

BMJ Open Impact of regional socioeconomic variation on coordination and cost of ambulatory care: investigation of claims data from Bavaria, Germany

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To cite: Mehring M, Donnachie E, Schneider A, *et al.* Impact of regional socioeconomic variation on coordination and cost of ambulatory care: investigation of claims data from Bavaria, Germany. *BMJ Open* 2017;7:e016218. doi:10.1136/bmjopen-2017-016218

► Prepublication history and additional material for this paper are available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2017-016218>).

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Received 31 January 2017

Revised 1 August 2017

Accepted 6 September 2017



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ABSTRACT

Objectives A considerable proportion of regional variation in healthcare use and health expenditures is to date still unexplained. The aim was to investigate regional differences in the gatekeeping role of general practitioners and to identify relevant explanatory variables at patient and district level in Bavaria, Germany.

Design Retrospective routine data analysis using claims data held by the Bavarian Association of Statutory Health Insurance Physicians.

Participants All patients who consulted a specialist in ambulatory practice within the first quarter of 2011 (n=3 616 510).

Outcomes measures Of primary interest is the effect of district-level measures of rurality, physician density and multiple deprivation on (1) the proportion of patients with general practitioner (GP) coordination of specialist care and (2) the mean amount in Euros claimed by specialist physicians.

Results The proportion of patients whose use of specialist services was coordinated by a GP was significantly higher in rural areas and in highly deprived regions, as compared with urban and less deprived regions. The hierarchical models revealed that increasing age and the presence of chronic diseases are the strongest predictive factors for coordination by a GP. In contrast, the presence of mental illness, an increasing number of medical condition categories and living in a city are predictors for specialist use without GP coordination. The amount claimed per patient was €10 to €20 higher in urban districts and in regions with lower deprivation. Hierarchical models indicate that this amount is on average higher for patients living in towns and lower for patients in regions with high deprivation.

Conclusion The present study shows that regional deprivation is closely associated with the way in which patients access primary and specialist care. This has clear consequences, both with respect to the role of the general practitioner and the financial costs of care.

INTRODUCTION

Research on healthcare use had its origin in the early 1960s. Initially, this involved a purely descriptive demographic analysis combined

Strengths and limitations of this study

- The study data covers all statutorily insured patients and are thus more representative than the data of individual insurances or treatment centres.
- Although unmeasured confounding is possible, we adjusted for regional deprivation and clinical factors that may affect healthcare use.
- Our results are robust with respect to the model specification.
- Due to the study data and design, our findings are highly generalisable.
- The study is limited by the absence of considering the quality of care or quality of life.

with a social science approach with the aid of behavioural models.¹ In 1968, Andersen *et al*² published a review of theoretical models in medical care services use, conceiving the use of healthcare as a function of 'need factors', 'enabling factors' and 'predisposing factors'. This model was developed further over the years^{3 4} and has established itself internationally as a reference model for the analysis of healthcare use.^{5 6} Steadily increasing costs still motivate the investigation in healthcare use and health expenditures. Several studies have examined the impact of a general practitioner (GP) led primary care model. It has been shown that primary care coordinated by GPs leads to lower ambulatory healthcare costs⁷ and lower overall mortality, even in countries with a high degree of income inequality.⁸ Macinko and colleagues demonstrated that nations with a more regulated and coordinated primary care system have lower expenditures and lower rates of all-cause mortality. In contrast, nations with a weaker implementation of primary care have higher costs and more adverse health outcomes.⁹

In the German healthcare system, both GPs and specialist physicians participate

in primary care. With few exceptions, patients are free to consult the specialists and GPs of their choice. Both the density of ambulatory physicians and patient characteristics such as female gender, non-smoking, higher morbidity and lower physical activity lead to a more frequent use of German ambulatory health services.¹⁰ GPs are more frequently consulted by patients who are elderly (>65 years), female, non-smokers, not economically active and have lower social status, higher morbidity and a poorer health-related quality of life. Kürschner *et al*¹¹ showed that the main indicators for enrolment in a general practitioner care model, where coordination of healthcare use is provided solely by GPs, were age above 60, lower social status, lower income status and residence in less populated areas.

In addition, other studies have shown^{10 12–15} that patients with a lower socioeconomic status have higher GP use and patients with a higher socioeconomic status use more specialist physicians. This use pattern has been demonstrated for many European countries, but the extent varies between healthcare systems.¹⁶ Social inequalities in outpatient healthcare use are therefore well known explanatory factors for use. Furthermore, it is widely recognised that lower individual socioeconomic status and higher regional deprivation are associated with greater morbidity and mortality.^{17 18}

Nevertheless, a considerable proportion of the regional variation in healthcare use and health expenditures is still unexplained. This is especially the case with respect to district level variation in ambulatory care.¹⁹ There are strong indications that systematic regional differences cannot adequately be explained by demographic factors, access to care or patient needs.²⁰ A recent systematic review by Babitsch *et al*²¹ comes to the conclusion that the reported correlations between respective determinants and the use of health services are highly inconsistent. In particular, the heterogeneity of the studies and their underlying setting are thought to have a significant impact on the results. Garrido *et al* and Thode *et al* suggested that previous results were insufficiently accounted for regional variation.^{10 22}

The present study investigates regional variation in the GP coordinated of specialist care and in the total cost of ambulatory care. Of primary interest is the effect of district-level measures of rurality, physician density and multiple deprivation on these two outcomes. By comparing the results of several modelling approaches at the district and patient level, we seek to provide new insight concerning the interplay of patient level and regional factors. The evaluation was based on anonymous claims data held by the Bavarian Association of Statutory Health Insurance Physicians ('KVB').

METHODS

We conducted a cross-sectional study based on claims data for the year 2011. The anonymised data covers all statutorily insured outpatients in the German federal state of

Bavaria and consists of patient metadata (age, gender and place of residence), diagnoses (International Classification of Diseases 10th Revision (ICD-10) Codes) and fees claimed by both general practitioners and specialists in ambulatory practice. Inclusion criteria were a minimum age of 18 years, a claim from a specialist in ambulatory practice and residency in Bavaria. Patients were excluded if age, sex or insurance number were missing. Patients were also excluded from the analysis if a change of residence was documented within the same quarter. All GPs and internists in family practice were defined as 'GPs'. The specialist groups investigated were anaesthetists, ophthalmologists, surgeons, gynaecologists, ear, nose and throat specialists, dermatologists, internists with further specifications (cardiology, gastroenterology, etc), neurologists, orthopaedists, psychotherapists, radiologists and urologists. Diagnoses were aggregated using the H15EBA grouper, which was developed by the Institute for Strategic Assessment of Reimbursement for Medical Services (in German: Institut des Bewertungsausschusses (InBA)) as an official measure of morbidity within the German ambulatory system. This grouper allocates diagnoses to 1 of 60 aggregated medical condition categories, thus providing a convenient and costs-based system for the analysis of the complex ICD-10 diagnoses. Chronic illnesses were defined according to a list of corresponding ICD-10 diagnoses compiled by InBA.

Each patient was allocated to an administrative district based on their recorded place of residence. The 96 Bavarian districts were classified according to three criteria. First, whether it was an independent city ($n=30$) or a rural district ($n=66$) (in German: 'Kreisfreie Stadt' for independent city, 'Landkreis' for rural district). Second, the settlement structure classification of the Federal Institute for Research on Building, Urban Affairs and Spatial Development (Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR)) was used as a measure of rurality. The four groups are 'large cities' (ie, more than 100 000 inhabitants), 'urban districts', 'rural districts showing densification' and 'sparsely populated rural districts'. Third, the Bavarian Index of Multiple Deprivation (BIMD) was used to assess socioeconomic regional deprivation at the district level. The BIMD was developed as a multidimensional area deprivation index²³ based on an established British method to create Indices of Multiple Deprivation.²⁴ This index combines official sociodemographic, socioeconomic and environmental data in seven domains of deprivation and showed already significant associations with different health outcomes.²³

Definition of GP coordinated and uncoordinated healthcare use

A patient was considered to be coordinated if a GP referral was available for each specialist contact within the quarter. Patients consulting specialists without referral were classified as uncoordinated. Specialist claims for which the concept of coordination is not applicable, for example in the context of emergency care or mammography



screening programme, were not considered when classifying the coordination status. Such claims were however included in the calculation of the treatment costs.

Statistical analysis

To provide context for the main analysis, descriptive analyses of the patient population were first prepared in tabular and graphical form. At the second step, aggregated district-level data were analysed to assess, for example, whether regions with high deprivation also tend to have high levels of GP coordination. To identify and quantify potential influencing factors for the target variables ‘GP-coordinated healthcare use’ and ‘mean claim by specialist physicians’, simultaneous autoregressive regression models (SAR) were fitted. While simple linear regression models assume independence of observations (ie, districts), the SAR models adjust for possible autocorrelation between adjacent districts. In a third step, hierarchical regression models were fitted using individual data. As with the SAR models, separate models were specified for the outcome variables ‘GP-coordinated healthcare use’ and ‘mean claim by specialist physicians’. Whereas the SAR models assess ecological correlations at a district level, hierarchical models assess the impact of the explanatory variables on individual patients. The use of hierarchical regression models is that characteristics from both (individual) patient level and (aggregated) district level can be taken into account within the same model. The variation of the different districts is modelled as a random effect with Gaussian distribution, mean zero and SD estimated from the data. This effect is an estimate of regional heterogeneity, incorporating all observed and unobserved variation between the districts. To assess the sensitivity of the hierarchical models to changes in specification, we fitted several variants to successively add different patient characteristics, demographic variables, diagnoses and regional factors. By comparing the results of the hierarchical models with each other and with the district-level results, we aimed to account for the

problems of model specification and ecological bias, thus facilitating a more robust and informative conclusion.

Data protection

The study was performed in accordance with the primary German guideline ‘Good Practice for Secondary Data Analysis’ (Gute Praxis Sekundärdaten). The data used were anonymous, and approval was obtained from the responsible data protection officer of the National Association of Statutory Health Insurance Physicians of Bavaria.

RESULTS

Patient-level data

Table 1 shows a description of the study population of the first quarter of 2011. A total of 3 616 510 unique patients consulted specialists in ambulatory practice, of whom 2 348 053 (64.9%) were female. The uncoordinated patient group accounts for the largest proportion with 50.5%, followed by the coordinated patient group with 45.1%. The remaining 4.5% of patients did not have a ‘regular’ consultation and the coordination status was therefore classified as ‘not applicable’. In comparison with the uncoordinated patient group, coordinated patients were on average almost 7 years older and the proportion with chronic diseases was almost 18% higher. On average, uncoordinated patients had 1.4% fewer mental health conditions and 7.6% fewer patients using multiple practices from the same specialist group. Patients in the ‘not applicable’ category had fewer recorded medical condition categories, almost no multiple use of the same specialist group and a low overall financial claim.

Figure 1 shows the age distribution for male and female patients, with the coordination status coded by colour. The average age was 50.9 years, and was higher for males (53.8 years) than for females (50.3 years). Among younger patients, female patients far outweigh the male patients. The majority of young patients (between 18 and 40 years) were uncoordinated. With increasing age, this

Table 1 Baseline characteristics of coordinated, uncoordinated and not applicable patients within the first quarter of 2011

First quarter of 2011	Coordinated care	Uncoordinated care	Not determinable
n (%)	1 629 302 (45.1)	1 825 840 (50.5)	1 61 368 (4.5)
Age (mean)	55.3	48.3	49.0
Gender: male (%)	614 274 (37.7)	606 793 (33.2)	47 390 (29.4)
Proportion with chronic illness (%)	85.4	67.5	51.4
Proportion with mental illness (%)	16.8	18.3	12.1
Number of medical condition categories (mean)	3.6	4.0	1.5
Proportion with doctor shopping (%)	1.3	8.9	0.1
Proportion utilising multiple specialist groups (%)	42.2	45.8	8.5
Mean claim by GPs (€)	73.10	73.59	75.15
Mean claim by specialists (€)	157.30	186.54	95.38
Mean claim by all ambulatory physicians (€)	224.41	234.52	135.41

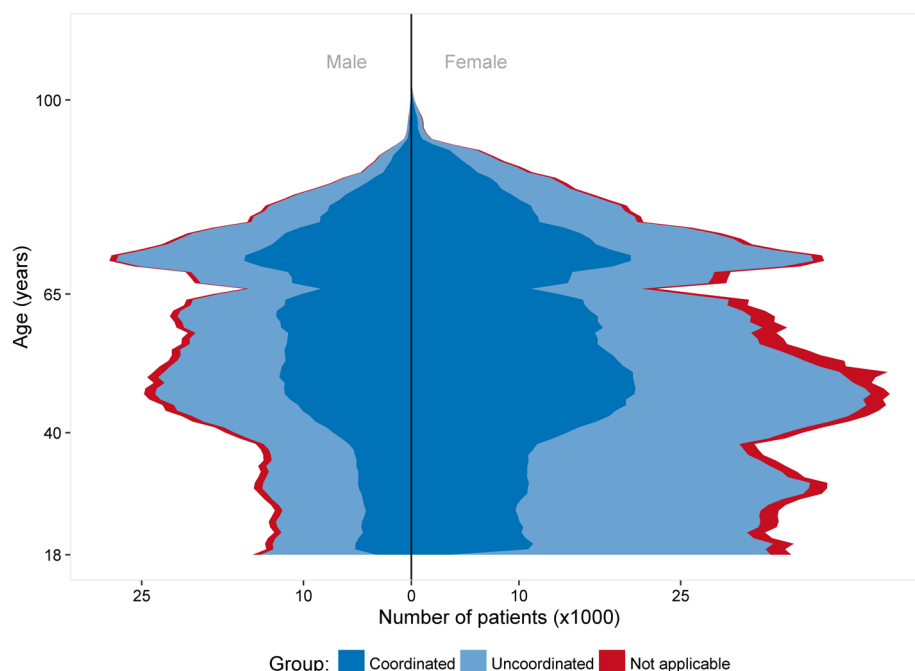


Figure 1 Patients' age and sex distribution with coordination status coded by colour.

effect of gender declines and the proportion of coordinated patients increase.

District-level analysis

Table 2 shows that the proportion of patients with GP-coordinated healthcare use is clearly higher in rural districts as compared with urban districts. In particular, as illustrated in figure 2, the city of Munich and neighbouring districts in the south of Bavaria exhibited very low proportions of patients with coordination of care.

Table 3 presents the results of nine distinct SAR models for the proportion of coordinated patients in a district. The district characteristics (independent town vs rural

district) and increasing regional deprivation were strongly associated with the proportion of coordinated healthcare use by GPs. In particular, the proportion of coordinated patients in cities is on average 7.5% lower than in districts without city status (models 1 and 2). Similar results are seen using the more differentiated BBSR structural types, with large cities having 9.8% fewer coordinated patients than 'sparsely populated rural areas' and a gradual decline observed with increasing rurality (models 2 and 3). The GP density was not associated with the level of GP coordination (models 4 and 5), but the total physician density (including specialists in ambulatory practice) was negatively associated with GP coordination (models

Table 2 Baseline characteristics of the four types of structural district in the first quarter of 2011

	Large cities	Urban districts	Rural districts showing densification	Sparsely populated rural districts
Number of districts	8	20	36	32
Number of patients	834 215	864 500	1 057 484	860 311
Proportion of all patients (%)	23.1	23.9	29.2	23.8
Age (mean)	50.8	51.8	51.7	51.7
Gender: male (%)	33.6	34.8	35.8	36.0
Proportion with GP coordination (%)	37.3	45.5	51.8	52.8
Proportion with chronic illness (%)	73.4	74.4	75.6	75.9
Proportion with mental illness (%)	21.2	16.3	16.2	16.1
Proportion using multiple specialist groups (%)	46.9	42.2	41.0	40.3
Proportion with doctor shopping (%)	6.4	5.0	4.5	4.5
Mean claim by GPs (€)	56.57	56.44	55.74	56.33
Mean claim by specialists (€)	189.60	166.09	160.92	163.15
Mean claim by all ambulatory physicians (€)	246.16	222.53	216.66	219.48

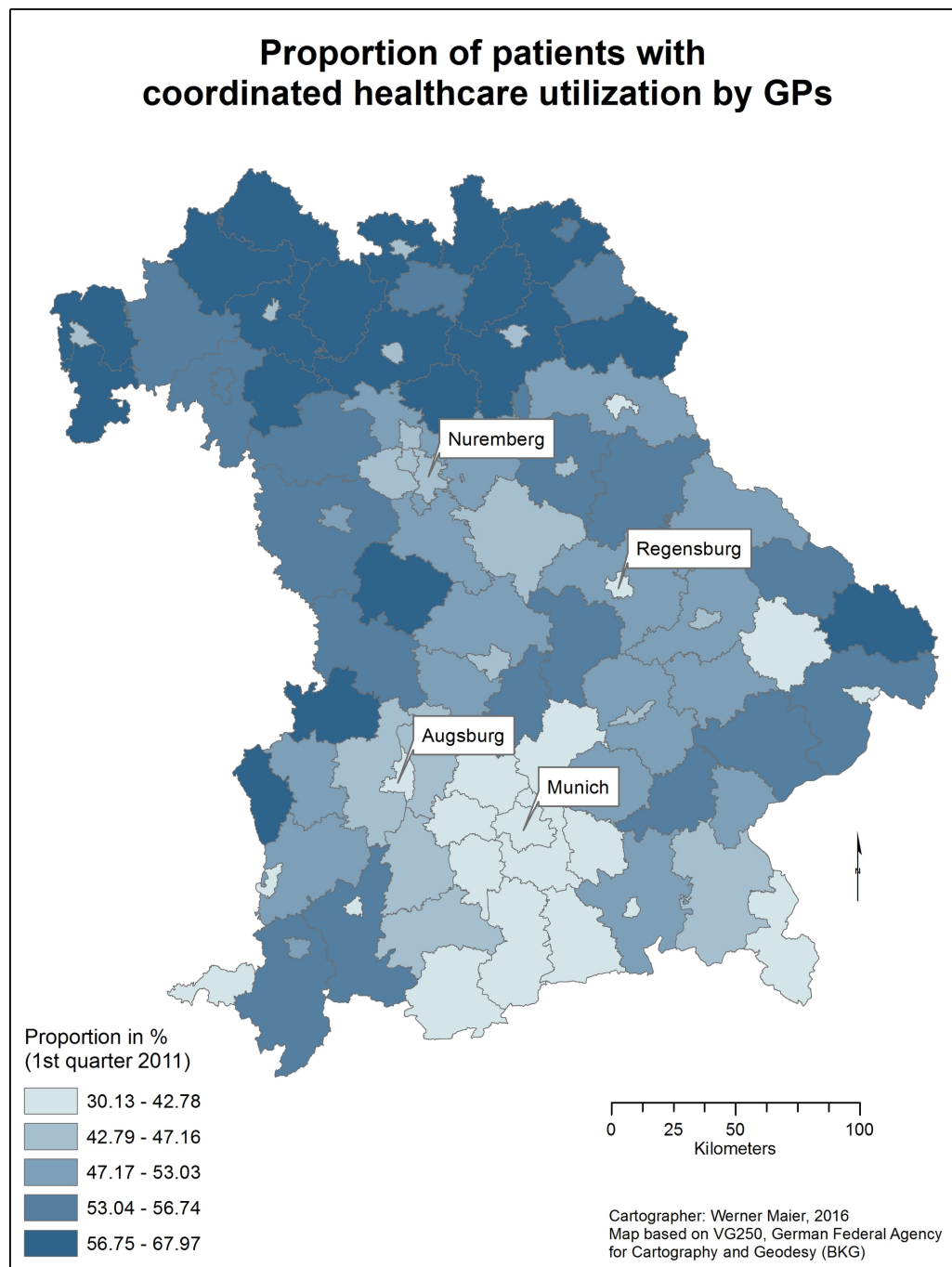


Figure 2 Proportion of patients with coordinated healthcare use by GPs. GP, general practitioner.

6 and 7). Increasing regional deprivation was associated with a higher proportion of coordinated healthcare use (models 8 and 9). The highest degree of coordination was observed in the fourth deprivation quintile ($\beta=12.55$), with city districts in the fifth quintile resulting a slightly lower proportion of coordinated patients.

Table 4 presents the results of four distinct SAR models for the mean claim by specialists. The mean claim in administrative cities was €9.94 higher than in districts without city status (model 1). The BBSR structural type shows that large cities in particular have higher average claims by specialists, with no significant variation between

the other three groups (differences between €14.72 and €17.36 as compared with large cities (model 2)). When including both city status and structural type in the model, these effects are smaller but remain significant (model 3). After adjusting for city status, total specialist claims in the least deprived districts (quintile 1) are €11.37 higher on average than in more deprived districts (model 4). Little variation is seen between districts in the quintiles 2 to 5.

Hierarchical models

Figure 3 visualises the results 11 distinct hierarchical regression models with coordination of care as the

Table 3 Results of nine different simultaneous autoregressive regression models with 'proportion of patients with coordinated healthcare use by GPs' as target variable in association with different independent variables

Model	Explanatory variables	β	SE	p Value
1	Administrative status (reference: rural district)			
	City	-7.52	1.67	<0.001
2	Settlement structure (reference: large cities)			
	Urban districts	3.11	2.99	0.300
	Rural districts with densification	8.99	2.80	0.001
	Sparsely populated rural districts	9.76	2.80	<0.001
3	Settlement structure (reference: large cities)			
	Urban districts	-3.78	3.36	0.264
	Rural districts with densification	2.70	3.09	0.383
	Sparsely populated rural districts	3.54	3.12	0.259
	Administrative Status (reference: rural district)			
	City	-7.49	1.89	<0.001
4	Physician density of GPs	-0.21	0.09	0.020
5	Physician density of GPs			
	Administrative Status (reference: rural district)	0.00	0.13	1.000
	City	-5.27	14.39	0.710
	Interaction of GP density and administrative status	-0.03	0.19	0.880
6	Physician density (all ambulatory physicians)	-0.06	0.01	<0.001
7	Physician density (all ambulatory physicians)	-0.16	0.03	<0.001
	Administrative Status (reference: rural district)	-24.10	10.08	0.017
	City			
	Interaction of density of all physicians: district	0.14	0.04	<0.001
8	Bavarian Index of Multiple Deprivation (reference: quintile 1 with least deprived districts)			
	Quintile 2	2.64	2.17	0.223
	Quintile 3	5.75	2.13	0.007
	Quintile 4	8.39	2.16	<0.001
	Quintile 5	1.48	2.36	0.531
9	Bavarian Index of Multiple Deprivation (reference: quintile 1 with least deprived districts)			
	Quintile 2	3.92	1.82	0.031
	Quintile 3	7.99	1.81	<0.001
	Quintile 4	12.55	1.88	<0.001
	Quintile 5	9.38	2.19	<0.001
	Administrative status (reference: rural district)			
	City	-11.02	1.59	<0.001

GP, general practitioner.

response variable. ORs with 95% CIs are displayed for all model specifications. Parameter estimates for each model are connected by lines, with colours used to code the types of variables included in the model. Thus, black curves were adjusted for age and gender; blue curves were additionally adjusted for regional variables (settlement structure; city/rural district), green curves were additionally adjusted for diagnoses variables (chronic disease; mental disorders; number of diagnosis groups) and red

curves were adjusted for all variable types. All models showed that the likelihood of GP-coordinated healthcare increased significantly with age. The main effect of sex reveals that female patients on average have a higher probability for uncoordinated healthcare use. The interaction effect shows that this is particularly the case with female patients under the age of 30 years. Chronic illness was a significant and strong predictor for GP coordination. In contrast, patients with a mental illness or with

**Table 4** Results of four different simultaneous autoregressive regression models with 'mean claim by specialists in Euro' as target variable in association with different independent variables

Model	Explanatory variables	β	SE	p Value
1	Administrative status (reference: rural district)			
	City	9.94	2.79	<0.001
2	Settlement structure (reference: large cities)			
	Urban districts	-14.72	5.04	0.004
	Rural districts with densification	-17.36	4.71	<0.001
	Sparsely populated rural districts	-14.84	4.76	0.003
3	Settlement structure (reference: large cities)			
	Urban districts	-8.44	5.59	0.131
	Rural districts with densification	-11.93	5.13	0.020
	Sparsely populated rural districts	-9.35	5.18	0.071
	Administrative Status (reference: rural district)			
	City	6.94	3.14	0.027
4	Bavarian Index of Multiple Deprivation (reference: quintile 1 with least deprived districts)			
	Quintile 2	-11.09	3.58	0.002
	Quintile 3	-11.17	3.62	0.002
	Quintile 4	-9.44	3.69	0.011
	Quintile 5	-13.78	4.04	<0.001
	Administrative status (reference: rural district)			
	City	14.00	2.99	<0.001

increasing numbers of medical condition categories were less likely to be coordinated. With respect to regional factors, increasing deprivation was associated with greater GP coordination, with the exception of the most deprived quintile, which in most models returned an effect size comparable to the third and fourth quintile. Additionally, an increasing number of different medical condition categories presented a linearly decreasing probability for GP coordination. Patients in cities were less frequently coordinated. Finally, the structural district type shows that increasing rurality is associated with increasing GP coordination. However, this effect disappears when additional adjustment is made for city status. These two regional variables contain very similar information, with the administrative city status being the stronger predictor.

Figure 4 visualises the effects estimated by the hierarchical regression models for the total amount claimed by specialists (in €). The underlying parameter estimates and CIs are provided as (see online supplementary information). On average, this increases with age. The effects observed for sex are more complex, with a significant interaction is found with age. Whereas female sex is associated with higher costs among younger patients, male sex is associated with higher cost in patients older than approximately 45 years. The number of medical condition categories also exhibited a strong predictive effect. Three or more medical condition categories resulted in an additional financial claim of €170 on average. The presence of a chronic disease was associated with an

additional specialist claim of about €76 on average and a mental illness with an additional claim of about €140. Overall, the number of medical condition categories, increasing age and the presence of a mental or chronic disease were the strongest predictive factors for a higher financial claim from specialists. Likewise, living in a city was a further predictor for a higher claim.

DISCUSSION

To our knowledge, the present study is the first investigation to measure the determinants and impact of GP-coordinated healthcare use with respect to regional variation in Bavaria, Germany. Claims data covering more than 3.6 million anonymous patients were analysed. The most prominent finding is that the GP coordination of specialist care was significantly higher in rural districts and in highly deprived regions, as compared with urban and less deprived regions. With respect to patient characteristics, increasing age and the presence of chronic diseases were the strongest predictive factors for coordinated healthcare use. In contrast, the presence of a mental illness, an increasing number of medical condition categories and living in an urban district are strong predictors for specialist use without coordination. The amount claimed per patient was €10 to €20 per quarter higher in urban districts and in regions with lower deprivation. These cost effects are relatively low in comparison with the average specialist claim (€157.30 for coordinated patients and €186.54 for uncoordinated patients), but amount to a

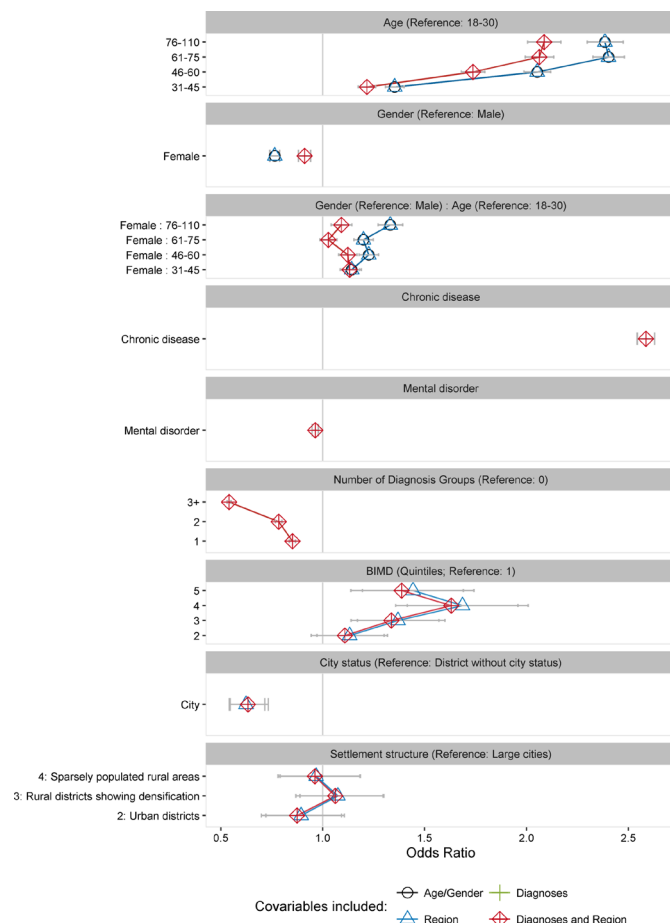


Figure 3 Results of four different hierarchical regression models with 'proportion of patients with coordinated healthcare use by GPs' as response variable (ORs with 95% CIs). Black curves were adjusted for age and gender only. Blue curves were additionally adjusted for different regional variables (settlement structure or city/rural district), green curves for different diagnoses variables (chronic disease or mental disorders or number of diagnosis groups) and red curves for all variable types. Parameter estimates and CIs are provided as (see online supplementary material). BIMD, Bavarian Index of Multiple Deprivation.

substantial cost difference at a population level. The results from both district and patient level analyses are consistent.

Bergmann *et al*¹³ have previously shown that an increasing number of chronic diseases as well increasing age, lower social status and a higher body mass index were associated with more frequent GP use in Germany. We add to this result by showing that increasing age and district-level deprivation are associated with stronger GP coordination of specialist care. Thode and colleagues¹⁰ found that female sex, unemployment and urban regions were associated with more frequent overall physician use. Moreover, they found that patients consulting general practitioners had more overall physician contacts, reasoning that this stands in contrast to the assumed gatekeeping function of the GPs. However, these studies did not explicitly consider the coordination function of the GPs and used an unusual definition of gatekeeping.

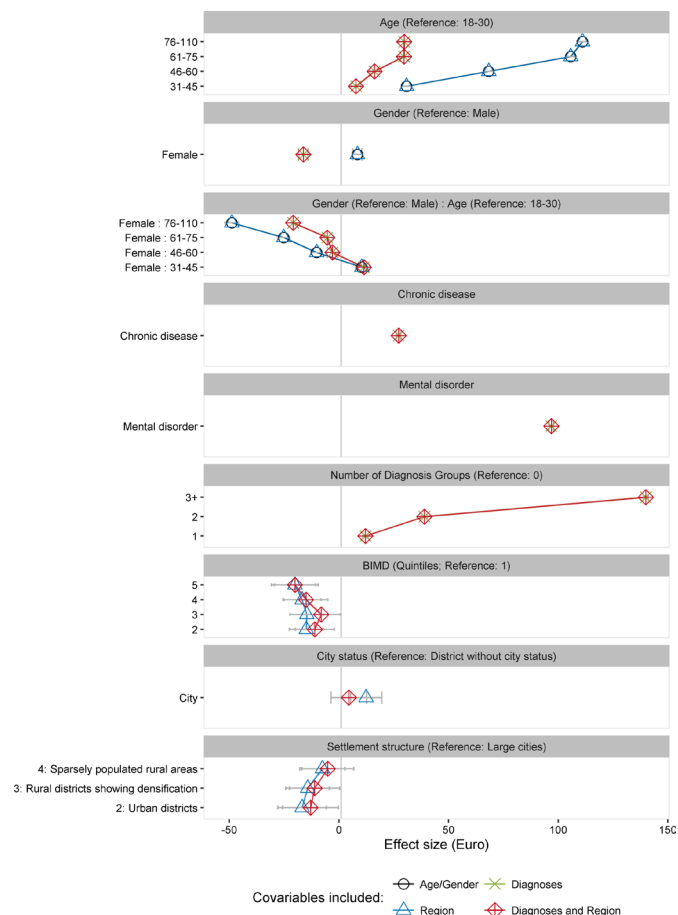


Figure 4 Results of four different hierarchical regression models with the estimated 'mean claim by specialists in Euro' as response variable. Black curves were adjusted for age and gender only. Blue curves were additionally adjusted for different regional variables (settlement structure or city/rural district), green curves for different diagnoses variables (chronic disease or mental disorders or number of diagnosis groups) and red curves for all variable types. Parameter estimates and CI are provided as (see online supplementary material). BIMD, Bavarian Index of Multiple Deprivation.

The concept of gatekeeping requires that every treatment episode starts with a GP consultation.²⁵ Therefore, the consultation of a GP alone does not satisfy this concept, because a patient could, for example, consult a GP for a minor infection and an orthopaedic specialist for back pain. We did not consider such cases to represent GP-coordinated care because the GP is not necessarily involved in or even aware of the specialist consultation.

The concept of a gatekeeping primary care physician was applied in the USA in the 1980s within the context of managed care.²⁶ However, the concept of primary care is a wider than gatekeeping alone. Recent reviews^{22 27} conclude that the current international evidence on the effects of isolated gatekeeping is still limited and inconsistent. The available studies on health and patient-related outcomes were found to be insufficient and inconclusive. Most studies have focused on healthcare use and expenditures, with the majority suggesting lower expenditures of 6% to 80% with gatekeeping. The example of



the US Health Maintenance Organisation model shows that healthcare rationing can also lead to problems and burden the relationship between physicians and patients. These problems can potentially lead to higher overall costs.^{28–31}

It is well known that coordination of care leads to cost savings across the healthcare system^{22 32 33} and that healthcare expenditures show clear regional differences all over the world.^{34–37} Analysing the claims data of around 6.3 million patients, Salm *et al*³⁸ found that regional variation in ambulatory German healthcare use can largely be explained by patient characteristics instead of supply factors as has been shown for other countries.³⁹ This is in line with the present findings, where patient characteristics had a higher influence on cost than regional factors. A recent study by Göppfarth *et al*⁴⁰ analysed a variety of administrative health-related and socioeconomic data covering about 90% of the German population. They found that, while the patient-level attributes of age, sex and diagnoses could explain 55% of variation in healthcare expenditure, the addition of district-level factors such as deprivation and rurality increased the variance explained to 72%. The authors conclude that regional variation is not simply a reflection of system inefficiency but due to real differences in need. Our results are in agreement that regional deprivation is a predictor for both GP coordination and the cost of health use. Busato *et al*⁴⁰ likewise reasoned that there are still unexplained regional differences in the per capita cost which are not explained by demographic factors, access to care or needs. Greater access to care could potentially lead to more inappropriate use of specialists to such an extent that gatekeeping systems or incentives for better coordination of primary care may slow growth in healthcare expenditure. Education status as an indicator for the socioeconomic level is a known determinant of healthcare use and might be a stronger predictor than income or employment status.^{41 42} Higher education is thereby associated with an increased specialist and lower GP use.^{12 14 15}

In Europe, lower individual socioeconomic status and higher regional deprivation are also associated with greater morbidity and mortality.^{17 23} Deprived regions in England show greater use of primary care and hospital services.⁴³ Additionally, Charlton *et al*⁴⁴ found within a cohort study of 282 887 patients in UK that higher deprivation is strongly associated with multiple morbidity, depression and increased healthcare costs. In New Zealand, the health use research alliance revealed that the rate of GP consultations increases with increasing socioeconomic deprivation.⁴⁵ In contrast, Cumming *et al* found that deprivation is unrelated to GP visits in New Zealand.⁴⁶ This contradiction leads to the assumption that there are still unexplained factors. However, compared with the healthcare system in Germany, it must be appreciated that the above-mentioned healthcare system are very different and heterogeneous. The peculiarity of the current German healthcare system is that almost all specialist physicians and general practitioners

may be consulted freely without control, which implies a relatively unrestricted patient demand. Therefore, it is of special interest to investigate the impact of a GP-coordinated healthcare use depending on regional variation compared with an uncoordinated use within the same healthcare system.

The present study shows that specialist care is more often coordinated by GPs in rural and deprived regions, which in turn are more cost-efficient. The question arises whether the effect of gatekeeping or rather the coordination of healthcare use was taken into account sufficiently in previous studies on regional variation. According to the review from Starfield *et al*, an optimal supply of primary care can be measured in terms of four different key characteristics.⁴⁷ The first characteristic is the first-contact access for each new need. That means that for an initial contact, a low-threshold access for all patients should be offered within primary care. The second characteristic is long-term person-focused care: a patient-centred care instead of a disease-centred care should be performed. The third characteristic is comprehensive care which covers the majority of healthcare needs and the fourth characteristic is coordination of care when the care must be sought elsewhere. These four elements ensure an optimal primary healthcare supply and represents a protection against overuse and misuse of healthcare practices and protects against potential harm due to unnecessary multiple examinations or medical interventions. Thus, differences in the gatekeeping role may lead to a more complete explanation of regional variation in future studies.

Strengths and limitations

Our study has several strengths. First, the study data cover all statutorily insured patients and are thus more representative than the data of individual insurances or treatment centres. Second, although unmeasured confounding is possible, we adjusted for regional deprivation and clinical factors (morbidity, involved specialists) that may affect healthcare use. Third, our results are robust with respect to the model specification. Finally, due to the study data and design, our findings are highly generalisable. Nevertheless, our cross-sectional study based on routinely collected data has a number of limitations. The data are routinely collected and largely uncontrolled and were not collected for the study purposes. Only patients with a use of specialists were considered. Patients without physician contact and patients with only GP use were not included in the analyses. Avoiding unnecessary medical treatments is an important part of primary care. However, it would appear difficult to investigate the question of unnecessary treatments in a reliable manner based on routine data. Further, the present investigation did not consider the quality of care or quality of life, thus the present results do not allow a final evaluation of the GP coordination depending on regional variation.

CONCLUSION

The present study shows that regional deprivation is closely associated with the way in which patients access primary and specialist care. The increasing average life expectancy and the related increase of chronic diseases suggest that the gatekeeping function will become more and more important. This has clear consequences, both with respect to the role of the GP and the financial costs of care. Additionally, the impact of gatekeeping should be considered in more detail by further investigations on regional variation.

Contributors AS, ED, MT, RG, WM, AM, KL, MM designed the study. ED performed the analysis. MM, ED, CS and WM wrote the initial version of the manuscript. WM created the map. ED, MT, RG, WM, AM, KL, CS revised the manuscript. All authors read and approved the final manuscript.

Funding The study was funded by the Central Research Institute for Ambulatory Health Care in Germany (Zentralinstitut für die Kassenärztliche Versorgung in Deutschland).

Competing interests ED, MT and RG are employees of the Association of Statutory Health Insurance Physicians of Bavaria.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement No additional data are available.

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BMJ Open 2017 7:
doi: 10.1136/bmjopen-2017-016218

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