each of the different data sources, including their use in the papers. A more detailed description of the specific variables is presented later (Section 4.5 Study variables).

Table 1: Data sources for the different papers and their respective time periods

Database	Data owned by	Variables	Time periods		
			Paper I	Paper II	Paper III
Municipal Health Care Services	The respective municipalities	-municipality -birth year[1] -sex -use of municipal services -short/long term institution stay	2012-2013		
KUHR	HELFO	Reimbursement claims with -date -tariff code	2012-2013	2007-2016	2006-2017
NPR	HELFO	-date of admission -level of urgency -type: inpatient or outpatient -diagnosis (ICD10)[2] -length of hospital stay[2]	2012-2013	2007-2016	2008-2016
The HUNT3 Study	HUNT/NTNU	-birth year[1] -sex -self reported health variables -blood pressure measurement		2006-2008[3]	
The General Practitioner Register	HELFO	GP characteristics: -birthyear[1] -sex -specialist in GP -number of list patients -municipality		2007-2016	2006-2016
The Norwegian Education Database	SSB	-the highest level of achieved education[4]		2007	2016
Demographics / Folkeregisteret	SSB	-birth year[1,5] -sex[5] -date of death -date of migration		2007-2016	2006-2017

1: precision yearly
2: variable used in Paper I only
3: HUNT3 was enrolled between 03 Oct 2006 and 25 Jun 2008[129]
4: highest level of achieved education by 01 Oct of the year in question
5: variable used in Paper III only
Notes: HELFO – The Norwegian Economics Administration

4.3.1 Municipal health care data.

The municipalities provide primary health care services to their inhabitants and keep track of services applied for and offered to whom and at what time. For Paper I, routine patient administrative data for all municipal health care service users were collected from the registers of four municipalities (Trondheim, Malvik, Melhus and Midtre Gauldal) from 2012 through 2013, covering a population of 214,722 persons. This data contained information regarding all health care data from the municipalities; what kind of service the respective recipient obtained and at what time (start and end dates). We used information regarding living in a nursing home (short-term and/or long-term institution stay) and receiving any municipality services (all types included), all with start and end dates.

4.3.2 Control and payment of health reimbursement— KUHR[55]

The Norwegian Control and Payment of Health Refunds (KUHR) is a system that handles reimbursement claims from practitioners and health institutions to the state: the Norwegian Health Economics Administration (HELFO). The system is owned by the Norwegian Directorate of Health. The KUHR database is a collection of all individual bills for treatment from GPs, contract secondary health care providers and physical therapists, among others. The register contains information on all claims from practitioners related to the treatment of individual patients, including date, type of treatment (coded according to "tariffs for general practitioners and out-of-hours service"[130, 131]) and medical diagnosis (coded using ICPC-2[2]).

Full data is available from 2006[132].

For all three papers, we used information regarding tariff codes for GP consultations (tariff code 2ad), out-of-hours service consultations (tariff code 2ak), and the date the bill was submitted. For Paper II, we also used the tariff code for GP consultations exceeding 20 minutes (tariff code 2cd).

4.3.3 The Norwegian Patient Register—NPR [133]

The Norwegian Patient Register (NPR) was established in 2008 and is run by the Norwegian Directorate of Health[133]. It contains routine patient administrative data regarding all publicly financed (public and contracted private) outpatient clinic visits and hospital stays[133].

For all three papers, we had patient-level data from NPR on the type of contact (outpatient vs inpatient), date of admission, level of urgency, medical diagnosis (ICD10 codes for Paper I: myocardial infarction (I21), heart failure (I50), stroke (I61, I63 and I64), fracture of hip/femur (S7) and pneumonia excl. COPD (J12-18, excl. those with COPD (J41-44 or J47) as a secondary diagnosis)). For Paper I, we also had the length of the hospital stay.

For Paper I, the data was directly obtained from St. Olav's University Hospital in Trondheim. St. Olav's is a publicly owned Norwegian academic teaching hospital, providing both local and regional specialised care for all the participating municipalities. For Papers II and III, data were delivered by NPR.

4.3.4 The Nord-Trøndelag Health Study (HUNT)

The Nord-Trøndelag Health Study (HUNT; an acronym for the Norwegian name **H**else**u**ndersøkelsen i **N**ord-**T**røndelag[134]) is a population-based cross-sectional health study that has been carried out four times so far: HUNT1 (1984-86), HUNT2 (1995-97), HUNT3 (2006-08) and HUNT4 (2017-19)[134, 135]. In each wave, all residents of Nord-Trøndelag County aged ≥20 years were invited to participate. Participants answered a questionnaire received by mail (Q1) and underwent physical examinations. From HUNT2 onward, biological material was also collected. After the examination, additional questionnaires were handed out; Q2 with a common part combined with an age- and sex-specific part for all and Q3 for the subgroups based on the answers given in Q1[134]. (All HUNT questionnaires are available online at https://www.ntnu.no/hunt/skjema).

Nord-Trøndelag was a Norwegian county until 01 January 2018, when it joined Sør-Trøndelag to form Trøndelag County[136]. At the time of HUNT3 (2006-08), Nord-Trøndelag County consisted of 24 municipalities (see Figure 8)[134]. The average level of education in Nord-Trøndelag was somewhat lower compared to the Norwegian average both in 2007 (21% vs 26% with tertiary education) and 2016 (26% vs 34% with tertiary education, respectively)[137].

From HUNT1 to HUNT3, the participation rate declined from 89% to 54%[134]. Overall, more women than men participated, and in HUNT3, the highest participation rate was among 60-69 year olds: 75% for women and 68% for men[134]. Among HUNT3 non-participants (inhabitants in Nord-Trøndelag who did not participate in HUNT3), more than 50% reported

lack of time or inconvenient sessions as their main reason for not participating[138]. However, HUNT3 non-participants had a lower socioeconomic status and higher mortality compared to HUNT3 participants[138]. Moreover, non-participants had a higher prevalence of cardiovascular diseases, diabetes and mental distress that seem to parallel differences in socioeconomic groups and risk factor exposure[138].

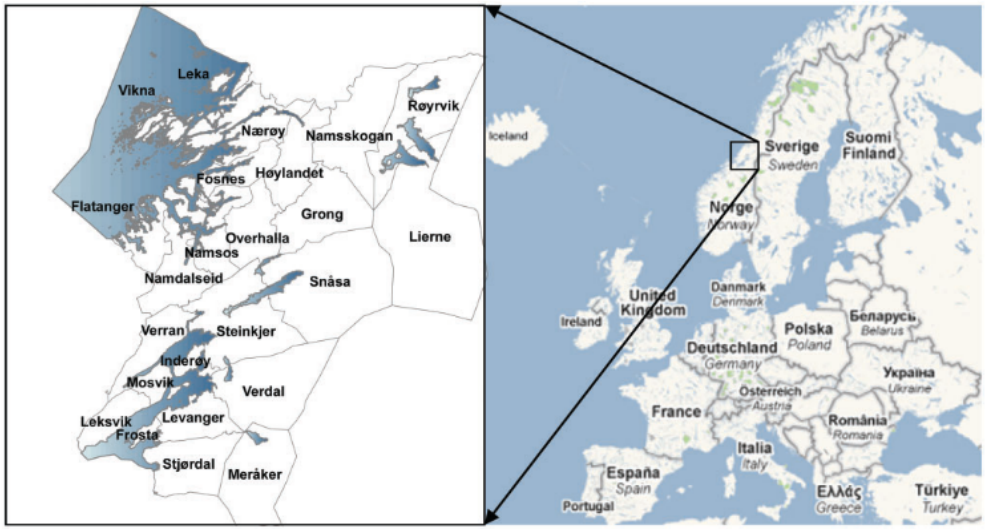

Figure 8: The HUNT study area with the 24 municipalities that used to constitute Nord-Trøndelag County at the time of HUNT1-3. Figure by Krokstad et al., 2013[134], used with permission.

HUNT provided a sub-population of participants in the HUNT study and provided different health measurements and self-reported health information from the physical examinations and questionnaires.

For Paper ll, we used participants in HUNT3 as our study population/cohort and collected health information from the physical examination (blood pressure measurement) and questionnaires (birth year, sex, symptoms of common mental disorders identified by the Hospital Anxiety and Depression Scale (HADS), and the answers to "have you ever…" for up to 21 chronic diseases).

4.3.5 The Norwegian General Practitioner Register[139]

The Norwegian General Practitioner Register provides an overview of all the Norwegian doctors with a regular GP contract and all their individual list patients on a monthly basis [139]

since the start of the GP list system in 2001. HELFO (The Norwegian Health Economics Administration, an external agency of the Norwegian Directorate for Health and Social Affairs) administers parts of the regular GP scheme on behalf of the municipalities and is responsible for keeping the Norwegian General Practitioner Register up to date[140].

For Papers II and III, we linked each study participant to their respective GP at defined time points and used information on individual GP characteristics (sex, birth year, specialist status, list size and practice municipality).

4.3.6 Statistics Norway (SSB)[141]

Statistics Norway (SSB) is the national statistical institute of Norway, regulated by the Statistics Act of 1989[142]. SSB is the main producer of official statistics and responsible for collecting, producing and communicating statistics related to the economy, population and society at the national, regional and local levels[141]. Each Norwegian citizen has a unique 11-digit identification number[143]. This number allows data to be merged from different sources.

For Papers II and III, Statistics Norway drew a selection of participants, generated a serial number based on the Norwegian personal identification number and stored the link key. In addition, they also provided data for our study population: demographics (birth year and month, sex, date for death and migration) and level of education.

The National Education Register (NUDB)[144]

The National Education Register (NUDB) was established in 1970 and contains information regarding each Norwegian citizen's educational enrolment, graduation and highest level of education. The database is updated annually on 1 October with information regarding education completed during the previous academic year[144]. The Norwegian standard for educational groups (NUS) consists of six hierarchical digits, where the first digit indicates nine different levels of education[145].

For Papers II and III, we used the highest achieved level of education at baseline (2007 in Paper II and 12 months prior to discontinuity in Paper III)—enabling us to use education level as a measure of socioeconomic status.

Demographics—censoring variables

Person-level information regarding migration and death, with precision at exact dates throughout the study period, enabled us to censor those who migrated at the exact month of emigration.

4.4 Study design and populations

4.4.1 Paper I

Paper I is a longitudinal design with data from Norwegian national and municipal registers. We applied register-based information on all somatic health care contacts for the inhabitants in four municipalities (one municipality containing a city (Trondheim) and three neighbouring, more rural municipalities (Malvik, Melhus and Midtre Gauldal)) in central Norway in a two-year period from 2012 to 2013, covering a population of 214,722 persons.

Inclusion criteria for the analysis were age 50 years or older by the end of 2012, having at least one emergency hospital admission in 2012 or 2013 for one of five selected diagnoses (myocardial infarction, heart failure, stroke, pneumonia (without COPD) or hip fracture), and having at least one month of observation time before admission (excluding emergency admissions before 1 February 2012).

4.4.2 Paper II

Paper II is a cohort study, linking survey data and clinical measurements from the Norwegian HUNT3 study (2006-2008) with national administrative data on GP list assignment and consultations with GP services.

HUNT3 data were linked to individual-level data on primary health care use (Control and Payment of Health Reimbursement—KUHR)[55], GP affiliation (Norwegian General Practitioner register[139]), education and demographic information (Statistics Norway[141]) (see Paper II, Supplementary Figure 1). For inclusion, participants had to be 20 years or older by 31 December 2007, and they had to have filled in the HUNT3 questionnaire. Our observation period was from 1 January 2007 to 31 December 2016 with information on health care use registered throughout the period.

4.4.1 Paper lll

Paper lll is a cohort study linking individual-level demographical information from Statistics Norway[141] with several Norwegian national registers: the Control and Payment of Health Reimbursement register (KUHR)[55] (on regular and out-of-hours consultations with GPs), the Norwegian General Practitioner Register[139] (on GP affiliation, patient list information, individual GP characteristics) and the Norwegian Patient Register[133] (on acute hospital admissions).

Among doctors with an episode of discontinuity (see Section 4.5.2 Main exposure—Time, Paper lll), we only included episodes of discontinuity for regular GPs registered as list owners (excluding locums, interns) in the last month of normal operation (number of GP episodes=5610) and who had a stable practice during at least 12 previous months – with the same list and no month with less than 10 consultations (excluding 2,399 episodes). Furthermore, we excluded 293 episodes for GPs registered with short lists (<500 patients) or low activity during the 12 months before the break (<1000 consultations or ratio<1 for the total number of consultations the last 12 months/registered list size). For each doctor, we only kept the first episode of discontinuity (whereas patients could experience several episodes), removing 415 episodes. The final GP population consisted of 2,501 GPs.

The patient population comprised all persons (0-80+ years old) registered as list patients of the GPs with an episode of practice discontinuity 12 months before this discontinuity (as described under Section 4.6.4 Statistical analysis, Paper lll).

4.5 Study variables

4.5.1 Main outcomes—Health service utilisation

GP consultations were our main outcome in all three papers. OOH consultations were a main outcome in Papers l and lll and an additional outcome in Paper ll. Regular GP consultations exceeding 20 minutes were an additional outcome in Paper ll. Emergency hospital admissions were a main outcome in Paper lll and were used to define the study population in Paper I.

GP and OOH contacts and consultations

We included all contacts with general practitioners working in a regular GP and/or OOH setting, defined by claims of reimbursement generated by each practitioner after each

contact and sent to the Norwegian Health Economics Administration (Helfo)—available from the KUHR database.

For Paper I, the KUHR data already provided information on whether the claim was made in a regular GP or OOH setting. We included *all* contacts made in either a regular GP setting or in an OOH setting, both dichotomised into "contact" or "no contact", each month for one year before hospital admission and in three-day intervals during the month before admission. We omitted contacts on both the day of admission and the day before (i.e. day 0-1) to avoid registration of the contact directly leading to the emergency hospital admission.

For Papers II and III, the KUHR data did not have information regarding the setting in which the claim was made. Regular and out-of-hours GP consultations were, therefore, identified by the tariff/reimbursement code for a regular GP consultation (code 2ad[131]) and a GP consultation outside normal working hours (code 2ak[131]). For Paper II, we also used the reimbursement code for consultations lasting more than 20 minutes (code 2cd[131]).

GP consultations, OOH consultations and consultations lasting more than 20 minutes were all dichotomised into monthly "consultations" or "no consultations".

Acute hospital admissions and hospital stays

For Papers I and III, we used information about acute hospital admissions as an inclusion criterion in Paper I and as an outcome in Paper III.

For both Papers I and III, acute hospital admissions were identified in the Norwegian Patient Registry, using the dates of admission and discharge for hospital stays that were coded as acute. In Paper III, we also identified acute hospital stays for ambulatory care sensitive conditions (ACSC), using NHS Digital's ICD-10 codes for ACSC episodes[146]: chronic conditions for which effective management prevents flare-ups (angina pectoris, asthma, chronic obstructive pulmonary disease, congestive heart failure, convulsions/epilepsy, diabetes complications, hypertension and iron deficiency anaemia), acute conditions for which early intervention may prevent more serious progression (ear, nose and throat infections, cellulitis, pyelonephritis, dehydration/gastroenteritis, pelvic inflammatory disease, gangrene, dental conditions, nutritional deficiencies, perforated/bleeding ulcer) and vaccine-preventable conditions (Influenza, pneumonia and other)[146].

In Paper I, we also used all kinds of hospital stays (both acute and elective, for causes other than the specific diagnosis) as an adjustment variable in the analyses the month before the acute hospital admission, as the study participants would not see their GP or OOH when in hospital.

Municipal services

For Paper I, we had person-level information on the use of municipal services such as home nursing care, home aid, and long- and short-term stays in institution, with both start and end dates. These services were combined and dichotomised into "use" or "no use" each month during the year before an emergency hospital admission, and each three-day period during the month before admission. Long- and short-term stays in institution were also used as an adjustment in the analyses of GP contacts, as institutionalised patients are usually provided with municipal primary health care physicians who are not included in the GP scheme (but they still use the OOH services).

4.5.2 Main exposure—Time

Time was the main exposure in all three papers, but it was treated differently in the respective papers, see Figure 9.

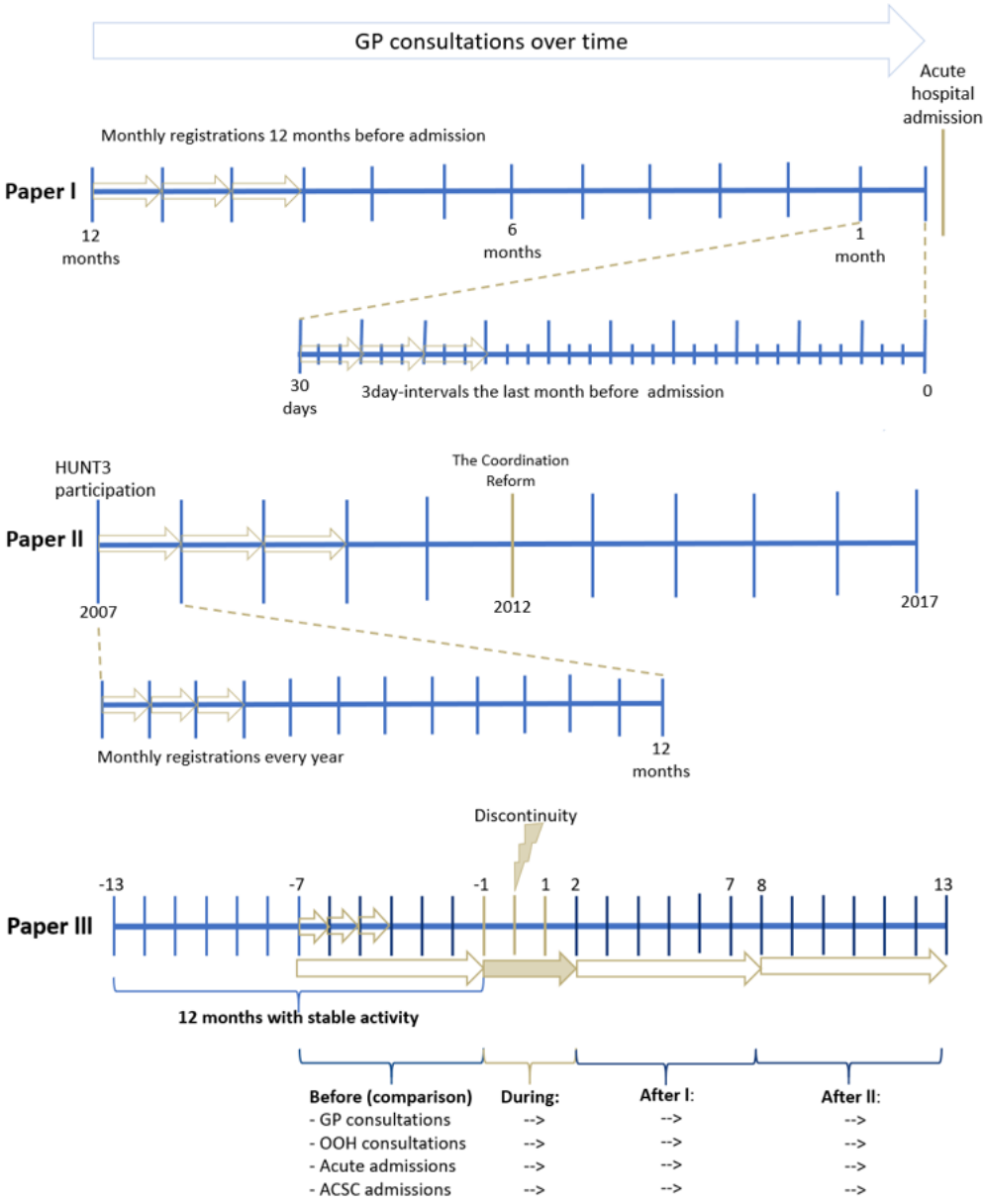

Figure 9: Time periods for Papers I, II and III. Figure by me, Skarshaug.

Paper I

For the analyses of GP and OOH contacts the year before hospital admission, we included time in the models as a categorical variable with 12 monthly intervals, each at a different temporal distance from the date of the admission (see Figure 9). Contact (at least one contact (1) vs. no contact (0)) was assessed for each monthly interval.

For the analyses of GP and OOH three-day contact the month before hospital admission, we grouped time as a categorical variable with 10 three-day intervals, each at a different temporal distance from the date of the event (see Figure 9). Contact (at least one contact (1) vs. no contact (0)) was assessed for each three-day interval.

Paper II

For the analysis of GP and OOH consultations, we measured consultations (at least one consultation (1) vs. no consultation (0)) per month per year from 2007 through 2016 (see Figure 9). In addition, we measured the number of consultations per year.

Paper III

From 2007 to 2017, we assessed the number of submitted reimbursement claims for ordinary consultations (code 2ad) in the KUHR database for all medical doctors working in general practice. Episodes of two or more consecutive months with no/very low (<10 consultations per month) activity were identified as **discontinuities**, with the first month indicating the time of discontinuity (see Figure 9). We defined the month two months before the index month as "last month of normal operation" (see Paper III, Figure 1). For each doctor, we only kept the first episode (whereas patients could experience several episodes) and linked their unique doctor identification number to data from the Norwegian General Practitioner Register, including GP and list characteristics and list identification 12 months before the discontinuity.

For each patient, we defined four different periods according to their time from the index month of discontinuity (see Figure 9), with monthly registrations of health care use before (2-7 months before), during (1 month before to 1 month after) and after (2-7 months after and 8-13 months after).

4.5.3 Covariates/adjustment variables—Participant characteristics

Age and sex

For all study participants, we had birth year and sex. Birth year enabled us to categorise participants into the following age groups:

Paper I: participants 50-64 years, 65-79 years, and 80+

Paper II: participants 20-39 years, 40-59 years, 60-79 years and 80+

Paper III: participants 0-18 years, 19-44 years, 45-64 years, 65-79 years and 80+ (standard MeSH groups)

Demographics and censoring variables[141]

For Papers II and III, we had the time of death from Statistics Norway, enabling us to censor at death. For Papers II and III, we also had access to dates of emigration; although it is possibly reversible, we censored participants at the first month of emigration in both studies.

Municipality

For Paper I, we had access to the participants' municipality of residency, allowing us to dichotomise participants into living in a big city or not. For Paper II, we used the municipality of the GP (from the Norwegian General Practitioner Register) to remove HUNT3 participants with GPs outside (former) Nord-Trøndelag county. For Paper III, we used the municipality of the GP to make two sub-selections consisting of 1) patients linked to GPs practicing in one of the 10 most populated Norwegian municipalities and 2) patients linked to GPs practicing in one of the municipalities with less than 2,000 inhabitants (both assessed per second quarter of 2019).

Education

For Papers II and III, we measured the participants' highest achieved level of education.

Originally divided into nine categories, we used the first digit of the original six-digit NUS codes to make three categories: 1= "no/primary/lower secondary school" (from NUS 0, 1, 2), 2= "upper secondary school" (from NUS 3, 4, 5) and 3= "college and university" (from NUS 6, 7, 8)[145].

For Papers II and III, we used the highest achieved level of education at baseline (2007 in Paper II, and 12 months prior to discontinuity in Paper III)—enabling us to include educational level as a covariate in our analyses.

GP characteristics

For Papers II and III, we included the GPs' sex and birth year. For Paper II, birth year was divided into GPs' birth decade (born in 1940s, 1950s, and so on, where 1970s also included 1980–81), whereas for Paper III, we dichotomised age into GPs <50 years old or 50+.

For Paper II and III, we included a GP identification number, enabling us to do multilevel models with participants nested in their assigned regular GP (Paper II) and only include GPs registered as the respective list owners (Paper III).

In addition, Paper II included information on whether the GP was a GP specialist, while Paper III included list size.

Health variables

Diagnosis groups in Paper I

For Paper I, we chose the following well-defined common causes of emergency hospital admissions in adults 50 years and older (with corresponding diagnosis codes used from International Classification of Diseases, ICD-10[1]):

Myocardial infarction (I21), heart failure (I50), stroke (I61, I63 and I64), fracture of hip/femur (S7) and pneumonia excl. COPD (J12-18, excl. those with COPD (J41-44 or J47) as a secondary diagnosis). Diagnoses were based on the primary diagnosis as recorded by the hospital. To make the pneumonia group of more homogenous we excluded all admissions with chronic obstructive pulmonary disease (COPD) as secondary diagnosis. Heart failure, hip fracture and pneumonia are also ambulatory care sensitive conditions (ACSC). For each patient, only the first admission for each specific diagnosis during the study period was included.

Hypertension

For Paper II, we used HUNT3 variables to make the hypertension groups. Specially trained nurses and technicians conducted the clinical examinations, and we used the mean blood pressure of the second and third measurements. The cut-off for hypertension was systolic blood pressure >140mmHg and/or diastolic blood pressure >90mmHg[147]. We combined the measured blood pressure with the response to the question, "Do you currently use antihypertensive medication, or have you done so previously?" (response alternatives yes/no, where any case of missing data was defined as the absence of the disease in question), giving the groups:

"Hypertension": current/previous antihypertensive medication regardless of measured blood pressure.

"Non-medicated hypertension": hypertension at examination, *no* current/previous antihypertensive medication.

"Normotensive": normotensive at examination, *no* current/previous antihypertensive medication.

Symptoms of anxiety/depression

For Paper II, we used HUNT3 variables to make the anxiety/depression groups. The 14-item Hospital Anxiety and Depression Scale measured symptoms of anxiety and depression (HADS, four-point Likert scale scored 0–3[148]), where seven items measured symptoms of depression (HADS-D) and anxiety (HADS-A), respectively. We used a cut-off score at ≥8/21, concordant with validation studies reporting sensitivity and specificity for both anxiety and depression to be between 0.80 and 0.90[149]. We combined the HADS score with the response to the question "Have you had, or do you have any of the following: mental health problems you sought help for?" (response alternatives yes/no, where any case of missing data was defined as the absence of the disease in question), giving the groups:

"Anxiety/depression symptoms, *having* sought help for mental health problems"

"Anxiety/depression symptoms, *never* sought help for mental health problems"

"'Normal' range of anxiety/depression symptoms, *having* sought help for mental health problems"

"'Normal' range of anxiety/depression symptoms, *never* sought help for mental health problems"

Comorbidity

In Paper II, self-reported health and physical examination from HUNT3 was used to construct a co-morbidity score. Hypothesising that the higher the level of co-morbidity, the higher the level of consultations, we adjusted for the level of co-morbidity on a continuous scale. Our analysis included 21 chronic diseases/conditions (detailed description found elsewhere[4]). Any case of missing data was defined as the absence of the disease in question. We calculated the

co-morbidity score of each participant in the different patient groups, excluding the condition in question (maximum 20 points/other diseases or conditions).

Premorbid conditions in Paper III

Patient's health status was assessed during a 12-month period prior to follow-up (8-19 months before discontinuity) according to availability. We identified three subgroups for which we considered continuity of care to be of particular benefit: 1) Hypertension – all patients having one or more diagnoses of hypertension (ICPC2 diagnosis K85-87) in the KUHR data. 2) Ischemic heart disease – all patients having one or more diagnoses of (ICPC2 diagnosis K74-80) in the KUHR data and 3) acute hospital stay – all patients having one or more acute hospital stay.

4.6 Statistical analysis

4.6.1 Software

We performed all analyses with STATA version 15.1, and we present all precision levels with 95% confidence intervals (CI).

4.6.2 Paper I

GP and OOH contacts before an acute hospital admission

We used binomial generalised estimation equation models with a logit function (GEE[150]) to investigate GP and OOH contacts before the hospital admission. Based on the results from these models, we estimated the percentage with contact per month during the year before the event. Secondly, we estimated the percentage with contacts per triplets of days (2-4, 5-7, …., 29-31 days) before the admission. We omitted contacts on both the day of admission and the day before (i.e. day 0–1) to avoid registration of the contact directly leading to the emergency hospital admission (see Figure 9). We performed the analysis separately for each of the selected patient groups.

For the analyses of GP and OOH contacts the year before hospital admission, we adjusted for calendar month, age, sex, and whether the patient lived in a city. Analyses of GP contacts were also adjusted for whether the patient was institutionalised (including long- and short-

term stays in municipal institutions), as institutionalised patients are usually provided with municipal primary health care physicians who are not included in the GP scheme (but they still use the OOH services).

For the analyses of the GP and OOH three-day contacts the month before hospital admission, we adjusted for the same variables as for the year before, with the exception that we adjusted for weekday of admission event. We also adjusted for whether the patient was an inpatient (acute or elective) during the month before admission, as they would see neither their GP nor OOH when in hospital.

We used the estimates from these analyses to produce graphical presentations of GP and OOH contacts during the year and month before hospital admission for each of the five patient groups. To make results more comparable between the patient groups, we chose to show the estimated percentages for a "standard" patient. We selected a woman aged 75 who was not in institution.

We repeated the analyses described above using conditional logistic regression models to calculate odds ratios of GP and OOH contacts at different time points during the year and month before admission (compared to six months before and the three-day interval 29-31 days before the admission, respectively). In these analyses, patients are compared with themselves, automatically adjusting for all characteristics that are stable within a person (e.g. sex, age and municipality of residence, as well as more difficult-to-measure variables such as stable co- or multimorbidities).

No contacts before an acute hospital admission

We explored the association between patient characteristics (sex, age group, institution) and having *no* GP or OOH contact in the month before an emergency hospital admission (no contact vs. contact) using logistic regression. These analyses included a statistical interaction term between age group and sex and adjustment for institutional stay and living in a city. For each patient group, we estimated the percentage with no contact for each of the subgroups according to age and sex, with predictions made for those not in institutions.

4.6.3 Paper II

GP consultations

We used generalised estimation equating (GEE) models[150] to estimate the level of GP consultations per year in 2016 compared to 2007, adjusted for increasing age during follow-up.

GEE models assessed the associations between baseline health and GP consultations per month per year from 2007 through 2016 (see Figure 9). Separate analyses were performed for baseline hypertension status (comparing three groups: hypertension, non-medicated hypertension and normotensive) and anxiety/depression status (comparing four groups according to anxiety and depression symptom level and previous help-seeking for mental problems). Main analyses were restricted to the age cohort 40–59 years (in 2007), avoiding the younger age groups with low HUNT3 participation and the older participants, which were more likely to exit the GP scheme by being institutionalised (Norwegian GPs keep institutionalised patients on their list[20] even though they are cared for by others, and we did not have data enabling us to sensor for institutional stay). The outcome measure was monthly consultation (consultation versus no consultation); we adjusted for year, educational level and increasing age during follow-up and included an interaction term between health status and year. Since help-seeking behaviour differs between the sexes[151], we did separate analyses for men and women. Additional analyses were performed with an adjustment for co-morbidity. Estimates from the regression analyses were used to calculate the percentage of people with consultations for each month and year during follow-up. All analyses were repeated for out-of-hours consultations (both sexes together). We also analysed the number of consultations per year as a continuous outcome variable.

Intra-class correlations

We used multilevel models with participants nested in their assigned GP to calculate GP-level intra-class correlation (ICC) coefficients[150], reflecting to what extent patients' consultation patterns could be attributed to the individual GP. We used the number of yearly consultations per participant as the basis for our calculations and adjusted for patient age and sex. Analyses were repeated for each of our consultation outcomes: regular consultations, consultations exceeding 20 minutes and out-of-hours consultations. We performed separate analyses for each year during follow-up, selecting 2007 (the first year), 2011 (in the middle/the year before

the Coordination Reform) and 2016 (the last year of follow-up) for presentation. Supplementary analyses included an adjustment for additional participant characteristics (education and co-morbidities) and GP characteristics (sex, age and whether specialist in GP medicine). We did sub-analyses of participants with the same GP in 2016 as in 2007 (as a sensitivity analysis).

4.6.4 Paper lll

Patients were divided in categories according to their age at discontinuity (0-18, 19-44, 45-64, 65-79 and 80+ years), and all analyses were repeated for each category separately. We used logistic regression with generalised estimation equation (GEE)[150] models to estimate the odds ratios (OR) of monthly regular GP consultations, out-of-hours consultations, emergency hospital admissions and ACSC admissions in the period during (1 month before to 1 month after) and for two periods after (2-7 months after and 8-13 months after) compared to the stable period before (2-7 months before) the discontinuity of care (see Figure 9).

We did separate analyses according to patient sex, patient educational level (primary, secondary or tertiary), the age of the GP (GP being older or younger than 50 years at the time of discontinuity) and size of practice municipality. In addition, we performed analyses on the patient subgroups with hypertension, ischemic heart disease and prior hospital stay.

In all analyses, we adjusted for calendar month, calendar year and patient sex (except when doing separate analyses for men and women). Since patients got 21 months older during follow-up, we also adjusted for the number of follow-up months as a continuous variable. Patients were censored on the exact month of migration or death and in periods lacking data.

5 Results

This thesis includes three papers, each with several additional analysis included as appendix/supplementary material. In this chapter, I will summarise the results, which are mainly described or referred to in tables and Figures in the respective papers or by their supplementary material.

5.1 Paper I

Among 66,952 identified participants, between 0.6% (heart failure) and 1.3% (pneumonia) of the participants were admitted at least once for each of the five selected diagnosis.

Paper I, Table 1 provides an overview of the patient groups analysed in the study. The groups differed in composition according to sex, age, living in a city and in the use of municipality and GP services during the month before the hospital admission.

Figures 10-13 show results from the regression analyses as estimated percentages of monthly GP and OOH contacts during the last year (Figures 10, 12) and of three-day GP and OOH contacts during the month (Figures 11, 13) before an emergency hospital admission. All estimated percentages are reported for our "standard" patient: a woman aged 75 in 2012, not in institution. Results from the conditional logistic regression analyses are presented in Paper I, Appendix Tables A1-A4, comparing each patient's GP and OOH contacts at different time points with their own contact level six months and 31-29 days before hospital admission. The results from these analyses were in line with the results from the main analysis.

Regarding GP contacts per month the year before hospital admission (Figure 10), the estimated percentage with GP contacts (estimated for our "standard" patient) increased the last three months before hospital admission for heart failure: The percentage with GP contacts increased from 68% six months before admission to 81% one month before admission, an increase of 12%-points (95CI, 7-19%). For acute myocardial infarction and pneumonia, the increase was seen in the month before hospital admission. Acute myocardial infarction increased from 54% six months before to 60% one month before admission (increase of 6%-points (95%CI, 1-11%)), and pneumonia increased from 59% six months before to 65% one month before admission (increase of 5%-points (95%CI, 1-10%)).

Compared with their own GP contacts six months before admission, the odds ratio of GP contacts in the month before admission was 2.44 (95% CI, 1.59-3.75), 1.40 (95% CI, 1.06-1.84) and 1.36 (95% CI, 1.04-1.77) for patients admitted for heart failure, myocardial infarction and pneumonia, respectively (see Paper I, Appendix Table A1).

When investigating GP contacts per three-day interval the month before hospital admission (Figure 11), an increase in contacts occurred during the three-day intervals close to the time of admission for stroke, pneumonia and myocardial infarction. The estimated percentage with GP contacts increased during the last three three-day intervals before hospital admission for stroke, increasing from 9% 31-29 days before to 12% 4-2 days before admission (increase of 3%-points (95%CI, 0-6%)). For pneumonia, the percentage with GP contacts increased in the last two three-day intervals before hospital admission, increasing from 12% 31-29 days before to 17% 4-2 days before admission (increase of 5%-points (95% CI, 2-8%)). For acute myocardial infarction, GP contacts increased day 21-19 and in the last three-day interval before hospital admission, increasing from 11% 31-29 days before, to 16% 4-2 days before admission (an increase of 6%-points (95% CI, 2-9%)). Compared with their own GP contacts in the three-day interval 31-29 days before admission, the odds ratio of GP contact in the last three-day interval (4-2 days before) before admission was 1.48 (95% CI, 1.02-2.14), 1.57 (95% CI, 1.16-2.12) and 1.73 (95% CI, 1.20-2.48) for patients admitted for stroke, pneumonia and myocardial infarction, respectively (see Paper I, Appendix, Table A2).

Regarding OOH contacts the year before hospital admission (Figure 12), *all* patient groups had increased contact the last month before admission. The estimated percentage with OOH contacts the last month before admission varied from 7% (95% CI, 4-9%) for myocardial infarction to 20% (95% CI, 15-25%) for heart failure. Compared with their own OOH contacts six months before admission, the odds ratio of OOH contacts in the month before admission varied from 1.96 (95%Ci, 1.11-3.48) for myocardial infarction to 3.68 (95% CI, 2.46-5.50) for pneumonia (see Paper I, Appendix, Table A3).

All patient groups had increased OOH contact the last three-day interval before an emergency hospital admission, except hip fracture patients (see Figure 13 and Paper I, Appendix, Table A4).

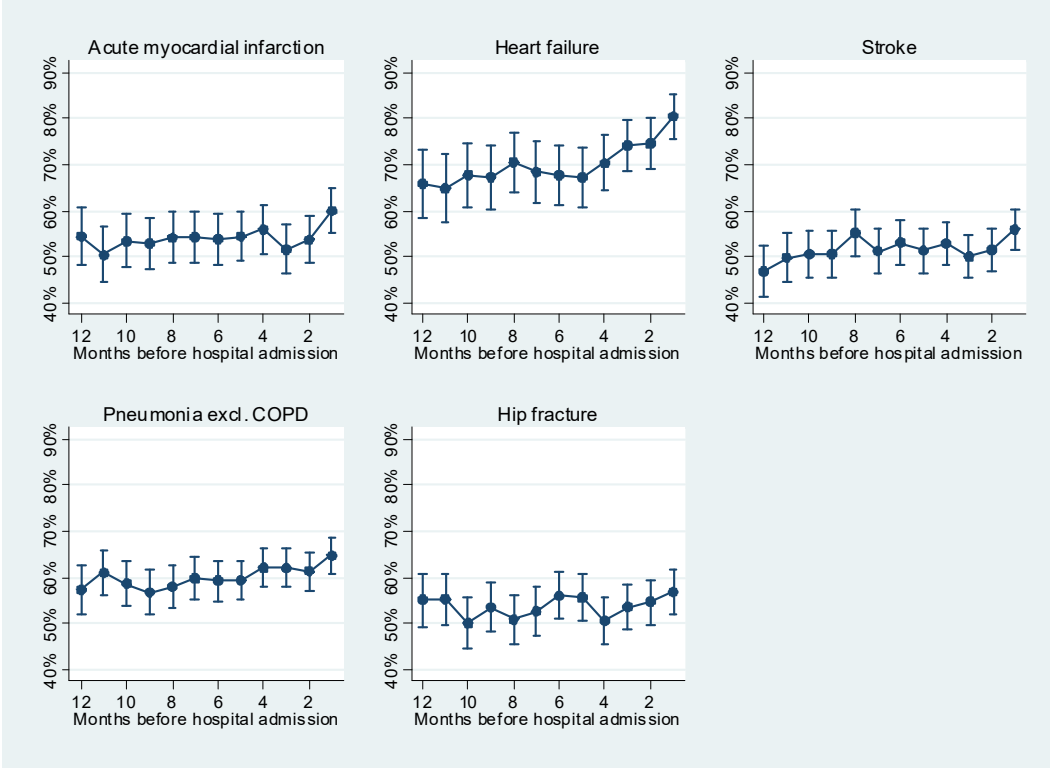

Figure 10: Estimated percentage (vertical axis) with at least one contact with a regular general practitioner (GP contact) per month for a woman aged 75 in 2012 not in institution according to time before an emergency hospital admission. Vertical lines represent 95% CIs. Analysis adjusted for calendar month, age, sex, living in a city and stay in an institution (both short- and long-term).

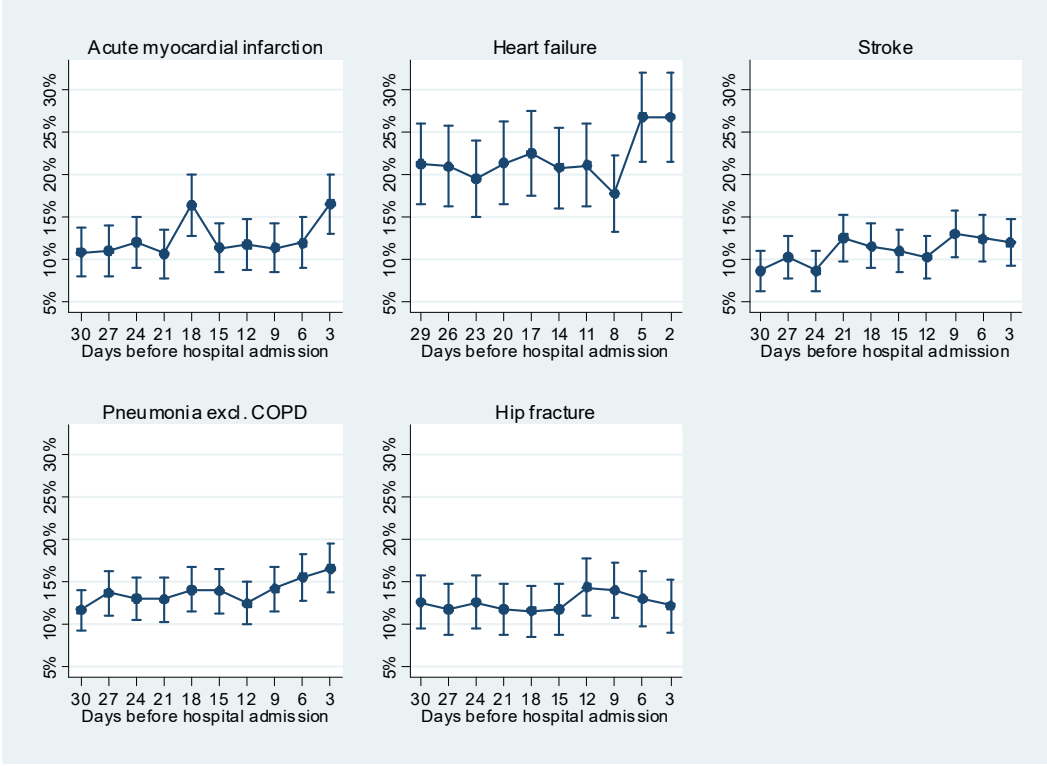

Figure 11: Estimated percentage (vertical axis) with at least one contact with a regular general practitioner (GP contact) per three-day interval for a woman aged 75 in 2012 not in institution according to time before an emergency hospital admission. Vertical lines represent 95% CIs. Analysis adjusted for weekday of admission, age, sex, living in a city, hospital stay and any stay in an institution (both short- and long-term).

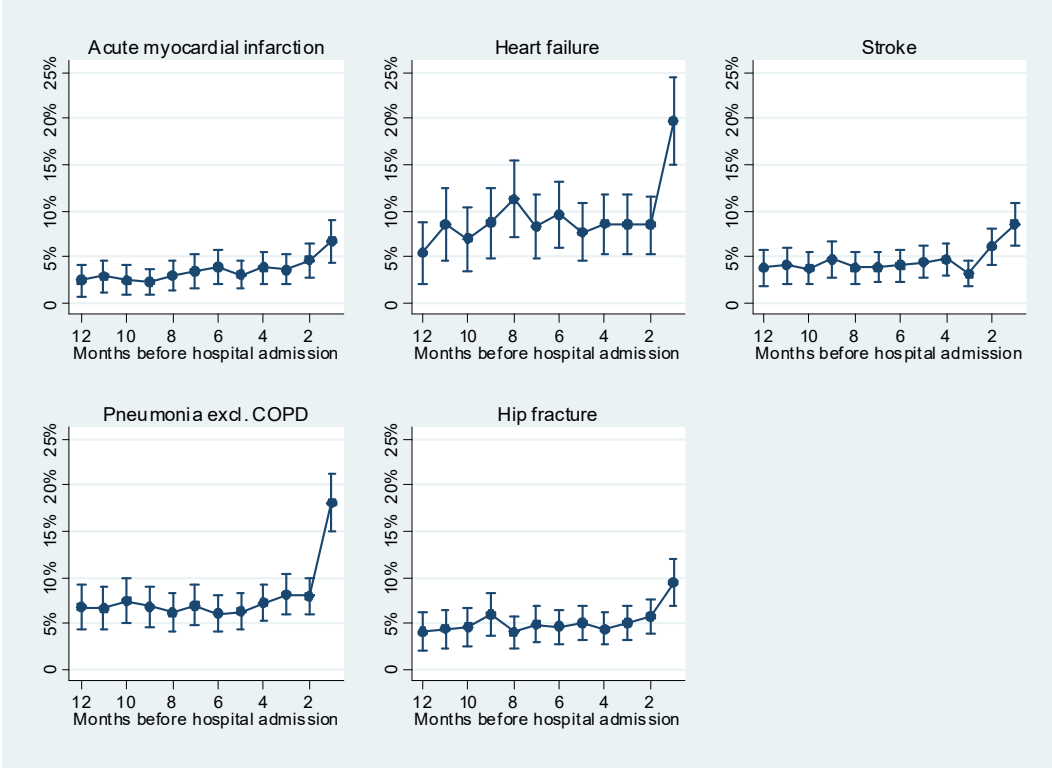

Figure 12: Estimated percentage (vertical axis) with at least one OOH (general practitioner out-of-hours services) contact per month for a woman aged 75 in 2012 not in institution according to time before an emergency hospital admission. Vertical lines represent 95% CIs. Analysis adjusted for calendar month, age, sex, living in a city, and stay in an institution (both short- and long-term).

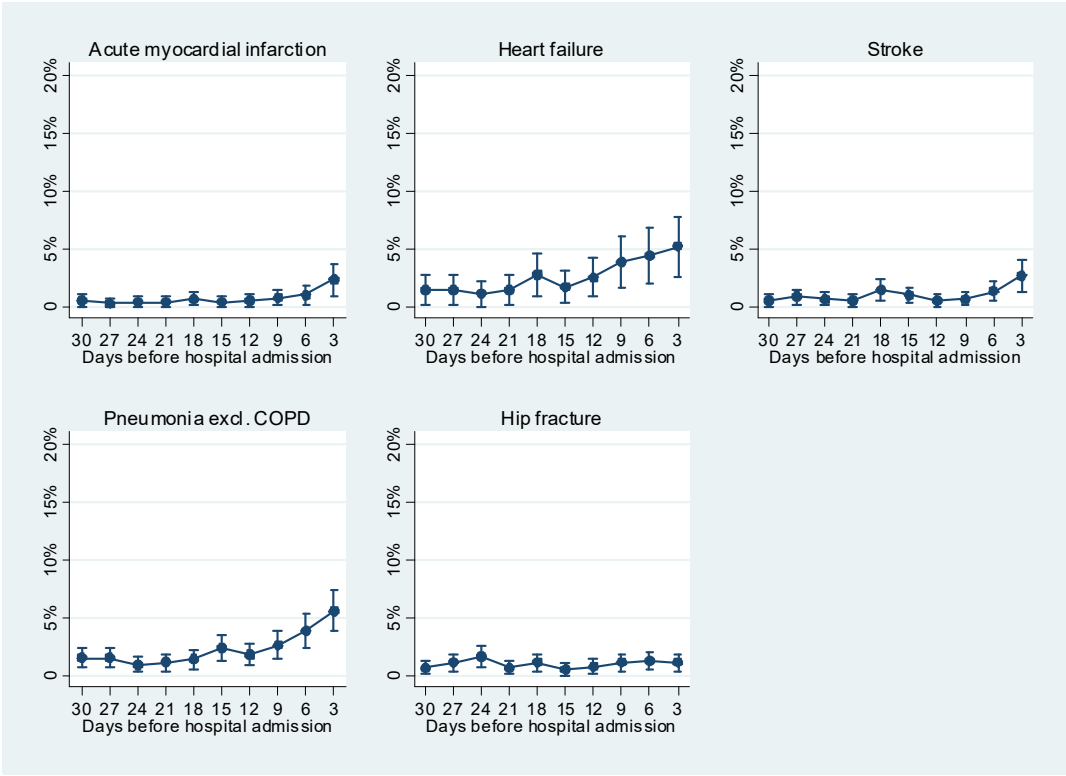

Figure 13: Estimated percentage (vertical axis) with at least one OOH (general practitioner out-of-hours services) contact per 3-day interval for a woman aged 75 in 2012 not in institution according to time before an emergency hospital admission. Vertical lines represent 95% CIs. Analysis adjusted for weekday of admission, age, sex, living in a city, hospital stay and stay in an institution (both short- and long term).

No contacts

For all patient groups, the estimated percentage with no GP or OOH contact during the last month before emergency hospital admission was higher among younger patients and men (Paper I, Appendix, Table A5), with larger differences between age groups in men compared to women (p-value for interaction term between age group and sex was <0.05 in *all* patient groups). The group without contact was highest for men 50-64 years who were admitted with stroke (estimated percentage 65% (95% CI, 62-68%)) and acute myocardial infarction (estimated percentage 62% (95% CI, 60-65%)). Few patients among those aged 80+ who were admitted to hospital with heart failure did not contact their GP prior to admission, only 10% (95% CI, 08-12%) of men and 17% (95% CI, 15-19%) of women.

5.2 Paper II

At baseline (2007), 47,550 participants were registered with 102 different GPs in Nord-Trøndelag County. Each GP had, on average, 1,298 [standard deviation (SD) 295] patients on their list, 523 (SD 154) being HUNT3 participants (see Paper II, Table 1).

GP consultations

The study population, regardless of age group or baseline health status, had an increase of 0.30 [95% confidence interval (CI) 0.26 to 0.34] GP consultations per year when comparing the number of consultations in 2016 with the number of consultations in 2007, adjusted for increasing age during follow-up (data not shown). For participants aged 40–59 at baseline (see Figures 14 and 15), the level of monthly GP consultations was higher among women than men and lower among healthier patients. In general, we observed an increasing trend in the level of monthly GP consultations during the study period. This increase was pronounced among the healthiest groups. The only groups with a steeper increase were those with non-medicated hypertension, with a 5% increase for both sexes [95% CI 3% to 7% (women); 3% to 6% (men)] from 2007 to 2016. For these groups, a rapid increase in monthly GP consultations was seen from 2007 to 2008, and non-medicated hypertensive men continued to have a higher level of consultations throughout the study period. In contrast, monthly consultations decreased during the study period for men with a high level of anxiety and/or depression symptoms who had sought help for mental health problems, from 26% (95% CI 24 to 28) in 2007 to 22% (95% CI 20 to 24) in 2016. The corresponding changes in the number of yearly consultations from 2007 to 2016 are shown in Paper II, Supplementary Tables 1–2.

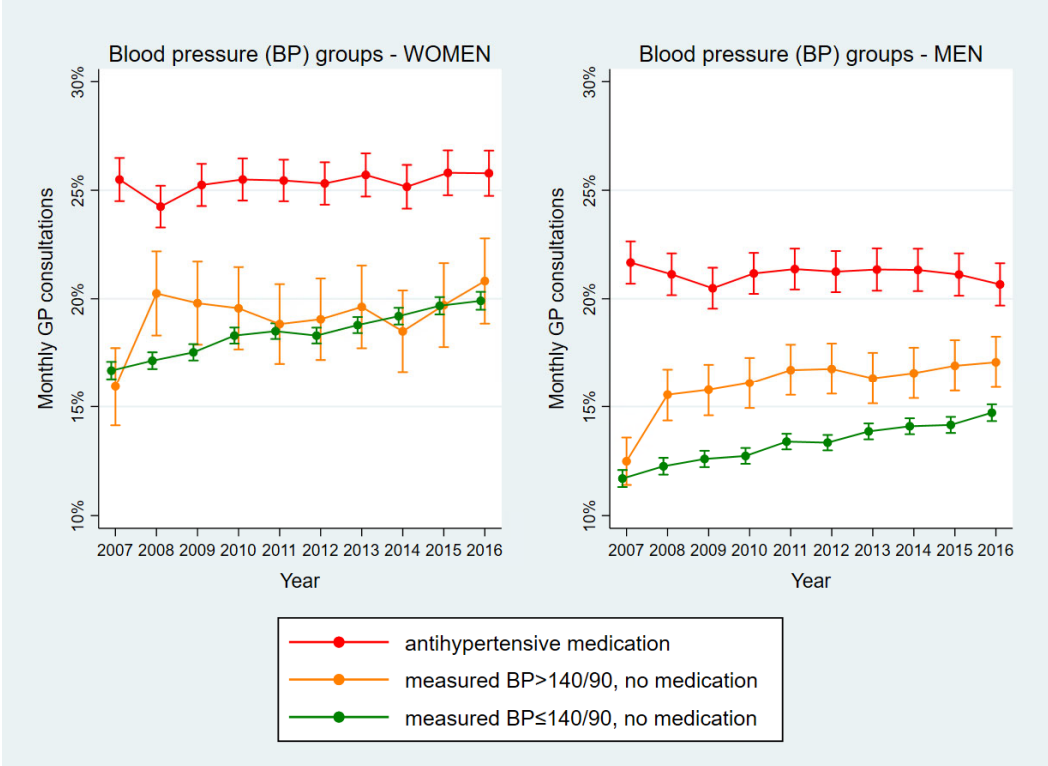

Figure 14: Hypertension groups: estimated percentage with monthly GP consultations per year for the cohort aged 40–59 years in 2007. Adjusted for increasing age and education.

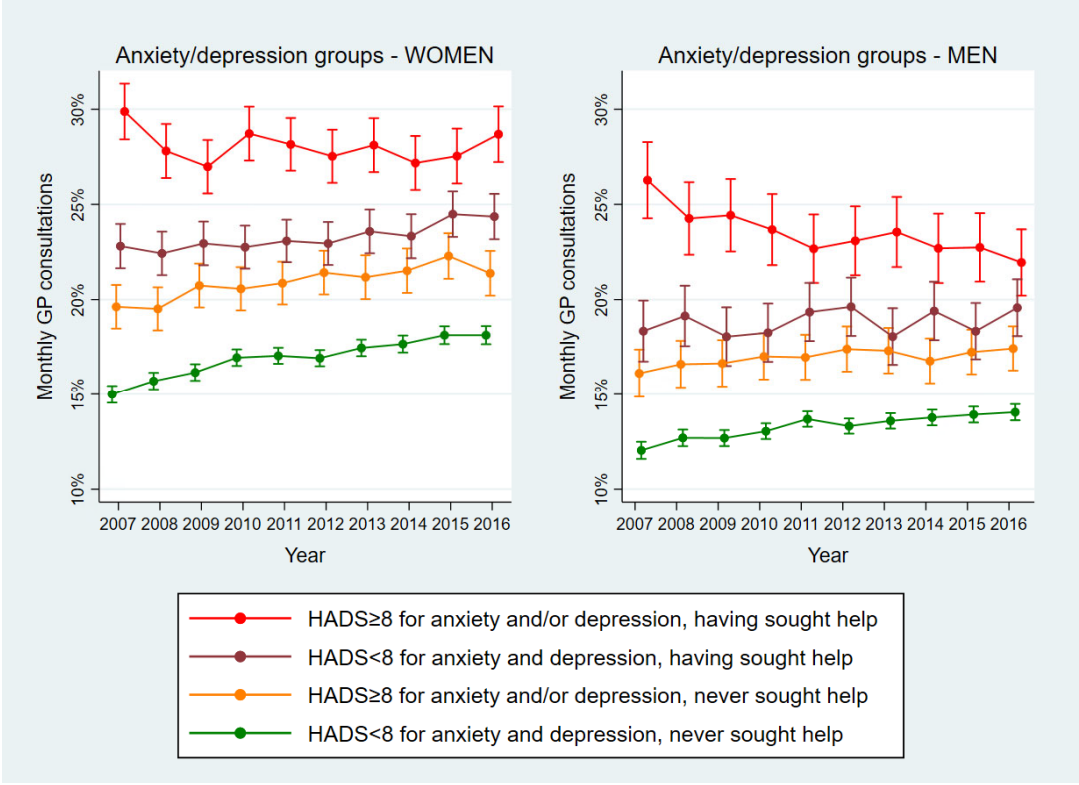

Figure 15: Anxiety/depression groups: estimated percentage with monthly GP consultations per year for the cohort aged 40–59 years in 2007. Adjusted for increasing age and education.

Intra-class correlations

About 2–3% of the variance in consultations could be attributed to differences between GPs [ICC 0.03 (95% CI 0.02 to 0.04) in 2007 and 0.02 (95% CI 0.02 to 0.03) in 2016]. The use of out-of-hours consultations differed even less between GP affiliation [ICC 0.02 (95% CI 0.01 to 0.02) in 2006 and 0.01 (95% CI 0.01 to 0.01) in 2016]. There was a larger variability between GPs in consultations exceeding 20 minutes, explaining 8% of the variance and increasing over time [ICC 0.08 (95% CI 0.06 to 0.11) in 2007 and 0.10 (95% CI 0.08 to 0.13) in 2016; see Table 2]. ICC estimates were not substantially changed in the analysis with additional adjustments for patient and/or GP characteristics (see Paper II, Supplementary Table 3) or in the analysis including only the sub-sample of HUNT3 participants who had the same GP in 2007 and 2016.

Table 2: ICC between the different GPs and their patients regarding the yearly number of consultations, GP consultations exceeding 20 minutes and out-of-hours service consultations

Year	GP consultations (95% CI)	GP consultations >20 minutes (95% CI)	Out-of-hours consultations (95% CI)
2007	0.03 (0.02 to 0.04)	0.08 (0.06 to 0.11)	0.02 (0.01 to 0.02)
2011	0.03 (0.02 to 0.04)	0.11 (0.09 to 0.14)	0.01 (0.01 to 0.01)
2016	0.02 (0.02 to 0.03)	0.10 (0.08 to 0.13)	0.01 (0.01 to 0.01)

Additional analysis: out-of-hours consultations and adjustments for co-morbidity

Those with anxiety/depression symptoms who had sought help for mental health at baseline had the highest level of monthly out-of-hours consultations in 2007 of 2.4% (95% CI 2.1 to 2.7), decreasing to 1.8% (95% CI 1.5 to 2.0) in 2016. All other groups had lower and stable levels of monthly consultations during the study period (see Paper ll, Supplementary Figures 2 and 3). Additional adjustment for co-morbidity did not substantially alter any of our results (see Paper ll, Supplementary Figures 4–7).

5.3 Paper lll

In the period from 2007 to 2016, a total of 2,529,311 patients were registered as list patients of our selection of 2,501 unique regular GPs with a stable practice, but who, 12 months later, had an episode of discontinuity. The number of patient episodes of discontinuity was 2,818,002, as each patient could experience several episodes of discontinuity related to different GPs; 84% had one episode, 99% had one or two episodes and the maximum number of episodes was five (data not shown). For patient and GP characteristics, see Paper lll, Table 1. Patient health care use during the year prior to follow-up is available in Paper lll, Supplementary Table 1.

As seen in Table 3, patients in all age groups had a 3%-5% decreased odds of monthly consultation during the discontinuity (OR 0.95; 95% CI 0.94,0.96 and 0.94,0,95) for 0-18-year-olds *and* 65-79-year-olds, respectively, (OR 0.97; 95% CI 0.97,0.97) for 19-44-year-olds compared with before the discontinuity. Most age-groups then had a normalisation after the discontinuity, except those 0-18-year-olds who had persistent lower odds of consultations the year following discontinuity (OR 0.97; 95% CI 0.96,0.98 and 0.94,0.98 2-7months and 8-13months after discontinuity, respectively). Compared with the period before the

discontinuity, all adult age groups had a 3%-7% increased odds of monthly out-of-hours consultations during the discontinuity (OR 1.03; 95% CI 1.01,1.05) for 45-64-year-olds, (OR 1.07; 95% CI 1.04,1.10) for 65-79-year-olds, which remained elevated after the discontinuity for most age groups (OR 1.05; 95%CI 1.03,1.08 2-7months after discontinuity and OR 1.07; 95%CI 1.03,1.11 8-13 months after discontinuity) for 19-44-year-olds, (OR 1.09; 95%CI 1.04,1.14 2-7months after discontinuity and OR 1.12; 95% CI 1.05,1.19 8-13months after discontinuity) for 65-79-year olds.

While there was little evidence for differences in acute hospital admissions for those under 65 years old, elderly patients had increased odds of acute hospitalisations after discontinuity. In the age group 65-79 years, the odds for ACSC admissions increased 6% during (95% CI 1.00-1.13), 12% 2-7 months after (95% CI 1.03-1.21) and 18% 8-13 months after (95% CI 1.04-1.35) compared with the period before discontinuity.

Supplementary analysis

Separate analyses on subgroups according to patient and GP characteristics are shown in Paper lll, Supplementary Tables 2-7. In general, the estimates for the sub-groups resembled those from the main analyses. Older patient groups with increased premorbidity showed increased risk of hospital admission.

Table 3: Estimated Odds Ratios (OR) with 95% Confidence Intervals (95% CI) for one or more monthly GP consultations, out-of-hours service consultations, acute hospital admissions and hospital admissions for ambulatory care sensitive conditions (ACSC) during (1 month before to 1 month after) and after (2-7 months after and 8-13 months after) a sudden discontinuity of GP care, compared to a 6-month stable period 2-7 months before the discontinuity. Separate analyses for each patient age group, adjusted for month/time, calendar month, calendar year and patient sex. (2007-2017)

	0-18 years		19-44 years		45-64 years		65-79 years		80+ years	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Monthly GP consultations (one or more)										
Before discontinuity (2-7 months before)	1.00	ref	1.00	ref	1.00	ref	1.00	ref	1.00	ref
During discontinuity (1 month before to 1 month after)	0.95	(0.94-0.96)	0.97	(0.97-0.97)	0.95	(0.95-0.96)	0.95	(0.94-0.95)	0.96	(0.95-0.97)
After discontinuity I (2-7 months after)	0.97	(0.96-0.98)	0.99	(0.98-1.00)	0.99	(0.99-1.00)	1.01	(1.00-1.02)	1.01	(1.00-1.03)
After discontinuity II (8-13 months after)	0.96	(0.94-0.98)	0.99	(0.98-1.00)	0.98	(0.97-1.00)	1.00	(0.98-1.01	0.99	(0.97-1.01)
Monthly out-of-hours consultations (one or more)										
Before discontinuity (2-7 months before)	1.00	ref	1.00	ref	1.00	ref	1.00	ref	1.00	ref
During discontinuity (1 month before to 1 month after)	1.00	(0.98-1.02)	1.05	(1.03-1.06)	1.03	(1.01-1.05)	1.07	(1.04-1.10)	1.06	(1.02-1.10)
After discontinuity I (2-7 months after)	0.99	(0.97-1.02)	1.05	(1.03-1.08)	1.02	(0.99-1.05)	1.09	(1.04-1.14)	1.06	(1.00-1.12)
After discontinuity II (8-13 months after)	0.99	(0.95-1.03)	1.07	(1.03-1.11)	1.02	(0.96-1.06)	1.12	(1.05-1.19)	1.05	(0.97-1.15)
Monthly acute hospital admissions (one or more)										
Before discontinuity (2-7 months before)	1.00	ref	1.00	ref	1.00	ref	1.00	ref	1.00	ref
During discontinuity (1 month before to 1 month after)	1.01	(0.96-1.06)	1.02	(1.00-1.05)	1.01	(0.98-1.04)	1.03	(1.00-1.06)	1.03	(1.00-1.06)
After discontinuity I (2-7 months after)	1.02	(0.94-1.09)	1.01	(0.98-1.05)	1.01	(0.97-1.05)	1.04	(1.00-1.09)	1.03	(0.99-1.08)
After discontinuity II (8-13 months after)	1.06	(0.94-1.19)	1.01	(0.95-1.07)	1.01	(0.95-1.08)	1.04	(0.98-1.11)	1.01	(0.94-1.08)
Monthly ACSC hospital admissions (one or more)										
Before discontinuity (2-7 months before)	1.00	ref	1.00	ref	1.00	ref	1.00	ref	1.00	ref
During discontinuity (1 month before to 1 month after)	0.89	(0.79-1.00)	1.02	(0.92-1.13)	1.01	(0.94-1.09)	1.06	(1.00-1.13)	1.07	(1.00-1.14)
After discontinuity I (2-7 months after)	0.96	(0.80-1.14)	0.99	(0.86-1.15)	1.04	(0.93-1.15)	1.12	(1.03-1.21)	1.11	(1.01-1.22)
After discontinuity II (8-13 months after)	0.98	(0.75-1.29)	0.95	(0.76-1.19)	1.01	(0.87-1.21)	1.18	(1.04-1.35)	1.07	(0.93-1.24)

6 Discussion

6.1 Main results

My objective in this thesis was to investigate core aspects GPs role in patients' use of health services. I have presented empirical evidence on patients' contact with GPs and how the use of health care services changed 1) prior to acute hospital admissions, 2) in a period when GPs' responsibilities for health care services increased and 3) when patients are suddenly exposed to a situation where the regular GP was unavailable for a longer period of time. The results underscore the central role of GPs in the management of patients in acute situations, as well as follow up of chronic diseases and follow up.

We found that most patients acutely admitted to hospital for common severe diagnoses were in contact with GPs during the month and year before the admission. Nevertheless, a substantial percentage of the patients admitted with severe diagnoses did *not* see their GPs the month before hospital admission.

We found an overall increase in regular GP consultations from 2007 to 2016, particularly for healthier participants. Interestingly, the implementation of the Coordination Reform did not seem to be associated with any shifts in the use of GP services. Overall, the GPs provided consultations at a fairly similar level, with an exception for time-consuming consultations where patients differed substantially according to GP affiliation.

The belief in positive effects of continuity of care is one of the theoretical foundations of the Norwegian GP system. In the last paper of my thesis, we investigated the possible effects of GP discontinuity of care. We found that overall, patients seem to access help when faced with a sudden discontinuity of care from their regular GP. However, the increase in acute hospital admissions for ambulatory care sensitive conditions in the older age groups suggests a crucial role of the GP and warrants attention and further research.

6.2 Methodological considerations: Strengths and limitations

This thesis consists of observational studies from different datasets and study populations. Alongside different methodological aspects, this might lead to various errors or bias. As in all studies, it is important to consider sources of bias, both random and more systematically. In the following, I will discuss the most important methodological considerations for this thesis.

6.2.1 Precision

In this thesis, presenting and interpreting random error were based on the evaluation of confidence intervals. We have avoided dichotomising study results based on any conventional threshold (i.e. 0.05). Hence, we have presented information on the point estimates together with confidence intervals indicating a distribution of possible estimates compatible with our model assumptions[152].The results from this thesis were based on different data sources. In Paper I, our assessment of GP service utilisation before an acute hospital admission was carried out in four municipalities. Although we started out with the full population, our observation groups were rather small, and the time we had data for was relatively short, leading to rather small groups with wide confidence intervals. In Paper II, we assessed GP service contacts from 2007 to 2017 for HUNT3 participants, according to baseline health status (regarding hypertension and anxiety/depression). In this study, our observation groups were larger, with relatively precise estimates. In Paper III, we started out with the entire Norwegian population to assess how a sudden discontinuity of GP care affected patients' GP consultations, out-of-hours consultations and acute hospital admissions (including admissions for ambulatory care sensitive conditions). This study had the largest observation groups and the narrowest confidence intervals, and we could precisely estimate rather small differences at the patient list level that still could be of public health interest.

6.2.2 Confounding

Confounding is a causal concept related to the mix-up of effects due to common causes of both exposure and outcome[153]. The two first papers in this thesis were more descriptive by nature and did not have a particular exposure-outcome focus, and confounding was less of a

problem in interpreting the results. However, as change in health care service use over time was investigated, we adjusted for factors related to both the timing of health care contact and acute hospital admission, such as age, sex, municipality and multi-/comorbidities. These were taken into account by restricting the study sample to patients aged 50 years or older, and statistical adjustment (age, sex, municipality). In addition, we performed a conditional logistic regression analysis. This analysis compares contact level *within* patients (i.e. compares patients with themselves at another time point)—thereby controlling for all characteristics that are stable within a person.

Main comparisons in Paper II were made according to calendar month and year within the different groups—restricting the analyses to age 40–59 years (in 2007) and assessing men and women separately. As co-morbidity could confound associations between baseline health and the level of consultations, we performed supplementary analysis with an adjustment for the level of co-morbidity on a continuous scale. However, these additional adjustments did not substantially alter any of our results (see Paper ll, Supplementary Figures 4-7). Factors at the GP level could also affect associations between prior health service use and level of consultations. However, the multi-level analysis with yearly patient observations nested in GP indicated that differences in consultation patterns between patients and over time can only, to a small (and stable) extent, be explained by the GP (except for long-lasting consultations).

The third paper aimed to investigate possible effects of GP discontinuity regarding health care use. For this association, confounding represents a possible challenge, because underlying differences (regarding age, sex, education, level of (co)morbidity, etc.) may influence both the extent of continuity/discontinuity and the level of health care use. In Paper lll, we used several strategies to reduce confounding. First, we chose a study design in which we could "standardise" the setting, both regarding the exposure and timeline. For the exposure, we only included discontinuities among stable regular GPs to minimise effects from, for instance, long-term instability, by only including patients on the lists of these selected GPs. As the exposure could be timed for each patient, we then synchronised the population around the time of discontinuity, comparing time periods before and after the break. By design, we thereby eliminated all time-invariant or slow-varying confounding factors related to the composition of patient lists (groups), including morbidity, help-seeking behaviour, sex and education. Furthermore, by comparing the patient populations to themselves, we did not

have to correct for patient factors known to influence the referral rate, such as income, education, comorbidity and self-rated health. By investigating patients who had a stable GP up to the discontinuity, we could also consider GP factors that may affect referral rate, including the age of the GP. Other factors influencing referral rate could be the availability of a secondary health care outpatient service or hospital, which we at least partly could assess by stratifying on the subgroups of least/most populated municipalities. An underlying assumption in this analysis was that GP discontinuity could not be attributed to changes in the morbidity of the list patients.

6.2.3 Selection bias

Selection bias is a systematic error arising from the selection of study participants and/or restrictions or adjustments on common consequences of the exposure and outcome[153, 154]. In all studies in this thesis, outcome data were collected from national registries. Hence, selection bias from loss to follow-up should be avoided. However, we cannot rule out possible effects of non-independent censoring from death and emigration in our results. Also, in Papers II and III, we lacked information on when participants moved to a nursing home. Patients in nursing homes are no longer eligible for regular GP consultations (nursing homes have their own primary care physicians) and should, therefore, be censored on the date/month of moving. The consequence could be an underestimation of health care use when following GP consultations in the oldest age groups over time.

The HUNT3 participants in Paper ll were self-selected, usually leading to unknown net bias[153] regarding characteristics of participants and non-participants. A thorough non-participant study found a higher prevalence of cardiovascular diseases and mental distress among the non-participants seemingly parallel to differences found in socioeconomic groups and risk factor exposures[138]. In Paper ll, we made groups with different health parameters and compared them to each other over time regarding GP visits (regular and OOH) and acute hospital admissions. We do not know how the non-participants, particularly among the least healthy groups, might differ from what we found. This is, of course, a limitation.

For Papers l and lll, we used official registers to make participant groups. By using a complete study population, we would be likely to minimise selection bias[155].

For Paper lll, we included all patients 12 months before the break in GP continuity to not condition on the patient surviving until discontinuity. Hence, we did not miss some of the acute (potentially fatal) hospital admissions in our observation time before the discontinuity, thereby avoiding immortal time bias [153].

6.2.4 Information bias

Systematic error occurs in a study when the information collection is erroneous[153]. The information is said to be *misclassified* if placed in an incorrect category, either *nondifferential* misclassification (if the misclassification is unrelated to the values on other important study variables, such as the outcome) or *differential* misclassification (if the misclassification is related to the values on other study variables)[153]. Nondifferential misclassification between two exposure categories will usually converge the estimates toward each other[153]. Differential misclassification bias, on the other hand, can either exaggerate or underestimate the effect of an exposure on the outcome, depending of the misclassification itself[153]. Using outcome data from registries, we believe that our results would be more prone to non-differential misclassification than differential. The prospective nature of the study designs reduces the possibility that the outcomes were affected by the exposure status and vice versa.

There is evidence to suggest high accuracy when using main diagnoses in the assessment of severe acute admissions[156, 157]. Blood pressure measures are sensitive to measurement error. In the HUNT study, blood pressure was an average of several measurements, something that is likely to reduce measurement error.

For Paper ll, some of the exposure variables relied on self-reported information regarding medication, help seeking and HADS scores. Self-reported information is known to be prone to misclassification. If enough participants forgot previous disease/medication information, this would make our groups appear more similar and, thus, might undermine the differences in outcome. Regarding the Hospital Anxiety and Depression Scale (HADS), a validation study was concluded with acceptable validity and reliability when applied to the general population[149]. However, a full diagnostic interview would assumedly provide better information of psychiatric morbidity.

6.2.5 Missing data

Missing information on collected data may also constitute a selection bias in our results, dependent of the mechanism underlying missing information.

We relied on register-based data for all our outcome variables. Since these data are complete for the entire population, missing data should not indicate problems for our outcome ascertainment. Also, assessment of covariates in register data ensured a low degree of excluded individuals in multivariable regression analyses. Missing on the covariates/adjustment variables hypertension groups and anxiety/depression groups are given in Paper ll, Table 1.

6.2.6 Generalisability—external validity

The topic of this thesis is patients' contact with GPs and how the use of health care services changes 1) prior to acute hospital admissions, 2) in a period when GPs' responsibilities for health care services increased and 3) when patients are suddenly exposed to a situation where the regular GP was unavailable for a longer period of time. Although all our results must be interpreted in relation to the Norwegian system (described in the background section) with a personal GP for each individual citizen, we believe that the findings have relevance for other health care systems with a well-developed and accessible health care system, despite differences in organisation of GP services and delineation of responsibilities between primary and secondary health care[158].

Some of the characteristics of the Norwegian health care system (see Section 2.1 The Norwegian health care system) that may influence the generalisability of our results are the regular GP scheme with its high participation rate and the Norwegian health care system with its financing system and accessibility for all, particularly when compared with countries with more private health care systems, more pronounced health care insurances and no upper limit on costs for patients.

6.3 Discussion and interpretation of main findings

In this section, I will shortly discuss some of the more overriding themes of the papers related to different functions of the GPs. (For a more specific discussion of each Paper, please see the discussion section of the respective Papers I, II and III).

The results from all three papers in this thesis point to the important role of the regular GP in the population. Most people saw their GP on a regular basis, both before an acute hospital admission (Paper I) and overall (all three papers). Such regularity and continuity increase the possibility for GP-initiated preventive care that could improve health and reduce the need for health care use in the short- and long-term, particularly OOH service visits and hospital admissions (see Background Section).

The frequent contacts with a GP during the year and the month before an acute hospital admission found in Paper I confirm that the GP is in a strategic position to prevent hospital admissions for conditions commonly seen among older adults and the elderly (see Section 2.2 General practitioners and prevention). This strategic position seems to apply to other settings, e.g. most Norwegian suicide committers saw their GPs before taking their lives[159]. Still, the differences in the patterns found for the five selected conditions (myocardial infarction, heart failure, stroke, pneumonia and hip fracture) in Paper I indicate that possibilities for prevention should be considered according to the medical diagnosis, supporting the development and use of guidelines. However, the challenging GP setting with complex, multimorbid patients makes applying clinical guidelines challenging[160] and disease-specific clinical pathways less feasible[161]. Evidence for large preventive interventions is also sparse, particularly among the elderly[66, 162].

Prevention strategies from primary care physicians would be challenging in patient groups with low levels of contacts with GP services. In Paper I, we found that a substantial percentage of the patients admitted with our five selected severe diagnoses did *not* see their GPs the month before hospital admission, especially middle-aged men admitted for a cardiovascular episode. These patient groups could still represent a possible target for prevention, although not easily reached. On that note, concerning the men who were detected with previously unknown hypertension at HUNT3 participation in Paper II, the 'post-screening' effect of the increased consultations did not wear off after HUNT3 participation. This raises the question

of possible underuse of GP services before HUNT3 participation among these men. Although underuse might lead to seeing a GP at a stage where illness has progressed to the need of secondary health care, an Australian study found a U-shaped relationship between primary health care visits and hospital admissions, indicating there might be an optimal level of GP care (as opposed to "the more, the better")[163].

Contact with the OOH services might indicate a suboptimal accessibility of the regular GP services[164], but it could also be indicative of emergency conditions that need to be dealt with immediately. Groups with high use of OOH services and an increase in OOH services before admission to hospital (as seen with heart failure and pneumonia in Paper I) could be an interesting target for further exploration of the potential for intervention in GP services. Unfortunately, our findings merely state a preventive potential, as they do not differentiate between events/admissions that were inevitable despite proper follow-up and events/admissions that could have been avoided by improved care. This calls for studies that can assess interventions aimed at reducing unnecessary hospital admission in an experimental or quasi-experimental setting.

The results from Paper III indirectly point to the importance of the GP in preventing hospital admission in the elderly: In Paper lll, we found that, when faced with a sudden discontinuity of care from their regular GP, the odds of hospital admissions increased in the age groups 65-79 years and 80+ years. This increase was particularly prominent for the admissions for ambulatory care sensitive conditions (ACSC[67]). This increase could indicate a health deterioration due to lack of proper treatment and follow-up in the absence of the GP, but it may also reflect that patients are more likely to be admitted to hospital when meeting unfamiliar doctors. The regular GP often has important knowledge of their list patients, such as medical history, medications, family and care arrangements. Such knowledge may be crucial to find safe and proper alternatives to hospital admission. These findings give support to the idea and previous research presented in Section 2.4 that continuity of care is considered important to keep patient care and costs at the lowest level desired, avoiding some of the unnecessary health care use (including OOH visits and hospital admissions) and health care costs.

In the debate of hospital admissions, and particularly potentially avoidable admissions and gatekeeping, one should keep in mind that not all patients are admitted by GPs. Despite the

strict Norwegian gatekeeping system, a recent Norwegian study found that among inpatients, just 26% were admitted by GPs, 31% were admitted by OOH services and the majority through other routes, pointing to a possible undermining of the GP's gatekeeping role[165]. This finding indicates that the role of GPs in explaining hospital admissions may be less than previously thought, and that it is important to target these other routes to reduce unnecessary hospital admissions.

In Paper ll, we studied GP and OOH consultations for different patient groups over time from 2007 to 2016, a period that comprised the implementation of the Coordination Reform. We found an overall increase in regular GP consultations in the period, particularly for healthier participants. The increase in GP use was gradual and not directly related to the timing of the implementation of the Coordination Reform.

More frequent consultations could indicate better prevention, monitoring and treatment from the GP. However, our finding that the consultations particularly increased among the heathier middle-aged groups could just as well be indicative of too much and unnecessary use of GP services, partly due to changes in help-seeking behaviour among the healthier part of the population. GPs provided consultations in a fairly similar way during the study period, pointing to possible explanations for increased consultations to be found outside the GP's office. Some GPs point to a societal change towards wanting a proper (doctor) answer to minor health concerns that would have previously been solved outside the doctor's office[72]. This could be a big problem, especially if patients with heavier and more complex needs are displaced by a healthier population, like the findings in Paper II indicate.

In recent years, there has been a lot of attention to reports of increased GP workload and recruitment and retention problems in both Norway[166, 167] and many other counties[168], especially England[169-171]. Norwegian GPs themselves are concerned about the sustainability of their work situation[172]. Recruitment problems in an increasing number of municipalities and shorter durations of regular GP contracts are interpreted as signs of the unsustainability of the regular GP scheme in the 2019 evaluation of the Norwegian regular GP scheme[173]. This evaluation also found the access to GPs being too low, GPs remaining in the profession for a shorter time than before, and that the tasks and expectations for GPs are increasing[173]. All this makes one wonder about the future of general practice, including the possibilities for improving preventive care and ensuring continuity of care. Continuity of (interpersonal) care

can be described as the "gold" of general practice, but in England, concerns have been raised as access is being prioritised over continuity[104, 174]. A Danish study found an association between GPs showing signs of mental distress (including job satisfaction and burn out) and increasing ACSC hospital admissions, a finding indicating GPs working conditions' having implications for both their patients and health care costs[175]. This is interesting combined with our results from Paper lll, where discontinuity of GP care also led to increased odds of hospital admissions for the elderly and ACSC. With the ongoing recruitment and retention problems, one can hypothesise vicious circles where overworked GPs leave their positions, with negative consequences for their patients and an increased pressure on the specialised health care system.

Days before turning in this thesis, a new action plan for general practice called "Attractive, quality-assured and team-based"[176] was presented by the Norwegian health minister Bent Høie. This plan aims for strengthened financing, better recruiting, more team-based general practice and less bureaucratic work, among other changes[176]. Nobody knows what the future brings, but it will surely be exciting to follow general practice forward.

6.4 Implications and future research

We found a substantial percentage of the patients admitted did *not* see their GPs the month before hospital admission. This group of patients could represent a possible target for prevention, although not easily reached. Likewise, groups with high use of OOH services and an increase in OOH services before admission to hospital could be an interesting target for further exploration of the potential for intervention in the GP services. As our findings merely state a preventive potential, future studies should assess interventions aimed at reducing unnecessary hospital admission in an experimental or quasi-experimental setting.

As GP services today are under a considerable capacity pressure, prioritisation principles and following up patients with different needs is a topic for further scrutiny. It should be further investigated whether patients with heavier and more complex needs are displaced by a healthier population or cared for in other primary care services. Furthermore, it is important

to consider whether the increase in consultations has spill-over effects in terms of referrals to secondary health care services.

The increase in acute hospital admissions for ambulatory care sensitive conditions during and after the discontinuity of care from their regular GP in the older age groups suggests a crucial role of the GP and warrants attention and further research.

7 Conclusions

The general objective of this thesis was to investigate patients' contact with GPs and how the use of health care services changed 1) prior to acute hospital admissions, 2) in a period when GPs' responsibilities for health care services increased and 3) when patients suddenly were exposed to a situation where their regular GP was unavailable for a longer period of time. These aims were analysed within the context of patients with expected close follow-up and need for attention from both primary and secondary health care.

We found that the majority of patients were regularly in contact with a general practitioner (GP) before an acute hospital admission for the five selected conditions (myocardial infarction, heart failure, stroke, pneumonia or hip fracture). This points towards GPs having an important role in these patients' health care. Nevertheless, a substantial percentage of the patients admitted with these severe diagnoses did *not* see their GPs the month before hospital admission. This group of patients could represent a possible target for prevention, although not easily reached.

We found indications of an increased use of GP services (but not OOH use) in Norway partly due to changes in help-seeking behaviour among the healthier part of the population: those with a 'normal' range of anxiety/depression symptoms who 'never' sought help for mental health problems; and those with normotension and no antihypertensive treatment. More frequent consultations could indicate better prevention, monitoring and treatment. However, as GP services are under considerable capacity pressure, prioritisation principles and the balance between follow-up of people with different needs is a topic for further scrutiny.

We found that overall, patients seem to access help when faced with a sudden discontinuity of care from their regular GP. However, the increase in acute hospital admissions for

ambulatory care sensitive conditions in the older age groups after such a discontinuity suggests a crucial role of the GP and warrants attention and further research.

8 References

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Paper I

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Contact with primary health care physicians before an acute hospitalisation

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RESEARCH ARTICLE

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Contact with primary health care physicians before an acute hospitalisation

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ABSTRACT

Objectives: To assess contacts with general practitioners (GPs), both regular GPs and out-of-hours GP services (OOH) during the year before an emergency hospital admission.

Design: Longitudinal design with register-based information on somatic health care contacts and use of municipality health care services.

Setting: Four municipalities in central Norway, 2012–2013.

Subjects: Inhabitants aged 50 and older admitted to hospital for acute myocardial infarction, hip fracture, stroke, heart failure, or pneumonia.

Main outcome measures: GP contact during the year and month before an emergency hospital admission.

Results: Among 66,952 identified participants, 720 were admitted to hospital for acute myocardial infarction, 645 for hip fracture, 740 for stroke, 399 for heart failure, and 853 for pneumonia in the two-year study period. The majority of these acutely admitted patients had contact with general practitioners each month before the emergency hospital admission, especially contacts with a regular GP. A general increase in GP contact was observed towards the time of hospital admission, but development differed between the patient groups. Patients admitted with heart failure had the steepest increase of monthly GP contact. A sizable percentage did *not* contact the regular GP or OOH services the last month before admission, in particular men aged 50–64 admitted with myocardial infarction or stroke.

Conclusion: The majority of patients acutely admitted to hospital for different common severe emergency diagnoses have been in contact with GPs during the month and year before the admission. This points towards general practitioners having an important role in these patients' health care.

KEY MESSAGES

- There is scarce knowledge about primary health care contact before an emergency hospital admission.
- The percentage of patients with contacts differed between patient groups, and increased towards hospital admission for most diagnoses, particularly heart failure.
- More than 50% having monthly general practitioner contact before admission underscores the general practitioners' role in these patients' health care.
- Our results underscore the need to consider medical diagnosis when talking about the role of general practitioners in preventing emergency hospital admissions.

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Introduction

General practitioners (GPs) play an important role in the management of patients with chronic conditions [1]. GPs are coordinators in the line of treatment, responsible for adequate preventive health care, referral of patients to secondary health care when needed, follow-up and monitoring after secondary health care treatment [2]. Adequate access to GP services and continuity of care from GPs have been suggested to prevent deterioration of several medical conditions [1,3–5] and decrease visits to emergency departments in both children [6,7] and the general population [8–10] across different healthcare systems [11].

In Norway, all inhabitants are provided with a regular GP within a list-based system introduced in 2001, and by the start of 2018 almost the whole population participated in this system [12]. Even though Northern European countries organise their primary health care

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sectors differently, they all emphasise the importance of general practice and primary care when discussing the public health challenges of an ageing population [13]. There is scarce knowledge on the use of primary health care before an emergency hospital admission. This study aims to explore the extent and timing of contacts with GPs (both regular and out-of-hours (OOH)) among adults 50 years and older during the year before emergency hospital admission for five common acute diagnoses (acute myocardial infarction; hip fracture; stroke; heart failure; and pneumonia).

We expected a gradual increase in contacts as patients got closer to the time of hospital admission, but that the extent and timing would differ according to diagnosis and type of GP contact (regular GP vs. OOH services). We wanted to explore whether an increase in GP contact could be observed over a longer period (e.g. several months), indicating a gradual health deterioration culminating in the acute or subacute situation causing the emergency hospital admission. This could point to both a preventive potential but also to the role of close monitoring of vulnerable patients in primary care. For acute myocardial infarction and stroke, we also wanted to explore whether these groups had a more stable level of GP contacts over time before an acute incident leading to their admission, or if there was any indication of increased contact in the weeks or months before admission – indicating a potential for prevention or early detection in primary care.

Methods

This study used a longitudinal design with data from Norwegian national- and municipal registers. We applied register-based information on all somatic health care contacts for the inhabitants in four municipalities (one municipality containing a city (Trondheim) and three neighbouring, more rural municipalities) in central Norway in a two-year period from 2012 to 2013, covering a population of 214,722 persons. The data included routine patient administrative data on inpatient and outpatient somatic health care use from St. Olav's University Hospital, and information on contacts with regular GPs and OOH services from the Norwegian Health Economics Administration database (Helfo). We linked the registers using a project ID based on the national ID number unique to each Norwegian citizen. We also included information regarding municipality health care services from the four municipalities. All data was de-identified before the analysis.

Inclusion criteria for the analysis were age 50 years or older by the end of 2012, having at least one emergency hospital admission in 2012 or 2013 for one of five diagnoses specified below, and having at least one month of observation time before admission (excluding emergency admissions before 1 February 2012).

The age of each participant in 2012 was categorised into age groups (50–64 years, 65–79 years, and 80+). We also included sex and municipality of residence (dichotomised into living in a city or not). Hospital stay (for other causes than the specific diagnosis) and use of municipal services such as home nursing care, home aid, and long- and short-term stay in institution was also recorded (dichotomised into *use* or *no use*) each month during the year before an emergency hospital admission, and each three-day period during the month before admission.

Acute admission to hospital

We identified dates of acute admission to hospital for the following common diagnosis (with corresponding diagnosis codes used from International Classification of Diseases, ICD-10 [14]):

Myocardial infarction (I21), heart failure (I50), stroke (I61, I63 and I64), fracture of hip/femur (S7) and pneumonia excl. COPD (J12-18, excl. those with COPD (J41-44 or J47) as a secondary diagnosis). Diagnoses were based on the primary diagnosis as recorded by the hospital. To make the pneumonia group of more homogenous we excluded all admissions with chronic obstructive pulmonary disease (COPD) as secondary diagnosis. For each patient, only the first admission for each specific diagnosis during the study period was included.

All included diagnoses are well-defined common causes of emergency hospital admissions in adults 50 years and older. Heart failure, hip-fracture and pneumonia are also ambulatory care sensitive conditions (ACSC). According to Ansari (2007): *"ACSCs are conditions for which hospitalisation is thought to be avoidable with the application of preventive care and early disease management, usually delivered in the ambulatory setting"* [15]. ACSCs are studied internationally with framework and definitions [15], and adapted to the Norwegian context [16].

General practice contacts before an emergency hospital admission

We included all contacts with general practitioners working in a regular GP and/or OOH setting, defined

by claims of reimbursement generated by each practitioner after each contact and sent to The Norwegian Health Economics Administration (Helfo). The Helfo-data provided information on whether the claim was made in a regular GP or OOH setting. We coded contact with a regular GP (GP contact) and with the OOH services (OOH contact) into *contact* or *no contact* each month during one year before hospital admission and in three-day intervals during the month before admission. We omitted contacts on both the day of admission and the day before (i.e. day 0–1) to avoid registration of the contact directly leading to the emergency hospital admission.

Statistics

We used binomial generalised estimation equation models with a logit function (GEE [17]) to investigate GP/OOH contacts before the hospital admission. First, we estimated the percentage with contact per month during the year before the event. Secondly, we estimated the percentage with contact per triplets of days (2–4, 5–7, …., 29–31 days) before the admission. We performed the analysis separately for each of the selected patient groups.

For the analyses of GP and OOH contacts the year before hospital admission, we included time in the models as a categorical variable with 12 monthly intervals (each in a different temporal distance from the date of the admission). We adjusted for calendar month, age, sex, and whether the patient lived in a city or not. Analyses of GP contacts were also adjusted for whether the patient was institutionalised or not (including long- and short-term stay in municipal institution), as institutionalised patients usually are provided with municipal primary health care physicians not included in the GP scheme (but they still use the OOH services).

For the analyses of GP and OOH three-day contact the month before hospital admission, we grouped time as a categorical variable with 10 three-day intervals (each in a different temporal distance from the date of the event). We adjusted for the same variables as for the year before with the exception that we adjusted for weekday of admission event. We also adjusted for whether the patient was an inpatient (acute or elective) during the last month before admission, as they would see neither their GP nor OOH when in hospital.

We used the estimates from these analyses to produce graphical presentations of GP and OOH contacts during the year and month before hospital admission for each of the five patient groups. To make results more comparable between the patient groups, we chose to show the estimated percentages for a "standard" patient. We selected a woman aged 75 not in institution.

We repeated the analyses described above using conditional logistic regression models to calculate odds ratios of GP and OOH contacts at different time points during the year and month before admission (compared to six months before and the tree-day interval 31–29 days before the admission, respectively). In these analyses, patients are compared with themselves, automatically adjusting for all characteristics that are stable within person (e.g. sex, age and municipality of residence, as well as more difficult to measure variables such as stable co- or multimorbidities).

We explored the association between patient characteristics (sex, age group, institution) and having *no* GP or OOH contact in the month before an emergency hospital admission (no contact vs. contact) using logistic regression. These analyses included a statistical interaction term between age group and sex, and adjustment for institutional stay and living in a city. For each patient group we estimated the percentage with no contact for each of the subgroups according to age and sex, with predictions made for those not in institutions.

We performed all analyses with STATA version 15.1, and we present all precision levels with 95% confidence intervals (CI).

Results

Among 66,952 identified participants, between 0.6% (heart failure) and 1.3% (pneumonia) of the participants were admitted at least once for each of the five selected diagnosis.

Table 1 provides an overview of the patient groups analysed in the study. The groups differed in composition according to sex, age, living in a city and in the use of municipality and GP services during the month before the hospital admission.

Figures 1–4 show results from the regression analyses as estimated percentages of monthly GP and OOH contact during the last year (Figures 1 and 3) and of three-day GP and OOH contact during the last month (Figures 2 and 4) before an emergency hospital admission. All estimated percentages are reported for our "standard" patient; a woman aged 75 in 2012, not in institution. Results from the conditional logistic regression analyses are presented in Tables A1–A4

Table 1. Characteristics of each patient group in the study, based on first-time emergency hospital admission for each patient group (1 January 2012–31 December 2013).

	Myocardial Infarction	Heart failure	Stroke	Pneumonia (excl. COPD)	Hip fracture
n (% of total study population[a])	720 (1.1%)	399 (0.6%)	740 (1.1%)	853 (1.3%)	645 (1.0%)
Female	31.8%	61.4%	49.6%	48.2%	71.9%
Age, mean (sd)	71.8 (12.1)	80.1 (10.3)	75.8 (11.0)	76.5 (11.7)	80.8 (10.7)
50–64 years	230 (31.9%)	39 (9.8%)	132 (17.8%)	162 (19.0%)	62 (9.6%)
65–79 years	264 (36.7%)	118 (29.6%)	284 (38.4%)	288 (33.8%)	169 (26.2%)
80+ years	226 (31.4%)	242 (60.7%)	324 (43.8%)	403 (47.2%)	414 (64.2%)
Living in a city	556 (77%)	330 (83%)	575 (78%)	692 (81%)	530 (82%)
Municipality services the month before emergency hospital admission					
Home care[b,c]	21.0%	46.4%	27.4%	43.7%	40.2%
Living in a nursing home[b,d]	6.6%	17.3%	9.2%	18.3%	29.6%
Having municipality services at all[b]	30.9%	63.7%	43.0%	61.4%	71.8%
Contacts with general practitioner, both regular GP (GP) and out-of-hours services (OOH) the month before emergency hospital admission					
GP and OOH	4.6%	14.5%	7.0%	12.3%	7.9%
Only GP	46.0%	59.6%	45.1%	47.4%	38.8%
Only OOH	2.5%	5.3%	2.3%	6.0%	3.1%
No contact	46.9%	20.6%	45.5%	34.3%	50.2%

All age ≥50 in 2012, receiving somatic health care service in the two-year period 2012 to 2013; each patient can be registered in more than one group, but not more than once in each group since we counted only the first hospital admission for the respective diagnosis.
[a]Total study population = 66,952 unique individuals.
[b]Measured during the last 30 days before admission to hospital.
[c]Both home nursing care and/or home aid.
[d]Both short-term and/or long-term institution stay.

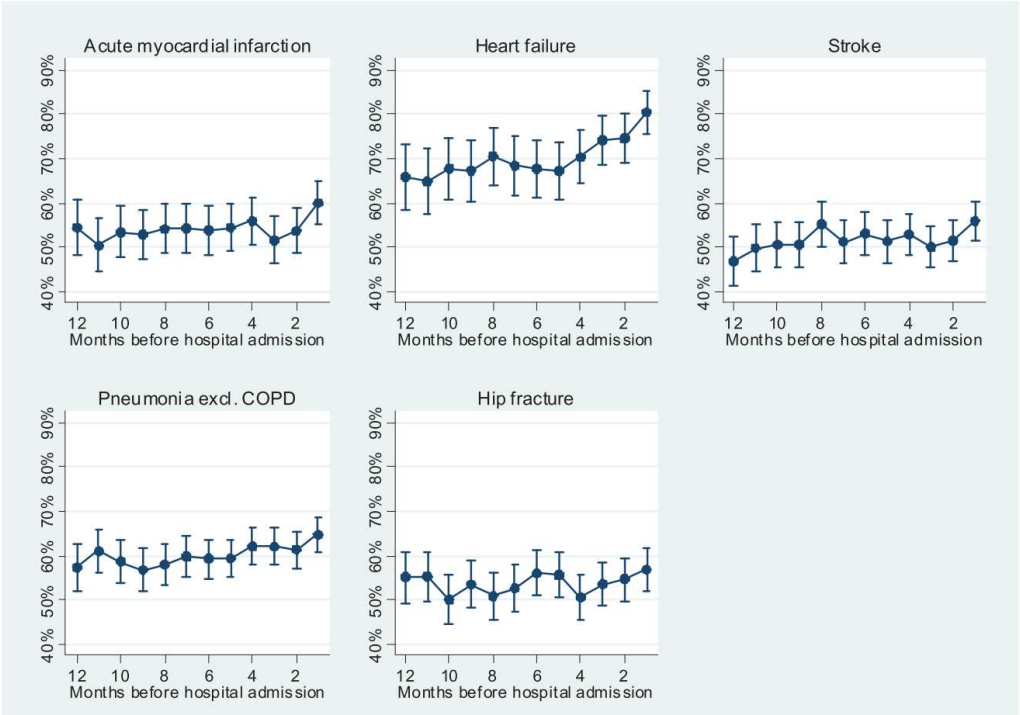

Figure 1. Estimated percentage (vertical axis) with at least one contact with a regular general practitioner (GP contact) per month for a woman aged 75 in 2012 not in institution according to time before an emergency hospital admission. Vertical lines represent 95% CIs. Analysis adjusted for calendar month, age, sex, living in a city and stay in an institution (both short- and long term).

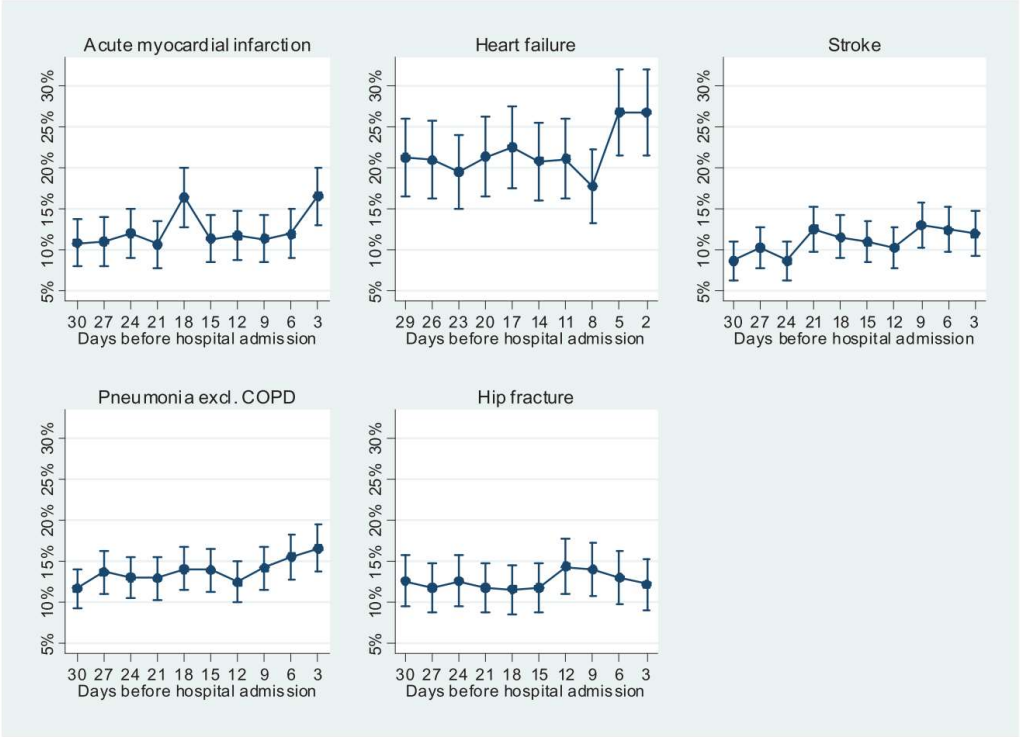

Figure 2. Estimated percentage (vertical axis) with at least one contact with a regular general practitioner (GP contact) per three-day interval for a woman aged 75 in 2012 not in institution according to time before an emergency hospital admission. Vertical lines represent 95% CIs. Analysis adjusted for weekday of admission, age, sex, living in a city, hospital stay and any stay in an institution (both short- and long term).

(Appendix), comparing each patients' GP and OOH contacts at different time points with their own contact level 6 months and 31–29 days before hospital admission. The results from these analyses were in line with the results from the main analysis.

Regarding GP contact per month the year before hospital admission (Figure 1), the estimated percentage with GP contact (estimated for our "standard" patient) increased the last three months before hospital admission for heart failure: the percentage with GP contacts increased from 68% six months before admission to 81% one month before admission, an increase of 12%-points (95CI, 7–19%). For acute myocardial infarction and pneumonia, the increase was seen in the last month before hospital admission. Acute myocardial infarction increased from 54% six months before, to 60% one month before admission (increase of 6%-points (95%CI, 1–11%)), and pneumonia increased from 59% six months before, to 65% one month before admission (increase of 5%-points (95%CI, 1–10%)). Compared with their own GP contact 6 months before admission, the odds ratio of GP contact in the month before admission was 2.44 (95% CI, 1.59–3.75), 1.40 (95% CI, 1.06–1.84) and 1.36 (95% CI, 1.04–1.77) for patients admitted for heart failure, myocardial infarction and pneumonia, respectively (see Appendix Table A1).

When investigating GP contact per three-day interval the last month before hospital admission (Figure 2), an increase in contacts occurred during the three-day intervals close to the time of admission for stroke, pneumonia and myocardial infarction. The estimated percentage with GP contact increased during the last three three-day intervals before hospital admission for stroke, increasing from 9% 31–29 days before, to 12% 4–2 days before admission (increase of 3%-points (95%CI, 0–6%)). For pneumonia, the percentage with GP contact increased in the last two three-day intervals before hospital admission, increasing from 12% 31–29 days before, to 17% 4–2 days before admission (increase of 5%-points (95% CI, 2–8%)). For acute myocardial infarction, GP contacts

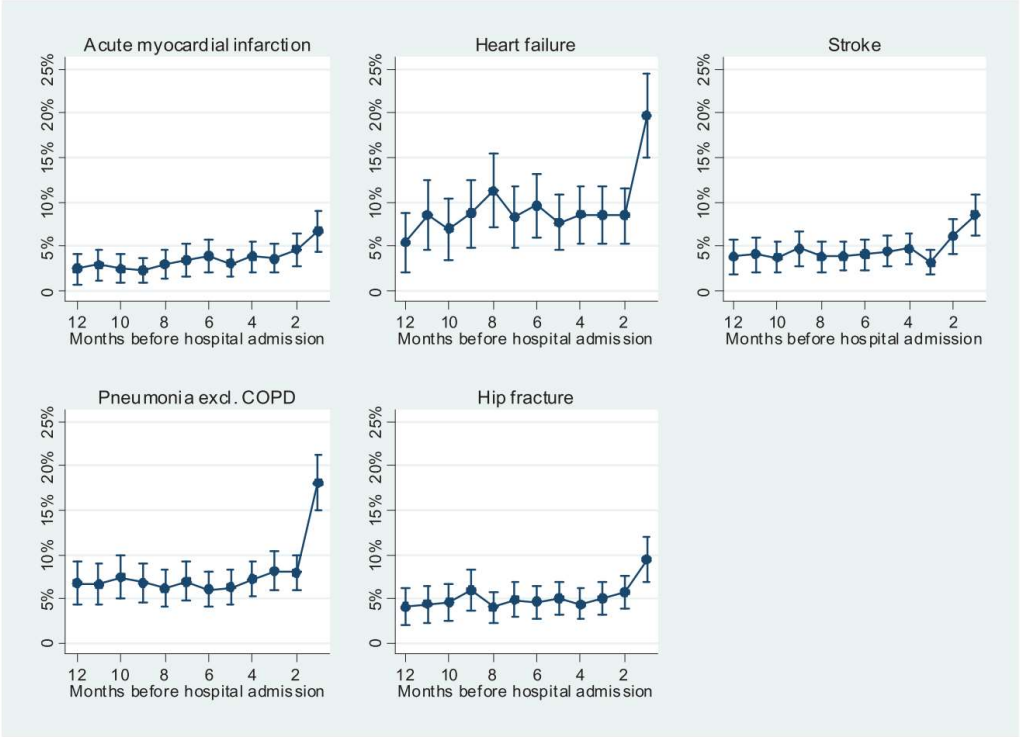

Figure 3. Estimated percentage (vertical axis) with at least one OOH (general practitioner out-of-hours services) contact per month for a woman aged 75 in 2012 not in institution according to time before an emergency hospital admission. Vertical lines represent 95% CIs. Analysis adjusted for calendar month, age, sex, living in a city, and stay in an institution (both short- and long term).

increased day 21–19 and in the last three-day interval before hospital admission, increasing from 11% 31–29 days before, to 16% 4-2 days before admission (an increase of 6%-points (95% CI, 2–9%)). Compared with their own GP contact in the three-day interval 31–29 days before admission, the odds ratio of GP contact in the last three-day interval (4–2 days before) before admission was 1.48 (95% CI, 1.02–2.14), 1.57 (95% CI, 1.16–2.12) and 1.73 (95% CI, 1.20–2.48) for patients admitted for stroke, pneumonia and myocardial infarction, respectively (see Table A2 in Appendix).

Regarding OOH contacts the year before hospital admission (Figure 3), *all* patient groups had increased contact the last month before admission. The estimated percentage with OOH contact the last month before admission varied from 7% (95% CI, 4–9%) for myocardial infarction to 20% (95% CI, 15–25%) for heart failure. Compared with their own OOH contact 6 months before admission the odds ratio of OOH contact in the month before admission varied from 1.96 (95%Ci, 1.11–3.48) for myocardial infarction to 3.68 (95% CI, 2.46–5.50) for pneumonia (see Table A3 in Appendix).

All patient groups had increased OOH contact the last three-day interval before an emergency hospital admission, except hip fracture patients (Figure 4 and Appendix Table A4).

No contacts

For all patient groups, the estimated percentage with no GP or OOH contact during the last month before emergency hospital admission was higher among younger and men (Table A5, Appendix), with larger differences between age groups in men compared to women (*p*-value for interaction term between age group and sex was <0.05 in *all* patient groups). The group without contact was highest for men 50–64 years being admitted with stroke (estimated percentage 65% (95% CI, 62–68%)) and acute myocardial infarction (estimated percentage 62% (95% CI, 60–65%)). Few patients among those aged 80+ being

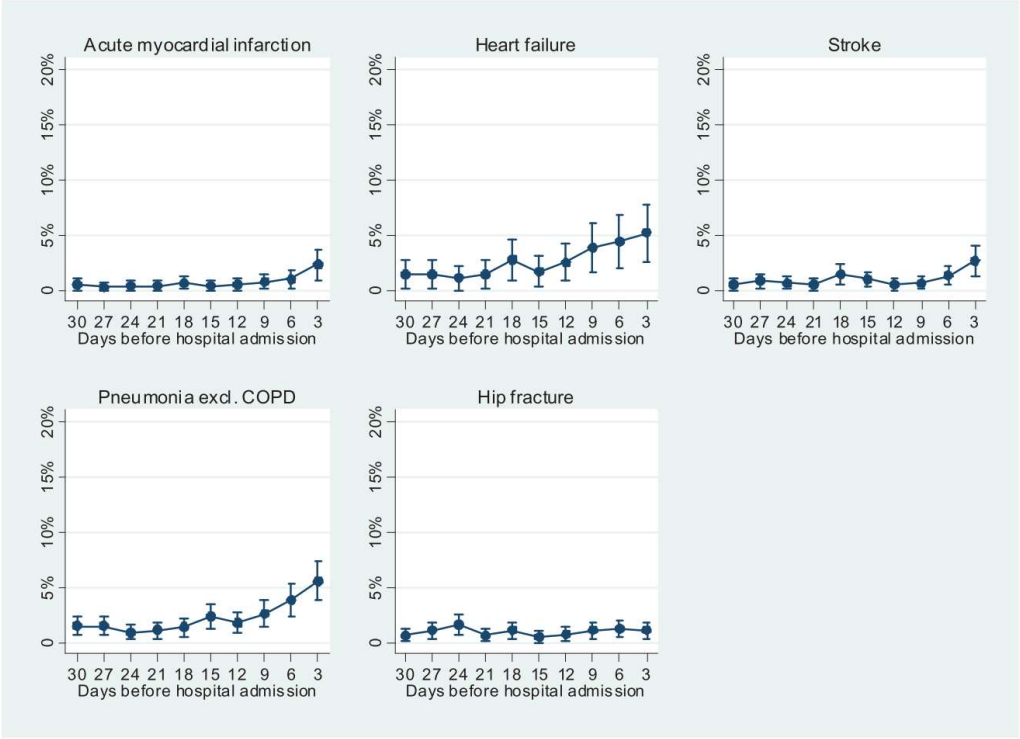

Figure 4. Estimated percentage (vertical axis) with at least one OOH (general practitioner out-of-hours services) contact per 3-day interval for a woman aged 75 in 2012 not in institution according to time before an emergency hospital admission. Vertical lines represent 95% CIs. Analysis adjusted for weekday of admission, age, sex, living in a city, hospital stay and stay in an institution (both short- and long term).

admitted to hospital with heart failure did not contact their GP prior to admission, only 10% (95% CI, 08–12%) in men and 17% (95% CI, 15–19%) in women.

Discussion

The majority of patients in the age group 50+ acutely admitted for one of the five selected conditions (myocardial infarction, heart failure, stroke, pneumonia or hip fracture) had contact with primary care physicians each month before the admission, especially with regular GPs. The percentage in contact with GPs often increased close to the time of hospital admission, but the time and extent of this increase varied substantially between groups according to diagnosis, as well as with type of GP service (regular GP and/or OOH services). Those admitted for heart failure stood out with a higher percentage with regular GP and OOH contacts before the hospital admission. A substantial group of patients contacted neither their GP nor OOH the last month before the emergency hospital admission, varying according to diagnosis, sex and age group.

Strengths and limitations

To our knowledge, this is the first study to investigate the contact with GP services before an emergency hospital admission. We based our study on data from a total population regarding contacts with both primary and secondary somatic health care, giving limited risk of selection bias. Our study population comprised both urban and rural municipalities, but since all three rural municipalities were located close to the urban municipality (a large city) we could only partly address possible urban-rural variations in health and help seeking behaviour [18].

The study could have benefitted from more information on clinical characteristics as well as the social situation of the patients. We only had data regarding somatic hospital contacts and did not include psychiatric specialised services. The included patient groups

were rather small, not providing precision to present smaller changes in health care contact prior to hospital admission.

The results should be interpreted in the light that health care, and especially primary care, is organised quite differently in different countries. Even in the Nordic countries there are differences in the organisation of GP services [13], though no distinct pattern has been found of GPs in one country providing more diverse services for their patients than in the other Nordic countries [19]. The delineation of responsibilities between primary and secondary health care also differs [20].

Interpretation of results and comparison with existing literature

In this study, we investigated contacts with primary care physicians as regular GPs and the OOH services. While regular GP contacts could indicate planned or proactive care, more frequent GP contact could indicate either poor health or recent deterioration [21]. Contact with the OOH services are indicative of emergency conditions which need to be dealt with immediately, but might also indicate a potential for prevention within the regular GP services [22].

The patient group admitted to hospital with heart failure had the highest contact with the primary physicians, increasing towards the date of admission. Heart failure is a heterogeneous disease due to both aetiology and comorbidity, and despite numerous treatments available, heart failure-patients experience progressively worsening symptoms, frequent admission to hospital, and premature death [23]. Our results indicate that GPs do monitor heart-failure-patients, and that GP contact increases when the condition worsens.

Those admitted to hospital with acute myocardial infarction and stroke had similar patterns: a modest increase in the contact with both regular GP and OOH services immediately before admission. This could mean that some patients contacted the services with symptoms related to the cardiovascular event that happened only days later. Streamlining of specialised services *after* a serious cardio- or cerebrovascular event is underscored as an important task for improving patient prognosis [24–26]. The extent to which GPs could better capture early signals of these events, and thereby intervene in order to prevent the need for emergency hospital admission has been less scrutinised, although there are several guidelines for the prevention according to risk factors [27,28].

For pneumonia (excl. COPD), the patients increased their GP and OOH contacts the last week the last month before the emergency hospital admission. Patients with pneumonia could be seen as a particularly interesting group, as the condition usually develops sub-acutely, and early detection and intervention (e.g. treatment with antibiotics initiated at an earlier stage) could possibly reduce risk of hospital admission [29]. For the pneumonia group, the increase in contact with the OOH services before admission was particularly prominent. This could be due to community-acquired pneumonia with acute symptoms and need for hospital admission for the most the severely ill [29]. The results do not support that an emergency hospital admission for pneumonia is the final stage of a general health deterioration over time as only a small trend of increased contact over the last months before admission could be observed.

A hip fracture is often regarded a result of a general health decline. Our results did not show any substantial change in contact with GP services as an indicator of such health decline neither the year nor month before the emergency hospital admission. The explanation for this could possibly relate to an underuse of GP services in this group or that the patients are monitored and treated in the municipal services. Hip fracture patients are often elderly, frail and multimorbid [30], which comply well with the characteristics of our patient group, including the fact that almost 30% were institutionalised and more than 70% had municipal care services.

Our study presented results for common diagnoses, three of them (heart failure, pneumonia and hip fracture) regarded as part of potentially avoidable hospitalisations, the ambulatory care sensitive conditions [15], adapted to the Norwegian context [16]. Other studies point to the role of GPs in preventing these hospital admissions [4,31], though Norwegian results have been inconclusive [16,32]. We did not find any striking differences between the contact patterns of the diagnosis regarding whether they were potentially avoidable or not, though our data are limited for any conclusion. Our study might suggest some important targets and relevant areas for further exploration. First, our results point towards the regular GP having an important role to most patients. Second, our results underscore the need to consider patient groups according to the medical diagnosis when talking about the role of primary health care in preventing admission to hospital. Prevention strategies from primary care physicians would be challenging in patient groups where a substantial part did not have any contacts with GP services

(e.g. by treating disease/symptoms at a stage so that admission to hospital becomes unnecessary). Groups with high use of OOH services and an increase in OOH services before admission to hospital (as seen with heart failure and pneumonia) could be an interesting target for further exploration of the potential for intervention in the GP services.

Conclusion

The majority of patients with emergency hospital admission for the five selected conditions (myocardial infarction, heart failure, stroke, pneumonia or hip fracture) were regularly in contact with a general practitioner (GP) before admission. This points towards GPs' having an important role in these patients' health care. Nevertheless, a substantial percentage of the patients admitted with these severe diagnoses did *not* see their GPs the month before hospital admission. This group of patients could represent a possible target for prevention, although not easily reached.

Ethics approval

The Regional Committee for Medical and Health Research Ethics in Central Norway approved the study (2011/2047).

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Appendix

Table A1. Odds ratios for GP (regular general practitioner) contact month by month compared to 6 months before an emergency hospital admission for the different diagnoses.

	Myocardial infarction		Heart failure		Stroke		Pneumonia (excl. COPD)		Hip fracture	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
12 months before	1.04	(0.75–1.44)	0.86	(0.53–1.38)	0.70	(0.50–0.97)	0.88	(0.65–1.20)	0.95	(0.66–1.39)
6 months before	1.00	(reference)	1.00	(reference)	1.00	(reference)	1.00	(reference)	1.00	(reference)
5 months before	1.04	(0.78–1.38)	0.96	(0.64–1.44)	0.91	(0.68–1.20)	1.00	(0.76–1.31)	0.98	(0.71–1.36)
4 months before	1.13	(0.85–1.49)	1.15	(0.77–1.73)	0.99	(0.75–1.32)	1.18	(0.90–1.55)	0.73	(0.53–1.01)
3 months before	0.89	(0.67–1.17)	1.51	(1.00–2.29)	0.85	(0.65–1.13)	1.17	(0.90–1.53)	0.87	(0.63–1.20)
2 months before	0.99	(0.75–1.31)	1.56	(1.03–2.35)	0.94	(0.71–1.23)	1.13	(0.87–1.47)	0.93	(0.67–1.27)
1 month before	1.40	(1.06–1.84)	2.44	(1.59–3.75)	1.18	(0.89–1.55)	1.36	(1.04–1.77)	1.04	(0.75–1.43)

Estimates from conditional logistic regression analyses, comparing contacts within patients.

Table A2. Odds ratios for GP (regular general practitioner) contact in three-day intervals compared to the three-day interval 31–29 days before an emergency hospital admission for the different diagnoses.

	Myocardial infarction		Heart failure		Stroke		Pneumonia (excl. COPD)		Hip fracture	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
31–29 days before	1.00	(reference)	1.00	(reference)	1.00	(reference)	1.00	(reference)	1.00	(reference)
19–17 days before	1.70	(1.19–2.45)	1.10	(0.76–1.60)	1.41	(0.98–2.04)	1.26	(0.92–1.71)	0.90	(0.60–1.36)
16–14 days before	1.07	(0.73–1.57)	0.99	(0.68–1.44)	1.32	(0.91–1.92)	1.24	(0.91–1.68)	0.92	(0.62–1.38)
13–11 days before	1.11	(0.75–1.63)	1.01	(0.69–1.47)	1.21	(0.83–1.77)	1.08	(0.79–1.48)	1.20	(0.81–1.77)
10–8 days before	1.07	(0.73–1.58)	0.80	(0.54–1.17)	1.63	(1.14–2.35)	1.27	(0.94–1.73)	1.15	(0.78–1.70)
7–5 days before	1.13	(0.77–1.65)	1.41	(0.98–2.02)	1.54	(1.07–2.23)	1.44	(1.06–1.95)	1.04	(0.70–1.54)
4–2 days before	1.73	(1.20–2.48)	1.40	(0.98–2.02)	1.48	(1.02–2.14)	1.57	(1.16–2.12)	0.96	(0.64–1.44)

Estimates from conditional logistic regression analyses, comparing contacts within patients.

Table A3. Odds ratios for OOH (general practitioner out-of-hours service) contact month by month compared to 6 months before an emergency hospital admission for the different diagnoses.

	Myocardial infarction		Heart failure		Stroke		Pneumonia (excl. COPD)		Hip fracture	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
12 months before	0.62	(0.27–1.43)	0.49	(0.23–1.04)	0.97	(0.49–1.93)	1.08	(0.63–1.85)	0.85	(0.44–1.65)
6 months before	1.00	(reference)	1.00	(reference)	1.00	(reference)	1.00	(reference)	1.00	(reference)
5 months before	0.78	(0.40–1.54)	0.75	(0.42–1.35)	1.12	(0.63–2.00)	1.03	(0.64–1.65)	1.10	(0.63–1.93)
4 months before	1.02	(0.54–1.92)	0.85	(0.49–1.49)	1.26	(0.72–2.20)	1.22	(0.78–1.91)	0.94	(0.53–1.65)
3 months before	0.93	(0.49–1.76)	0.86	(0.49–1.50)	0.76	(0.42–1.39)	1.36	(0.87–2.11)	1.11	(0.64–1.91)
2 months before	1.31	(0.72–2.38)	0.91	(0.52–1.57)	1.56	(0.92–2.65)	1.30	(0.84–2.02)	1.30	(0.77–2.22)
1 month before	1.96	(1.11–3.48)	2.83	(1.74–4.61)	2.42	(1.45–4.03)	3.68	(2.46–5.50)	2.47	(1.50–4.06)

Estimates from conditional logistic regression analyses, comparing contacts within patients.

Table A4. Odds ratios for OOH (general practitioner out-of-hours service) contact in three-day intervals compared to the three-day interval 31–29 days before an emergency hospital admission for the different diagnoses.

	Myocardial infarction		Heart failure		Stroke		Pneumonia (excl. COPD)		Hip fracture	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
31–29 days before	1.00	(reference)	1.00	(reference)	1.00	(reference)	1.00	(reference)	1.00	(reference)
19–17 days before	1.82	(0.42–7.84)	2.05	(0.69–6.10)	3.15	(0.99–9.97)	0.91	(0.40–2.10)	1.87	(0.62–5.66)
16–14 days before	1.08	(0.21–5.49)	1.23	(0.37–4.10)	2.05	(0.60–6.94))	1.60	(0.77–3.35)	0.82	(0.22–3.09)
13–11 days before	1.50	(0.32–6.91)	1.90	(0.62–5.78)	1.00	(0.25–4.07)	1.17	(0.53–2.56)	1.30	(0.39–4.35)
10–8 days before	2.27	(0.55–9.41)	3.03	(1.07–8.59)	1.26	(0.33–4.77)	1.77	(0.86–3.65)	2.06	(0.67–6.27)
7–5 days before	3.19	(0.81–12.51)	3.56	(1.27–9.93)	2.90	(0.90–9.35)	2.66	(1.34–5.26)	2.33	(0.78–6.97)
4–2 days before	8.10	(2.29–28.63)	4.33	(1.58–11.88)	6.16	(2.07–18.35)	3.95	(2.05–7.59)	2.09	(0.68–6.36)

Estimates from conditional logistic regression analyses, comparing contacts within patients.

Table A5. The estimated percentage (with 95% Confidence intervals) with *no contact* with general practitioners (regular or out-of-hours service) the last month before an emergency hospital admission for patients not living in an institution, according to age group and sex.

	Myocardial infarction	Heart failure	Stroke	Pneumonia (excl. COPD)	Hip fracture
Female					
50–64 years	43% (39–48)	25% (18–32)	46% (41–50)	32% (29–36)	44% (38–49)
65–79 years	33% (30–36)	15% (12–19)	45% (42–47)	30% (27–32)	41% (38–44)
80+ years	36% (33–39)	17% (15–19)	35% (32–37)	32% (30–34)	32% (30–34)
Male					
50–64 years	62% (60–65)	33% (27–39)	65% (62–68)	42% (39–45)	52% (46–58)
65–79 years	51% (49–54)	13% (11–15)	47% (45–49)	29% (27–31)	47% (42–51)
80+ years	30% (27–32)	10% (08–12)	35% (32–38)	24% (22–25)	30% (27–34)
p-value for interaction[a]	<0.001	0.002	<0.001	<0.001	0.024

Based on the results from a logistic regression with an interaction between sex and age group, and adjusted for living in an institution (patients who had no days/nights in institution the last month before an emergency hospital admission) and living in a city (patients living in a city when admitted to hospital).

[a]Interaction term between age group and sex.

Paper II

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Health Service Research

Changes in General Practitioners' consultation frequency over time for patients with hypertension or anxiety/depression symptoms: a 10-year follow-up of the Norwegian HUNT study

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Abstract

Background: General Practitioners' (GPs') workload has been suggested to increase in many countries; how does this impact patient follow-up?
Objective: To investigate trends in GP consultation patterns for adults according to baseline hypertension and anxiety/depression symptoms and attribution of the GP to trend differences.
Methods: Prospective cohort study, linking survey data and clinical measurements from the Norwegian HUNT3 study (2006–08) with national administrative data on GP list assignment and consultations with GP services. We grouped participants aged 40–59 years according to sex and their baseline status regarding hypertension and anxiety/depression symptoms. We registered GP consultations in 2007–16 and used general estimation equation models to estimate the level of GP consultations per month per year during follow-up. We used multilevel models with participants nested in their assigned regular GP to calculate GP-level intra-class correlation coefficients, reflecting to what extent patients' consultation patterns could be attributed to the individual GP.
Results: In total, 47 550 HUNT3 participants were registered with 102 different GPs in Nord-Trøndelag County, Norway, in 2007. Adjusted for age, we observed an overall increase in GP consultations in 2007–16, particularly in those with a better health status at baseline. About 2% of the variance of patient consultations could be attributed to differences between GPs and 10% to the use of lengthy consultations. Out-of-hours consultations did not change much in the study period 2007–16.
Conclusion: Increased use of GP consultations, mainly among the healthiest participants, encourage further research into whether these patients displace patients with heavier and more complex needs.

Key words: Anxiety disorders, continuity of patient care, depression, general practice, hypertension, primary health care.

Key Messages

- General Practitioners (GPs) are reporting increased workload, recruitment and retention problems.
- We observed GP consultations in 2007–16 according to baseline health status.
- A general increase in GP consultations was observed during the study period.
- This increase was prominent among the healthier groups.
- Consultations in men with anxiety/depression decreased over the study period.
- Further research should explore if GPs spend more time on healthier patients.

Background

General practitioners (GPs) are key service providers in primary care (1), responsible for the coordination of services, preventive care, referral to secondary health care when needed, follow-up and monitoring (2). In addition to an ageing and more medically complex (3,4) population, many countries are shifting responsibilities from secondary to primary health care (5) (systemized in Norway through The Coordination Reform in 2012 (6)). A heavier caseload for GPs, together with increased public expectations about health/health services and advances in medicine, are key factors claimed to increase GPs workload (7,8) in many countries.

Recent studies have not only indicated an increased GP workload (8–10) but also GP recruitment and retention problems (11–13). Whether these changes have altered consultation patterns and the care patients receive from their GPs are unknown, and there is limited knowledge on differences between the GPs in the follow-up of their list population.

The aim of this study was to investigate GP consultation patterns in older adults from 2007 through 2016 and whether the development over time differed according to sex and baseline status regarding hypertension and symptoms of anxiety/depression. We also investigated whether consultation patterns changed after the initiation of the Norwegian Coordination Reform (1 January 2012). Both hypertension and anxiety/depression are common in the general population worldwide (14,15) with substantial impacts on individual and overall population health. To a large extent, hypertension and anxiety/depression are managed within the primary health care services and frequent causes of patient contact in general practice (16). Otherwise, these conditions differ in most aspects. While prevention and follow-up of hypertension have been standardized and regulated through GP guidelines (17), no direct recommendations exist regarding anxiety/depression. Our hypothesis was that the patient groups would show different GP consultation patterns over time and that consultations for those with chronic conditions would increase after the Coordination Reform. Since all Norwegian inhabitants are entitled to a regular GP within a list-based system (2) (implemented in 2001; in 2016, the average number of patients on a GP list was 1120 (18)), we also wanted to investigate how much of the variance in consultation patterns could be attributed to the specific GP and whether this had changed with time.

Method

This is a prospective cohort study, linking survey data and clinical measurements from the Norwegian HUNT3 study (2006–08) with national administrative data on GP list assignment and consultations with GP services. All residents of Nord-Trøndelag County in Norway, aged ≥20 years, were invited to participate in the third wave of the HUNT Study (HUNT3, 2006–08; http://www.ntnu.edu/hunt/databank). Participants answered questionnaires and underwent physical examinations. Of the 93 860 invited, 54% participated (19). Details regarding study procedures (19) and non-participation (20) are described elsewhere.

HUNT3 data was linked to individual-level data on primary health care use (Control and Payment of Health Reimbursement—KUHR) (21), GP affiliation (Norwegian General Practitioner register (22)), education and demographic information (Statistics Norway (23)) (see Supplementary Fig. 1). For inclusion, participants had to be ≥20 years by 31 December 2007 and they had to have filled in the HUNT3 questionnaire. Our observation period was from 1 January 2007 to 31 December 2016 with information on health care use registered throughout the period.

Patient groups

Specially trained nurses and technicians conducted the clinical examinations, and we used the mean blood pressure of the second and third measurements. The cut-off for hypertension was systolic blood pressure >140 mmHg and/or diastolic blood pressure >90 mmHg (24). We combined the measured blood pressure with the response to the question 'Do you currently use antihypertensive medication, or have you done so previously?' (response alternatives yes/no), resulting in the following groups:

'Hypertension': current/previous antihypertensive medication regardless of measured blood pressure.

'Non-medicated hypertension': hypertension at examination, *no* current/previous antihypertensive medication.

'Normotensive': normotensive at examination, *no* current/previous antihypertensive medication.

The 14-item Hospital Anxiety and Depression Scale measured symptoms of anxiety and depression (HADS, four-point Likert scale scored 0–3 (25)), where seven items measured symptoms of depression (HADS-D) and anxiety (HADS-A), respectively. We used a cut-off score at ≥8/21, concordant with validation studies reporting sensitivity and specificity for both anxiety and depression to be between 0.80 and 0.90 (26). We combined the HADS score with the response to the question 'Have you had, or do you have any of the following: mental health problems you sought help for?' (response alternatives yes/no), resulting in the groups:

'Anxiety/depression symptoms *having* sought help for mental health problems'

'Anxiety/depression symptoms *never* sought help for mental health problems'

'Normal range of anxiety/depression symptoms, *having* sought help for mental health problems'

'Normal range of anxiety/depression symptoms, *never* sought help for mental health problems'.

Outcome

Our main outcome was regular GP consultations from 2007 through 2016. Additional outcomes were regular GP consultations exceeding 20 minutes and out-of-hours GP consultations.

Covariates

HUNT3 provided birth year, sex and health variables. Self-reported health and physical examination was also used to construct a co-morbidity score; hypothesizing that the higher the level of co-morbidity, the higher the level of consultations, we adjusted for the level of co-morbidity on a continuous scale. Our analysis included 21 chronic diseases/conditions (detailed description found elsewhere (3)). Any case of missing data was defined as the absence of the disease in question. We calculated the co-morbidity score of each participant in the different patient groups, excluding the condition in question (maximum 20 points/other diseases or conditions). The highest achieved level of education by 2007 was measured in three categories: 'no/primary/lower secondary school', 'upper secondary school' and 'college/ university'. Characteristics of the GPs and their patient lists included the GPs' sex, being a GP specialist or not and birth decade (born in 1940s, 1950s and so on, where 1970s also included 1980–81). Participants were censored at migration or death.

Analysis

We used generalized estimation equating (GEE) models (27) to estimate the level of GP consultations per year in 2016 compared to 2007, adjusted for increasing age during follow-up. GEE models assessed the associations between baseline health and GP consultations per month per year from 2007 through 2016. Separate analyses were performed for baseline hypertension status (comparing three groups: hypertension, non-medicated hypertension and normotensive) and anxiety/depression status (comparing four groups according to anxiety and depression symptom level and previous help-seeking for mental problems). Main analyses were restricted to the age cohort 40–59 years (in 2007), avoiding the younger age groups with low HUNT3 participation and the older participants, who were more likely to exit the GP scheme by being institutionalized (Norwegian GPs keep institutionalized patients on their list (2) even though they are cared for by others, and we did not have data enabling us to sensor for institutional stay). The outcome measure was monthly consultation (consultation versus no consultation); we adjusted for year, educational level and increasing age during follow-up and included an interaction term between health status and year. Since help-seeking behaviour differs between the sexes (28), we did separate analyses for men and women. Additional analyses were performed with adjustment for co-morbidity. Estimates from the regression analyses were used to calculate the percentage of people with consultation for each month and year during follow-up. All analyses were repeated for out-of-hours consultations (both sexes together). We also analysed the number of consultations per year as a continuous outcome variable.

We used multilevel models with participants nested in their assigned GP to calculate GP-level intra-class correlation (ICC) coefficients, reflecting to what extent patients' consultation patterns could be attributed to the individual GP. We used the number of yearly consultations per participant as the basis for our calculations and adjusted for patient age and sex. Analyses were repeated for each of our consultation outcomes: regular consultations, consultations exceeding 20 minutes and out-of-hours consultations. We performed separate analyses for each year during follow-up, selecting 2007 (the first year), 2011 (in the middle/the year before The Coordination Reform) and 2016 (the last year of follow-up) for presentation. Supplementary analyses included adjustment for additional participant characteristics (education and co-morbidities) and GP characteristics (sex, age and whether specialist in GP medicine or not). We did sub-analyses of participants with the same GP in 2016 as in 2007 (as a sensitivity analysis).

Results

At baseline (2007), 47 550 participants were registered with 102 different GPs in Nord-Trøndelag County. Each GP had on average 1298 [standard deviation (SD) 295] patients on their list, 523 (SD 154) being HUNT3 participants (see Table 1).

GP consultations

The study population, regardless of age group or baseline health status, had an increase of 0.30 [95% confidence interval (CI) 0.26 to 0.34] GP consultations per year when comparing the number of consultations in 2016 with the number of consultations in 2007, adjusted for increasing age during follow-up (data not shown).

For participants aged 40–59 at baseline (see Figs. 1 and 2), the level of monthly GP consultations was higher among women than men and lower among the healthier. In general, we observed an increasing trend in the level of monthly GP consultation during the study period. This increase was pronounced among the healthiest groups. The only groups who had a steeper increase were those with non-medicated hypertension, with 5% increase for both sexes [95% CI 3% to 7% (women); 3% to 6% (men)] from 2007 to 2016. For these groups, a rapid increase in monthly GP consultation was seen from 2007 to 2008, and non-medicated hypertensive men continued to have a higher level of consultations throughout the study period. In contrast, monthly consultations decreased during the study period for men with a high level of anxiety and/or depression symptoms having sought help for mental health problems from 26% (95% CI 24 to 28) in 2007 to 22% (95% CI 20 to 24) in 2016. The corresponding changes in the number of yearly consultations from 2007 to 2016 are shown in Supplementary Tables 1–2.

Intra-class correlations

About 2–3% of the variance in consultations could be attributed to differences between GPs [ICC 0.03 (95% CI 0.02 to 0.04) in 2007 and 0.02 (95% CI 0.02 to 0.03) in 2016]. The use of out-of-hours consultations differed even less between GP affiliation [ICC 0.02 (95% CI 0.01 to 0.02) in 2006 and 0.01 (95% CI 0.01 to 0.01) in 2016]. There was a larger variability between GPs in consultations exceeding 20 minutes, explaining 8% of the variance and increasing over time [ICC 0.08 (95% CI 0.06 to 0.11) in 2007 and 0.10 (95% CI 0.08 to 0.13) in 2016; see Table 2].

ICC estimates were not substantially changed in the analysis with additional adjustments for patient and/or GP characteristics (see Supplementary Table 3) or in the analysis including only the sub-sample of HUNT3-participants who had the same GP in 2007 and 2016.

Additional analysis; out-of-hours consultations and adjustments for co-morbidity

Those with anxiety/depression symptoms 'having' sought help for mental health at baseline had the highest level of monthly out-of-hours consultations in 2007 of 2.4% (95% CI 2.1 to 2.7), decreasing to 1.8% (95% CI 1.5 to 2.0) in 2016. All other groups had lower and stable levels of monthly consultations during the study period (see Supplementary Figs. 2 and 3). Additional adjustment for co-morbidity did not substantially alter any of our results (see Supplementary Figs. 4–7).

Discussion

Summary

There was an overall increase in regular GP consultations from 2007 to 2016, particularly for healthier participants. We did not observe

Table 1. Participants and characteristics at baseline (2007)

	Female	Male	Total
Total *n* (%)	26 001 (55%)	21 549 (45%)	47 550 (100%)
Age groups *n* (%)			
20–39 years	5678 (22%)	4094 (19%)	9772 (21%)
40–59	10 912 (42%)	9387 (44%)	20 299 (43%)
60–79	7980 (31%)	7065 (33%)	15 046 (32%)
80+	1430 (6%)	1003 (5%)	2433 (5%)
Educational level *n* (%)			
Primary	6191 (24%)	4294 (20%)	10 485 (22%)
Secondary	12 558 (48%)	12 626 (59%)	25 184 (53%)
Tertiary	7252 (28%)	4629 (21%)	11 881 (25%)
Co-morbid conditions (range 0–21) mean (SD)	2.15 (1.89 SD)	1.79 (1.66 SD)	1.99 (1.80 SD)
Hypertension groups (shown for age group 40–59)			
Hypertension[a]	1559 (14%)	1420 (15%)	2979 (15%)
Non-medicated hypertension[b]	339 (3%)	767 (8%)	1106 (5%)
Normotensive[c]	8977 (82%)	7157 (76%)	16 134 (79%
Missing[d]	37 (0.3%)	43 (0.5%)	80 (0.4%)
Anxiety/depression groups (shown for age group 40–59)			
Anxiety/depression symptoms,[e] having sought help for mental health problems[f]	764 (7%)	402 (4%)	1166 (6%)
Anxiety/depression symptoms,[e] 'never' sought help for mental health problems[f]	945 (9%)	737 (8%)	1682 (8%)
'Normal' range anxiety/depression symptoms,[g] having sought help for mental health problems[f]	1045 (10%)	492 (5%)	1537 (8%)
'Normal' range anxiety/depression symptoms,[g] 'never' sought help for mental health problems[f]	5801 (53%)	5316 (57%)	11 117 (55%)
Missing[h]	2357 (22%)	2440 (26%)	4797 (24%)

[a]Current/previous antihypertensive medication regardless of measured blood pressure at baseline.
[b]Systolic blood pressure >140 and/or diastolic blood pressure >90 and no current/previous antihypertensive medication at baseline.
[c]Systolic blood pressure ≤140 and diastolic ≤90 and no current/previous antihypertensive medication at baseline.
[d]Missing physical examination; did not have their blood pressure measured at participation in HUNT3/at baseline.
[e]HADS-A ≥8 and/or HADS-D ≥8 at baseline.
[f]Having (or 'never' having) sought help for mental health problems at baseline.
[g]HADS-A <8 and HADS-D <8 at baseline.
[h]Missing the extra form regarding mental health; did not fill in the additional form when participating in HUNT3/at baseline.

any change in consultation patterns related to the implementation of The Coordination Reform (6) but a substantial increase in consultations during the year after HUNT3 participation for those registered with an elevated blood pressure measurement.

Women with a high anxiety and/or depression symptom level having sought help for mental health problems had the most frequent consultations with their GP. Interestingly, men with a high anxiety and/or depression symptom level having sought help for mental health problems decreased their GP consultations during the period.

Overall, the GPs provided consultations in a fairly similar amount with 2–3% of the variance attributed to differences between GPs. However, regarding the use of consultations exceeding 20 minutes, about 8–10% of the variance could be attributed to the GPs.

Strengths and limitations

In this study, we followed GP consultation patterns for a large population over a 10-year period, linking baseline health status with prospective accurate registry information. The large study provided relatively precise estimates, even in the stratified analyses. The Norwegian GP scheme with <1% non-participants since the start in 2001 (18) made it possible to link each individual in the population to their regular GP.

The HUNT study is a fairly representative sample although, non-participants to some extent may have a higher prevalence of both cardiovascular disease and psychiatric disorders than participants (20). Our groups were defined based on a combination of clinical examination and self-reported information from questionnaires. More precise information on diagnoses at baseline could have been an advantage, but this was not feasible given the size of the study and availability of routine patient data from Norwegian registries. Also, diagnostic coding by GPs has low accuracy (29), partly because GP consultations cannot be categorized easily (30), and patients tend to address several concerns per consultation (31). Using information from the HUNT Study allowed us to group people according to baseline symptoms making the groups more comparable across different health care systems.

Although our results must be interpreted in relation to the Norwegian system with a personal GP for each individual citizen, we believe that the findings have relevance for other health care systems with a well-developed and accessible health care system.

Comparison with existing literature

We found an overall increase in the level of monthly consultations and the absolute number of yearly consultations in concordance with the increased practice of consultation rates in English general practice in the same time period (7,9). A common explanation is that it reflects an older and more multimorbid population. Our study showed that middle-aged patients with the presumably lowest health risk contributed the most to the increased GP workload during the study period in terms of patient consultations. The lack of accompanying increase for out-of-hours consultations indicates that the prevalence of acute and more serious health problems did not change during the study period.

In concordance with expectations and previous research (28), women had a higher level of GP consultations than men. The lower

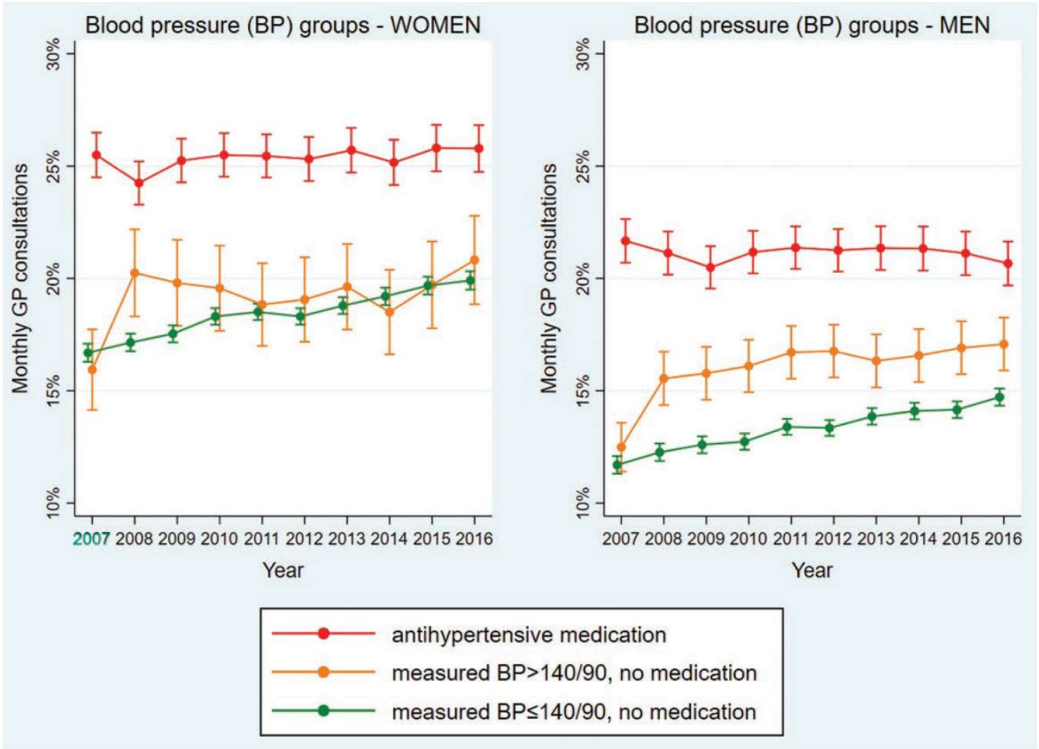

Figure 1. Hypertension groups: estimated percentage with monthly GP consultations per year for the cohort aged 40–59 years in 2007. Adjusted for increasing age and education.

use of GP services in men with high symptom levels of anxiety and depression allows for reflection given the elevated risk of suicide in men with depression (32). These findings underscore the importance of gender in explaining health care utilization and when considering potential overuse and underuse of available services.

The study period covered the implementation of a major Coordination Reform between Norwegian health services, which has been suggested to add an extra burden to GP workload (8). However, we did not find any trend changes corresponding to the timing of the reform for any of our patient groups in line with studies investigating other diagnoses for a shorter time span (33).

Despite hypertension and anxiety/depression being substantially different health problems, our affected groups had surprisingly similar development in their consultation frequency across the study period. Compared with groups with lower symptom levels, they did not show a marked increase over the 10-year period. However, while those with hypertension had stable levels of GP consultation, the groups most heavily affected by anxiety/depression symptoms showed decreasing consultation trends. This difference could be related to the standardized follow-up of hypertensive patients according to guidelines in contrast to patients with common mental disorders for whom follow-up is more based on help-seeking behaviour. Since men, in general, use fewer health services, this could explain why men with anxiety/depression showed a more pronounced decrease in GP consultation compared with women. We found an increase in GP consultations among those with non-medicated hypertension during the HUNT3 period (2006–08), likely a direct consequence of the clinical examination (participants received information about their test results, including recommendations to visit their GP in case of high values on, e.g., blood pressure). This 'post-screening' effect of increased consultations after HUNT3 participation wore off among women but not among men, raising the question of possible underuse of GP services before HUNT3 participation among men. No information was given to participants with elevated HADS score, thereby explaining why no change in consultation patterns was observed according to the time of HUNT3 for anxiety/depression groups.

The consultation patterns were fairly similar between GPs. Norwegian GPs have a high degree of autonomy, displaying differences in meeting participation (34), referral to specialist health services (35–38) and carrying out practical procedures (39). We found substantial variability between GPs in the use of consultations exceeding 20 minutes but low variability regarding regular or out-of-hours consultations. All variability estimates were stable through the study period and remained unchanged after adjustment for patient and GP characteristics. The low and stable variability in use of out-of-services between patient lists indicates a low degree of spill-over from regular GPs, even as workload increased.

Conclusion

This study indicates an increased use of GP services in Norway partly due to changes in help-seeking behaviour among the healthier part

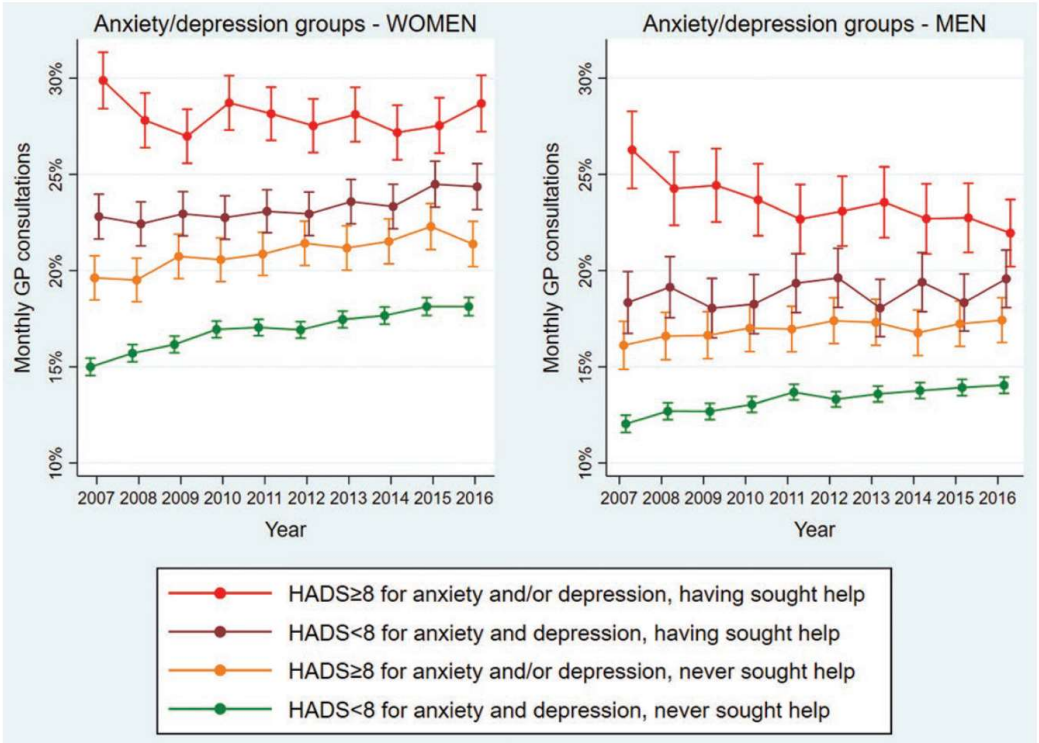

Figure 2. Anxiety/depression groups: estimated percentage with monthly GP consultations per year for the cohort aged 40–59 years in 2007. Adjusted for increasing age and education.

Table 2. ICC between the different GPs and their patients regarding the yearly number of consultations, yearly number of GP consultations exceeding 20 minutes and number of yearly out-of-hours service consultations

Year	GP consultations (95% CI)	GP consultations >20 minutes (95% CI)	Out-of-hours consultations (95% CI)
2007	0.03 (0.02 to 0.04)	0.08 (0.06 to 0.11)	0.02 (0.01 to 0.02)
2011	0.03 (0.02 to 0.04)	0.11 (0.09 to 0.14)	0.01 (0.01 to 0.01)
2016	0.02 (0.02 to 0.03)	0.10 (0.08 to 0.13)	0.01 (0.01 to 0.01)

Calculated at three different years to investigate changes over time and adjusted for patient sex and patient age.

of the population; those with 'normal' range of anxiety/depression symptoms who 'never' sought help for mental health problems and those with normotension and no antihypertensive treatment. More frequent consultations could indicate better prevention, monitoring and treatment. However, as GP services are under considerable capacity pressure, prioritization principles and the balance between follow-up of people with different needs is a topic for further scrutiny. It should be further investigated whether patients with heavier and more complex needs are displaced by a healthier population or cared for in other primary care services. Further, it is important to consider whether the increase in consultations has spillover effects in terms of referrals to specialist services.

Supplementary material

Supplementary material is available at *Family Practice* online.

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Declaration

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Ethical approval: each HUNT participant signed a written consent for the data being used in future research. The Regional Committee for Medical and Health Research Ethics in central Norway (REC Central) approved the project (2016/2158/REK midt).

Conflict of interest: none.

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Supplementary file Paper ll

Available at: https://academic.oup.com/fampra/article/37/2/248/5613653#supplementary-data

Supplementary material

Supplementary Table 1: Mean difference in number of yearly general practitioner (GP)- and out-of-hours consultations for the different hypertension groups in 2011 and 2016 compared to 2007 (with 95% confidence intervals). Estimates from general estimating equations models adjusted for education and increasing age.

Year	Hypertension (95% CI)[1]	Non-medicated hypertension (95% CI)[2]	Normotensive (95% CI)[3]
GP consultations; Women			
2007	0 (ref)	0 (ref)	0 (ref)
2011	0.21 (0.03 to 0.40)	0.58 (0.18 to 0.97)	0.37 (0.29 to 0.46)
2016	0.26 (0.07 to 0.46)	0.83 (0.43 to 1.23)	0.52 (0.42 to 0.63)
GP consultations; Men			
2007	0 (ref)	0 (ref)	0 (ref)
2011	0.08 (-0.10 to 0.26)	0.67 (0.43 to 0.92)	0.24 (0.16 to 0.33)
2016	-0.01 (-0.20 to 0.18)	0.82 (0.57 to 1.07)	0.41 (0.30 to 0.51)
Out-of-hours consultations, women and men combined			
2007	0 (ref)	0 (ref)	0 (ref)
2011	-0.03 (-0.06 to -0.01)	0.01 (-0.03 to 0.05)	-0.00 (-0.01 to 0.01)
2016	-0.04 (-0.06 to -0.01)	-0.01 (-0.05 to 0.03)	-0.01 (-0.02 to 0.01)

1: Current/previous antihypertensive medication regardless of measured blood pressure at baseline

2: Systolic blood pressure >140 and/or diastolic blood pressure >90 and no current/previous antihypertensive medication at baseline

3: Systolic blood pressure<=140 and diastolic <=90 and no current/previous antihypertensive medication at baseline

Supplementary Table 2: Mean difference in absolute numbers of yearly general practitioner (GP)- and out-of-hours consultations for the different anxiety/depression groups in 2011 and 2016 compared to 2007 (with 95% confidence intervals). Estimates from general estimating equations models, adjusted for education and increasing age.

	Anxiety/depression symptoms[1]		**"Normal" range of anxiety/depression symptoms[2],**	
	***having* sought help for mental health problems[3] (95% CI)**	***never* sought help for mental health problems[3] (95% CI)**	***having* sought help for mental health problems[3] (95% CI)**	***never* sought help for mental health problems[3] (95% CI)**
GP consultations; Women				
2007	0 (ref)	0 (ref)	0 (ref)	0 (ref)
2011	-0.08 (-0.34 to 0.18)	0.38 (0.16 to 0.62)	0.18 (-0.04 to 0.40)	0.39 (0.29 to 0.49)
2016	0.03 (-0.24 to 0.30)	0.45 (0.23 to 0.70)	0.33 (0.09 to 0.56)	0.48 (0.35 to 0.60)
GP consultations; Men				
2007	0 (ref)	0 (ref)	0 (ref)	0 (ref)
2011	-0.60 (-0.92 to -0.27)	0.14 (-0.10 to 0.38)	0.38 (0.08 to 0.68)	0.20 (0.11 to 0.30)
2016	-0.62 (-0.96 to -0.28)	0.24 (-0.02 to 0.49)	0.56 (0.25 to 0.86)	0.22 (0.10 to 0.33)
Out-of-hours consultations, women and men combined				
2007	0 (ref)	0 (ref)	0 (ref)	0 (ref)
2011	-0.01 (-0.02 to 0.00)	-0.02 (-0.05 to 0.01)	-0.01 (-0.04 to 0.03)	-0.01 (-0.02 to 0.01)
2016	-0.06 (-0.10 to -0.03)	-0.00 (-0.04 to 0.03)	-0.01 (-0.05 to 0.02)	-0.01 (-0.03 to -0.00)

1: HADS-A ≥8 and/or HADS-D ≥8 at baseline

2: HADS-A <8 and HADS-D <8 at baseline

3: Having (or *never* having) sought help for mental health problems at baseline

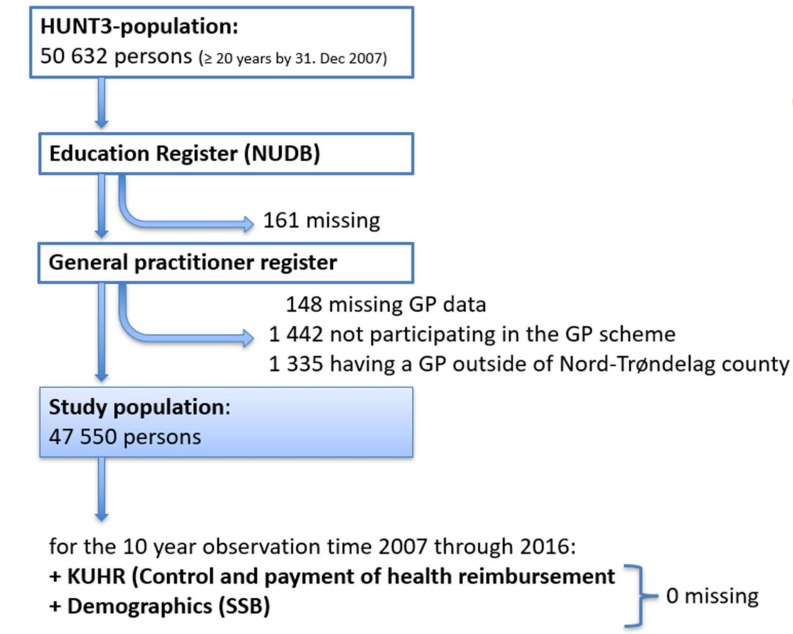
Supplementary Table 3: Intra Class Correlation (ICC) between the different general practitioners (GPs) consultations and their patients regarding the yearly number of consultations, yearly number of GP consultations exceeding 20 minutes, and number of yearly out-of-hours consultations. Calculated at three different years to investigate changes over time and adjusted for both patient- and GP characteristics.

Year	"crude" ICC[1]; ICC (95% CI)	+ adjustment for patient characteristics[2] ICC (95% CI)	+ adjustment for GP characteristics[3] ICC (95% CI)
GP consultations			
2007	0.03 (0.02 to 0.04)	0.03 (0.02 to 0.04)	0.03 (0.02 to 0.04)
2011	0.03 (0.02 to 0.04)	0.03 (0.02 to 0.03)	0.02 (0.02 to 0.03)
2016	0.02 (0.02 to 0.03)	0.02 (0.02 to 0.03)	0.02 (0.02 to 0.03)
GP consultations >20 minutes			
2007	0.08 (0.06 to 0.11)	0.09 (0.07 to 0.11)	0.07 (0.06 to 0.10)
2011	0.11 (0.09 to 0.14)	0.11 (0.09 to 0.14)	0.12 (0.09 to 0.015)
2016	0.10 (0.08 to 0.13)	0.11 (0.08 to 0.13)	0.11 (0.08 to 0.014)
Out-of-hours consultations			
2007	0.02 (0.01 to 0.02)	0.02 (0.01 to 0.02)	0.02 (0.01 to 0.02)
2011	0.01 (0.01 to 0.01)	0.01 (0.01 to 0.01)	0.001 (0.01 to 0.01)
2016	0.01 (0.01 to 0.01)	0.01 (0.01 to 0.02)	0.01 (0.01 to 0.02)

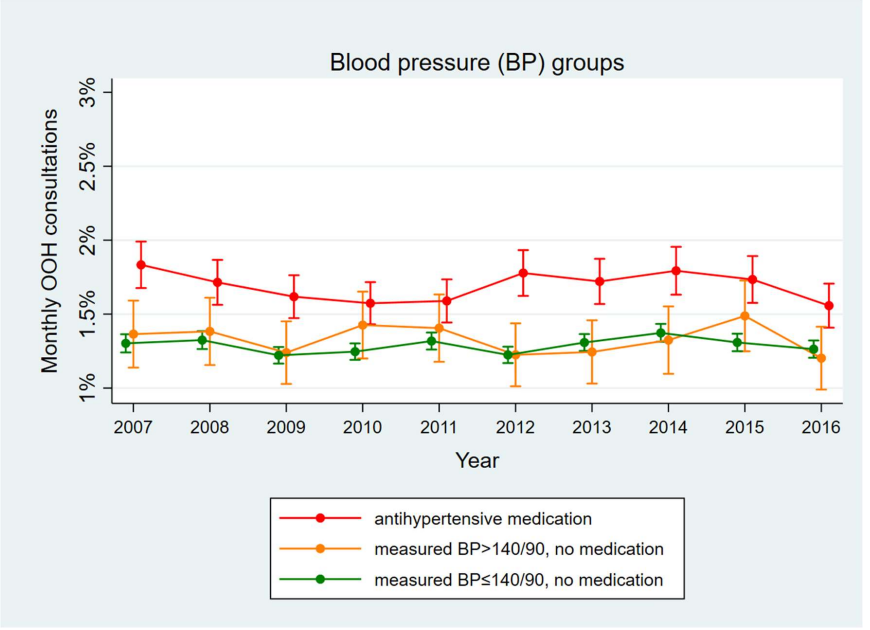
1: Adjusted for participant age and sex

2: Adjusted for participant age and sex + comorbidity and level of education

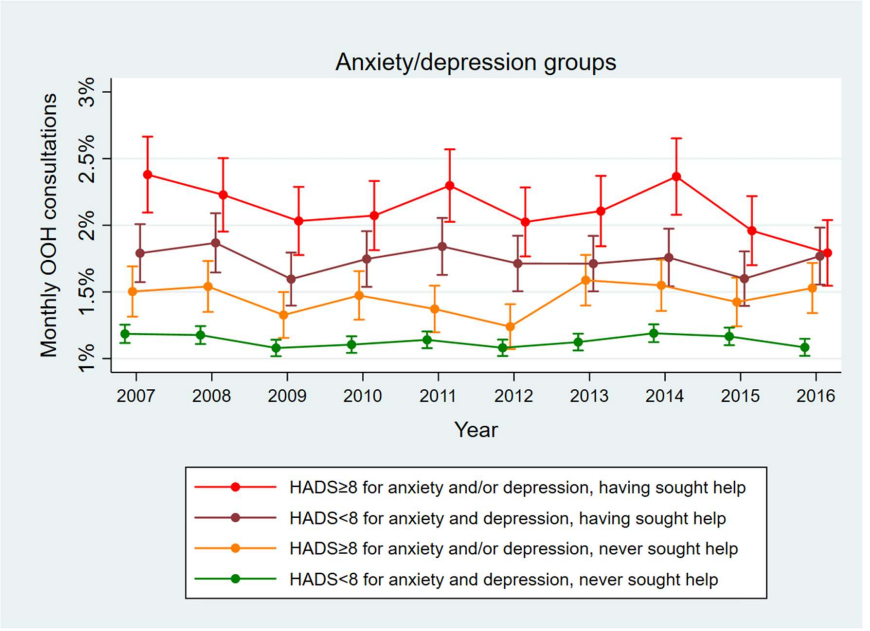
3: Adjusted for participant age, sex, comorbidity, level of education + GP sex, number of years as a GP, GP specialist/not



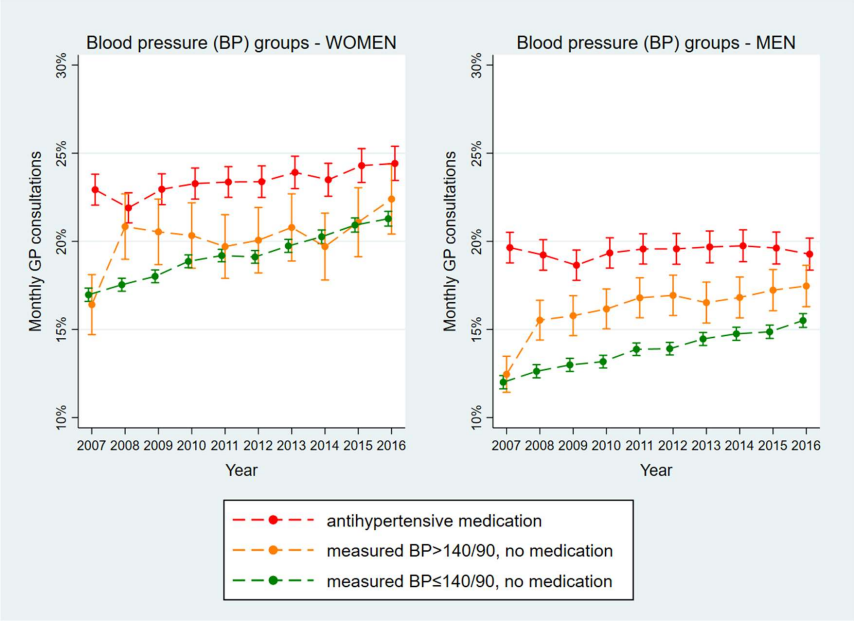
Supplementary Figure 1: Flow chart defining the study population and registers used for the study.



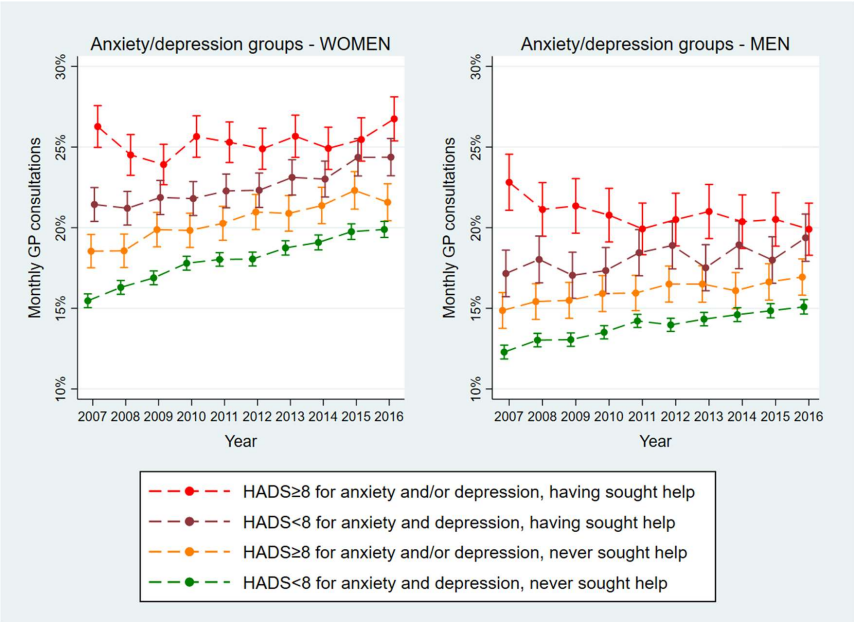
Supplementary Figure 2: Estimated percentage with monthly out-of-hours (OOH) consultations per year, hypertension, 40-59 years (in 2007). Adjusted for increasing age, sex and education.



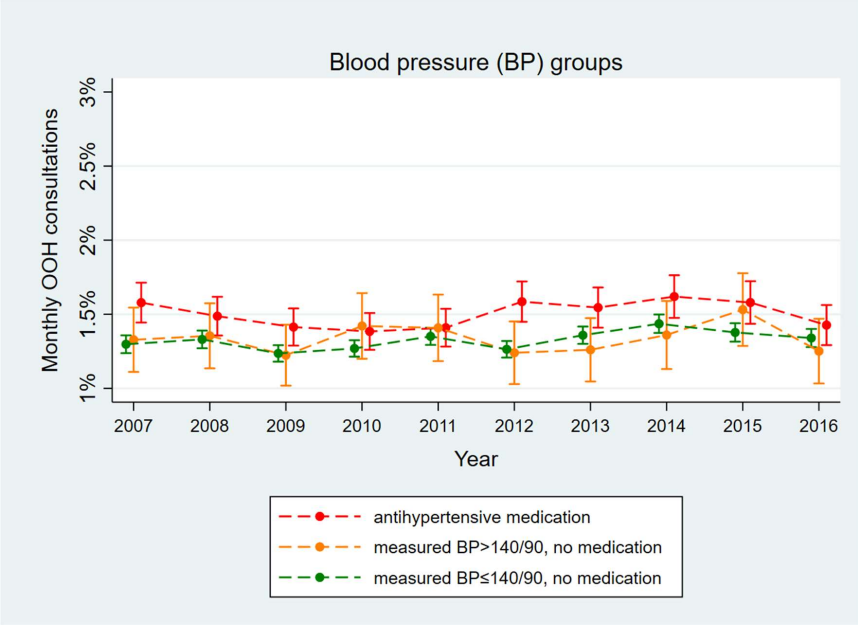
Supplementary Figure 3: Estimated percentage with monthly out-of-hours (OOH) consultations per year, anxiety/depression, 40-59 years (in 2007). Adjusted for increasing age, sex and education.



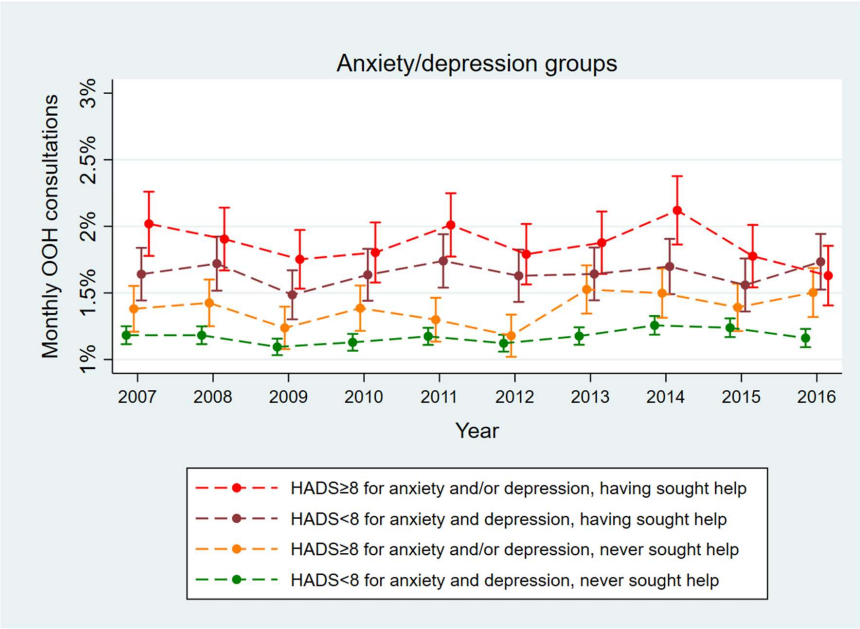
Supplementary Figure 4: Estimated percentage with monthly GP consultations per year, hypertension, 40-59 years (in 2007). Adjusted for increasing age, sex, education and comorbidity.



Supplementary Figure 5: Estimated percentage with monthly GP consultations per year, anxiety/depression, 40-59 years (in 2007). Adjusted for increasing age, sex, education and comorbidity.



Supplementary Figure 6: Estimated percentage with monthly out-of-hours (OOH) consultations per year, hypertension, 40-59 years (in 2007). Adjusted for increasing age, sex, education and comorbidity.



Supplementary Figure 7: Estimated percentage with monthly out-of-hours (OOH) consultations per year, anxiety/depression, 40-59 years (in 2007). Adjusted for increasing age, sex, education and comorbidity.

Paper lll

General practitioner discontinuity and health care utilisation in 2.5 million Norwegians

Running head (short title): GP discontinuity and health care utilisation

Article category: Health Service Research

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