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Importance of relationships with primary care

Implications for patients and health care

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Importance of relationships with primary care; implications for patients and health care

Abstract
Background: Primary care is an essential part of all health care systems, constituting complex networks of relationships. If choice of primary care provider, i.e. active listing is allowed this could be linked to the strength of the relations between patients and primary care. Other aspects of these relationships could be measured using number of consultations. Primary care could be described as a healthcare system, with hospitalisation as an outcome.
Objectives: The first aim of this thesis was to describe active listing and the associations with age, sex, multimorbidity, consultations, socioeconomic status and location. The second aim was to study whether relationships between patients and primary care are associated with hospitalisation, when adding patient complexity and investigating differences in performance within primary care.
Methods: Cross-sectional population studies in a small Swedish county with 151 731 inhabitants in 2007. Data were collected from patient records, merged with data from Statistics Sweden in Papers II and IV. Active listing was the outcome of logistic regression models in Papers I-II. Hospitalisation, i.e. risk of hospital admission and mean hospital days, was the outcome of zero-inflated negative binomial regression models adjusted for multimorbidity, age and sex in Papers III-IV. Hospitalisation was analysed as an outcome of primary care investigating associations with active listing and number of consultations in primary care. Paper III also investigated psychiatric disorders, and Paper IV also investigated socioeconomic factors and differences in primary care.
Results: The results of Paper I showed that number of consultations, multimorbidity level, age and sex were associated with active listing, and that data from primary care explained more of active listing than data from all health care. Paper II showed that multimorbidity, age, geographical location and primary care explained more of active listing than socioeconomic factors and distances to health care.
Papers III-IV showed that patients actively listed or with more than one consultation were hospitalised for less than mean (0.9) days while patients passively listed or with 0-1 consultation were hospitalised for more than mean. Paper III showed that in RUB 3, moderate need for care, patients actively listed were in mean hospitalised for 3.45 (95%CI 2.84-4.07) days, if diagnosed with any psychiatric disorder and 1.64 (95%CI 1.50-1.77) days if not. Patients passively listed in RUB 3 were in mean hospitalised for 5.17 (95%CI 4.36-5.98) days, if diagnosed with any psychiatric disorder and 2.41 (95%CI 2.22-2.60) if not. Paper IV established differences within primary care comparing two types of primary care practices. Odds off hospital admission differed 49% and mean days hospitalised 0.24 days.
Conclusions: Active listing in primary care is explained more by multimorbidity, age, sex and factors in local society and health care, than socioeconomic status and distances to health care.
Good relationships with primary care are associated with less hospitalisation, more so when health care handles more complex multimorbidity, like including psychiatric disorders. Differences in primary care imply that management of primary care could affect hospitalisation.

Key words: Health care, Primary care, Professional-Patient Relations, Choice Behavior, Consultation, Hospitalization, Length of Stay, Hospital Admission, Assessment of Helath Care Needs

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"A good set of data can go a long way toward describing human behavior as long as the proper questions are asked of it"

Steven D. Levitt, Stephen J. Dubner. 2009. Superfreakonomics

HARPER. ISBN 978-0-06-206337-3

Content

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care practices. Odds off hospital admission differed 49% and mean days hospitalised 0.24 days.

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Good relationships with primary care are associated with less hospitalisation, more so when health care handles more complex multimorbidity, like including psychiatric disorders. Differences in primary care imply that management of primary care could affect hospitalisation.

Abbreviations

ACG	Adjusted Clinical Group
AIC	Akaike's Information Criterion
AUC	Area under the receiver operating characteristics
CV	Coefficient of Variance
GP	General Practitioner/Physician
ICD10	International Statistical Classification of Diseases and Related Health Problems diagnoses
IRR	Incidence Rate Ratio
LR-test	Likelihood Ratio statistics
NB2	Negative Binomial (with variance modelled as a quadratic function of the mean)
NPM	New Public Management
OR	Odds Ratio
ROC	Receiver Operating Characteristics
RUB	Resource Utilization Bands

Word definitions

Adjusted Clinical Groups	Summary measure of morbidity burden focused on stratification and classification of patients into groups according to diseases and conditions, age and sex
Disease	Classified disorder
Hospitalised	Being admitted to hospital
Illness	Experience of lost health
Morbidity	Presence of one or more diseases
Morbidity burden	Overall impact of the different diseases in one person taking into account their severity
Patient complexity	The overall impact of the different diseases in one person taking into account their severity and other attributes such as socioeconomic, cultural, environmental, and patient behavioural characteristics
Trust	Prerequisite for cooperative behaviour that can improve communication

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Original papers

This thesis is based on the following papers referred to in the text by their Roman numerals:

I. Ranstad K, Midlöv P, Halling A: Importance of healthcare utilisation and multimorbidity level in choosing a primary care provider in Sweden. Scandinavian Journal of Primary Health Care, 2014; 32: 99–105

II. Ranstad K, Midlöv P, Halling A: Socioeconomic status and geographical factors associated with active listing in primary care: a cross-sectional population study accounting for multimorbidity, age, sex and primary care. BMJ Open, 2017 Jun 9;7(6):e014984

III. Ranstad K, Midlöv P, Halling A: Active listing and more consultations in primary care are associated with shorter mean hospitalisation and interacting with psychiatric disorders when adjusting for multimorbidity, age and sex. Submitted

IV. Ranstad K, Midlöv P, Halling A: How active listing and number of consultations in primary care are associated with hospitalisation, taking multimorbidity level and socioeconomic status into account. A cross-sectional study. Submitted

Introduction

Primary care is an essential part of the complex networks constituting healthcare systems. Complex networks are founded on relationships. Different aspects of the relationships between patients and primary care could be measured using active listing, and number of consultations.

If choice of primary care provider, i.e. active listing, is allowed, this is a complex choice that could be linked to the strength of the relation between patients and primary care.

Primary care could be described as a healthcare system comprising settings, processes and outcomes, and hospitalisation could be analysed as an outcome of primary care.

In Sweden, listing in primary care was introduced to empower patients, resulting in several quasi-market models. Blekinge County Council introduced listing in primary care in 2004.

This thesis studies relationships between patients and primary care. Papers I-II describe active listing and Papers III-IV study how the relationship between patients and primary care is associated with hospitalisation.

The specific factors concerning the relationship between patients and primary care studied in this thesis were:

I. Active listing and the associations with healthcare utilisation, multimorbidity level, age and sex.

II. Active listing and the associations with socioeconomic status and geography.

III. Hospitalisation and the associations with relationships with primary care, investigating added patient complexity (psychiatric disorders), while accounting for age, sex and multimorbidity level.

IV. Hospitalisation and the association with relationships with primary care, investigating differences within primary care, while accounting for age, sex, multimorbidity level and socioeconomic status.

Background

At the interface between illness and disease

There are several concepts of morbidity. Disease is classified morbidity, while illness is an experience of lost health (1). Primary care works at the interface between illness and disease, where it is not possible to predict what is going to happen to the individual, even if it is at population level (2). Small absolute benefits for an individual may aggregate large benefits for the population if the prevalence of the condition is high, and large absolute benefits for an individual may fail to aggregate benefits for the population (3).

Best available evidence about diseases is essential to clinical practice. Evidence-based medicine (EBM) evaluates and organises available evidence, and communicates guidelines to clinicians. A substantial share of research referenced is of uncertain relevance to primary care patients (4). Guidelines based on relevant high quality research often exclude patients with comorbidity or frailty, excluding those most likely to benefit from the results and most susceptible to potential harms (3).

Patient-focused care and shared decision-making acknowledge patients as individuals. Patients are persons living their individual lives within their particular families and sociocultural contexts (5,6). Sociologists and anthropologists use the concept of ‘lifeworld’ to describe the everyday context in which meaning is generated to individuals (7). The experience of illness evolves, when previous functional adaptations do not work anymore for a particular person (1). This experience could be shared with others, but stays individual. Patients may have different values and preferences from their doctor, as well as best available evidence.

Doctors’ knowledge on how to manage diseases overlaps only partially with patients’ knowledge about how to manage their own illness. Patients’ knowledge also includes their own experiences of symptoms and treatments. Consultations in health care have cultural and moral significance and occur against personal sense making, information seeking and lay consultations (8). The illness as lived will differ from the disease in the evidence-based guideline. The success of the evidence-based consultation depends as much on its humanistic elements as on sharing information (9).

Multimorbidity

There are several definitions associated with clinical management, health outcomes and health costs of individuals with more than one disorder. Comorbidity is the presence of additional diseases in relation to an index disease in the same person. Multimorbidity is the presence of multiple diseases in one person, without any reference to an index condition. Morbidity burden is the overall impact of the different diseases in one person taking into account their severity. Patient complexity is the overall impact of the different diseases in one person taking into account their severity and other attributes such as socioeconomic, cultural, environmental, and patient behavioural characteristics (10).

In primary care focus is on the patient as a whole, and multimorbidity or morbidity burden might be a good choice of construct (10). These constructs could summarise specified conditions or be summary measures. The summary measures aim to link diagnoses with their impact on the consumption of health care, or compare different clinicians. Adjusted Clinical Groups (ACGs), Diagnosis-Related Groups (DRGs) and Healthcare Resource groups (HRGs) are summary measures focused on stratification or classification of patients into groups according to diseases and conditions, age and sex (10,11).

For this thesis multimorbidity was estimated using the Johns Hopkins Adjusted Clinical Groups Case-Mix System (ACG). This is a measure of morbidity burden based on the patients' diagnoses characterised in five clinical dimensions: duration, severity, diagnostic certainty, aetiology and need for specialist care. The ACG index is then categorised into levels called Resource Utilization Bands (RUBs) ranging from 0 (no need for health care) to 5 (very strong need for health care) (11,12).

The prevalence of multimorbidity depends on method, and the distribution of multimorbidity is uneven. In youth, morbidity is concentrated in a minority of individuals, while ageing multimorbidity spreads to the majority (10,13). Most people experience "good health" most of the time, independent of their diseases (1). For both patients and professionals, managing a cluster of related, concordant, conditions (such as coronary heart disease and diabetes) with synergistic management strategies is potentially simpler than dealing with unrelated conditions (such as cancer and drug abuse) with non-synergistic management strategies. Adding stigmatising mental conditions to the mix worsens the outcome (14).

Socioeconomic status

The connection between health and socioeconomic factors is well established (15,16). Recent studies indicate that there is a social gradient in morbidity and mortality among the aged, i.e. older people in a low socioeconomic position generally have a higher morbidity and mortality (17,18). Overall, these inequalities tend to be smaller than among middle-age groups (18). Results indicate that social inequalities in self-rated health, functional status and health-related quality of life among older multimorbid patients are mainly due to income and partly explained by the disease burden. Among patients with a similar disease burden, those with a low income were worse off (19).

Trust and the relation to social capital

We have trust if we expect others to behave in predictable and desirable ways, even in the absence of incentives or scrutiny. Trust is a prerequisite for cooperative behaviour that can improve communication (20). Of particular importance to health care are the relationships between patient and provider, and health worker and employer. Respectful treatment is central to both these relationships. Patient trust is linked to continuous relationship and recognition (21), and workplace trust has relevance to healthcare management (22). Social networks, trusting relationships and cultural norms facilitating coordinated action are known as social capital and likely to affect health.

In the theoretical framework of social capital, trust is a key factor (22,23). The four levels of social capital entail the macro level, i.e. countries and regions, the meso level, i.e. contexts such as neighbourhoods, the micro level, i.e. social networks and social participation, and the level of individual attitudes such as psychological factors and trust (24). Low levels of trust and social participation are positively associated with lack of belief in the possibility of influencing one's own health (25). Individuals with low trust in the healthcare system to a significantly higher extent have poor self-perceived health that might be partly mediated by care-seeking behaviour (26). Analyses of self-reported lack of access to a regular doctor suggest that both healthcare district and social capital may partly explain this lack (27).

Trust is also central when building societies. Trust in the healthcare workers patients meet builds their trust in health care (23,28). Actions that harm this trust destroy trust at higher levels. Hence trust in primary care is important to trust in health care due to a high share of consultations in primary care.

Choice of healthcare provider

A choice could be more or less complex. When a choice involves too many factors to handle with ease it is simplified. Some factors are emphasised and used for anchoring the process of choosing, while others are ignored. The choice of factors used for anchoring is often unreflected. This is a complex choice, and if there are unknown factors as well, it is called a complex choice with uncertainty according to psychological theory (29). Active listing in primary care involves different factors like availability, attachment, previous contacts, quality (perceived and formal) and others. Some factors are not possible for patients to judge, some are uncertain and others not available to patients. Combined, this justifies choice of primary care provider to be characterised as a complex choice with uncertainty.

Patients' choice of provider is expected to improve the efficiency, quality and responsiveness of the health system by the threat of exit. Strengthening primary care is seen as central to enhanced efficiency in health care. This makes choice of primary care provider an important choice to health care. Individuals in general are interested in choice and participation in primary care services. In a Swedish study, the majority thought that they had enough information to be able to choose primary care provider, and regarded choosing to stay with their current provider as exercising choice. Their most common source of information was the chosen provider and the least common source was the Internet (30).

Comparative information is often used to evaluate performance in health care, but needs reflecting critically. There are differences in how providers could control the factors, like structural and organisational characteristics, underlying the factors compared. Providers are faced with the challenge of meeting the expectations of their patients, as well as the demands from the healthcare organisation and the public payer. Solutions to the fulfilment of objectives related to individual patients' preferences may not correspond to solutions related to the healthcare organisations' preferences (31).

Health care and organisation

The specialised nature of medicine leads to asymmetry in knowledge. A principal-agent framework could be used to investigate how inputs in health care and health are associated. The principal (patient or healthcare organisation) delegates activities to an agent (health worker), who is expected to accomplish these activities at the principal's best. How asymmetries of information and potential incongruent objectives between principal and agent can be minimised has been the focus of analysis.

Hierarchy and markets models are the two main principal-agent frameworks. In hierarchies upper levels place constraints on lower levels. Agents operate within rule-based frameworks based on technically derived evidence, penalised if they deviate from defined structures. In market models, material self-interest motivates principals and agents to make rational decisions on their consequent effects. Each individual is taught to be best suited to judge his/her own welfare and to promote it. The welfare of society according to market economy is the sum of all individual welfare. New Public Management (NPM) joins hierarchy and market, combining public availability of system performance data with choice and competition (20).

The theory on non-linear networks shifts the focus from analysing parts of complex systems to analysis of interrelationships amongst their parts. A key feature for a network model is the level of interpersonal trust, and the emphasis on exchange of knowledge and negotiation of meaning. The patient–healthcare professional relationship becomes one of the central units of analysis of healthcare systems, and nuances in these relationships important for the production of health (20). Characteristics of complex non-linear networks are for example that simple relationships between cause and effect are rare and small changes in one part of the system can have large and unexpected consequences elsewhere. The emphasis moves away from prediction and control to the configuration of relationships and understanding patterns of order among them (32).

Primary care and the healthcare system

Primary care is an essential part of all healthcare systems. Trustworthy local health workers have been shown to be vital to trust in the system when building healthcare systems (33). Good relations between individuals in a population and well performing primary care contribute to more adequate care, trust and better health (34,35). The generalistic approach of primary care facilitates coordination of care for patients and personalised care is facilitated by long-term personal relations. The role of primary care increases when focus in managing disease changes from "one disease at the time" to handling multimorbidity (34,36).

Primary care is at the entrance of health care. Patients are supposed to consult primary care first; then to be referred elsewhere if needed. When primary care is used for gatekeeping, this is compulsory. Availability and organisation of primary care have been shown to be related to health, and geographical factors shown to be associated with these results (36). Quality and availability of primary care could affect secondary care. Hospitalisation for ambulatory care sensitive disorders is inversely associated with supply of primary care (37). Continuity of care in primary care is associated with reduced emergency department attendance and emergency hospital admissions (38).

Settings and role for primary care differ amongst healthcare systems. Differences in the strength of the primary care structure and services across Europe have been studied by Kringos et al. (39,40). Development of a strong primary care is influenced by national political agenda, economy, prevailing values, and type of healthcare system. Wealthier countries are associated with a weaker structure and lower accessibility of primary care, and social security-based systems with a lower accessibility and continuity of primary care.

Primary care, approached as a care system

Primary care could be described as a multidimensional care system, comprising settings and processes generating outcomes like quality, efficiency and equity of care (34,39). This could be used to evaluate how performance in primary care affects other parts of a healthcare system or population health. It could also be used to investigate how changes in settings affect processes and outcomes of primary care. In this thesis hospitalisation was used to evaluate the influence of primary care on secondary care.

Well performing primary care is characterised by a combination of person-focused care over time, use as first contact in health care, completeness of services and coordination of care (39,40). Differences in performance could be investigated by comparing providers within a primary care system. Settings and processes could be manipulated and subsequent changes of outcomes evaluated.

Patient-healthcare relationship in primary care, and how to measure it

Evidence-based medicine depends on a partnership where people are more important than separate diseases and commitment to patient-centredness, both requiring relationships to achieve (8,9). Continuity of care with a primary care physician is associated with substantial reduction in long-term mortality in older adults (41). Patients' perceptions of the doctors' empathy is of key importance to patient enablement in general practice consultations in both high and low deprivation settings (42). Long-term relationships between patients and caregivers facilitate person-focused care (39). To the patient, continuous relationship needs to be combined with recognition. The GP has to respect and remember the patient, in order to create and sustain a trustful relationship (43). Attachment theory may explain patients' need for attachment to a caregiver. The vulnerability of being a patient creates a need for a professional relationship different from more customer-related relationships (21).

Measures of the relationship between patients and health care could be found in patient records. This thesis uses active listing as a measure of aspects of the relationship between patients and primary care. The rationale for this is that within this study population choice of primary care provider is owned by patients reassured that primary care is available and affordable, regardless of listing status. Furthermore, care is distributed by need, and practices cannot deny anyone to be listed. This creates a context where active listing is owned by patients not having to protect their availability of primary care. Active listing could then be considered a patient acting to establish or maintain a relationship.

Number of consultations with a doctor was available and reliable, but not with other caregivers in primary care. Consultations are the result of negotiations between patients and primary care. Patients approach the caregiver with a request for an appointment that has to be approved before a consultation is granted. As a measure of the relationship between patients and primary care, number of consultations includes need for care, social interaction and availability of care.

Sweden and quasi-market primary care

Average life expectancy at birth in Sweden is among the highest in the world and the country performs well in comparisons related to disease-oriented indicators. The state is responsible for overall health policy, while the funding and provision of services mainly lie with the county councils. County councils have considerable freedom in organising health care. Almost all hospitals and the majority of primary care practices are owned by the county councils. Healthcare expenditure is mainly tax funded (80%) and was equivalent to 9.9% of gross domestic product in 2009 (44).

Compared to the EU average of 3.3 practicing physicians per 1000 population, Sweden had 3.7 in 2008. The share of general practitioners was less than 25%, lower than most countries in the EU. Over the past decade health reforms have aimed to concentrate hospital services, coordinate care; increase choice, competition and privatisation in primary care; public comparison of quality and efficiency indicators and responsiveness to patients' needs (44). The Swedish healthcare system aims to ensure the health of all citizens by basic principles intended to apply to all health care (44). The principle of human dignity means that all human beings have an equal entitlement to dignity and should have the same rights. The principle of need and solidarity means that those in greatest need take precedence in medical care. The principle of cost–effectiveness means that in terms of improved health and improved quality of care, there should be a reasonable relationship between costs and effects. Reforms initiated at the national level have focused on the responsibilities of county councils, more direct benefits for patient groups and regional equality of services.

Sweden is divided into 290 municipalities and 21 county councils. The average population of a county is about 420 000 inhabitants (44). County councils often introduce reforms, which lead to variations across counties and mimicking behaviour. During the past decades, reforms have focused on listing systems in primary care and coordinated care for older people. The number of private primary care providers has increased substantially, but the norm is still public ownership in most counties. Reconstruction of the hospital sector involves concentration and specialisation of services. The governance and management of services focus on comparisons of quality and efficiency (44).

Swedish primary care is rather weak compared to other European countries. Primary care is organised in several quasi-market models. Funding is generally based on capitation for registered patients, complemented with fee-for-service and performance-based payments. The level of investment in primary care is rather low, influenced by past investments favouring hospital-based care. Choice of primary care provider (listing) was introduced to empower patients and to introduce market models. Since 2010 listing systems in primary care are mandatory for county councils (44). Primary care practices comprise general practitioners (GPs) organised within multidisciplinary teams. Most GPs are salaried employees working with colleagues. The teams include several nurses, assisting nurses and medical secretaries. Physiotherapists, occupational therapists, psychiatrically skilled therapists, secondary care specialists and others could be included or associated with the teams.

County of Blekinge

In the southeastern part of Sweden, five municipalities with differences in socioeconomic factors such as educational level, income, geographical factors and urbanisation constitute the County of Blekinge. To the west it borders on Skåne, to the north on Småland and to the south and east on the Baltic Sea. City of Karlskrona at the east is the administrative center of the county. The coastal towns, Karlskrona, Ronneby, Karlshamn and Sölvesborg, and rural Olofström, are centers of their municipalities. The population on 31 December 2007 was 151 731 inhabitants. The average age was slightly higher (42.7 years) and there were more males (50.5%) compared to all of Sweden (41 years and 49.7%) (45).

The organisation of health care is relatively simple. The County Council funds health care and runs most of it. Secondary care is predominantly public, concentrated in two interconnected hospitals situated in Karlskrona and Karlshamn. In 2007, public psychiatric care was established in all municipalities with local wards. Primary care comprised both publicly and privately owned practices.

In 2007, the cost of all health care of Blekinge was 3155 million SEK, including administration. Cost of primary care was 441 million SEK (544 million including homecare) and hospitalisation 1868 million SEK.

Primary care in Blekinge in 2007

Primary care in Blekinge in 2007 was stable in terms of regulations, staff and funding. The introduction of listing in 2004 had settled and the legislation of listing systems in primary care in 2010 not yet introduced. Availability of general practitioners, 90 specialists, was fairly good compared to all of Sweden. Primary care comprised 12 public and 13 private primary care practices. Publicly owned practices were typically bigger and older than privately owned. A total of 127 624 inhabitants were listed with public primary care and 24 107 with private primary care. Both public and private primary care was available in all municipalities.

Listing was introduced in 2004. The listing system included accreditation of practices, mandatory passive listing and active choice at will. The funding system was adapted to fund practices with an option to choose general practitioner (GP). Capitation for registered patients (the same for actively and passively listed) adjusted for age was used, supplemented with fee-for service. The aim was to distribute costs for listed patients (medication, tests etc.) at primary care practices. Practices were obliged to accept any patient and to distribute care by need. The same regulations were used for private and public practices, and all practices with passive listing used the same computerised patient journal. The exception was that private practices established before 2004 had the option to only list actively, then all their former patients were listed active. In 2007, a population of 8498 were listed at a practice with only active listing.

Active listing was formally initiated by the patient leaving a form at the practice of choice that was registered with the County Council. Family members over 15 years of age made their choices separately. Changing address within the same municipality did not affect active listing. Active listing was allowed within the county. Passive listing was managed by the County Council. The population was distributed to the nearest primary care practice with passive listing within the municipality of home address, if not actively listed. Children 15 years of age or less followed their mother. Being unlisted was not an option.

Aims of the thesis

General aim

This thesis is about relationships between patients and primary care in a quasi-market primary care system. Active listing was considered a measure of aspects of this relationship together with number of consultations in primary care.

The aim was to describe active listing and the associations with age, sex, multimorbidity, socioeconomic status and location. The aim was also to study whether the relationships between patients and primary care were associated with hospitalisation, challenging the system by adding patient complexity and investigating differences within primary care.

Specific aims

- Explore the relationships with primary care by describing the associations between active listing, healthcare utilisation, multimorbidity level, age and sex, comparing use of data from primary care and all health care.
- Further exploration of active listing in primary care by describing the associations with socioeconomic status and geography, while adjusting for multimorbidity, age, sex and type of primary care practice.
- Study hospitalisation as outcome of primary care by studying associations with active listing, consultations and psychiatric disorders, while adjusting for age, sex and multimorbidity level.
- Study hospitalisation as outcome of primary care by studying associations with active listing and consultations comparing two types of practices, while adjusting for age, sex, multimorbidity level and socioeconomic status.

Materials and Methods

Study design

Papers I-IV all were register-based cross-sectional studies on the population of Blekinge County in 2007. An overview of the design of the studies is presented in Table 1.

Table 1
Overview of the papers

Paper	I	II	III	IV
Design	Cross-sectional population study	Cross-sectional population study	Cross-sectional population study	Cross-sectional population study
Participants	Population 1 (N=151 731)	Population 2 (N=123 168)	Population 1 (N=151 731)	Population 2 (N=123 168)
Outcomes	Actively listed on 31 December 2007	Actively listed on 31 December 2007	Days hospitalised during 2007	Days hospitalised during 2007
Data collection methods	Patient records	Patient records and Statistics Sweden	Patient records	Patient records and Statistics Sweden
Data package	Stata 13.0	Stata 14.1	Stata 14.0	Stata 14.1
Data analysis	Binary logistic regressions	Binary logistic regressions	Zero-inflated negative binomial regressions, clustered	Zero-inflated negative binomial regressions, clustered
	Average marginal effects	Average marginal effects	Average marginal effects	Average marginal effects
	Model tests	Model tests		Model tests

Data collection

All inhabitants of Blekinge 2007 (Population 1)

All papers are based on the population of Blekinge as of 31 December 2007 collected from patient records from Blekinge County Council (N=151 731). This population was slightly older (42.7 years) and with more males (50.5%) compared to all of Sweden (41 years and 49.7%) (45).

Table 2
Descriptive data on all inhabitants of Blekinge 2007

Descriptive Population of Blekinge 2007	***Group size***		***Actively listed***		***Admitted to hospital***		***Hospitalisation***	
	N =	%	N =	%	N =	%	Total days	Mean days
Sex								
Women	75 087	49.5	52 256	69.6	7 078	9.4	73 455	0.98
Men	76 644	50.5	46 344	60.5	6 044	7.9	62 007	0.81
Age groups								
0-19 years	33 096	21.8	17 608	53.2	1 179	3.6	8 308	0.25
20-39 years	35 297	23.3	18 175	51.5	3 651	10.3	26 600	0.75
40-59 years	39 667	26.1	26 305	66.3	2 285	5.8	21 707	0.55
60-79 years	33 786	22.3	27 646	81.8	3 725	11.0	46 604	1.38
80+ years	9 885	6.5	8 866	89.7	2 282	23.1	32 243	3.26
Multimorbidity, all health care								
RUB 0	60 911	40.1	30 204	49.6	22	0.0	289	0.00
RUB 1	20 586	13.6	13 543	65.8	1 340	6.5	5 746	0.28
RUB 2	33 551	22.1	23 897	71.2	2 153	6.4	14 108	0.42
RUB 3	32 651	21.5	27 352	83.8	7 133	21.9	66 690	2.04
RUB 4	3 398	2.2	3 013	88.7	1 965	57.8	31 564	9.29
RUB 5	634	0.4	591	93.2	509	80.3	17 065	26.92
Multimorbidity, primary care								
RUB 0	85 846	56.6	45 563	53.1	5 307	6.2	50 410	0.59
RUB 1	20 078	13.2	14 526	72.4	1 529	7.6	11 637	0.58
RUB 2	27 304	18.0	21 441	78.5	2 559	9.4	23 967	0.88
RUB 3	17 549	11.6	16 144	92.0	3 332	19.0	42 064	2.40
RUB 4	865	0.6	840	97.1	344	39.8	5 945	6.87
RUB 5	89	0.1	86	96.1	51	57.3	3 704	16.17
Psychiatric disorders								
No psychiatric disorder	144 602	95.3	92 773	64.2	11 463	7.9	100 139	0.69
Any psychiatric disorder	7 129	4.7	5 827	81.7	1 659	23.3	35 323	4.95
Categorised psychiatric disorder								
Psychoses	193	0.1	132	68.4	55	28.5	2 466	12.77
Depressive disorders	2 348	1.6	2 006	85.4	549	23.4	12 513	5.33
Anxiety disorders	2 133	1.4	1 769	82.3	396	18.6	6 685	3.13
Other psychiatric disorders	2 455	1.6	1 920	78.2	659	26.8	13 659	5.56
Listing status, primary care								
Passively listed	53 131	35.0	-	-	3 338	6.3	31 484	0.59
Actively listed	98 600	65.0	-	-	9 784	9.9	103 978	1.05
Consultations, all health care								
0 or 1 consultation	91 354	60.2	50 754	55.6	2 515	2.8	17 060	0.19
2 or 3 consultations	31 937	21.1	23 775	74.4	2 804	8.8	20 667	0.65
4 or 5 consultations	14 138	9.3	11 585	81.9	2 393	16.9	19 565	1.38
6 or 7 consultations	6 578	4.3	5 639	85.7	1 849	28.1	19 384	2.95
8- consultations	7 724	5.1	6 847	88.7	3 561	46.1	58 786	7.61
Consultations, primary care								
0 or 1 consultation	118 759	78.3	69 788	58.8	8 269	7.0	79 979	0.67
2 or 3 consultations	23 981	15.8	20 410	85.1	3 003	12.5	32 822	1.37
4 or 5 consultations	6 367	4.2	5 888	92.5	1 184	18.6	13 545	2.13
6 or 7 consultations	1 740	1.2	1 656	95.2	392	22.5	4 828	2.77
8- consultations	884	0.6	858	97.1	274	31.0	4 288	4.85
Type of primary care practice								
Private	24 107	15.9	17 951	74.5	1 783	7.4	17 131	0.71
Public	127 624	84.1	80 649	63.2	11 339	8.9	118 331	0.93
Population 1	151 731	100.0	98 600	65.0	13 122	8.7	135 297	0.89

Unadjusted active listing on 31 December 2007 and hospitalisation during 2007 for the population of Blekinge

A total of 98 600 were actively listed. In mean 2.0 encounters with a physician (0.9 in primary care) were made during 2007. A total of 13 122 were hospitalised for 135 297 days altogether. Mean days hospitalised were 0.89. Descriptive data on this population are presented in Table 2.

Analyses for Papers I and III were performed on this population.

Inhabitants of Blekinge 2007 over 15 years of age (Population 2)

Socioeconomic and geographic data were collected from Statistics Sweden and merged with the data from patient records from Blekinge County Council. This database requires permission from Statistics Sweden on how to use factors that restricted use of some data from patient records.

The merged population was slightly smaller as some individuals had died, but not yet registered as deceased by Blekinge County Council on 31 December 2007. Data on education and income are not collected for children less than 16 years of age (24 741), and older data on education level are not reliable. Information on educational level or residence was missing for 3471 individuals. Study population 2 is restricted to the 123 168 individuals with no missing data. This population had an average age of 50.1 years, 50.2% were men, and 83 738 (68%) were actively listed. Descriptive data on this population are presented in Table 3.

Analyses for Papers II and IV were performed on this population using MONA, the Microdata on line access provided by Statistics Sweden.

Table 3
Descriptive data on inhabitants of Blekinge 2007 over 15 years of age with no missing data

Descriptive Population > 15 years 2007	**Group size**		**Actively listed**		**Admitted to hospital**		**Hospitalisation**	
	N =	%	N =	%	N =	%	Total days	Mean days
Sex								
Women	61 386	49.8	45 004	73.3	6 447	10.5	67 729	1.10
Men	61 782	50.2	38 734	62.7	5 356	8.7	55 961	0.91
Age groups								
16-19 years	6 846	5.6	3 777	55.2	182	2.7	2 077	0.30
20-39 years	34 067	27.7	17 904	52.6	3 571	10.5	25 571	0.75
40-59 years	39 374	32.0	26 176	66.5	2 261	5.7	21 197	0.54
60-79 years	33 420	27.1	27 386	81.9	3 646	10.9	45 225	1.35
80+ years	9 461	7.7	8 495	89.8	2 143	22.7	29 620	3.13
Multimorbidity, all healthcare								
RUB 0	48 211	39.1	25 030	51.9	21	4.4	280	0.01
RUB 1	15 315	12.4	10 391	67.8	1 224	8.0	5 405	0.35
RUB 2	25 242	20.5	18 861	74.7	1 603	6.4	11 149	0.44
RUB 3	30 566	24.8	25 983	85.0	6 629	21.7	62 098	2.03
RUB 4	3 233	2.6	2 909	90.0	1 849	57.2	29 134	9.01
RUB 5	601	0.5	564	93.8	477	79.4	15 622	26.03
Listing status in primary care								
Passively listed	39 430	32.0	-	-	2 704	6.9	25 722	0.65
Actively listed	83 738	68.0	-	-	9 099	10.9	97 968	1.17
Consultations, all health care								
0 or 1 consultation	73 136	59.4	42 415	58.0	2 339	3.2	15 972	0.22
2 or 3 consultations	25 816	21.0	20 145	78.0	2 461	9.5	18 839	0.73
4 or 5 consultations	11 820	9.6	10 014	84.7	2 132	18.0	18 046	1.53
6 or 7 consultations	5 586	4.5	4 958	88.8	1 633	29.2	17 351	3.11
8- consultations	6 811	5.5	6 207	91.1	3 238	47.5	53 482	7.85
Consultations, primary care								
0 or 1 consultation	95 810	77.8	59 077	61.7	7 453	7.8	72 982	0.76
2 or 3 consultations	19 673	16.0	17 332	88.1	2 661	13.5	29 699	1.51
4 or 5 consultations	5 383	4.4	5 108	94.9	1 064	19.8	12 430	2.31
6 or 7 consultations	1 522	1.2	1 457	95.7	372	24.4	4 622	3.04
8- consultations	781	0.6	765	97.9	253	32.4	3 956	5.07
Individual income								
Quartile 1	29 588	24.0	18 843	63.7	2 948	10.0	36 702	1.19
Quartile 2	30 933	25.1	23 764	76.8	4 279	13.8	51 886	1.68
Quartile 3	31 339	25.4	21 415	68.3	2 553	8.1	20 703	0.67
Quartile 4	31 308	25.4	19 716	63.0	2 023	6.5	14 399	0.47
Educational level								
Less than 9 years	21 602	17.5	18 034	83.5	3 173	14.7	41 848	1.94
9 years	15 956	13.0	10 128	63.5	1 135	7.1	12 663	0.79
College degree	54 693	44.4	37 319	68.2	4 931	9.0	47 750	0.87
University degree	30 917	25.1	18 257	59.0	2 564	8.3	21 429	0.69
Distance primary care								
0-1 km	53 885	43.7	37 044	68.7	5 380	10.0	60 929	1.13
>1-5 km	40 669	33.0	27 268	67.0	3 654	9.0	34 728	0.85
>5-10 km	21 374	17.3	14 704	68.8	2 059	9.6	20 688	0.97
>10-15 km	5 088	4.1	3 370	66.2	478	9.4	4 815	0.95
>15-20 km	1 852	1.5	1 164	62.8	196	10.6	2 169	1.17
>20 km	300	0.2	188	62.7	36	12.0	361	1.20

Distance hospital								
0-5 km	45 378	36.8	30 514	67.2	4 460	9.8	49 708	1.10
>5-10 km	14 659	11.9	9 786	66.8	1 515	10.3	14 587	1.00
>10-15 km	11 689	9.5	7 267	62.2	1 207	10.3	11 175	0.96
>15-20 km	15 911	12.9	10 850	68.2	1 340	8.4	13 298	0.84
>20-25 km	31 141	25.3	22 492	72.2	2 851	9.2	30 622	0.98
>25 km	4 390	3.6	2 829	64.4	430	9.8	4 300	0.98
Municipality								
A	49 931	40.5	27 700	55.5	5 164	10.3	53 785	1.08
B	23 286	18.9	15 297	65.7	2 269	9.7	24 044	1.03
C	25 405	20.6	21 723	85.5	2 338	9.2	25 337	1.00
D	13 697	11.1	10 924	79.5	1 107	8.1	11 819	0.86
E	10 849	8.8	8 094	74.6	925	8.5	8 705	0.80
Practice type								
Private	20 428	16.6	15 798	77.3	1 654	8.1	15 982	0.78
Public	102 740	83.4	67 940	66.1	10 149	9.9	107 708	1.05
Population 2	123 168	100.0	83 738	67.9	11 803	9.6	123 690	1.00

Unadjusted active listing on 31 December 2007 and hospitalisation during 2007 for the population of Blekinge > 15 years of age

Conceptual models

Active listing (Papers I-II)

Good relations between patients and primary care contribute to more adequate care, trust and better health. Socioeconomic and geographical factors affect individual health, availability and demand for health care, along with multimorbidity. Active listing could be seen as patients acting to promote and stress their relationship with primary care. This choice is affected by a variety of factors related to both individuals and health care. According to theories on decision-making, it is a complex choice with unknown factors. Differences in individual preferences and options can be explained using trust and other constructs related to theories on social capital.

Hospitalisation (Papers III-IV)

When primary care and other parts of ambulatory care are not sufficient to meet the patient's medical needs, patients are hospitalised. Socioeconomic status affects individual health, availability and demand for health care. Increased multimorbidity is associated with age and sex, and increases risk of hospitalisation. Psychiatric disorders contribute to patient complexity and morbidity burden, introduce non-synergistic management strategies, and affect use of health care and trust. Primary care is a part of the complex network of health care. Relationships are at the core of networks, where knowledge is exchanged and meaning negotiated. The patient–healthcare professional relationship is the central unit of organisational analysis of healthcare systems. Nuances in this interaction are important for the production of health.

Active listing could be regarded as patients acting to maintain their relationship with primary care, provided individuals initiate active listing themselves, and that health care distributes care according to medical need, and not providing favours to actively listed patients or practices according to actively listed patients. Number of consultations in primary care measures negotiated encounters between patients and primary care professionals, thus also including demand for health care balanced against availability and need of care.

Well performing primary care is characterised by a combination of person-focused care over time, use as first contact in health care, completeness of services and coordination of care. Primary care could be described as a care system comprised of settings and processes generating outcomes. Hospitalisation is an outcome of primary care within the complex network of health care. Differences within primary care indicate that change of settings and processes could affect performance.

Outcomes and explanatory factors

Active or passive listing in primary care

Listing status was collected from patient records on 31 December 2007. A total of 98 600 (65%) were actively listed. The options were actively or passively listed at primary care practice with an additional option to choose general practitioner. The listing system was constructed to handle distribution of funding at practice level, focusing on listing at practice. Listing on GP was handled at practice level both to distribute patients to GPs and to handle vacancies. To the patient, active listing on practice, or being content with the passive choice, could also include established continuity with a specific GP. Active listing on GP was considered unreliable.

When the listing system was introduced in 2004 some patients were actively listed by the system either to protect patients with established continuity with a GP in public primary care (6581 persons with the same choice in 2007 treated as actively listed) or having consulted practices with only active listing (8498 in total in 2007). If the latter was wrong, it was discovered when consulting the practice of choice for the first time. Year 2007 was chosen to give patients time to correct their listing. This bias would overestimate active listing. A relationship between patients and primary care did not require active listing, merely being registered on the patient list of the practice. Actively and passively listed had the same access and availability to primary care. This bias would underestimate good relationships in primary care using active listing as a measure.

Number of days hospitalised

Number of days hospitalised was collected from patient records during 2007. A total of 13 122 persons (8.6% of all inhabitants) were hospitalised for 135 297 days during year 2007. Mean days hospitalised for all inhabitants was 0.9 days and for those hospitalised 10.3 days.

Number of consultations

Consultations were collected from patient records for 2007. Data on consultations with professionals other than physicians were not reliable. Of the population of Blekinge, 81.3% consulted any physician less than four times in 2007. Mean number of consultations in all health care was 2.0. In 2007, 94.1% of the population consulted a GP less than four times, and mean number of consultations in primary care was 0.9. Eight or more consultations were unusual, 5.1% in all health care and 0.6% in primary care.

In Sweden, productivity of physicians is considered low. Comparison between healthcare systems is always difficult due to differences in regulations and culture. For example, follow-up could be a registered consultation at the clinic or an unregistered phone call, and uncomplicated prescriptions requiring repeated registered consultations or renewed on unregistered demand. Number of consultations was grouped (0-1, 2-3, 4-5, 6-7, 8-consultations) or (0-1, 2-3, 4-5, 6-7, 8-9, 10-consultations). The low share of more than six consultations in primary care could be a problem statistically.

Multimorbidity level

For the purpose of this thesis a measure of multimorbity burden recognising the coexistence of many different types of illnesses was needed. This was needed both to be able to analyse additional patient complexity and to separate performance of primary care from health outcomes of patients. Multimorbidity level was estimated using diagnostic data from electronic patient records for 2007, using the Johns Hopkins Adjusted Clinical Groups Case-Mix System (ACG). This is a summary measure of morbidity burden based on the patients' diagnoses characterised in five clinical dimensions: duration, severity, diagnostic certainty, aetiology and need for specialist care. The ACG index is then categorised into levels called Resource Utilization Bands (RUBs) ranging from 0 (no need for health care) to 5 (very strong need for health care) (11,12).

Multimorbidity level was estimated using diagnostic data from all health care as well as for primary care alone. Using data from all health care gave 24.2% of the population in RUB 3 or more, compared to 12.8% using data from primary care. Multimorbidity level on all health care was used for Papers II-IV to get as much information on morbidity burden as possible from a single year.

Psychiatric disorders

Diagnoses were collected from electronic patient records of all health care for 2007, using the International Classification of Diseases and Related Health Problems diagnoses (ICD 10, F00-F99).

Psychiatric disorders were chosen to add patient complexity. For both patients and professionals, managing a cluster of conditions with non-synergistic management strategies (discordant conditions) and the stigma of mental conditions is potentially more challenging than dealing with conditions with non-synergistic management strategies (14).

Psychiatric disorders were categorised as psychoses (F20-F29), depressive disorders (F30-F39), anxiety disorders (F40-F48), and others (F00-F19 and F49-F99). When categorisation violated statistical requirements, presence of psychiatric disorder was used.

A total of 7129 were diagnosed with any psychiatric disorder, of them 193 with psychoses, 2348 with depressive disorders, 2133 with anxiety disorders and 2455 with other psychiatric disorders.

Individual income

Income was collected from Statistics Sweden for 2007. Income at disposal was adjusted for taxation and subsidiaries. Disposable income was categorised into four equally numbered groups (quartiles).

Highest educational level

Education was collected from Statistics Sweden as of 31 December 2007. Education was divided into four levels: 1) less than 9 years of education, 2) completed 9 years of compulsory education, 3) college degree, or 4) university degree. For the eldest population information on education is not complete, and educational level could be underestimated. Of the study population over 15 years of age, 13% had completed 9 years of education, 44.4% had a college degree and 25.1% had a degree from university.

Closest distance to primary care

Distance was collected from Statistics Sweden as of 31 December 2007, using coordinates of registered home address, and primary care practices. The distance was measured as the shortest distance between two points. Distance in kilometres (km) from home to nearest primary care practice was categorised into seven levels (0-1, >1-5, >5-10, >10-15, >15-20, >20-25, more than 25 km). Of the population more than 15 years of age, 76.7% lived no more than 5 km, and 1.7% more than 15 km from a primary care practice.

Closest distance to hospital

Distance collected from Statistics Sweden as of 31 December 2007, using coordinates of a registered home address and a hospital. The distance was measured as the shortest distance between two points. Distance in kilometres (km) from home to nearest hospital was categorised into six levels (0-5, >5-10, >10-15, >15-20, >20-25, more than 25 km). Of the population more than 15 years of age, 36.8% lived 5 km or less, and 41.8% more than 15 km from a hospital.

Municipality of home address

Geographical location of home address was collected from Statistics Sweden as of 31 December 2007. Blekinge County consists of five local government areas, called municipalities. The population in municipality A was 41%, in B 19%, in C 21%, in D 11% and in E 9% of the total population. Hospitals were located in municipalities A and C. Both public and private primary care was available in every municipality.

Primary care practice

Primary care practices were identified using the listing system in 2007 as 25 different practices, of them 12 private practices. The listing system categorised primary care practices into three groups. Practices owned by the County Council could be characterised as well established with several GPs, nurses in home care employed and a demand to be available to small communities. Private practices were more often less established and with more differences in size, location and staff. Those already established in 2004 could choose between the same regulations as publicly owned practices, including active and passive listing or only actively listed patients and a different accreditation. Practices established after the introduction of listing system could only have active and passive listing. An exception was a small practice operating on patient fees only. Their patients were handled as passively listed by the listing system. Type of primary care was used to group primary care practices according to ownership, including also the other differences.

Of the 24 107 listed in private primary care, 8498 were listed in practices with only active listing. Both types of private practices were classified as private primary care. Primary care practices owned by the County Council were classified as public primary care. Of the population 15.1% were listed with private primary care and 84.1% with public primary care.

Age and sex

Age was collected from patient records or Statistics Sweden and categorised into five groups (-19, 20-39, 40-59, 60-79, 80- years of age). Sex was collected from patient records or Statistics Sweden.

Specific data collection

Data collection for each paper is described in detail in Tables 4-5.

Statistical analyses

Descriptive statistics

Scatterplots, boxplots and histograms were used to analyse the distribution and spread of numerical data.

For categorical factors contingency tables and chi-squared statistics of association were used. This is computed using the squared differences between the observed proportions of individuals in each cell of the table and the corresponding proportions that would be expected if the null hypothesis were true. The associated P-value is computed using the chi-squared distribution with degrees of freedom specified. Chi-squared statistics is a global indicator of whether or not an association may be present.

Linear pairwise correlations were analysed using the Pearson correlation coefficient. This is a scale free measure of association that varies between –1 and 1, and correlations of absolute value 0.7 or larger are considered strong. With the kind of noisy data of this thesis, a linear correlation of 0.2 was considered meaningful.

Count outcome of days hospitalised

Scatterplots, boxplots and histograms were used to analyse normal distribution, skewness and kurtosis.

Locally weighted scatterplot technique (LOWESS), to draw a smooth line representing the average value of the variable on the y-axis as a function of the variable on the x-axis, was used as complementary graphic analysis of linearity.

Regression models

Binary model: logistic regression

Binary outcomes take only the values of 1 or 0. The binomial probability distribution is characterised by the probability that the outcome occurs in the population (π) and the sample size (n). As the sample size increases, the normal distribution could be used as an approximation of a binomial distribution.

Count model: zero-inflated negative binomial regression

Contemporary statistical packages tailor the analysis of data rather than manipulate them to fit the analysis. Poisson distribution requires the mean and variance to be the same. An alternative distribution for count data that allows more variability is the negative binomial distribution. The Stata package offers a negative binomial regression, in which the variance is modelled as a quadratic function of the mean called the NB2 model (46).

For a large percentage of the population days hospitalised take the value of zero, with the non-zero outcomes taking on integer values. This type of count data is said to have overrepresentation of zeroes and could require tailoring of the regression model. Zero-inflated models of both Poisson and NB2 regressions are available. Count data models, with and without zero inflation, were tested. A clustered zero-inflated negative binomial model was considered most statistically valid to analyse days hospitalised.

Zero-inflated negative binomial regression is a combined model. The probability of y=0 could be a constant or parametrised by a binary model. A logit regression was used to assess the odds ratios (ORs) of a non-zero outcome. In the binomial part of the model, incidence rate ratio (IRR) was used to show the influence of increasing the explanatory factors by one unit for those at risk of a non-zero value of the outcome. This lets zero count occur in two ways: as a realisation of the binary process and as a realisation of the count process (with a binary variable of 1).

The set of variables is specified for each part of the model separately. This thesis used the same set of variables in both parts of the models. The binary and the count process could be combined using postestimations, and average marginal effects for the population calculated. This gives adjusted means of the outcome, adjusted for odds ratios of being at risk of a non-zero outcome.

The assumption that the outcome of each individual is independent of other individuals is violated when the outcome of a group of individuals is on average more similar to each other than to the rest of the population. Data could be clustered on the factor violating independency, and methods that allow for the clustering must be used.

Postestimations

Based on univariate and multivariate regression models further analyses were performed.

Marginal effects, predictions and more

In Stata package the margins command is a flexible tool for predictions, marginal effects and elasticities. The default is to calculate predictions, evaluated at the sample mean and then averaged. The calculation metrics, method of averaging and comparisons could be set in different ways to interpret and visualise regression models.

Model estimations

Model performance was assessed using several different methods.

Akaike's Information Criterion (AIC) has a penalty term for additional parameters, lower values preferred.

Likelihood ratio statistics (LR test) test differences between nested models. Higher values indicate greater difference from the simpler model than lower values.

Correctly classified compares model predictions with individual outcomes of the population in a two-by-two table presenting share of correctly classified positive or negative, and falsely classified as positive or negative.

Coefficient of variance (CV) standardises standard deviation, using absolute mean to allow for comparison of variance across models.

C-statistics (AUC), equivalent to the area under the receiver operating characteristics (ROC) curve, 1 indicating perfect discrimination and 0.5 equal to chance.

Specific statistical analysis

Tables 4-5 show an overview of specific statistical analysis of Papers I-IV. When analysing hospitalisation for Paper IV, analysis was performed analogous to Papers I-II on the relation between listing status and number of consultations in primary care, and comparing adjustment for multimorbidity level and socioeconomic factors. A statistical manipulation of the relationship with primary care was also performed, based on mean days hospitalised, to get an approximative effect size of changes of the relationships in primary care to health care. All statistical analyses were performed with STATA (Stata Corporation, Texas, USA) versions 13.0-14.2.

Further analyses of hospitalisation

Model tests on logistic and zero-inflated negative binomial regression models, clustered on municipality. Postestimations at set share of actively listed and number of consultations in primary care, using continuous variables.

Table 4
Specific data collection and statistical analysis for Papers I-II.

Paper	**I**	**II**
Design	Cross-sectional population study	Cross-sectional population study
Outcomes	Actively listed	Actively listed
Data collection	Multimorbidity level	Multimorbidity level
	Number of consultations	Individual income.
	Type of practice	Highest educational level
	Age and sex	Distance primary care
		Distance hospital
		Municipality
		Age and sex
Cluster factor		Primary care practice
Data package	Stata 13.0	Stata 14.1
Descriptive	Contingency tables and chi-squared statistics	Contingency tables and chi-squared statistics
	Pairwise correlations	Pairwise correlations
Regression model	Binary logistic regressions	Binary logistic regressions
Postestimations	Average marginal effects	Average marginal effects
	Akaike's Information Criterion (AIC)	Akaike's Information Criterion (AIC)
	Correctly classified	Coefficient of Variance
	Likelihood Ratio statistics (LR-statistics)	Likelihood Ratio statistics (LR-statistics)
		c-statistics (AUC)

Table 5
Specific data collection and statistical analysis for Papers III-IV.

Paper	**III**	**IV**
Design	Cross-sectional population study	Cross-sectional population study
Outcomes	Odds of hospital admission	Odds of hospital admission
	Number of days hospitalised	Number of days hospitalised
Data collection	Multimorbidity level	Multimorbidity level
	Number of consultations	Number of consultations
	Psychiatric disorders	Individual income.
	Age and sex	Highest educational level
		Distance primary care
		Distance hospital
		Type of practice
		Age and sex
Cluster factor	Primary care practice	Municipality
Data package	Stata 14.0	Stata 14.1-14.2
Descriptive	Contingency tables and chi-squared statistics	Contingency tables and chi-squared statistics
	Pairwise correlations	Pairwise correlations
Regression model	Zero-inflated negative binomial regressions	Zero-inflated negative binomial regressions
Postestimations	Average marginal effects	Average marginal effects
		Akaike's Information Criterion (AIC)
		Coefficient of Variance (CV)
		Likelihood Ratio statistics (LR tests)

Ethical considerations

This thesis is based on the population living in Blekinge on 31 December 2007.

Individual informed consent was not realistic. Instead, information on the research project was advertised on the website of Blekinge County Council and local newspapers with an option for the population to opt out.

Sensitive individual health data from patient records were used in all papers. Additional sensitive information on socioeconomic and geographical factors from Statistics Sweden was used in Papers II and IV. The risk of violating integrity for both inhabitants and primary care practices was handled by depersonalising prior to statistical analysis, grouping to avoid identification and limiting access to the databases.

The study protocol for Papers I-II was approved by the Regional Ethics Review Board in Lund (date 9 June 2010; case number 2010/314).

The study protocol for Papers III-IV was approved by the Regional Ethics Review Board in Lund (date 23 February 2016; case number 2016/71).

Findings

Main findings

- Active listing in primary care was associated with number of consultations, multimorbidity level, age and sex. Modelling these factors explains about 70% of active listing. Data from primary care showed a stronger association with active listing in primary care than data from all health care. Higher income, shorter education, short distance to primary care and long distance to hospital were significant to active listing; though multimorbidity, age, geographical location and primary care explained more.
- Patients actively listed or with more than one consultation in primary care were hospitalised less than the population mean of 0.9 days, while patients passively listed or with one consultation or less in primary care were hospitalised more. Models adjusting for age, sex, multimorbidity, type of primary care and socioeconomic factors gave similar results.
- Being diagnosed with psychiatric disorder was associated with increased mean days hospitalised compared to others at the same multimorbidity level, keeping the associations with relationship in primary care. At RUB 3, patients actively listed were in mean hospitalised for 3.45 (95%CI 2.84-4.07) days if diagnosed with any psychiatric disorder and 1.64 (95%CI 1.50-1.77) days if not. At RUB 3, patients passively listed were in mean hospitalised for 5.17 (95%CI 4.36-5.98) days, if diagnosed with any psychiatric disorder and 2.41 (95%CI 2.22-2.60) if not.
- Difference within primary care was investigated comparing two groups of primary care practices, adjusting for sex, age, multimorbidity and socioeconomic factors. Odds of hospital admission differed 49% and adjusted mean days hospitalised 0.24 days.

The population of Blekinge in 2007

Blekinge county had 151 731 inhabitants on 31 December 2007. A total of 98 600 (53% women, 47% men) were actively listed with a primary care clinic and 60 921 of them also chose a personal GP. A total of 63.2% of those listed with public primary care and 74.5% of those listed with private primary care were actively listed. Individuals actively listed were on average 14 years older, had 40% more consultations and 30% higher multimorbidity level and were more likely to be female than those passively listed. Mean number of consultations with a physician was 2.0, of them 0.9 in primary care.

A total of 13 122 were hospitalised for 135 297 days in all. Mean days hospitalised was 0.89 days. During 2007 10% of the population >15years of age were admitted to hospital and were hospitalised for 123 690 days altogether. The 68% actively listed accounted for 77% of admissions to hospital and 79% of hospital days. The 22% with more than two consultations in primary care accounted for 37% of admissions to hospital and 39% of days hospitalised. The 83% of hospitalised that were listed in public primary care accounted for 86% of admissions to hospital and 87% of days hospitalised.

The baseline characteristics of the population of Blekinge in 2007 are described in Tables 2-3. Study population 1 includes all inhabitants found using patient records on 31 December 2007. Study population 2 includes all inhabitants over 15 years of age found merging patient records and Statistics Sweden on 31 December 2007, with complete data on education, income and home address.

Active listing, descriptive (Paper I)

Four separate models, including number of consultations, multimorbidity level using data from primary care and all health care, gave similar predictive power of about 70% to correctly classify listing status in primary care. Models including both number of consultations and multimorbidity level did not improve the results (Table 6).

Table 6
Modelling multimorbidity and number of consultations, controlling for age and sex, on active listing with public primary care in Blekinge 2007 (n=127 624), comparing data from primary care and all health care.

Model	**AIC**	**Correctly classified**
Number of consultations, primary care	146 160	67.6
Number of consultations, all health care	147 874	67.9
Multimorbidity, primary care	141 111	71.2
Multimorbidity, all health care	145 361	69.9
Consultations and multimorbidity, primary care	140 008	71.2
Consultations and multimorbidity, all health care	144 596	70.0

N=127 624; AIC = Akaike's Information Criterion

For those listed with public primary care, number of consultations had a stronger association in primary care (OR 2.11 for continuous factor, 95%CI 2.08-2.15) with active listing than in all health care (OR 1.31, 95% CI 1.30-1.32), adjusting for age and sex. (Figure 1).

For those listed with public primary care, multimorbidity level in primary care (OR 2.14, 95%CI 2.11-2.17) had a stronger association with active listing than multimorbidity level in all health care (OR 1.70, 95% CI 1.69-1.72), adjusting for age and sex. RUB 0-4 was significantly ($p<0.001$) positively associated with active listing, both in primary care and all health care (Figure 2).

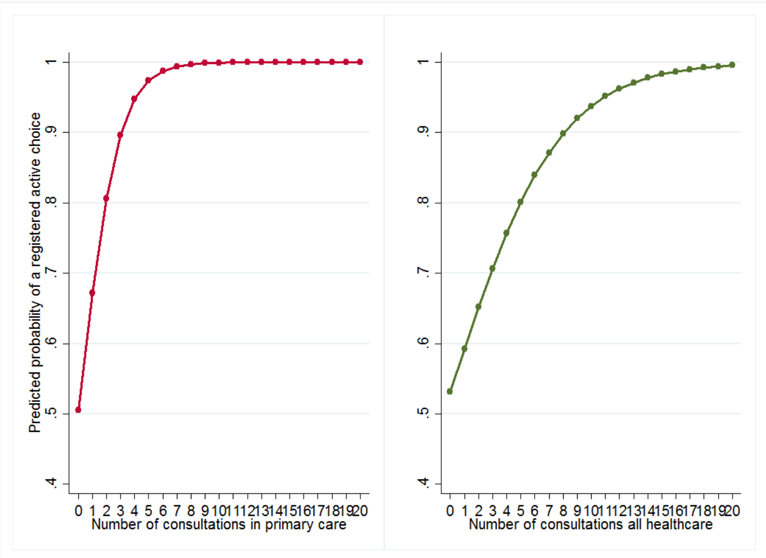

Figure 1
Predicted probability of a registered active choice of primary care provider according to number of consultations in primary care and all health care, controlling for age and sex, in the population listed with public primary care (n=127 624) in Blekinge 2007.

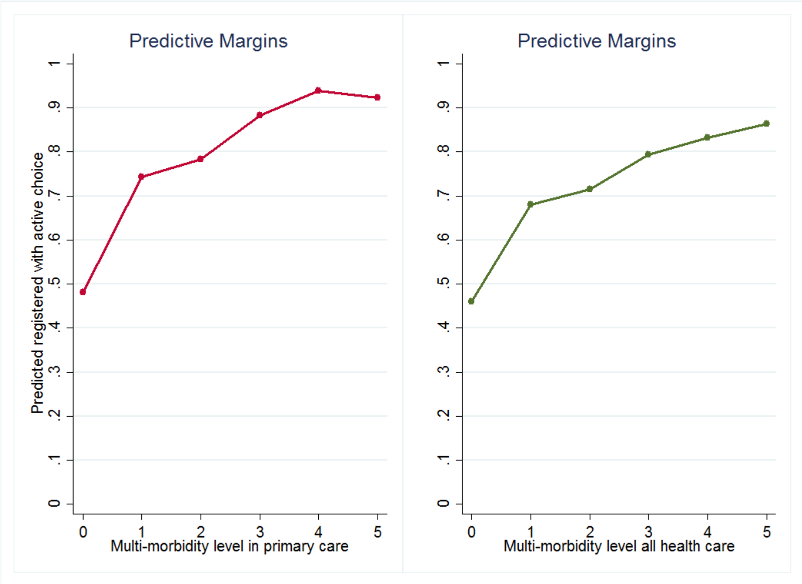

Figure 2
Predicted probability of a registered active choice of primary care provider according to multimorbidity level measured in primary care and all health care, controlling for age and sex, in the population listed with public primary care (n=127 624) in Blekinge 2007.

Active listing with model tests (Paper II)

All factors were significantly (p<0.01) associated with active listing in univariate models, but variance and model fit differed. Coefficient of variance was 8.1 for income, 11.8 for education, 1.6 for distance to primary care, 4.3 for distance to hospital and 17.8 for municipality (Table 7).

Table 7
Univariate models. Active listing in primary care according to multimorbidity, income, education, distances to health care, age, sex, practice type and geographical location for the population of Blekinge 2007 aged >15 years, with no missing data (N=123 168).

Univariate models, Paper II	**Area under ROC Curve**		**CV**	**AIC**
	AUC	(95% CI)	%	
Individual income	0.567	(0.563-0.570)	8.1	152 676
Education level	0.596	(0.592-0.599)	11.8	150 534
Distance primary care	0.512	(0.509-0.515)	1.6	154 387
Distance hospital	0.535	(0.532-0.539)	4.3	153 970
Municipality	0.653	(0.650-0.656)	17.8	145 699
Multimorbidity level	0.678	(0.675-0.681)	20.7	142 772
Age	0.663	(0.660-0.666)	18.9	144 592
Sex	0.561	(0.558-0.564)	11.5	152 848
Practice type	0.687	(0.684-0.691)	21.0	142 320

N=123 168 and all models p<0.01; CI = Conficence interval; AUC = Area Under the Curve; CV = Coefficient of Variance; AIC = Akaike's Information Criterion

Multivariate models

Both unadjusted and adjusted multivariate models showed significance (p<0.01) for socioeconomic and geographical factors. The model including all socioeconomic and geographical factors, adjusting for multimorbidity, age, sex and type of practice, gave the lowest odds of active listing according to income for those in the first quartile with OR 0.63 (95%CI 0.63-0.64) and highest for those in quartile two or three with OR 0.70 (95%CI 0.69-0.70). According to educational level this model gave those with less than nine years of education OR 0.70 (95%CI 068-0.70) and those with a university degree OR 0.65 (95%CI 0.64-0.65) for active listing. A distance to primary care of >15-20 km gave OR 0.62 (0.60-0.65) and of 1 km or less OR 0.69 (95%CI 0.69-0.70) of active listing. For distance to hospital >5-10 km gave OR 0.64 (95%CI 0.64-0.65) and more than 25 km OR 0.71 (95%CI 0.70-0.73). Odds ratios according to geographic location for active listing ranged from 0.58 (95%CI 0.57-0.58) in municipality A to 0.85 (95%CI 0.85-0.86) in municipality C (Table 8).

Table 8
Multivariate models on active listing in primary care, socioeconomic status and geographical factors unadjusted and adjusted for multimorbidity, age, sex and practice type for the population of Blekinge 2007, aged >15 years with no missing data (N=123 168).

Multivariate models, Paper II	Unadjusted			Adjusting for age and sex			Adjusting for age, sex, multimorbidity, practice type and municipality		
	p	OR	(95%CI)	p	OR	(95%CI)	p	OR	(95%CI)
Individual income	<0.01			<0.01			<0.01		
Quartile1		0.62	(0.61-0.62)		0.62	(0.61-0.63)		0.63	(0.63-0.64)
Quartile 2		0.75	(0.74-0.75)		0.71	(0.71-0.72)		0.70	(0.69-0.70)
Quartile 3		0.70	(0.69-0.70)		0.70	(0.70-0.71)		0.70	(0.69-0.70)
Quartile 4		0.66	(0.65-0.67)		0.68	(0.68-0.69)		0.69	(0.68-0.69)
Education level	<0.01			<0.01			<0.01		
Less than 9 years		0.82	(0.82-0.83)		0.70	(0.69-0.71)		0.70	(0.68-0.70)
9 years		0.65	(0.65-0.66)		0.70	(0.69-0.71)		0.69	(0.69-0.70)
College degree		0.67	(0.67-0.68)		0.69	(0.69-0.70)		0.69	(0.69-0.69)
University degree		0.61	(0.61-0.62)		0.64	(0.63-0.64)		0.65	(0.64-0.65)
Distance primary care	<0.01			<0.01			<0.01		
0-1 km		0.69	(0.68-0.69)		0.69	(0.69-0.70)		0.69	(0.69-0.70)
>1-5 km		0.67	(0.67-0.68)		0.67	(0.67-0.68)		0.67	(0.67-0.68)
>5-10km		0.68	(0.67-0.69)		0.67	(0.67-0.68)		0.67	(0.67-0.68)
>10-15 km		0.66	(0.65-0.68)		0.66	(0.64-0.67)		0.65	(0.64-0.66)
>15-20 km		0.64	(0.62-0.67)		0.64	(0.61-0.66)		0.62	(0.60-0.65)
>20 km		0.64	(0.59-0.69)		0.64	(0.59-0.69)		0.64	(0.59-0.69)
Distance hospital	<0.01			<0.01			<0.01		
0-5 km		0.68	(0.68-0.69)		0.68	(0.68-0.69)		0.68	(0.67-0.69)
>5-10 km		0.65	(0.64-0.66)		0.65	(0.64-066)		0.64	(0.64-0.65)
>10-15 km		0.66	(0.65-0.66)		0.66	(0.65-0.67)		0.65	(0.64-0.66)
>15-20 km		0.69	(0.69-0.70)		0.70	(0.69-0.70)		0.70	(0.69-0.70)
>20-25 km		0.69	(0.68-0.69)		0.69	(0.68-0.69)		0.69	(0.69-0.70)
>25 km		0.69	(0.67.0.71)		0.69	(0.68-0.71)		0.71	(0.70-0.73)
Municipality	<0.01			<0.01			<0.01		
A		0.57	(0.56-0.57)		0.57	(0.56-0.57)		0.58	(0.57-0.58)
B		0.65	(0.64-0.66)		0.65	(0.64-0.66)		0.64	(0.63-0.64)
C		0.86	(0.85-0.86)		0.85	(0.85-0.86)		0.85	(0.85-0.86)
D		0.79	(0.78-0.80)		0.79	(0.78-0.79)		0.78	(0.77-0.79)
E		0.73	(0.72.0.74)		0.72	(0.71-0.73)		0.72	(0.71-0.73)
Multimorbidity level	-			-			<0.01		
Age	-			<0.01			<0.01		
Sex	-			<0.01			<0.01		
Practice type	-			-			<0.01		
AUC	0.700		(0.700-0.701)	0.747		(0.744-0.750)	0.792		(0.789-0.795)
CV	22.2			27.7			33.2		
AIC	140 941			133 332			123 934		

N=123 68; p = significance level; OR = Odds Ratio; CI = Confidence Interval; km = kilometres

Model tests

AIC for the model with age and sex was 143 382, including multimorbidity, and practice type gave AIC 133 429, also including municipality to that model gave AIC 124 801. The model including all socioeconomic and geographical factors, and adjusting for multimorbidity, age, sex and type of practice, gave AIC 123 934 (Table 9).

Coefficient of variance for a model including multimorbidity, age and sex was 26.0 and municipality, multimorbidity, age and sex 32.2. Including income, education or distances to health care to this model gave at most CV 32.4, including type of practice CV 32.7. The model including all socioeconomic and geographical factors and adjusting for multimorbidity, age, sex and type of practice gave CV 33.2 (Table 9).

Nested models were tested with LR-tests. Adding municipality, multimorbidity or practice type added most difference to a model with age and sex. Adding socioeconomic factors or distances to health care to the model including municipality, multimorbidity, age and sex gave LR-tests ranging from 123 for adding distance to primary care to 359 for adding individual income (Table 9).

Model performance was also tested using c-statistics. Univariate models on municipality, multimorbidity level, age and type of practice gave AUC >0.6. Age and sex gave a model with AUC 0.679 (95%CI 0.676-0.682). Modelling multimorbidity, age, sex and type of practice gave AUC 0.747 (95%CI 0.744-0.750) and including municipality to that model AUC 0.788 (95%CI 0.785-0.790). The model including all factors gave AUC 0.792 (95%CI 0.789-0.795) (Table 9).

Table 9
Multivariate model tests. Associations between active listing in primary care, socioeconomic status and geographical factors, adjusting for sex and age. Blekinge 2007, aged >15 years with no missing data (N=123 168).

Multivariate model tests, Paper II	Area under ROC Curve		CV	AIC	LR test
	AUC	(95% CI)	%		
Age and sex	0.679	(0.676-0.682)	20.1	143 382	
Adjusted for age and sex					0
Individual income	0.685	(0.682-0.688)	20.6	142 779	552
Education level	0.686	(0.683-0.689)	20.8	142 615	715
Distance primary care	0.681	(0.678-0.684)	20.2	143 235	99
Distance hospital	0.685	(0.682-0.688)	20.6	142 833	502
Municipality	0.740	(0.737-0.743)	26.9	134 599	8 831
Multimorbidity level	0.732	(0.729-0.735)	26.0	135 902	7 432
Practice type	0.687	(0.684-0.690)	21.0	142 320	1 006
Adjusted for multimorbidity, age and sex					0
Individual income	0.734	(0.731-0.736)	26.2	135 586	322
Education level	0.735	(0.732-0.737)	26.4	135 364	543
Distance primary care	0.732	(0.729-0.735)	26.1	135 805	106
Distance hospital	0.736	(0.733-0.739)	26.4	135 258	654
Municipality	0.784	(0.781-0.787)	32.2	125 689	10 221
Practice type	0.747	(0.744-0.750)	27.7	133 429	2 475
Adjusted for multimorbidity, age, sex and practice type					0
Individual income	0.749	(0.746-0.751)	27.9	133 130	305
Education	0.749	(0.747-0.752)	28.1	132 926	508
Distance primary care	0.747	(0.744-0.750)	27.8	133 350	89
Distance hospital	0.750	(0.748-0.753)	28.1	132 875	564
Municipality	0.788	(0.785-0.790)	32.7	124 801	8 636
Adjusted for municipality, multimorbidity, age, sex and practice type					0
Individual income	0.789	(0.787-0.792)	32.9	124 448	359
Education	0.789	(0.786-0.792)	32.8	124 577	230
Distance primary care	0.789	(0.786-0.791)	32.8	124 688	123
Distance hospital	0.789	(0.786-0.792)	32.8	124 621	190

N=123 168; AUC = Area Under the Curve; CV = Coefficient of Variance; AIC = Akaike's Information Criterion; LR test = Likelihood Ratio test

Hospitalisation adding patient complexity (Paper III)

A total of 118 759 consulted a GP once or less in 2007 and 884 more than 7 times, with a mean of 0.67 and 4.85 days hospitalised, respectively.

A total of 7129 persons had a diagnosed psychiatric disorder. None in RUB 0-1 were diagnosed with any psychiatric disorder. RUB 3 was the most common multimorbidity level for all categories of psychiatric disorders. Of persons with psychiatric disorder, 23.3% were admitted to hospital. Mean days hospitalised for persons with psychiatric disorder were 4.95 compared to 0.69 for persons without psychiatric disorder (Table 2).

Clustered zero-inflated negative binomial model

Odds of hospital admission were 0.77 (95%CI 0.58-0.76) for persons actively listed compared to passively listed, 0.41 (95%CI 0.31-0.50) with 2-3 consultations in primary care compared to less. For persons with psychoses odds of hospital admission were 0.77 (95%CI 0.47-1.08), and with anxiety disorders 0.78 (95%CI 0.65-0.92) compared to persons without psychiatric disorder. At risk of hospitalisation, adjusted mean days hospitalised were 0.76 (95%CI 0.72-0.79) without psychiatric disorder, with psychoses 4.67 (95%CI 2.77-6.57) and anxiety disorders 1.63 (95%CI 1.23-2.03) (Table 10).

Table 10
Clustered zero-inflated negative binomial regression for the population of Blekinge in 2007 (N=151 731), same factors in both parts of the model. Mean days hospitalised calculated as average marginal effects, combining the logit and the negative binomial parts of the multivariate model.

Multivariate regression, Paper III	Odds ratio for hospital admission		Adjusted rate ratio of days hospitalised		Mean days hospitalised	
	OR	(95%CI)	IRR	(95%CI)	Days	(95%CI)
Psychiatric disorder						
No psychiatric disorder	1.00		1.00		0.76**	(0.72-0.79)
Psychoses	0.77	(0.47-1.08)	7.05**	(4.97-10.01)	4.67**	(2.77-6.57)
Depressive disorders	0.81**	(0.69-0.92)	2.81**	(2.43-3.26)	1.90**	(1.61-2.18)
Anxiety disorders	0.78**	(0.65-0.92)	2.45**	(1.97-3.05)	1.63**	(1.23-2.03)
Other psychiatric disorders	0.90	(0.74-1.07)	2.37**	(1.98-2.82)	1.69**	(1.32-2.07)
Listing status						
Passively listed	1.00		1.00		1.23**	(1.09-1.37)
Actively listed	0.67**	(0.58-0.76)	0.84**	(0.77-0.93)	0.86**	(0.81-0.92)
Consultations, primary care						
0 or 1 consultation	1.00		1.00		1.16**	(1.08-1.23)
2 or 3 consultations	0.41**	(0.31-0.50)	0.89**	(0.83-0.96)	0.74**	(0.67-0.81)
4 or 5 consultations	0.53**	(0.40-0.67)	0.76**	(0.70-0.84)	0.68**	(0.62-0.75)
6 or 7 consultations	0.51**	(0.32-0.70)	0.74**	(0.61-0.89)	0.65**	(0.54-0.77)
8- consultations	0.73	(0.47-1.00)	0.82	(0.65-1.03)	0.82**	(0.57-1.07)
Multimorbidity level						
RUB 0	1.00		1.00		0.00	(0.00-0.01)
RUB 1	6.63**	(5.93-7.33)	0.29**	(0.15-0.59)	0.31**	(0.27-0.36)
RUB 2	6.71**	(6.00-7.43)	0.39**	(0.21-0.71)	0.44**	(0.40-0.49)
RUB 3	8.28**	(7.60-8.96)	0.51*	(0.27-0.95)	2.00**	(1.87-2.12)
RUB 4	9.97**	(9.29-10.66)	0.93	(0.50-1.76)	8.14**	(7.47-8.80)
RUB 5	11.26**	(10.58-11.95)	1.79	(0.95-3.38)	20.13**	(17.38-22.87)
Sex						
Women	1.00		1.00		0.90**	(0.84-0.96)
Men	1.14**	(1.09-1.19)	0.99	(0.94-1.04)	0.96**	(0.89-1.03)
Age						
0-19 years	1.00		1.00		0.55**	(0.49-0.61)
20-39 years	1.96**	(1.85-2.07)	0.98	(0.90-1.08)	0.95**	(0.85-1.05)
40-59 years	1.01	(0.87-1.14)	1.04	(0.93-1.17)	0.58**	(0.52-0.64)
60-79 years	1.10	(0.98-1.23)	1.60**	(1.44-1.78)	0.94**	(0.88-1.01)
80+ years	1.66**	(1.53-1.78)	1.89**	(1.69-2.12)	1.55**	(1.42-1.68)

OR = Odds Ratio; IRR = Incidence Rate Ratio; CI = Confidence Interval; * = p<0.05, ** = p<0.01; RUB = Resource Utilization Band; Mean days hospitalised = average marginal effects combining both parts of the statistic model

Predicted mean days hospitalised for persons without psychiatric disorder with 0-1 consultations were 0.77 (95%CI 0.73-0.81) for actively listed and 1.10 (95%CI 0.98-1.21) for passively listed, and with more than 7 consultations 0.54 (95%CI 0.37-0.71) for actively and 0.78 (95%CI 0.51-1.04) for passively listed (Table 11). Predicted mean days hospitalised for persons with psychiatric disorder with 0-1 consultations were 7.53 (95%CI 6.46-8.60) for actively listed and 10.23 (95%CI 8.70-11.75) for passively listed, and with more than 7 consultations 5.47 (95%CI 3.87-7.08) for actively and 7.51 (95%CI 5.25-9.76) for passively listed (Table 11).

At RUB 3, patients actively listed were in mean hospitalised for 3.45 (95%CI 2.84-4.07) days if diagnosed with psychiatric disorder and 1.64 (95%CI 1.50-1.77) days if not. At RUB 3 patients passively listed were in mean hospitalised for 5.17 (95%CI 4.36-5.98) days, if diagnosed with psychiatric disorder and 2.41 (95%CI 2.22-2.60) if not (Table 11 and Figures 3-4).

Table 11
Predicted mean days hospitalised according to listing and number of consultations in primary care or multimorbidity level for the population without (N=144 602) and with (N=7129) psychiatric disorders. Mean days hospitalised calculated as average marginal effects, combining the logit and the negative binomial parts of the multivariate zero-inflated negative binomial model.

Predicted mean days hospitalised, Paper III	**Actively listed**		**Passively listed**	
	Days	(95%CI)	Days	(95%CI)
Population without psychiatric disorder				
0 or 1 consultation	0.77**	(0.73-0.81)	1.10**	(0.98-1.21)
2 or 3 consultations	0.48**	(0.44-0.52)	0.70**	(0.60-0.80)
4 or 5 consultations	0.45**	(0.40-0.49)	0.65**	(0.54-0.75)
6 or 7 consultations	0.42**	(0.34-0.50)	0.61**	(0.47-0.75)
8- consultations	0.54**	(0.37-0.71)	0.78**	(0.51-1.04)
Population with psychiatric disorders				
0 or 1 consultation	7.53**	(6.46-8.60)	10.23**	(8.70-11.75)
2 or 3 consultations	5.10**	(4.30-5.90)	7.08**	(5.82-8.33)
4 or 5 consultations	4.65**	(4.05-5.25)	6.42**	(5.41-7.44)
6 or 7 consultations	4.43**	(3.65-5.21)	6.12**	(4.92-7.32)
8- consultations	5.47**	(3.87-7.08)	7.51**	(5.25-9.76)
Population without psychiatric disorder				
RUB 0	0.00	(0.00-0.01)	0.01	(0.00-0.01)
RUB 1	0.25**	(0.21-0.28)	0.39**	(0.32-0.46)
RUB 2	0.35**	(0.31-0.39)	0.56**	(0.49-0.62)
RUB 3	1.64**	(1.50-1.77)	2.41**	(2.22-2.60)
RUB 4	6.97**	(6.45-7.50)	9.09**	(7.97-10.20)
RUB 5	17.53**	(15.37-19.69)	21.53**	(17.79-25.27)
Population with psychiatric disorders				
RUB 2	0.70**	(0.56-0.84)	1.12**	(0.89-1.34)
RUB 3	3.45**	(2.84-4.07)	5.17**	(4.36-5.98)
RUB 4	16.37**	(14.04-18.69)	21.75**	(18.58-24.93)
RUB 5	43.93**	(35.77-52.10)	54.52**	(43.64-65.41)

Mean days hospitalised predicted holding consutations, age and sex at mean; CI = Confience Interval; ** = p<0.01; None with psychiatric disorder in RUB 0-1

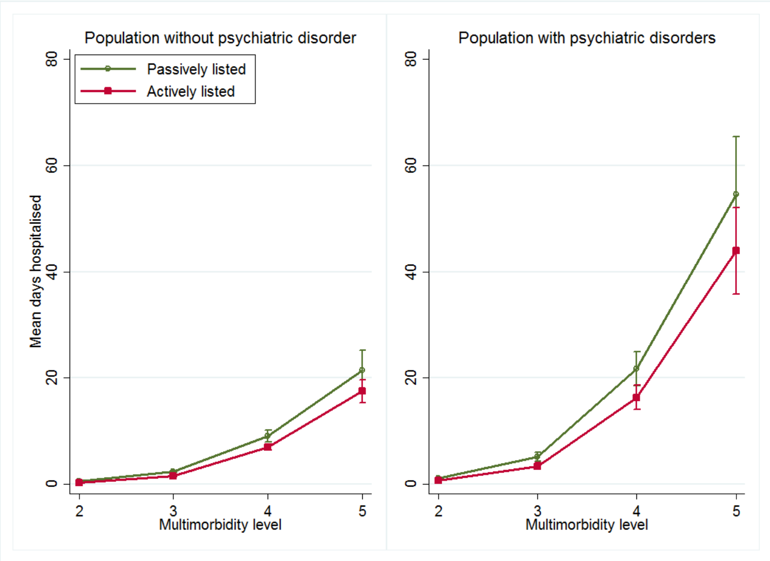

Figure 3
Predicted mean days hospitalised for the population without (N=144 602) and with (N=7129) psychiatric disorders according to listing and multimorbidity level, adjusting for age, sex and number of consultations in primary care. Mean days hospitalised calculated as average marginal effects, combining the logit and the negative binomial parts of the multivariate zero-inflated negative binomial model.

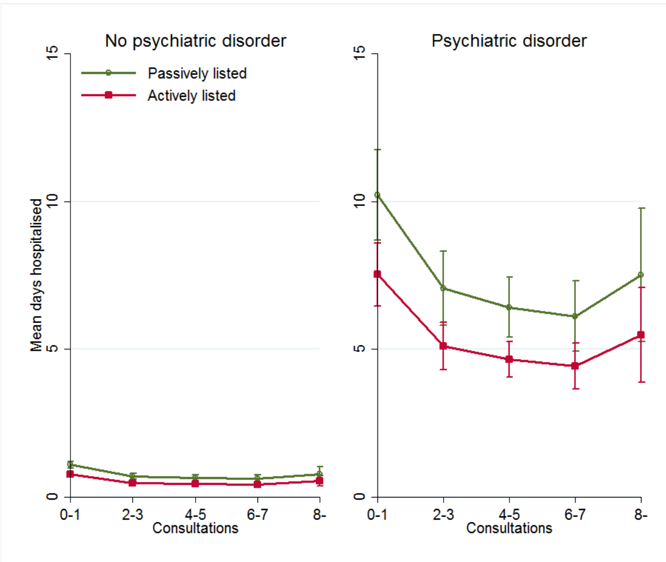

Figure 4
Predicted mean days hospitalised for the population without (N=144 602) and with (N=7129) psychiatric disorders according to listing and number of consultations in primary care, adjusting for age, sex and multimorbidity level. Mean days hospitalised calculated as average marginal effects, combining the logit and the negative binomial parts of the multivariate zero-inflated negative binomial model.

Hospitalisation comparing two types of primary care practices adjusting for socioeconomic factors (Paper IV)

Table 12
Associations between active listing, consultations in primary care and hospitalisation for the population > 15 years of age in Blekinge in 2007 (N=123 168). The statistical model adjusted for sex, age, multimorbidity level, income and education. Odds of hospital admission, mean days hospitalised and mean days hospitalised adjusting for odds of hospitalisation are assessed.

Multivariate model, Paper IV	**Adjusted odds ratio for hospital admission**		**Adjusted rate ratio of days hospitalised**		**Adjusted mean days hospitalised**	
	OR	(95%CI)	IRR	(95%CI)	Days	(95%CI)
Listing status						
Passively listed	1.00		1.00		1.32**	(1.24-1.40)
Actively listed	0.69**	(0.61-0.77)	0.85**	(0.78-0.92)	0.94**	(0.90-0.99)
Consultations, primary care						
0 or 1 consultation	1.00		1.00		1.21**	(1.13-1.29)
2 or 3 consultations	0.44**	(0.34-0.54)	0.90*	(0.83-0.97)	0.80**	(0.75-0.84)
4 or 5 consultations	0.55**	(0.37-0.74)	0.81*	(0.71-0.93)	0.77**	(0.72-0.83)
6 or 7 consultations	0.60**	(0.48-0.72)	0.79*	(0.64-0.96)	0.77**	(0.66-0.87)
8 or 9 consultations	0.73*	(0.48-0.99)	0.77	(0.57-1.03)	0.80**	(0.51-1.10)
10- consultations	0.91	(0.63-1.19)	0.92	(0.72-1.18)	1.06**	(0.67-1.46)
Type of practice						
Private practice	1.00		1.00		1.22**	(1.16-1.28)
Public practice	0.51**	(0.39-0.63)	1.04	(0.98-1.11)	0.98**	(0.94-1.01)
Multimorbidity level						
RUB 0	1.00		1.00		0.00*	(0.00-0.01)
RUB 1	6.66**	(5.95-7.37)	0.38**	(0.29-0.50)	0.40**	(0.34-0.45)
RUB 2	6.50**	(5.78-7.23)	0.52**	(0.46-0.60)	0.47**	(0.44-0.51)
RUB 3	8.13**	(7.49-8.77)	0.74*	(0.61-0.88)	2.34**	(2.12-2.57)
RUB 4	9.85**	(9.21-10.49)	1.32*	(1.11-1.57)	9.21**	(8.70-9.84)
RUB 5	11.13**	(10.66-11.60)	2.78**	(2.24-3.45)	24.96**	(23.87-26.05)
Individual income						
Income quartile 1	1.00		1.00		1.10**	(1.08-1.13)
Income quartile 2	1.10**	(1.06-1.14)	0.98	(0.90-1.06)	1.15**	(1.07-1.22)
Income quartile 3	1.01	(0.84-1.04)	0.75**	(0.73-0.78)	0.84**	(0.80-0.87)
Income quartile 4	1.02	(0.97-1.08)	0.64**	(0.61-0.68)	0.72**	(0.66-0.78)
Education level						
No basic education	1.00		1.00		1.03**	(1.01-1.07)
Basic education	0.89*	(0.79-1.00)	1.15*	(1.05-1.26)	1.12**	(1.06-1.18)
College	0.87**	(0.61-0.93)	1.02	(0.92-1.12)	0.97**	(0.89-1.06)
University	0.88	(0.72-1.04)	1.00	(0.94-1.06)	0.97**	(0.93-1.01)
Sex						
Women	1.00		1.00		0.94**	(0.89-0.98)
Men	1.13**	(1.09-1.17)	1.08*	(1.00-1.17)	1.09**	(1.03-1.15)
Age						
16-19 years	1.00		1.00		0.63**	(0.37-0.90)
20-39 years	2.45**	(2.26-2.63)	0.75	(0.50-1.13)	1.12**	(1.01-1.22)
40-59 years	1.45**	(1.27-1.64)	0.91	(0.62-1.35)	0.77**	(0.69-0.86)
60-79 years	1.52**	(1.33-1.71)	1.03	(0.61-1.74)	0.91**	(0.85-0.98)
80+ years	2.05**	(1.88-2.21)	1.15	(0.69-1.94)	1.39**	(1.30-1.47)

OR = Odds Ratio; IRR = Incidence Rate Ratio; CI = Confidence Interval; * = p<0.05, ** = p<0.01; RUB = Resource Utilization Band; Mean days hospitalised = average marginal effects combining both parts of the statistic model

Clustered zero-inflated negative binomial model

OR for hospitalisation for actively listed was 0.69 (95%CI 0.61-0.77) compared to passively listed. Persons with 6-7 consultations in primary care had OR for hospital admission 0.60 (95%CI 0.48-0.72) compared to one or less consultations. For those listed in public primary care OR for hospital admission was 0.51 (95%CI 0.39-0.63) compared to those listed in private primary care (Table 12).

Adjusted mean number of days hospitalised for the entire population was calculated combining both parts of the statistical model. Mean number of days hospitalised was 0.94 days (95%CI 0.90-0.99) for actively listed and 1.32 days (95%CI 1.24-1.40) for passively listed. Patients with 0-1 consultations in primary care were in mean hospitalised 1.21 days (95%CI 1.13-1.29), and with 6-7 consultations in primary care 0.77 days (95%CI 0.66-0.87). Mean number of days hospitalised for those listed in private primary care was 1.22 days (95%CI 1.16-1.28) and for those listed in public primary care 0.98 days (95%CI 0.94-1.01) (Table 12 and Figure 5).

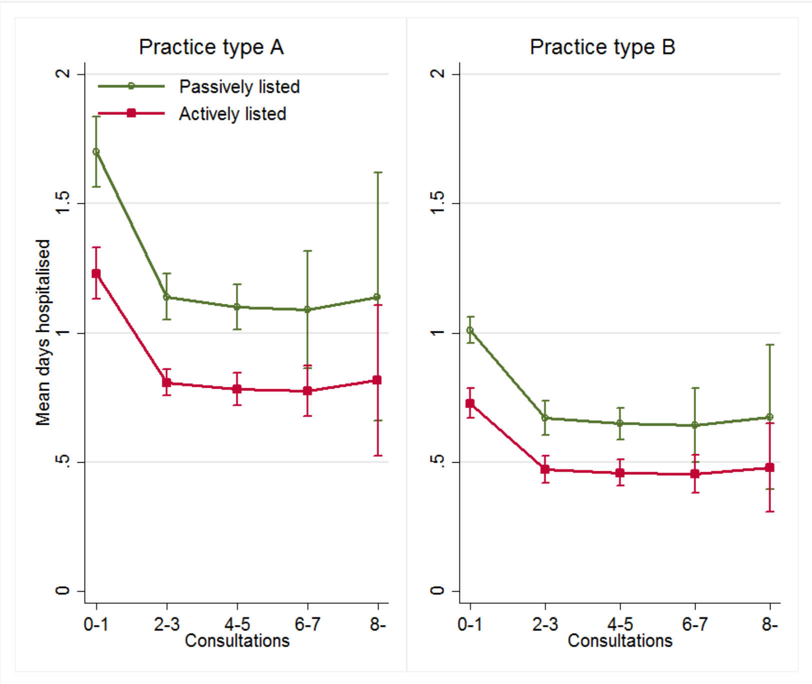

Figure 5
Predicted mean days hospitalised for the population > 15 years of age for listed in type A (N=20 428) and type B (N=102 740) practices according to active listing and number ofconsultations in primary care, adjusting for sex, age, multimorbidity level, income and education. Mean days hospitalised calculated as average marginal effects, combining the logit and the negative binomial parts of the multivariate zero-inflated negative binomial model.

Hospitalisation comparing adjustment for multimorbidity level, relationships with primary care and socioeconomic factors

A logistic model on hospitalisation adjusting for age and sex gave AIC 74 959. Including socioeconomic factors to the model gave LR-test 372, including relationship with primary care instead LR-test 1331 or multimorbidity level LR-test 18 503.

AIC for the logistic model including age, sex and multimorbidity level was 56 466. Including socioeconomic factors to this model gave LR-test 46 or relationship with primary care LR-test 850. AIC for a model including sex, age, multimorbidity level, socioeconomic factors and relationships with primary care was 55 587 (Table 13).

Table 13
Model tests for logistic models on hospitalised or not. Population of Blekinge > 15 years of age 2007 (N=123 168), adjusting for age, sex, income, education, active listing, consultations in primary care and multimorbidity level.

Multivariate logistic model tests, Paper IV	**Area under ROC Curve**		**CV**	**AIC**	**LR test**
	AUC	(95% CI)	%		
Age and sex	0.637	(0.632-0.642)	4.9	74 959	0
Adjusted for age and sex					
Individual income and education	0.652	(0.647-0.658)	5.2	74 599	372
Relationships in primary care	0.668	(0.663-0.674)	6.2	73 638	1 331
Multimorbidity level	0.858	(0.855-0.861)	13.7	56 466	18 503
Adjusted for multimorbidity, age and sex					
Individual income and education	0.859	(0.856-0.862)	13.7	56 432	46
Relationships in primary care	0.864	(0.861-0.866)	14.1	55 626	850
Socioeconomy and relationship	0.864	(0.861-0.867)	14.2	55 587	901

N=123 168; AUC = Area Under the Curve; CV = Coefficient of Variance; AIC = Akaike's Information Criterion; LR test = Likelihood Ratio test

Hospitalisation and different measures of relationships with primary care

The final count NB2 model on days hospitalised including listing status showed AIC 130 410. Using number of consultations as measure of relationships with primary care instead showed AIC 130 122. Including both measures of relationships with primary care in the model showed AIC 129 962.

Hospitalisation and changes of the patient-provider relation in primary care

Instead of 68% actively listed, setting share of active listing at 48% increased hospitalisation with 6.6% and at 88% decreased hospitalisation with 2.2%.

Instead of the mean number of consultations in primary care at 0.9 during 2007, setting number of consultations at 0.6 increased hospitalisation that year with 3.1% and setting consultations at 1.2 decreased hospitalisation with 3.0%.

Setting actively listed at 88% and consultations in primary care at 1.2 decreased hospitalisation 9.4% (11 627 days) (Table 14).

Table 14
Estimated changes of total days hospitalised when changing relationships in primary care. Population of Blekinge > 15 years of age in 2007(N=123 168). Estimations from zero-inflated NB2-model on mean hospitalisation, adjusting for age, sex, socioeconomic factors and multimorbidity.

Hospitalisation and simulations, Paper IV	**All** N=123 168	**RUB 0** N=48 211	**RUB 1** N=15 315	**RUB 2** N=25 242	**RUB 3** N=30 566	**RUB 4** N=3 233	**RUB 5** N=601
Unadjusted number of hospital days	123 690	280	5 405	11 149	62 098	29 134	15 622
Simulations							
Active listing							
Actively listed at 48%	140 968	220	6 257	12 376	75 041	31 432	15 642
Actively listed at 68%	132 241	201	5 761	11 386	69 968	29 898	15 027
Actively listed at 88%	124 009	184	5 302	10 472	65 198	28 422	14 431
Consultations							
Mean consultations at 0.6	135 707	210	6 297	12 129	71 430	30 538	15 103
Mean consultations at 0.9	131 685	199	6 011	11 570	68 920	30 009	14 976
Mean consultations at 1.2	127 752	189	5 738	11 034	66 467	29 477	14 847
Relationships							
Actively listed at 48%, consultations at 0.6	143 879	224	6 721	12 944	76 119	32 129	15 742
Actively listed at 68%, consultations at 0.9	130 559	194	5 887	11 320	68 225	29 966	14 967
Actively listed at 88%, consultations at 1.2	118 339	168	5 152	9 890	61 018	27 893	14 218

Unadjusted 68% of the population are activey listed with 0.9 consultations in primary care and 1.1 consultations in other parts of health care; Calculated from mean days hospitalised; RUB = Resource Utilization Bands

Discussion

This is a thesis about relationships between patients and primary care. Choice of primary care provider (listing) and number of consultations could be linked to the strength of relationships between patients and primary care. Active listing was associated with more consultations, high multimorbidity level, older age and being a woman. Most of the contribution of socioeconomic status and geographical factors was lost, when adjusting for multimorbidity, age and sex. Municipality was the geographical factor that contributed most to the models.

Good relationships in primary care were associated with lower odds of hospital admission and few days hospitalised, adjusting for age, sex and multimorbidity. Adding psychiatric disorders prolonged hospitalisation, while the association between good relationship in primary care and shorter hospitalisation became stronger. The same positive association between good relationships in primary care and lower hospitalisation was shown adjusting for socioeconomic status, age, sex and multimorbidity level, and difference between types of primary care practices was established. Extending Paper IV it was shown that using active listing and number of consultations gave similar models on hospitalisation, and that relationships with primary care added more to models on hospitalisation than socioeconomic status. Manipulating data on the relationship with primary care showed a decrease of hospitalisation by improvement of relationships and increase of hospitalisation by impaired relationships.

Active listing in primary care

Active listing as output

Surveys and discrete choice experiments have investigated reported choice of primary care provider in Sweden (30,47). In Blekinge it was shown that individuals with a higher multimorbidity level were more likely to be registered as actively listed a year after introduction of the listing system (48). This thesis confirms that frequent attenders, people with high multimorbidity level, the elderly and women more often are actively listed.

Socioeconomic status and geographical factors affect morbidity and trust; therefore, they were expected to affect active listing. Most of the contribution of socioeconomic status and geographical factors was lost, when adjusting for multimorbidity, age and sex. The remaining association was still statistically significant and showed a positive association between active listing and higher income, shorter education, short distance to primary care or long distance to a hospital. Municipality was the geographical factor that contributed most to the adjusted models when tested.

Number of consultations and multimorbidity level are related and affect listing in primary care similarly.

Associations between hospitalisation and relationships in primary care

Good relationships in primary care, i.e. active listing and more than mean number of consultations, are associated with decreased mean hospitalisation accounting for multimorbidity level, socioeconomic factors, age and sex.

Studies on predictors of high quality primary care have stated that longer consultations and good teamwork are important for quality of care (49,50). This thesis shows that good relationships in primary care are associated with lower odds of hospital admission and shorter hospitalisation. When psychiatric disorders add to patient complexity, hospitalisation is prolonged and the association between good relationship in primary care and shorter hospitalisation stronger.

In a German study, associations between costs of hospitalisation and socioeconomic status were not found for the elderly (51). Others have studied the associations between multimorbidity, social deprivation and hospitalisation and found complex associations, depending on settings (52,53). How data are collected affects the results. A Swedish study investigating hospitalisation using aggregated data concluded that socioeconomic factors were needed to investigate the role of primary care (54). This thesis shows that multimorbidity, active listing and consultations in primary care affect mean days hospitalised more than socioeconomic status and implies that location could be of importance.

Studies on larger populations, like countries, tend to show significant benefits of primary care, and there is evidence of regional and local variation in quality of care (55). Studies on predictors of high quality primary care have stated that longer consultations and good teamwork are important for quality of care, and also that no single type of practice has a monopoly on high quality care (50,56). This thesis confirms that more consultations in primary care lower mean number of days hospitalised. There is a difference between groups of primary care practices in mean days hospitalised, possibly explained by several factors separating the groups, indicating a potential to improve capability of primary care to minimise hospitalisation by modified settings and processes.

The relationship between patients and primary care

The impact of a good relationship with primary care on health and health care use

Individuals benefit from a good relationship with primary care. As shown in Papers I-II, the elderly, women and those with higher multimorbidity level and more consultations in primary care are more likely to be actively listed. Geographical location was shown to explain more of active listing than income, education and distances to health care. As shown in Papers III-IV old age and high multimorbidity level affected hospitalisation most.

Active listing and more than mean number of consultations were shown to be associated with decrease in mean hospital days, more for those at higher age and with more of multimorbidity burden. Persons with increased patient complexity, including psychiatric disorder, decrease hospitalisation significantly more when having good relationships with primary care, compared to persons at the same multimorbidity level.

The relationship between primary care and health care

Building trust in health care

Trust in healthcare systems is built where patients and health workers meet. Primary care serves as the entrance to healthcare systems meeting unselected illness. Even in a country like Sweden, with a weak primary care and low share of GPs, almost half of the consultations are registered in primary care. Primary care builds trust in health care.

Hospitalisation as an outcome of primary care

The analysis of non-linear networks is the analysis of interrelationships amongst their parts. Hospitalisation is affected by settings, processes and performance in primary care, as well as of other parts of health care. Hospitalisation is a measure of effectiveness and quality of primary care. The size of the impact of relationships in primary care is dependent on patient complexity like ageing, socioeconomic factors, discordant conditions and high multimorbidity level. When patients become more complex, performance of primary care affects mean hospitalisation more at individual level.

At population level, the relationships between primary care and patients with moderate multimorbidity contribute more to total days hospitalised than the relationships with more complex patients. Patients in RUB 3 contribute with half of the days hospitalised in this population.

The logit part of the zero-inflated negative binomial regressions of Papers III-IV shows that primary care affects hospitalisation mainly by reducing risk of hospitalisation. Performance in primary care differed with 49% according to risk of hospitalisation while mean days hospitalised differed 0.24 days, while with regard to secondary care the performance and organisation of the hospital will influence length of hospitalisation and the decision to hospitalise.

The impact of increased patient complexity, like psychiatric disorders

Introducing psychiatric disorders was used to investigate the importance of primary care when handling increasing patient complexity. The associations with hospitalisation differ according to type of psychiatric disorder, although small numbers made multivariate statistics including subgrouped psychiatric disorder unjustifiable. Patients with psychiatric disorder have a multimorbidity level of at least RUB 2, and most of them are found in RUB 3. Comparing patients with and without psychiatric disorder within the same multimorbidity level showed a considerate increase in hospitalisation when psychiatric disorder contributes to the level of morbidity burden.

Relationships in primary care lower need for hospitalisation for patients with psychiatric disorders as well as for patients without. Adding patient complexity, both active listing and more consultations in primary care follow the same pattern in decreasing need for hospitalisation. While the level of hospitalisation increases several times by adding patient complexity, a good relationship with primary care remains protective.

Primary care as an option to affect hospitalisation

Difference in performance within primary care was established by comparing two types of primary care practices. This thesis does not analyse what causes this difference. The difference per se means that acting on settings and processes of primary care practices could affect hospitalisation. Both measures of relationships in primary care are associated with mean hospitalisation. Good relationships in primary care are associated with decreased hospitalisation, especially when patients have conditions with non-synergistic management strategies. Since half of the total hospitalisation comprised persons in RUB 3, this is where to improve primary care performance to affect total hospitalisation.

Setting the relationships in primary care at different levels, the theoretical impact on hospitalisation was investigated. Improving active listing and number of consultations in primary care both decrease hospitalisation for all levels of multimorbidity, and they have synergistic effects. Increasing the share of active listing to 88%, slightly above the actual share of listed in one of the municipalities (85.5%), and increasing number of consultations in primary care to 1.2 a year (slightly more than actual consultations in other parts of health care) would theoretically decrease total hospitalisation by 9.4% (11 627 days), corresponding to almost 40% of primary care funding in 2007). The effect of improved primary care could not be tested, but the established difference within primary care implicates that this would add to decrease hospitalisation. Well performing primary care could be an option to reduce hospitalisation, especially for patients with more of patient complexity.

Strengths and limitations

The setting of this thesis is a Swedish county, with a quite simply organised health care, a large enough population, and a listing system that is still valid. Health care of Blekinge is organised and financed by the County Council. Primary care practices are connected by the listing system. The hospitals are connected by a common board. With a population of 150 000 inhabitants, most multivariate analyses could be performed on the population of Blekinge. The listing system is comparable to contemporary Swedish primary care and the legislation from 2010 (44). Year 2007 is a strategic choice. If data had been collected more recently, the interpretation of listing status might have changed. The associations between relationships in primary care and hospitalisation could have been more affected by processes of adaptation to the legislation of listing systems in 2010 and increasing lack of continuity in primary care.

Patient-professional relationships and consultations are core features of primary care, not depending on individual disorders. Active listing could be regarded as patients acting to maintain their relationship with primary care, and number of consultations as required and negotiated appointments. Thus, both could be regarded as measures of different aspects of the relationship between the population and primary care. To interpret number of consultations as an aspect of patient-professional relationships, adjusting for multimorbidity was necessary.

Listing status was unlikely to be changed from active to passive during year 2007 according to listing regulations. Most actively listed choose to stay listed at the nearest primary care practice. Active listing underestimates good relationships with primary care, since passive listing at the practice of choice would be sufficient to maintain the relationship. Some were content with the passive choice made for them, and a patient-professional relationship that was not protected. Whether or not patients act to protect this relationship could be influenced by other circumstances such as factors related to social capital and local health care.

The listing system was constructed to distribute funding on a primary care practice level. Data on active listing were reliable at practice level. The option to choose GP was used to handle vacancies within practices creating unreliable data on active listing on GPs. Reliable data on consultations were only available for GPs, and active listing on practices which limited our analyses. Private practices established before 2004 had the opportunity to register only actively listed, with all prior patients actively listed. In 2007 only a minority of their healthy patients would not have had the opportunity to correct this.

This thesis could benefit from the unique possibility of combining individual register-based data from different data sources in Sweden. Socioeconomic and geographical data were collected from Statistics Sweden for Papers II and IV and merged with the data from patient records from Blekinge County Council. Statistics Sweden restricted use of some data from patient records limiting the analyses, mainly of associations between socioeconomic factors and individual diseases, and comparing municipalities and primary care practices.

For the population over 15 years of age, it was possible to analyse socioeconomic and geographical factors while adjusting for multimorbidity. For active listing as well as hospitalisation it was shown that multimorbidity level added more to the models than socioeconomic factors. A summary measure of multimorbidity regarding the coexistence of many different illnesses and types of illnesses was preferred to measure morbidity burden.

Psychiatric disorders were chosen to add patient complexity. Low prevalence of psychiatric disorders, especially psychoses, prevented detailed multivariate analyses of differences between categories of psychiatric disorders. Hospitalisation was summarised as days hospitalised (somatic and psychiatric care), without data on cause of hospitalisation or individual admissions. Using ACG to get multimorbidity level in RUBs gave the opportunity to analyse the contribution of psychiatric disorders adjusting for multimorbidity level.

In Sweden, listing was introduced in primary care to empower patients and to introduce market models by allowing the population to choose primary care provider. Since county councils regulate and organise local health care there is no national primary care system. Swedish primary care is known to be weak compared to most European primary care (57-59). Generalisation of our findings depends on analyses of strength of primary care, and similarities between healthcare organisations and listing systems. Then our findings are generalisable to other primary care systems allowing patients to choose primary care practice across practice boundaries.

The use of statistical methods allows for studies on associations. Neither logistic regression nor binomial regression allows for studies on causality. Qualitative methods would be needed to build hypothesis and mixed methods to investigate how patients and professionals in health care perceive their relationships.

Conclusions

A good relationship with primary care matters to patients

Elderly, women and individuals with higher level of multimorbidity or more consultations in primary care show that by higher share of active listing, as expected from previous studies on reported data.

Good relationship with primary care decreases the need for hospitalisation, taking multimorbidity and socioeconomic factors into account.

Patients with more patient complexity, e.g. patients with psychiatric disorders have more to gain from a good relationship with primary care than less complicated patients with the same level of multimorbidity.

Patients having good relationships with primary care matter to health care

A good relationship with primary care is associated with lowering mean days hospitalised.

Total days hospitalised are more affected by good relationships with primary care in the case of persons with moderate need of health care than in the case of persons with very high need of care.

Primary care matters to health care

Relationships in primary care affect hospitalisation since health care is a complex network with relations as core transactions.

Primary care matters more when health care handles complexity and discordant conditions, as shown when adding patient complexity.

Improving primary care to improve patient-provider relationships is an option to lower need for hospitalisation, especially for more complex patients.

Implications for patients and health care

Primary care and patient-provider relationships in primary care are important to both patients and health care, but implications to the individual differ from that of the population. The point of view depends on the purpose. This thesis emphasises the importance of primary care and relationships in health care.

Respectful treatment is central, with trust as a key factor, in the relationship between patients and health workers in primary care as well as within the complex network of health care. Improving performance of primary care is an option to improve health outcomes for patients as well as costs in other parts of health care.

Performance of primary care depends on settings and processes. A well performing primary care characterised by a combination of person-focused care over time, use as first contact in health care, completeness of services and coordination of care improve individual health as well as need for other parts of health care. Improving performance in primary care has the option to improve health and need for other parts of health care, more so in the case of more complex patients than in the case of less complex patients.

Psychiatric disorders add to multimorbidity level and patient compexity within the same multimorbidity level. Higher patient complexity and multimorbidity level increase hospitalisation, as well as the impact of good relationships with primary care at individual level. At population level, good relationships with primary care for persons with moderate need for health care are more important to decrease hospitalisation.

Morbidity burden and socioeconomic factors are correlated at individual level and unevenly spread within populations and locations. Data on individual level should be preferred to aggregate data. When data on multimorbidity are available, the contribution of adding socioeconomic factors could be minor.

Future research

The causalities of the associations found in this thesis need further research using combinations of qualitative and quantitative methods. Theory from different fields, e.g. medicine, psychology, economics and organisational research, needs to be merged to find and test hypothesis on the role of relationships in health care.

Research on management of disorders needs to acknowledge health care as a complex network handling both the linearity of patients with a single disorder, and non-linearity of complex and chaotic patients with concordant or discordant multimorbidity.

The role of trust to individual health has been studied. An effect of good relationships in health care on individual health is expected from those studies, but not investigated yet. For example, could active listing in primary care be associated with death rates the subsequent years, taking age and multimorbidity into account.

It was not within the scope of this thesis to investigate how to improve settings in primary care to increase trust and relationships in primary care. But to benefit from the established differences in performance within primary care this needs to be done.

Healthcare costs could benefit from the ability of primary care to handle patient complexity. Analysing costs was not within the scope of this thesis. Microeconometric methods could be used to stratify costs on different parts of healthcare systems to analyse how to use assets effectively, including both monetary and social capital.

Svensk sammanfattning

Primärvården är grunden för alla sjukvårdssystem. Om sjukvårdens organisation beskrivs som ett komplext nätverk blir analys av de relationer som finns inom vården och patienters relationer med vårdgivare av centralt intresse. Aktiv listning och antal besök kan betraktas som mått på relationen mellan patienter och vårdgivare i primärvården. Sjukhusvård kan analyseras som utfallsmått av primärvård. Det här är en avhandling om relationer mellan patienter och primärvård, och om hur de påverkar andra delar av sjukvården.

Studierna i avhandlingen är tvärsnittsstudier av befolkningen i Blekinge 2007. Data kommer från patientjournaler och i delstudie II och IV kompletterat med data från Statistiska Centralbyrån. Utfallet i delstudie I-II var aktiv listning och i delstudie III-IV risk för sjukhusvård och medelvårddagar. I delstudie I-II användes logistisk regression och i delstudie III-IV negativ binomial regression för de statistiska analyserna. Studierna sammanfattas i tabell 1 och 4-5.

Blekinge hade 151 731 invånare 31/12 2007. Befolkningen var något äldre (42.7 år) med något fler män (50.5%) jämfört med hela Sverige (41 år och 49.7%) (45). I medeltal gjordes 2,0 läkarbesök, varav 0,9 i primärvården, och 98 600 var aktivt listade. 13 122 hade vårdats på sjukhus i sammanlagt 135 297 dagar. Medelvårddagar var 0,89 för hela befolkningen. Socioekonomiska faktorer saknades för den del av befolkningen som var under 16 år. Därför gjordes de beräkningar som innefattade uppgifter från Statistiska Centralbyrån på befolkningen över 15 år med fullständiga uppgifter (N=123 168). Populationerna beskrivs i tabell 2-3.

Syftet med avhandlingens första del var att beskriva aktiv listning och associationen med ålder, kön, multisjuklighet, socioekonomiska och geografiska faktorer. Den andra delen studerade hur relationen mellan patienter och vårdgivare i primärvården påverkade behovet av sjukhusvård, med hänsyn tagen till ålder, kön, multisjuklighet och socioekonomiska faktorer. Den studerar också hur behovet av sjukhusvård påverkas om vården utmanas av ökad patientkomplexitet och undersöker om det finns skillnader i behovet av sjukhusvård inom primärvården.

Aktiv listning, beskrivande (delstudie I)

Viljan att välja vårdgivare i primärvård har beskrivits tidigare i svenska och internationella studier. De visar att intentionen att välja är associerad till ålder, kön, avstånd och sjukdomsbörda. Patientnöjdhet och anknytning till primärvård har också visats påverka val av vårdgivare i primärvård.

Studien bekräftar att äldre, kvinnor och sjuka i högre grad aktivt har valt vårdgivare i en population som erbjuds listning i primärvård. Studien visar också att associationen med aktiv listning är liknande för multisjuklighet och antal läkarbesök och att data från primärvården förklarar mer än data från hela sjukvården. De olika modellerna kan förutsäga ungefär 70% av de aktiva valen korrekt.

Aktiv listning, socioekonomiska och geografiska faktorer, med hänsyn tagen till multisjuklighet, ålder och kön (delstudie II)

Det finns ett välkänt samband mellan socioekonomiska faktorer, geografiska faktorer, sjukvårdsanvändning och hälsa. För patienter är val av vårdgivare ett komplext val knutet till tillit. Låg tillit är kopplat till bristande tilltro till att kunna påverka sin egen hälsa. Upplevd tillgänglighet till vård har knutits till både geografiskt område och socialt kapital. Både multisjuklighet och tillit har knutits till socioekonomiskt status och geografiska faktorer.

Högre inkomst, kort utbildning, kort avstånd till närmaste vårdcentral och långt avstånd till sjukhus var associerade till aktiv listning. Det som betydde mest för aktiv listning i studien var dock multisjuklighet, ålder, geografiskt område och typ av vårdcentral.

Sjukhusvård och ökad patientkomplexitet (delstudie III)

Sjukhusvård ökar vid allvarlig sjukdom och minskar om den öppna vården fungerar väl. Psykisk sjukdom bidrar till multisjuklighet, ökar risken för vanliga somatiska sjukdomar och ökar patientkomplexiteten. För både patienter och sjukvård är det svårare att hantera sjukdomar med konkurrerande behandlingsstrategier än sjukdomar med likartade behandlingsstrategier. När multisjuklighet innefattar psykisk sjukdom försämras hälsan och sjukvården utmanas.

Studien visade att aktivt listade och personer med minst två läkarbesök i primärvård hade färre medelvårddagar än passivt listade och med mindre än två läkarbesök i primärvård med hänsyn taget till multisjuklighet, ålder och kön.

Diagnosticerad psykisk sjukdom ökade medelvårdtiden jämfört med personer med samma grad av multisjuklighet. För personer med medelbehov av sjukvård (RUB 3) var aktivt listade i medeltal sjukhusvårdade 3,45 (95%CI 2,84-4,07) dagar vid psykisk sjukdom och 1,64 (95%CI 1,50-1,77) dagar för psykiskt friska. För passivt listade med samma sjukvårdsbehov var medelvårdtiden 5,17 (95%CI 4,36-5,98) dagar vid psykisk sjukdom och 2,41 (95%CI 2,22-2,60) dagar för psykiskt friska.

Sjukhusvård och skillnader inom primärvården med hänsyn tagen till socioekonomiska faktorer (delstudie IV)

Socioekonomiska faktorer påverkar både individens hälsa, sjukvårdsutnyttjande och tillit till sjukvården. Internationell forskning har visat att välfungerande primärvård karaktäriseras av en kombination av personfokus över tid, första kontakt i vården, omfattande utbud och koordination av vård. Om sjukvårdens organisation beskrivs som ett komplext nätverk blir relationer inom vården och mellan vårdgivare och patienter av centralt intresse. Aktiv listning och antal besök kan betraktas som mått på relationen mellan patienter och vårdgivare i primärvården. Organisation, ekonomi och andra förutsättningar påverkar primärvårdens vårdprocesser och därmed utfall som kvalitet, effektivitet och jämlik vård. Sjukhusvård kan analyseras som mått på primärvårdens kvalitet och effektivitet.

Studien visade att relationen mellan patienter och primärvård hade samma association till behovet av sjukhusvård när hänsyn togs till både multisjuklighet och socioekonomiska faktorer. Studien visade också att det fanns skillnader inom primärvården i jämförelsen mellan två typer av vårdcentraler. Skillnaden i odds för inläggning på sjukhus var 49%, och medelvårddagar 0,98 respektive 1,22 dagar.

Diskussion

Avhandlingen visar att aktiv listning är associerad med antal läkarbesök i primärvård, multisjuklighet, ålder och kön. Multisjuklighet, ålder, geografiskt område och typ av primärvård förklarar mer av aktiv listning än socioekonomi och avstånd till sjukvård.

Avhandlingen visar också att aktivt listade, och de med mer än ett läkarbesök i primärvård har mindre vårddagar än befolkningens medelvårddagar (0,9 dagar) medan passivt listade och de med 0-1 läkarbesök i primärvården har fler vårddagar i medeltal, om hänsyn tas till ålder, kön, sociala faktorer och multisjuklighet. Ökad patientkompexitet i form av psykisk sjukdom ökar medelvårddagar påtagligt också inom samma grad av multisjuklighet samtidigt som associationen mellan en god relation till primärvården och minskat behov av sjukhusvård kvarstår. Det finns skillnader inom primärvården i behovet av sjukhusvård. Odds för sjukhusvård skiljer 49% och medelvårdtiden 0,24 dagar mellan de olika typerna av vårdcentraler.

Nyhetsvärde

Den här avhandlingen bygger på teorier från skilda forskningsområden. Val av vårdgivare analyseras som ett komplext val med okända faktorer. Sjukvårdssystem analyseras som komplexa nätverk vilket ger relationer central betydelse och primärvården som ett vårdsystem vilket gör att sjukhusvård kan analyseras som utfall av primärvård. Registerdata används som mått på patient-vårdarrelationer i primärvården.

Avhandlingen består av populationsstudier som kombinerar faktorer kända för att påverka hälsa och behov av sjukhusvård. Nyare statistiska modeller används som kan hantera få sjukhusvårdade och få medelvårddagar.

En god relation till primärvården visas vara associerad med färre medelvårddagar och lägre odds för sjukhusinläggning. Primärvårdens ökade betydelse vid ökad patientkomplexitet visas liksom skillnader mellan den enskilde och befolkningen, och betydelsen av skillnader inom primärvården.

Slutsatser

Aktiv listning i primärvård förklaras mer av multisjuklighet, ålder, kön och lokala faktorer än socioekonomiska faktorer och avstånd till sjukvård.

Goda relationer mellan befolkning och primärvård är associerade med mindre behov av vård på sjukhus, mest uttalat när vården hanterar mer komplexa patienter.

Behov av sjukhusvård kan påverkas genom att påverka primärvårdens förutsättningar. Förbättrade förutsättningar för primärvården skulle kunna vara ett sätt att minska behov av sjukhusvård.

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Paper I

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ORIGINAL ARTICLE

Importance of healthcare utilization and multimorbidity level in choosing a primary care provider in Sweden

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Abstract

Objective. To study the associations between active choice of primary care provider and healthcare utilization, multimorbidity, age, and sex, comparing data from primary care and all healthcare in a Swedish population. *Design.* Descriptive cross-sectional study using descriptive analyses including t-test, correlations, and logistic regression modelling in four separate models. *Setting and subjects.* The population (151 731) and all healthcare in Blekinge in 2007. *Main outcome measure.* Actively or passively listed in primary care, registered on 31 December 2007. *Results.* Number of consultations (OR 1.31, 95% CI 1.30–1.32), multimorbidity level (OR 1.69, 95% CI 1.67–1.70), age (OR 1.03, 95% CI 1.03–1.03), and sex (OR for men 0.67, 95% CI 0.65–0.68) were all associated with registered active listing in primary care. Active listing was more strongly associated with number of consultations and multimorbidity level using primary care data (OR 2.11, 95% CI 2.08–2.15 and OR 2.14, 95% CI 2.11–2.17, respectively) than using data from all healthcare. Number of consultations and multimorbidity level were correlated and had similar associations with active listing in primary care. Modelling number of consultations, multimorbidity level, age, and sex gave four separate models with about 70% explanatory power for active listing in primary care. Combining number of consultations and multimorbidity did not improve the models. *Conclusions.* Number of consultations and multimorbidity level were associated with active listing in primary care. These factors were also associated with each other differently in primary care than in all healthcare. More complex models including non-health-related individual characteristics and healthcare-related factors are needed to increase explanatory power.

Key Words: *Choice behaviour, general practice, health-related characteristics, healthcare utilization, multimorbidity, primary care, Sweden*

Introduction

The importance of primary care increases when the focus in healthcare changes from patients with single illnesses to persons with complex health problems. Within populations good relations between patients and primary care contribute to more adequate care, trust, and better health [1,2]. It has been shown that strategies to encourage patient–doctor relations increase availability of care and also the risk of individuals not feeling the need for continuous relations in primary care receiving insufficient care. Continuity is particularly valued for more serious and psychological problems [3–6]. When asked, a majority of participants in Swedish surveys wanted to choose their primary care provider [7].

Choices in healthcare are affected by a variety of factors related to both individuals and healthcare [8]. How patients relate to primary care is linked to choice of primary care provider [9–14]. Differences in individual preferences and options can be explained using trust and other constructs related to theories on social capital [15]. According to theories on decision-making, choice behaviour in healthcare is complex, due to either not using all information available or not having enough information [16].

In Sweden, healthcare is managed by county councils, financed by taxation, and with low co-payment for health services. Primary care is organized in group practices with general practitioners (GP) and multidisciplinary teams. Choice of primary care provider (listing) was introduced as a concept of patient empowerment, mandatory since 2010 [17]. In Blekinge, a county in south-eastern Sweden, listing was introduced in primary care in 2004. Passive

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Active listing in primary care has implications for individual health as well as healthcare systems.

- Frequent attenders, patients with a high multimorbidity level, women, and the elderly choose the primary care provider more often than expected.
- The association of number of consultations and multimorbidity level with active listing in primary care is stronger when using only primary care data.
- Number of consultations and multimorbidity level has about 70% explanatory power for active listing in primary care.

listing with a nearby clinic was registered, until active listing was registered by the individual.

Listing is part of the structure that affects processes and outcomes of primary care systems. Primary care providers work with patient lists formed by repeated individual choices. Robust knowledge regarding these choices is needed to improve primary care systems. Most previous studies are based on reported data, not focusing on choice behaviour. We use patient records from primary care and all healthcare in a population, comparing the explanatory power of number of consultations and multimorbidity level in four models. This study contributes by linking choice behaviour and individual characteristics, comparing primary care with all healthcare. The aim is to explore the associations of healthcare utilization, multimorbidity level, age, and sex with active listing in primary care, comparing data from primary care with data from all healthcare.

Material and Methods

Study Population and Design

In 2007, Blekinge had 151 731 inhabitants. The average age was slightly higher (42.7 years) and there were more males (50.5%) compared with all of Sweden (41 years and 49.7%) [18]. All healthcare, including two hospitals and five psychiatric clinics, was funded by the county council. Primary care (90 GPs) comprised 12 public and 13 private clinics. Listing in primary care was introduced in 2004. Funding, allocated at clinic level, favoured listing with clinic rather than GP. Passive listing was registered with a nearby clinic, until changed to active by the individual. Active listing could be changed monthly, and children followed their mother's choice.

Data on healthcare utilization and morbidity were collected from electronic patient records, not available from all private providers. This study was approved by the Regional Ethical Review Board at Lund University (application no. 2010/314). The alternative of not participating was possible, but was not used by any in the study population.

Outcome and Explanatory Factors

Outcome was registered active or passive listing in primary care on 31 December 2007. Listing with individual GP was not analysed.

Healthcare utilization was measured as number of consultations with a physician (categorized into 0–1, 2–3, 4–5, 6–7, 8–9 and >9) during 2007. Multimorbidity level was measured from patient records for 2007 using the Johns Hopkins Adjusted Clinical Groups Case Mix System (ACG), a summary measure of morbidity burden. All individuals were assigned to one of six levels called resource utilization bands (RUBs), ranging from 0 (no need of healthcare services) to 5 (very strong need of healthcare services) [19–22]. Number of consultations and multimorbidity level were analysed separately for primary care and all healthcare, including primary care as well as secondary somatic and psychiatric care. Due to different electronic patient record systems, individual data on number of consultations and morbidity in private primary care were not reliable, hence not used to compare primary care and all healthcare. Age and sex were used as complementary factors in all models, age in 20-year strata.

Statistical Analysis

Descriptive analyses including t-test, correlations, and logistic regression modelling using Akaike's Information Criterion (AIC) for model comparison were performed with STATA version 13.0 (Stata Corporation, Texas, USA). The population of Blekinge (151 731) was used when complete data were available. Private and public primary care was compared using available data on age and sex. Four separate models for number of consultations and multimorbidity level were used, when data from primary care were compared with all healthcare. Two models with number of consultations, multimorbidity level including interaction, age, and sex were then used to explore interaction.

Results

Blekinge county had 151 731 inhabitants on 31 December 2007. All were passively or actively listed

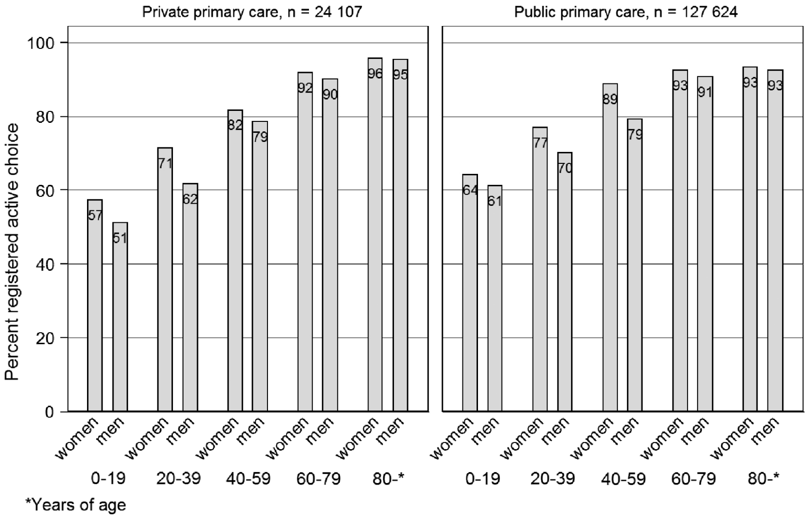

Figure 1. Percentage of the population in Blekinge (n = 151 731) with a registered active choice of primary care provider in 2007 for individuals listed with private or public primary care.

in primary care, 127 624 with public and 24 107 with private primary care. A total of 98 600 (53% women, 47% men) were actively listed with a primary care clinic and 60 921 of them also chose a personal GP. A total of 63.2% of those listed with public primary care and 74.5% of those listed with private primary care were actively listed. Elderly patients were more frequently actively listed than younger patients

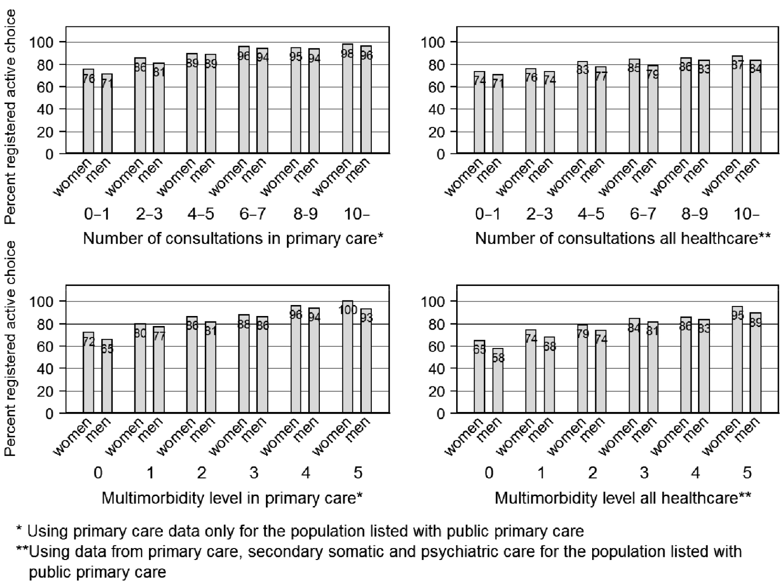

Figure 2. Percentage of the population with a registered active choice of primary care provider in 2007 according to number of consultations and multimorbidity level, comparing primary care and all healthcare for the population listed with public primary care in Blekinge (n = 127 624).

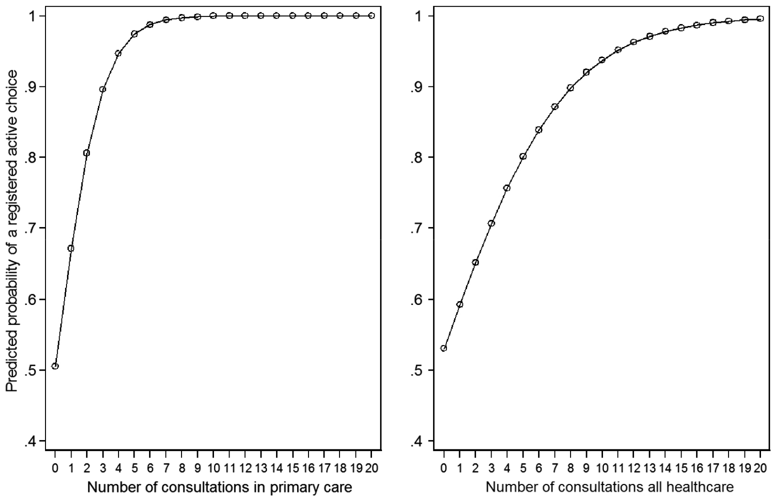

Figure 3. Predicted probability of a registered active choice of primary care provider according to number of consultations in primary care and all healthcare, controlling for age and sex, in the population listed with public primary care (n = 127 624) in Blekinge 2007.

(OR 1.03, 95% CI 1.03–1.03), in both public and private primary care (Figure 1). Individuals with many consultations (OR 1.31, 95% CI 1.30–1.32) or a high multimorbidity level (OR 1.69, 95% CI 1.67–1.70) in all healthcare were more likely to be actively listed (Figure 2). Individuals actively listed were on average 14 years older, had 40 % more consultations and 30% higher multimorbidity level and were more likely to be female than those passively listed (each difference $p < 0.001$).

For those listed with public primary care, number of consultations had a stronger association in primary care (OR 2.11 for continuous factor, 95% CI 2.08–2.15) with active listing than in all healthcare (OR 1.31, 95% CI 1.30-1.32), adjusting for age and sex. Predicted probability of active listing was increasing

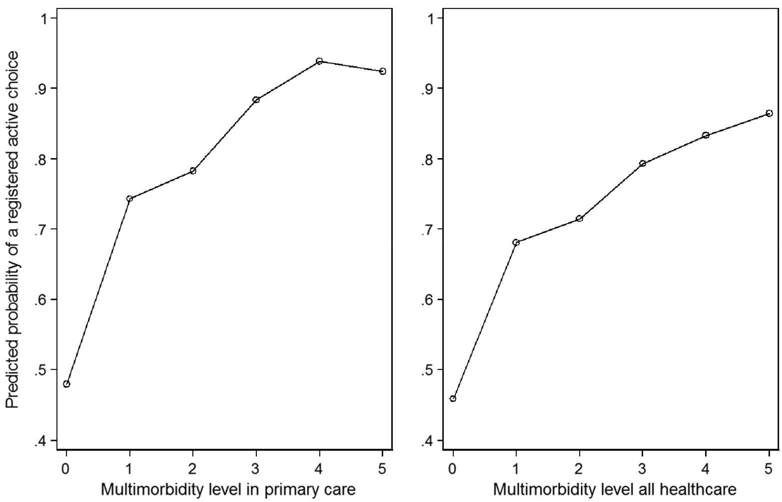

Figure 4. Predicted probability of a registered active choice of primary care provider according to multimorbidity level measured in primary care and all healthcare, controlling for age and sex, in the population listed with public primary care (n = 127 624) in Blekinge 2007.

Table I. Modelling multimorbidity and number of consultations, controlling for age and sex, on active listing with public primary care in Blekinge 2007 (n = 127 624), comparing data from primary care and all healthcare.

	Model estimates			Model classification		
		Log likelihood	Model comparison		Predictive values %	
Model description	Pseudo R-squared	Chi^2 test	AIC	Correctly classified %	Pos.	Neg.
1: Number of consultations, primary care	0.1298	−73069.26 $p < 0.001$	146160.5	67.55	74.39	55.90
2: Number of consultations, all healthcare	0.1196	−73925.95 $p < 0.001$	147873.9	67.88	72.01	57.98
3: Multimorbidity, primary care	0.1599	−70544.43 $p < 0.001$	141110.9	71.16	75.85	61.88
4: Multimorbidity, all healthcare	0.1345	−72669.77 $p < 0.001$	145361.5	69.92	73.49	61.41
5: 1(continuous) + 3 with interaction, primary care	0.1665	−69986.82 $p < 0.001$	140007.6	71.16	75.85	61.88
6: 2(continuous) + 4 with interaction, all healthcare	0.1392	−72280.87 $p < 0.001$	144595.7	70.01	72.34	63.29

most for the first 10 consultations then tapered off, in primary care as well as all healthcare (Figure 3).

For being listed with public primary care the overall association of multimorbidity in primary care (OR 2.14, 95% CI 2.11–2.17) had a stronger association with active listing than multimorbidity in all healthcare (OR 1.70, 95% CI 1.69–1.72), adjusting for age and sex. Multimorbidity level predicted active listing, significantly ($p < 0.001$) increasing for RUB 0-4, both in primary care and all healthcare (Figure 4).

The correlation between multimorbidity level and number of consultations, in six categories, was 62% in primary care and 68% in all healthcare. Comparing primary care and all healthcare, categorized consultations had a 72% correlation and multimorbidity level a 77% correlation.

The four separate models, including number of consultations, and multimorbidity level using data from primary care and all healthcare, gave similar predictive power of about 70% to correct classification of listing in primary care. Models including both number of consultations and multimorbidity level did not improve the results (Table I).

Discussion

Our aim was to explore the associations of healthcare utilization, multimorbidity, and active listing in primary care. We found that both number of consultations and multimorbidity level predicted registered listing in primary care, which had not been shown in a Swedish population before. Number of consultations and multimorbidity level were related and their predictions were similar.

It was confirmed that individual factors, such as healthcare utilization, multimorbidity level, age, and sex not only influenced patient attitudes towards continuity, but also predicted choice of primary care [23,24]. Number of consultations and multimorbidity level had a similar association with listing in primary care, stronger when only using primary care data. As expected, the correlations between number of consultations and multimorbidity level indicated common latent factors. In primary care those correlations were weaker, indicating that the latent factors worked differently in primary care than in all healthcare.

Modelling the associations of number of consultations, multimorbidity level, and listing in primary care, adjusting for age and sex, gave four separate models with similar explanatory power. Considering that active listing in primary care is a complex choice affected by both individual factors and healthcare system factors, it is expected that these models need to include more individual characteristics and factors related to healthcare in order to increase their explanatory power and precision.

In Sweden, data from health registers could be used to link choice behaviour and individual characteristics. Reliable data and an understandable listing system were available for the population of Blekinge. The listing system was almost the same as the mandatory listing system legislated in 2010 and allowed generalization within a Swedish context [25]. Some bias in registered listing remained since 2004. In public primary care established patient–-doctor continuity was protected by assigning an active listing with that GP, including clinic. Patients (6581) with the same choice in 2007 were treated as actively listed. Some private primary care clinics (8498 listed) were allowed to list all patients with previous consultations as actively listed, regardless of established patient continuity, which was noticed when healthcare was needed. All patients registered in private primary care were excluded when comparing primary care with all healthcare due to missing data.

Recent Swedish surveys have investigated reported choice of primary care provider. Glenngård et al. reported (response rate 50%, bias towards high educational level and high self-rated health) choice of primary care clinics as 61% with proportions differing with regard to age, municipality, and occupation, but not with regard to self-reported health status, sex, living conditions, county, or education [23]. In a discrete choice experiment, with response rate 58%, Hjelmgren and Anell found that older individuals and individuals in poor health preferred a GP, and individuals working or living at a greater distance from a hospital preferred a primary care team [24]. We confirmed that individual health-related factors were related to active listing in primary care.

Zielinski et al. studied the passively listed population, when a clinic was established in Blekinge in 2005. One year later, older individuals and those with a higher multimorbidity level were more likely to be registered as actively listed [26]. We confirmed that frequent attenders, people with high multimorbidity level, the elderly, and women more often were actively listed.

Both number of consultations and multimorbidity level are related to morbidity burden and the wider concept of patient complexity [27]. We showed that they are related constructs, working differently in primary care than in all healthcare, similarly affecting listing in primary care.

Conclusions and Perspectives

Number of consultations, multimorbidity level, age, and sex were associated with active choice of primary care provider, as expected from surveys.

Listing in primary care had a stronger association with number of consultations and multimorbidity level using primary care data than using data from all healthcare. Number of consultations and multimorbidity level were correlated. Their different relations in primary care and all healthcare remain to be investigated.

Modelling number of consultations and multimorbidity level gave four separate models with similar explanatory power for active listing in primary care. More complex models are needed to increase the explanatory power and precision.

Including individual characteristics such as socioeconomics, geography, and social capital in the models should be explored. The latent factors underlying the observed correlation between number of consultations and multimorbidity level should also be explored using structural equation modelling, and the different correlations in primary care and all healthcare fully investigated. Choices of primary care provider ought to be studied according to theories on complex choices and with constructs like patient satisfaction, trust, and attachment. The influence of characteristics of different primary care clinics also needs to be further investigated.

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Declaration of interest

The authors report no conflict of interest. The authors alone are responsible for the content and writing of the paper.

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Paper II

BMJ Open

Socioeconomic status and geographical factors associated with active listing in primary care: a cross-sectional population study accounting for multimorbidity, age, sex and primary care

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ABSTRACT

Background Socioeconomic status and geographical factors are associated with health and use of healthcare. Well-performing primary care contributes to better health and more adequate healthcare. In a primary care system based on patient's choice of practice, this choice (listing) is a key to understand the system.

Objective To explore the relationship between population and practices in a primary care system based on listing.

Methods Cross-sectional population-based study. Logistic regressions of the associations between active listing in primary care, income, education, distances to healthcare and geographical location, adjusting for multimorbidity, age, sex and type of primary care practice.

Setting and subjects Population over 15 years (n=123 168) in a Swedish county, Blekinge (151 731 inhabitants), in year 2007, actively or passively listed in primary care. The proportion of actively listed was 68%.

Main outcome measure Actively listed in primary care on 31 December 2007.

Results Highest ORs for active listing in the model including all factors according to income had quartile two and three with OR 0.70 (95% CI 0.69 to 0.70), and those according to education less than 9 years of education had OR 0.70 (95% CI 0.68 to 0.70). Best odds for geographical factors in the same model had municipality C with OR 0.85 (95% CI 0.85 to 0.86) for active listing. Akaike's Information Criterion (AIC) was 124 801 for a model including municipality, multimorbidity, age, sex and type of practice and including all factors gave AIC 123 934.

Conclusions Higher income, shorter education, shorter distance to primary care or longer distance to hospital is associated with active listing in primary care. Multimorbidity, age, geographical location and type of primary care practice are more important to active listing in primary care than socioeconomic status and distance to healthcare.

Strengths and limitations of this study

- ► Cross-sectional study combining individual factors from different data sources for the population of a small Swedish county (N=151 731 inhabitants).
- ► The study county had a relatively simply organised healthcare system and a listing system comparable to contemporary Swedish primary care.
- ► Active listing, reflecting the relationship between patients and primary care practices, underestimated this relationship since passive listing at the practice of choice would be sufficient.
- ► It was within the aim of this paper to investigate associations with active listing according to studied factors, not causality.

INTRODUCTION

Importance of primary care increases as healthcare focuses more on complex health problems than on single diagnoses. Good relations between individuals in a population and well-performing primary care contribute to better health and a healthcare system that is more adequate.[1 2] Patient satisfaction and attachment to primary care affect the choice of primary care practices.[3–7]

To patients, active listing is a complex choice,[8] linked to trust. In the theory on social capital, trust is a key factor at the individual level.[9] Low levels of trust and social participation are positively associated with lack of belief in the possibility to influence one's own health.[10] When analysing self-reported lack of access to a regular doctor, it is suggested that both healthcare district and social capital contribute to the perceived lack of access.[3] Individuals with low institutional trust in the healthcare system have poor self-perceived health that might be partly mediated by care-seeking behaviour.[11] Both multimorbidity and trust are connected to socioeconomic status and geographical factors.[11–13]

In Sweden, primary care practices composed of general practitioners (GPs) organised within multidisciplinary teams.[14] County councils finance and regulate local healthcare, organising primary care into quasi-market models, which have been mandatory since 2010.[15 16] In 2004, the County of Blekinge introduced listing (choice of practice) in primary care. Listing was mandatory passive or active, and the choice between them was owned by the individual. Patients initiated active listing by notifying any practice within the county. Access and availability to primary care were the same despite listing status. Active listing could be associated with the relationship between patients and their primary care practice. This listing system was generalisable within a Swedish context[14 17] and was comparable with other primary care systems allowing active listing.

The combined associations between active listing, multimorbidity, socioeconomic status and geographical factors have not been assessed before in a European population. Our aim was to explore the relation between population and practices in a primary care system based on listing by describing the associations between active listing, socioeconomics and geography, adjusting for multimorbidity, age, sex and type of primary care practice.

Materials and methods

Study population and design

Year 2007 represents a period without major structural or political changes, with stability in regulations, funding and workforce settings in primary care in Blekinge. On 31 December 2007, the County of Blekinge had 151 380 inhabitants. Of these, 50.5% were men and the average age was 42.7 years.[18] Healthcare was provided by two hospitals, five psychiatric clinics and 25 primary care practices. Half of the primary care practices were owned privately, established in all municipalities.

Listing in primary care was introduced in 2004 to empower patients, introduce market economy principles and distribute funding to practices. Active or passive listing was the only listing options. The practice of choice administrated active listing. Fundings and regulations were the same for actively and passively listed and for all practices. A total of 65% inhabitants were actively listed, ranging between 50% and 85% according to municipality. The majority (84%) were listed in practices owned by the county council, mostly at the nearest primary care practice.

We collected data on diagnoses used for estimating multimorbidity level and listing status from electronic patient records and other factors from Statistics Sweden.[19] Socioeconomic data were missing for individuals <16 years of age (24 741), and information on educational level or residence was missing for 3471 individuals >15 years of age. This cross-sectional population-based study was restricted to the 123 168 individuals with no missing data. This population had an average age of 50.1 years, 50.2% were men and 83 738 (68%) were actively listed.

The Regional Ethical Review Board at Lund University (application no. 2010/314) approved the study.

Conceptual model

Socioeconomic and geographical factors affect individual health, availability and demand for healthcare, along with multimorbidity. Primary care is a substantial part of ambulatory care. Listing is a key to the system in primary care based on patient's choice of provider. Listing status could measure aspects of the relation between primary care and the population other than number of contacts. Active listing could be seen as patients acting to promote and stress their relationship with primary care, as long as care is available to all and nothing obvious is gained by active listing instead of passive.

Outcome

Actively listed in primary care on 31 December 2007.

Listing was mandatory passive at the nearest primary care practice. Active or passive listing was the only options. Patients could change listing to active at will, at the same practice or another within the county, by notifying the practice of choice. Family members over 15 years of age made their choices individually. Access and availability to primary care were the same regardless of listing status. Patients or practices gained no obvious favours from primary care by active instead of passive listing. Passively listed were relisted if they moved to another municipality or if a new primary care practice became the nearest. Primary care practices were obliged to accept any patient and to distribute care according to medical need.

Explanatory factors

Disposable income in four equally numbered groups (quartiles)

Income at disposal is net income, adjusted for taxation and subsidiaries.

Education was divided into four levels: (1) less than 9 years of education, (2) completed 9 years of compulsory education, (3) college degree or (4) university degree. Of the study population, 13% had completed 9 years of education, 44.4% had a college degree and 25.1% had a degree from university.

Distance in kilometres (km) from home to nearest primary care practice, in seven levels (0–1, >1–5, >5–10, >10–15, >15–20, >20–25 and >25), was measured as the shortest distance between two points.

Distance in kilometres (km) from home to nearest hospital, in six levels (0–5, >5–10, >10–15, >15–20, >20–25 and >25), was measured as described above.

Geographical location were five municipalities (local government areas). The population in municipality A was 41%, in B was 19%, in C was 21%, in D was 11% and in E was 9% of the total population. Hospitals were located in municipalities A and C. Private primary care was available in every municipality.

Multimorbidity level was calculated from patient records from all healthcare for 2007 using the Johns Hopkins Adjusted Clinical Groups Case Mix System (ACG). This is one of the summary measures aiming to link diagnoses with their impact on consumption of healthcare. These measures are focused on stratification or classification of patients into groups according to diseases and conditions, age and sex. ACG weights patients' diagnoses according to five clinical dimensions: duration, severity, diagnostic certainty, aetiology and need for specialist care. That index is then categorised into multimorbidity levels with similar impact on consumption of healthcare called Resource Utilization Bands (RUBs) ranging from 0 (no need for healthcare) to 5 (very strong need for healthcare).[20 21]

Age and sex were age grouped in 16–19, 20–39, 40–59, 60–79 and 80 years and above.

Type of primary care practice was categorised in two groups according to ownership that also included differences in size and time since establishment. The county council contracted all primary care practices. This gave equal funding and regulations but different settings and processes among primary care practices. Public practices were typically older, with more listed patients and GPs, than private practices. Of patients listed in private primary care, 60% had little or no need for healthcare, compared with 35% in public primary care; income and education were equally distributed. A few older private practices used an option not to have passively listed.

Statistical analysis

Statistical analyses were performed with STATA V.14.1 (Stata). We used pairwise correlations, univariate and multivariate logistic regression models and several methods to test our models. Akaike's Information Criterion (AIC) has a penalty term for additional parameters; lower values were preferred. Coefficient of variance (CV) standardises SD, using absolute mean, to allow for comparison of variance across models. Likelihood ratio statistics (LR test) tested differences between nested models. Higher values indicate greater difference from the simpler model than low values. Model performance was also assessed using c-statistics (area under the curve (AUC)), equivalent to the area under the receiver operating characteristics (ROC) curve, with one indicating perfect discrimination and 0.5 equal to chance.

RESULTS

Pairwise correlations showed correlation between active listing and multimorbidity (0.30), age (0.27) and municipality (0.21). Income and education were correlated (0.35). Income was also correlated with sex (0.23). Education level also correlated with age (−0.31). Distances to primary care and hospital were correlated (0.36). Municipality was also correlated with practice type (−0.25) and distance to hospital (0.44).

The share of actively listed ranged from 63% to 77% according to income and ranged from 59% to 83% according to education. According to distance to primary care, active listing ranged from 63% to 69%, and that according to distance to hospital ranged from 62% to 72%. Active listing ranged from 55% to 85% according to geographical location (table 1).

In univariate models, all factors were significantly (p<0.01) associated with active listing, but variance and model fit differed. CV was 8.1 for income, 11.8 for education, 1.6 for distance to primary care, 4.3 for distance to hospital and 17.8 for municipality (table 2).

Multivariate models

Both unadjusted and adjusted multivariate models showed significance (p<0.01) for socioeconomic and geographical factors (table 3). The model including all socioeconomic and geographical factors, adjusting for multimorbidity, age, sex and type of practice, gave the lowest odds of active listing according to income for those in the first quartile with OR 0.63 (95% CI 0.63 to 0.64) and highest for those in quartile two or three with OR 0.70 (95% CI 0.69 to 0.70). According to educational level, this model gave those with less than 9 years of education OR 0.70 (95% CI 068 to 0.70) and those with university degree OR 0.65 (95% CI 0.64 to 0.65) for active listing. A distance to primary care of >15–20 km gave OR 0.62 (0.60 to 0.65) and that of 1 km or less gave OR 0.69 (95% CI 0.69 to 0.70) of active listing. For distance to hospital >5–10 km gave OR 0.64 (95% CI 0.64 to 0.65) and more than 25 km gave OR 0.71 (95% CI 0.70 to 0.73). ORs according to geographic location for active listing ranged from 0.58 (95% CI 0.57 to 0.58) in municipality A to 0.85 (95% CI 0.85 to 0.86) in municipality C (table 4).

Model tests

AIC for the model with age and sex was 143 382, including multimorbidity, practice type gave AIC 133 429, and including municipality to that model gave AIC 124 801 (table 4). The model including all socioeconomic and geographical factors and adjusting for multimorbidity, age, sex and type of practice gave AIC 123 934 (table 4).

CV for a model including multimorbidity, age and sex was 26.0 and that including municipality, multimorbidity, age and sex was 32.2 (table 3). Including income, education or distances to healthcare to this model gave at most CV 32.4, including type of practice CV 32.7 (table 3). The model including all socioeconomic and geographical factors and adjusting for multimorbidity, age, sex and type of practice gave CV 33.2 (table 3).

We tested nested models using LR tests. Adding municipality, multimorbidity or practice type added most difference to a model with age and sex (table 3). Adding socioeconomic factors or distances to healthcare to the model including municipality, multimorbidity, age and sex gave LR tests ranging from 123 for adding distance to primary care to 359 for adding individual income (table 3).

Model performance was also tested using c-statistics. Univariate models on municipality, multimorbidity level, age and type of practice gave AUC >0.6 (table 2). Age and sex gave a model with AUC 0.679 (95% CI 0.676 to 0.682).

Table 1 Descriptive: unadjusted for the population of Blekinge 2007 >15 years, with no missing data (n=123 168)

Descriptive	Group size N (%)	Actively listed N (%)
Individual income		
1/4	29 588 (24.0)	18 843 (63.7)
2/4	30 933 (25.1)	23 764 (76.8)
3/4	31 339 (25.4)	21 415 (68.3)
4/4	31 308 (25.4)	19 716 (63.0)
Educational level		
Less than 9 years	21 602 (17.5)	18 034 (83.5)
9 years	15 956 (13.0)	10 128 (63.5)
College degree	54 693 (44.4)	37 319 (68.2)
University degree	30 917 (25.1)	18 257 (59.0)
Distance primary care		
0–1 km	53 885 (43.7)	37 044 (68.7)
>1–5 km	40 669 (33.0)	27 268 (67.0)
>5–10 km	21 374 (17.3)	14 704 (68.8)
>10–15 km	5088 (4.1)	3370 (66.2)
>15–20 km	1852 (1.5)	1164 (62.8)
>20 km	300 (0.2)	188 (62.7)
Distance hospital		
0–5 km	45 378 (36.8)	30 514 (67.2)
>5–10 km	14 659 (11.9)	9 786 (66.8)
>10–15 km	11 689 (9.5)	7 267 (62.2)
>15–20 km	15 911 (12.9)	10 850 (68.2)
>20–25 km	31 141 (25.3)	22 492 (72.2)
>25 km	4390 (3.6)	2829 (64.4)
Municipality		
A	49 931 (40.5)	27 700 (55.5)
B	23 286 (18.9)	15 297 (65.7)
C	25 405 (20.6)	21 723 (85.5)
D	13 697 (11.1)	10 924 (79.5)
E	10 849 (8.8)	8094 (74.6)
Multimorbidity level		
RUB 0	48 211 (39.1)	25 030 (51.9)
RUB 1	15 315 (12.4)	10 391 (67.8)
RUB 2	25 242 (20.5)	18 861 (74.7)
RUB 3	30 566 (24.8)	25 983 (85.0)
RUB 4	3233 (2.6)	2909 (90.0)
RUB 5	601 (0.5)	564 (93.8)
Age		
16–19 years	6846 (5.6)	3777 (55.2)
20–39 years	34 067 (27.7)	17 904 (52.6)
40–59 years	39 374 (32.0)	26 176 (66.5)
60–79 years	33 420 (27.1)	27 386 (81.9)
80+ years	9461 (7.7)	8495 (89.8)

Continued

Table 1 Continued

Descriptive	Group size N (%)	Actively listed N (%)
Sex		
Women	61 386 (49.8)	45 004 (73.3)
Men	61 782 (50.2)	38 734 (62.7)
Practice type		
Private	20 428 (16.6)	15 798 (77.3)
Public	102 740 (83.4)	67 940 (66.1)
Population of Blekinge	123 168	83 738 (68.0)

Unadjusted actively listed 2007 distributed on subgroups of each explanatory factor for the population of Blekinge >15 years of age.
RUB, Resource Utilization Band.

Modelling multimorbidity, age, sex and type of practice gave AUC 0.747 (95% CI 0.744 to 0.750) and including municipality to that model gave AUC 0.788 (95% CI 0.785 to 0.790) (table 3). The model including all factors gave AUC 0.792 (95% CI 0.789 to 0.795) (table 4).

Comparing multivariate logistic models

When modelling all factors for the population of Blekinge, those with incomes in the third quartile showed 49% (95% CI 42% to 55%) more actively listed than those in the lowest quartile. Of those with a university degree, 26% (95% CI 22% to 30%) less were actively listed than those without completed 9 years compulsory school. OR for active listing in municipality C was 5.62 (95% CI 5.37 to 5.87) times the OR in municipality A. OR for active listing increased with multimorbidity level to 9.27 (95% CI 6.60 to 13.02) for RUB 5 compared with RUB 0. The association between age group and active listing was not linear. Men had OR 0.68 (95% CI 0.66 to 0.70) compared with women. Public practices had OR 0.53 (95% CI 0.51 to 0.55) compared with private practices (table 5).

The logistic model for the subpopulation of municipality A showed OR for the second income quartile 1.45 (95% CI 1.36 to 1.55) compared with the first quartile. University degree had OR 0.77 (95% CI 0.71 to 0.84) compared with those without completed 9 years compulsory school (table 5).

The model for the subpopulation of municipality C showed OR 1.87 (95% CI 1.66 to 2.11) for third income quartile compared with first quartile. University degree had OR 0.66 (95% CI 0.56 to 0.79) compared with those without completed 9 years compulsory school (table 4).

DISCUSSION

Summary of main findings

Higher income, shorter education, short distance to primary care and long distance to hospital had a significant association with active listing in primary care.

Multimorbidity, age, geographical location and primary care explain more of the differences in active listing than socioeconomic status and distance to healthcare.

Table 2 Univariate models: active listing in primary care according to multimorbidity, income, education, distances to healthcare, age, sex, practice type and geographical location for the population of Blekinge 2007 aged >15 years, with no missing data (n=123 168)

	Area under ROC Curve	CV	
Univariate models	**AUC (95% CI)**	**%**	**AIC**
Individual income	0.567 (0.563 to 0.570)	8.1	152 676
Educational level	0.596 (0.592 to 0.599)	11.8	150 534
Distance primary care	0.512 (0.509 to 0.515)	1.6	154 387
Distance hospital	0.535 (0.532 to 0.539)	4.3	153 970
Municipality	0.653 (0.650 to 0.656)	17.8	145 699
Multimorbidity level	0.678 (0.675 to 0.681)	20.7	142 772
Age	0.663 (0.660 to 0.666)	18.9	144 592
Sex	0.561 (0.558 to 0.564)	11.5	152 848
Practice type	0.687 (0.684 to 0.691)	21.0	142 320

n=123 168 and all models p<0.01.
AIC, Akaike's Information Criterion; AUC, area under the curve; CV, coefficient of variance; ROC, receiver operating characteristics.

In Sweden, there is a unique possibility to use register-based data instead of reported data for research purposes, which we could benefit from. We collected individual factors from different data sources to assess the contribution of socioeconomic status, geographical factors, multimorbidity, age, sex and type of primary care to active listing in primary care. To the best of our knowledge, this has not been done before.

Socioeconomic status and geographical factors affect morbidity and trust; therefore, we expected them to affect active listing. We found them to have significant associations with active listing in primary care, but multimorbidity, age, geographical location and primary care explained more than socioeconomic status and distance to healthcare. We also found unexplained differences in the associations between active listing and our explanatory factors according to geographic location.

We found that municipality was the geographical factor that contributed most to the models when tested. To analyse differences in active listing among municipalities was not within the aim of this paper, but we show the complexity by comparing the municipalities with hospitals, also the extremes regarding active listing. Several factors act differently comparing these subpopulations. The models also had difficulties handling type of primary care practice, due to the importance of geographical location. In municipality A, private practices were established before the listing system, with patient lists of only actively listed. On the other hand, private practices in municipality C were just established; hence, with very few patients listed. To analyse these differences further, our data on local settings and local healthcare were not sufficient.

The relationship between patients and primary care practices was underestimated using active listing, since passive listing at the practice of choice would be sufficient to maintain the relationship. Most actively listed choose to stay listed at the nearest primary care practice. We anticipate that some were contented with the passive choice made for them and a patient-professional relationship that was not protected. Whether patients act to protect this relationship or not could be influenced by other circumstances such as factors related to social capital and local healthcare.

Data on exact geographical location (GIS data) or active listing at individual primary care practices or GPs were not available. We could group primary care practices by ownership, also including differences in size, team competence, number of listed patients and time since establishment. It was within the aim of this paper to investigate if we could find differences in active listing according to factors in primary care and not how these factors worked. The use of statistical methods allows us to study associations, not causality. To investigate the differences between municipalities, we would need more data on differences between local societies and local healthcares. We also would use mixed methods to investigate how these local factors were perceived by patients and primary care practices.

In Sweden, listing was introduced in primary care to empower patients and to introduce market models by allowing the population to choose primary care provider. Since county councils regulate and organise local healthcare, there is no national primary care system. The County of Blekinge in 2007 provided us with a listing system comparable to contemporary Swedish primary care, as well as the legislation in 2010.[14] Swedish primary care is known to be weak compared with most European primary care.[22–24] Generalisation of our findings depends on analyses of strength of primary care and on similarities between healthcare organisations and listing systems. Then our findings are generalisable to other primary care systems allowing patients to choose primary care practice across practice boundaries.

Table 3 Multivariate model tests: associations between active listing in primary care, socioeconomic status and geographical factors, adjusting for sex and age

	Area under ROC curve		CV		
Multivariate models, model tests	AUC	(95% CI)	%	AIC	LR test
Age and sex	0.679	(0.676 to 0.682)	20.1	143 382	
Adjusted for age and sex					0
Individual income	0.685	(0.682 to 0.688)	20.6	142 779	552
Educational level	0.686	(0.683 to 0.689)	20.8	142 615	715
Distance primary care	0.681	(0.678 to 0.684)	20.2	143 235	99
Distance hospital	0.685	(0.682 to 0.688)	20.6	142 833	502
Municipality	0.740	(0.737 to 0.743)	26.9	134 599	8831
Multimorbidity level	0.732	(0.729 to 0.735)	26.0	135 902	7432
Practice type	0.687	(0.684 to 0.690)	21.0	142 320	1006
Adjusted for multimorbidity, age and sex					0
Individual income	0.734	(0.731 to 0.736)	26.2	135 586	322
Educational level	0.735	(0.732 to 0.737)	26.4	135 364	543
Distance primary care	0.732	(0.729 to 0.735)	26.1	135 805	106
Distance hospital	0.736	(0.733 to 0.739)	26.4	135 258	654
Municipality	0.784	(0.781 to 0.787)	32.2	125 689	10 221
Practice type	0.747	(0.744 to 0.750)	27.7	133 429	2475
Adjusted for multimorbidity, age, sex and practice type					0
Individual income	0.749	(0.746 to 0.751)	27.9	133 130	305
Educational level	0.749	(0.747 to 0.752)	28.1	132 926	508
Distance primary care	0.747	(0.744 to 0.750)	27.8	133 350	89
Distance hospital	0.750	(0.748 to 0.753)	28.1	132 875	564
Municipality	0.788	(0.785 to 0.790)	32.7	124 801	8636
Adjusted for municipality, multimorbidity, age, sex and practice type					0
Individual income	0.789	(0.787 to 0.792)	32.9	124 448	359
Educational level	0.789	(0.786 to 0.792)	32.8	124 577	230
Distance primary care	0.789	(0.786 to 0.791)	32.8	124 688	123
Distance hospital	0.789	(0.786 to 0.792)	32.8	124 621	190

Blekinge 2007, aged >15 years with no missing data (n=123 168).
AIC, Akaike's Information Criterion; AUC, area under the curve; CV, coefficient of variance; LR test, likelihood ratio test; ROC, receiver operating characteristics; n, 123 168.

Comparison with existing literature

Other Swedish surveys have investigated reported choice of primary care provider. Glenngard *et al* reported variance according to age, municipality and occupation, but not self-reported health status, sex or education.[25] In a previous paper, we found that more consultations, higher multimorbidity level, older age and female gender were positively associated with active listing in primary care.[26] Here we combined these factors with socioeconomic status, type of primary care practice and geographical factors, and we found that multimorbidity level, age and geographical location contributed most to active listing and that type of primary care practice contributes more than socioeconomic status and distances to healthcare.

In 2012/2013, general practices in four UK National Health Service primary care trusts piloted a scheme allowing patients living outside practice boundaries to enlist as out-of-area patients (active listing). A pilot study using mixed methods investigated patients' experiences of their choice of practice. A patient with a choice across practice boundaries was younger and more likely to be working compared with other patients at the same practices. Common reasons to become an out-of-area patient were convenience, not wanting to change practice after moving house, newcomers to the area and dissatisfaction with previous practice.[27] We found that, after some years allowing all to list actively, higher multimorbidity level and older age were associated with active listing. We also

Table 4 Multivariate models: models on active listing in primary care, socioeconomic status and geographical factors unadjusted and adjusted for multimorbidity, age, sex and practice type for the population of Blekinge 2007, aged >15 years with no missing data (n=123 168)

Multivariate models	Unadjusted			Adjusting for age and sex			Adjusting for age, sex, multimorbidity and practice type			Adjusting for age, sex, multimorbidity, practice type and municipality		
	p	**OR**	**(95% CI)**	**p**	**OR**	**(95% CI)**	**p**	**OR**	**(95% CI)**	**p**	**OR**	**(95% CI)**
Individual income	<0.01			<0.01			<0.01			<0.01		
1/4		0.62	(0.61 to 0.62)		0.62	(0.61 to 0.63)		0.63	(0.63 to 0.64)		0.63	(0.63 to 0.64)
2/4		0.75	(0.74 to 0.75)		0.71	(0.71 to 0.72)		0.70	(0.69 to 0.70)		0.70	(0.69 to 0.70)
3/4		0.70	(0.69 to 0.70)		0.70	(0.70 to 0.71)		0.70	(0.69 to 0.70)		0.70	(0.69 to 0.70)
4/4		0.66	(0.65 to 0.67)		0.68	(0.68 to 0.69)		0.69	(0.68 to 0.69)		0.69	(0.68 to 0.69)
Education level	<0.01			<0.01			<0.01			<0.01		
Less than 9 years		0.82	(0.82 to 0.83)		0.70	(0.69 to 0.71)		0.71	(0.71 to 0.72)		0.70	(0.68 to 0.70)
9 years		0.65	(0.65 to 0.66)		0.70	(0.69 to 0.71)		0.70	(0.69 to 0.71)		0.69	(0.69 to 0.70)
College degree		0.67	(0.67 to 0.68)		0.69	(0.69 to 0.70)		0.69	(0.69 to 0.70)		0.69	(0.69 to 0.69)
University degree		0.61	(0.61 to 0.62)		0.64	(0.63 to 0.64)		0.63	(0.62 to 0.63)		0.65	(0.64 to 0.65)
Distance primary care	<0.01			<0.01			<0.01			<0.01		
0–1 km		0.69	(0.68 to 0.69)		0.69	(0.69 to 0.70)		0.68	(0.67 to 0.68)		0.69	(0.69 to 0.70)
>1–5 km		0.67	(0.67 to 0.68)		0.67	(0.67 to 0.68)		0.67	(0.67 to 0.67)		0.67	(0.67 to 0.68)
>5–10 km		0.68	(0.67 to 0.69)		0.67	(0.67 to 0.68)		0.71	(0.70 to 0.72)		0.67	(0.67 to 0.68)
>10–15 km		0.66	(0.65 to 0.68)		0.66	(0.64 to 0.67)		0.66	(0.65 to 0.68)		0.65	(0.64 to 0.66)
>15–20 km		0.64	(0.62 to 0.67)		0.64	(0.61 to 0.66)		0.63	(0.60 to 0.65)		0.62	(0.60 to 0.65)
>20 km		0.64	(0.59 to 0.69)		0.64	(0.59 to 0.69)		0.64	(0.59 to 0.70)		0.64	(0.59 to 0.69)
Distance hospital	<0.01			<0.01			<0.01			<0.01		
0–5 km		0.68	(0.68 to 0.69)		0.68	(0.68 to 0.69)		0.70	(0.69 to 0.70)		0.68	(0.67 to 0.69)
>5–10 km		0.65	(0.64 to 0.66)		0.65	(0.64 to 066)		0.66	(0.65 to 0.66)		0.64	(0.64 to 0.65)
>10–15 km		0.66	(0.65 to 0.66)		0.66	(0.65 to 0.67)		0.58	(0.58 to 0.59)		0.65	(0.64 to 0.66)
>15–20 km		0.69	(0.69 to 0.70)		0.70	(0.69 to 0.70)		0.66	(0.66 to 0.67)		0.70	(0.69 to 0.70)
>20–25 km		0.69	(0.68 to 0.69)		0.69	(0.68 to 0.69)		0.71	(0.71 to 0.72)		0.69	(0.69 to 0.70)
>25 km		0.69	(0.67.0.71)		0.69	(0.68 to 0.71)		0.67	(0.65 to 0.68)		0.71	(0.70 to 0.73)

Continued

Table 4 Continued

Multivariate models	Unadjusted			Adjusting for age and sex			Adjusting for age, sex, multimorbidity and practice type			Adjusting for age, sex, multimorbidity, practice type and municipality		
	p	OR	(95% CI)	p	OR	(95% CI)	p	OR	(95% CI)	p	OR	(95% CI)
Municipality	<0.01			<0.01			-			<0.01		
A		0.57	(0.56 to 0.57)		0.57	(0.56 to 0.57)					0.58	(0.57 to 0.58)
B		0.65	(0.64 to 0.66)		0.65	(0.64 to 0.66)					0.64	(0.63 to 0.64)
C		0.86	(0.85 to 0.86)		0.85	(0.85 to 0.86)					0.85	(0.85 to 0.86)
D		0.79	(0.78 to 0.80)		0.79	(0.78 to 0.79)					0.78	(0.77 to 0.79)
E		0.73	(0.72.0.74)		0.72	(0.71 to 0.73)					0.72	(0.71 to 0.73)
Multimorbidity level	-			-			<0.01			<0.01		
Age	-			<0.01			<0.01			<0.01		
Sex	-			<0.01			<0.01			<0.01		
Practice type	-			-			<0.01			<0.01		
AUC	0.700		(0.700 to 0.701)	0.747		(0.744 to 0.750)	0.755		(0.752 to 0.758)	0.792		(0.789 to 0.795)
CV	22.2			27.7			28.7			33.2		
AIC	140 941			133 332			131 895			123 934		

n=123 168; p, significance level.
AIC, Akaike's Information Criterion.

Table 5 Multivariate logistic regression models: associations between active listing in primary care, socioeconomic status and geographical factors, adjusting for multimorbidity, type of primary care practice, sex and age

Logistic models	Including all factors, municipality A (n=49 931)		Including all factors, municipality C (n=20 020)		Including all factors, population of Blekinge (n=123 168)	
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Individual income						
1/4	1.00		1.00		1.00	
2/4	1.45**	(1.36 to 1.55)	1.54**	(1.34 to 1.75)	1.45**	(1.39 to 1.52)
3/4	1.37**	(1.28 to 1.46)	1.87**	(1.66 to 2.11)	1.49**	(1.42 to 1.55)
4/4	1.22**	(1.14 to 1.31)	1.71**	(1.51 to 1.94)	1.40**	(1.33 to 1.46)
Education level						
Less than 9 years	1.00		1.00		1.00	
9 years	0.90	(0.81 to 1.00)	1.08	(0.88 to 1.33)	0.97	(0.91 to 1.04)
College degree	0.94	(0.87 to 1.01)	0.95	(0.81 to 1.12)	0.96	(0.91 to 1.01)
University degree	0.77**	(0.71 to 0.84)	0.66**	(0.56 to 0.79)	0.74**	(0.70 to 0.78)
Distance primary care						
0–1 km	1.00		1.00		1.00	
>1–5 km	0.83**	(0.79 to 0.88)	1.08	(0.98 to 1.18)	0.90**	(0.87 to 0.93)
>5–10 km	0.81**	(0.74 to 0.87)	2.44**	(2.07 to 2.87)	0.90**	(0.86 to 0.94)
>10–15 km	0.73**	(0.63 to 0.84)	1.45	(0.98 to 2.13)	0.79**	(0.72 to 0.85)
>15–20 km	0.65**	(0.50 to 0.85)	0.73	(0.38 to 1.39)	0.68**	(0.59 to 0.78)
>20 km	0.51	(0.17 to 1.56)	-		0.74**	(0.56 to 0.98)
Distance hospital						
0–5 km	1.00		1.00		1.00	
>5–10 km	0.80**	(0.76 to 0.86)	0.45**	(0.40 to 0.51)	0.81**	(0.77 to 0.85)
>10–15 km	0.89**	(0.83 to 0.96)	0.47**	(0.37 to 0.60)	0.83**	(0.78 to 0.88)
>15–20 km	1.04	(0.95 to 1.14)	0.78	(0.48 to 1.27)	1.10**	(1.03 to 1.17)
>20–25 km	0.89	(0.77 to 1.04)	0.38*	(0.17 to 0.85)	1.09**	(1.02 to 1.16)
>25 km	0.72**	(0.58 to 0.89)	-		1.23**	(1.10 to 1.38)
Municipality	-		-			
A					1.00	
B					1.35**	(1.28 to 1.43)
C					5.62**	(5.37 to 5.87)
D					3.21**	(3.01 to 3.43)
E					2.12**	(1.97 to 2.28)
Multimorbidity level						
RUB 0	1.00		1.00		1.00	
RUB 1	3.14**	(2.96 to 3.34)	3.97**	(3.50 to 4.50)	2.70**	(2.58 to 2.81)
RUB 2	4.00**	(3.79 to 4.22)	4.42**	(3.97 to 4.93)	3.29**	(3.17 to 3.42)
RUB 3	5.89**	(5.57 to 6.22)	8.16**	(7.14 to 9.33)	5.08**	(4.88 to 5.29)
RUB 4	8.95**	(7.59 to 10.56)	6.72**	(4.63 to 9.77)	6.99**	(6.18 to 7.89)
RUB 5	10.40**	(6.72 to 16.10)	7.17**	(2.23 to 23.04)	9.27**	(6.60 to 13.02)
Age						
16–19 years	1.00		1.00		1.00	
20–39 years	1.05	(0.93 to 1.18)	0.54**	(0.44 to 0.66)	0.74**	(0.68 to 0.79)
40–59 years	1.60**	(1.42 to 1.81)	1.01	(0.82 to 1.25)	1.24**	(1.15 to 1.34)
60–79 years	3.25**	(2.87 to 3.69)	1.81**	(1.43 to 2.29)	2.44**	(2.25 to 2.64)

Continued

Table 5 Continued

Logistic models	Including all factors, municipality A (n=49 931)		Including all factors, municipality C (n=20 020)		Including all factors, population of Blekinge (n=123 168)	
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
80 years	4.93**	(4.22 to 5.75)	7.42**	(4.85 to 11.35)	3.93**	(3.54 to 4.36)
Sex						
Women	1.00		1.00		1.00	
Men	0.64**	(0.62 to 0.67)	0.69**	(0.64 to 0.76)	0.68**	(0.66 to 0.70)
Practice type						
Private	1.00		-		1.00	
Public	0.01**	(0.00 to 0.01)	-		0.53**	(0.51 to 0.55)

Separate models for the subpopulations of municipality A (n=49 931) and C (n=20 020), and Blekinge (n=123 168) 2007, aged >15 years with no missing data.
*p<0.01; **p<0.05.

showed that factors in local society (geographical location and type of primary care practice) played a role in patients' choice of practice, while distances to healthcare, education and income were less important to active choice.

In a Scottish study, it was found that more than half of people with multimorbidity were <65 years old and that there was an excess of multimorbidity in the most deprived areas.[28] A retrospective cohort study in England showed that multimorbidity, age and deprivation were strongly related and that people with multimorbidity had higher consultation rates and less continuity of care compared with people without multimorbidity.[29] We confirmed the associations previously found between multimorbidity, age and municipality and their associations with active listing. We found no significant correlation between municipality and multimorbidity level. In accordance with the established influence of socioeconomic and geographical factors on both morbidity and trust, we expected that including such factors would contribute to variance and explanatory power of active listing. We found that most of the contribution of socioeconomic status and geographical factors was lost, when we adjusted for multimorbidity, age and sex, except for geographical location. The remaining association was still statistically significant and showed a positive association between active listing and higher income, shorter education, short distance to primary care or long distance to a hospital.

Conclusions and perspectives

Multimorbidity, age, geographical location and type of primary care practice are more important to active listing in primary care than socioeconomic status and distance to healthcare.

Higher income, shorter education and short distance to primary care or long distance to hospital still have some importance to active listing in primary care.

Influence of socioeconomic status on health, and vice versa, partly could explain the unexpected weak associations between socioeconomic status and active listing in adjusted models. The stronger association between geographical location, rather than distances to healthcare, and active listing implicates that data on geographical location (GIS data) should be used to investigate the influence of geographical factors to the strength of the relation between patients and practices in primary care.

The associations between active listing, geographical location and primary care implicate that factors within local societies and local healthcare affect active listing. The cause and implications of these differences in the relation between patients and primary care need further research, as well as the use of mixed methods to include how studied factors are perceived.

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Importance of relationships with primary care

This is a thesis about the relationships between patients and primary care, and whether these could have consequences elsewhere in the complex network of health care. Primary care, and patient-provider relationships in primary care, is important to both patients and health care, while the implications are different. In conclusion good relationships with primary care are associated with less need for hospitalisation, and more so with increasing patient complexity.

The difference in performance within primary care indicates that changed settings in primary care could affect hospitalisation. Improving primary care, and patient-provider relationships, could be a possibility to decrease hospitalisation.

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