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Social disparities in Disease Management Programmes for coronary heart disease in Germany: a cross-classified multilevel analysis

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ABSTRACT

Background Disease Management Programmes (DMPs) aim to improve effectiveness and equity of care but may suffer from selective enrolment. We analysed social disparities in DMP enrolment among elderly patients with coronary heart disease (CHD) in Germany, taking into account contextual effects at municipality and primary care practice levels.

Methods Cross-sectional analysis of effects of educational attainment and regional deprivation on physician-reported DMP enrolment in a subsample of a large population-based cohort study in Germany, adjusting for individual-level, practice-level and area-level variables. We calculated OR and their 95% CIs (95% CI) in cross-classified, multilevel logistic regression models.

Results Among N=1280 individuals with CHD (37.3% women), DMP enrolment rates were 22.2% (women) and 35% (men). The odds of DMP enrolment were significantly higher for male patients (OR=1.98 (1.50 to 2.62)), even after adjustment for potential confounding by individual-level, practice-level and area-level variables (range: OR=1.60 (1.08 to 2.36) to 2.16 (1.57 to 2.98)). Educational attainment was not significantly associated with DMP enrolment. Compared to patients living in least-deprived municipalities, the adjusted propensity of DMP enrolment was statistically significantly lower for patients living in medium-deprived municipalities (OR=0.41 (0.24 to 0.71)), and it also tended to be lower for patients living in the most-deprived municipalities (OR=0.70 (0.40 to 1.21)). Models controlling for the social situation (instead of health-related behaviour) yielded comparable effect estimates (medium-deprived/most-deprived vs least-deprived areas: OR=0.45 (0.26 to 0.78)/OR=0.68 (0.33 to 1.19)). Controlling for differences in comorbidity attenuated the deprivation effect estimates.

Conclusions We found evidence for marked gender, but not educational disparities in DMP enrolment among patients with CHD. Small-area deprivation was associated with DMP enrolment, but the effects were partly explained by differences in comorbidity. Future studies on DMPs should consider contextual effects when analysing programme effectiveness or impacts on equity and efficiency.

INTRODUCTION

Coronary heart disease (CHD) is the leading cause of death and an important cause of morbidity worldwide[1 2] and in Germany.[3] CHD is among the major chronic diseases covered by Disease Management Programmes (DMPs), which were introduced between 2002 and 2005 into the German statutory health insurance system (SHI). The rationale was to improve quality of care,[4] provide financial incentives for purchasers and providers to care for the chronically ill[5] and to improve survival and quality of life of enrolled patients.[6] The first DMPs for CHD (DMP-CHD) were introduced in 2003. Ten years later, more than 1.7 million patients across Germany were enrolled in about 1700 accredited DMPs for CHD.[7]

An unresolved issue concerning all DMPs is whether there is selective enrolment, favouring patients with higher socioeconomic status (SES). This would affect conclusions on the effectiveness of DMPs regarding the programme goals.[8 9] Three mechanisms, operating at different levels, could lead to disparities in DMP enrolment: First, participation in DMPs is voluntary for patients. Uptake might be inversely associated with need and individual SES.[10] Second, physicians have the mandate to enrol only 'active patients' with respect to their therapy who can potentially benefit from the programme,[6] which might be those who are already adherent to physician recommendations and have less risk factors, amplifying pre-existing behavioural barriers towards uptake of preventive programmes for patients with lower SES. Third, contextual factors of the small-area social environment[11] such as neighbourhood socioeconomic disadvantage,[12 13] as well as characteristics at the level of primary care practices,[14] might jointly or independently affect the access to and utilisation of DMPs.

The aim of this study was to assess social disparities in enrolment in DMPs among elderly people with CHD. We analysed whether individual educational attainment and regional deprivation are independently associated with DMP enrolment, considering potential confounding by characteristics at individual-level, practice-level and/or area-level.

METHODS

Design, study population and context

This analysis was based on a subsample of the "Epidemiological Study for the Prevention, Early Diagnosis and Optimal Treatment of Chronic Diseases in an Elderly Population" (ESTHER), a prospective cohort study including non-institutionalised people from the general population living in the federal state of Saarland/Germany, who were recruited by their general practitioners (GPs) during a general health check-up between 2000 and 2002 (t0). Baseline recruitment (t0) occurred before DMPs were introduced.[5]

A total of 9949 out of 12 000 invited individuals, aged 50–75 years, agreed to participate in the cohort. This sample is representative for the population of Saarland in the respective age range.[15] Numerous GP-reported and patient-reported measures were captured by postal questionnaires at baseline and after two (t1), five (t2), eight (t3) and 11 (t4) years of follow-up.[15–17]

Saarland is divided into 52 municipalities (*Gemeinden*) comprising 1.2% of the overall population in Germany. Population sizes at the municipality level range from 6100 inhabitants (smallest) to more than 175 800 (largest).

Inclusion and exclusion criteria

Since information on DMP enrolment was not available prior to t3 (2008–2010), we a priori excluded N=2937 individuals. These were non-responders (ie, participants for whom neither patient questionnaires nor GP-reported information was available, n=694), and participants who died (n=1033) or dropped out (n=1210) on health grounds (n=253) or other and unknown reasons (n=957) since t0. At t3, the response rate among survivors who were still physically and mentally able to participate was 80.9% (N=7012). Exclusion criteria specific to this study were defined as not having a GP-reported diagnosis of myocardial infarction (MI) and/or angina pectoris (AP) between t0 and t3 (n=5694), missing data on baseline SES (n=36) and being institutionalised at t3 (n=2). A non-responder analysis was performed comparing the cohort population at t3 (N=7012) with those who were a priori excluded (N=2937) with respect to relevant baseline criteria (see online supplementary file 2).

Outcome, exposure and covariables

The outcome was the GP-reported enrolment status (yes/no) in the DMP-CHD at t3. Self-reported DMP-CHD status was used for n=133 individuals for whom GP-reported diagnosis of MI and/or AP, but no GP-reported information on DMP-CHD status, was available.

Educational attainment

The highest educational attainment at baseline was used to approximate individual-level SES. It was defined as an ordinal variable with three levels (table 1).

Area-level SES

We used the German Index of Multiple Deprivation (GIMD) for the year 2006[18 19] to assess the effects of small-area deprivation on the propensity of DMP enrolment. Patients and their GPs were assigned a distinct value of regional deprivation at the municipality level by linking their ZIP codes (at t3) to one of 52 municipalities ('patient-residential area' and 'GP-residential area'). Municipalities were grouped into tertiles (table 1) in relation to all 9620 municipalities in Germany.

Individual-level covariables

As part of a variable selection process, we considered three categories of individual-level characteristics (beyond age and sex) as potential confounders in separate models. These were (table 1):

I. Comorbidities captured by the Cumulative Illness Rating Scale for Geriatrics (CIRS-G) severity index[20] to adjust for differences in need;
II. Behavioural risk factors;
III. Ethnic differences in terms of immigration background and the social situation.

We present the results of the comorbidity-adjusted models since these are essential for analyses of disparities in healthcare.[21] The other models are presented in online supplementary file 1 (tables S1–S2).

Practice-level and area-level covariables

We controlled for potential differences in DMP enrolment that could arise due to (1) provider characteristics[14] (differences in gender of GPs that could lead to different treatment of individuals based on their social group characteristics such as educational attainment or deprivation of place of residence) or due to (2) rural/urban characteristics following the definition of the European Union Commission[22] (table 1).

Missing data

Patients without ZIP codes (n=14) or GP identifiers (n=25) were not included in the regression analysis. Missing data in covariables were treated as missing at random and a complete case analysis was performed.

Statistical analysis

We calculated absolute frequencies and proportions stratified by sex for all variables used in this study. Owing to the cross-nested nature of the data, we assessed the effects of educational attainment and area-level SES on DMP enrolment using cross-classified, multilevel logistic regression models. In contrast to conventional multilevel analysis, cross-classified models consider the fact that patients are simultaneously nested *both* in their residential area *and* in GP practices, while patients' and GPs' residential areas may differ. In the cross-classified model, patients (level 1) are nested at level 2 in the cross-classification of 'GPs-by-municipality' (or more specifically: "GP-practices-by-patient-residential-area").

We calculated the median ORs (MORs)[23] to quantify the degree of clustering at higher levels, and tested the model fit of cross-classified null models by means of likelihood-ratio tests against three alternative models (see online supplementary file 1).

We present crude and adjusted subject-specific OR with their 95% CIs to quantify the fixed effects of the predictors on the outcome. We calculated the proportional change in variance (PCV) at municipality-level and practice-level, respectively, in order to assess the effects of individual-level, practice-level and/or area-level variables on the random part.[24] To check for violations of the assumption of normality of random effects that may arise due to small average cluster sizes quantile–quantile plots were created (see online supplementary file 1). All analyses were performed using Stata V.12.1.

RESULTS

Descriptive results

The lifetime prevalence of physician-reported CHD in the cohort at t3 (N=7012) was 18.8% (n=1318). Of these, N=1280 (37.3% women) fulfilled all inclusion criteria. The mean age was 72.3 years (SD 6.2). Three-quarters of the subsample with CHD had a low educational attainment and 47.8% lived in municipalities categorised as most deprived (T3; table 2).

Absolute and relative differences in deprivation scores between the most and least deprived municipality were 25.50 index points and 327%, respectively. The lifetime prevalence of physician-reported MI in the study population (N=1280) was lower among female participants (26.3%) compared to male participants (44.1%), while the prevalence of AP was fairly balanced. The vast majority (72.6%) of patients enrolled in the DMP-CHD (N=387) were male. The overall DMP enrolment

Table 1 Definition of outcome, exposure and covariables

	Definition
Outcome	
DMP enrolment	GP-reported enrolment status (yes/no) in the DMP-CHD at t3 (2008–2010)
Exposure	
Individual-level	
Highest educational attainment	Level I (lowest): no formal degree or at least 9 years of schooling qualifying for professional training, *Hauptschule* Level II (medium): at least 10 years of schooling qualifying for professional training, *Realschule/Mittlere Reife* Level III (highest): at least 12 or 13 years of schooling qualifying for university entrance, *Fachhochschulreife/Abitur*
Area-level	
Regional deprivation of patients' residential areas (GIMD)	The GIMD includes seven domains of area deprivation: income, employment, education, municipal or district revenue, social capital, environment and security. Absolute deprivation scores were grouped into tertiles comprising: T1: least-deprived municipalities T2: medium-deprived municipalities T3: most-deprived municipalities
Covariables	
Comorbidity	
Cumulative Illness Rating Scale for Geriatrics (CIRS-G) severity index	GP-reported comorbidities calculated as CIRS-G score divided by the number of endorsed CIRS-G categories
Behavioural risk factors	
Hypercholesterolaemia	Self-reported diagnosis of hypercholesterolaemia (yes/no) (ever diagnosed)
Smoking status	Self-reported smoking status in three categories 'Never smoker', 'Former smoker' and 'Current smoker'
Alcohol consumption in g/day according to the WHO drinking categories*	Self-reported alcohol consumption of beer, wine or liquor per week Abstainers: reporting a consumption of 0 g/day DI: female: 0–19.99; male: 0–39.99 DII: female: 20–39.99; male: 40–59.99 DIII: female: >40.0; male: >60.0
Body mass index (BMI)	Self-reported weight (in kilograms) over height (to the power of two) in four categories BMI<25: underweight-normal BMI 25.00–29.99: Overweight/pre-obese BMI 30.00–39.99: Obese class I+II BMI≥40: Obese Class III
Social situation and ethnicity	
Immigration background (yes/no)	Having an immigration background was defined as having (1) a foreign nationality or (2) a German nationality and a place of birth outside of Germany
Living in a partnership (yes/no)	Self-reported answer to question: do you live in a partnership?
Social contacts	The number of social contacts was included as a proxy of loneliness. It was captured by the question "How many family members/relatives/friends do you have which whom you can discuss any problems and on which you can rely?". The responses were collapsed into an ordinal variable with three categories ('0–1', '2–4' and '5–10 and more'
Approved need of long-term care	Need of long-term care as approved by the Medical Review Board of Statutory Health Insurance Funds (*Medizinischer Dienst der Krankenkassen*) as a self-report. The variable was used as a measure to approximate ability to participate in social life
Current economic activity	Self-reported current economic activity, categorical variable comprising six categories ('Full-time employment', 'Minor/occasional employment', 'Part-time employment', 'Housewife/Domestic activity', 'Retired' and 'Unemployed')
Area characteristics	
Degree of urbanisation	Rural: <300 inhabitants/km^2 or less than 5000 inhabitants Urban cluster: ≥300 inhabitants/km^2 and minimum population of 5000 inhabitants, but less than 50 000 High-density cluster: ≥1000 inhabitants/km^2 and minimum population of 50 000 inhabitants

All data refer to the 8-year follow-up phase (t3: 2008–2010) if not otherwise stated.
*Amount of alcohol per type of alcohol used to calculate categories: 1 bottle of beer=11.88 g; 1 glass of wine=22.0 g; 1 shot of liquor=6.4 g.
GP, general practitioner; DMP-CHD, Disease Management Programmes coronary heart disease; GIMD, German Index of Multiple Deprivation.

rates were 22.2% among women with CHD (N=478) and 35% among men (N=802). More details are shown in table 2.

Out of all GP practices (N=391), the majority (76.6%) drew their patients with CHD from only one (not necessarily their own) municipality. The number of GP practices per municipality ranged from as few as one GP to 83 GPs. The average number of patients with CHD residing in the 52 municipalities or being treated in the 391 practices was 24.3 (SD: 33.8) and 3.2 (SD: 4.4), respectively. About 90% (n=1103) of the patients for whom linkage to both patient-residential area and GP-residential area was possible (N=1221) were treated by primary care physicians whose practices were located in municipalities with deprivation tertiles equal to that of their patients with CHD. Thus, the overall heterogeneity at practice level in terms of SES among patients with CHD was relatively low.

Regression results

Crude analysis

According to the crude models, the odds of enrolment in the DMP-CHD were significantly higher—regardless of the place of residence or practice-level effects—for male participants, participants categorised to drinking category DI compared to abstainers and patients with a higher severity of comorbidities (CIRS-G). The crude point estimates for the effects of educational attainment and GIMD tertiles on DMP enrolment

Table 2 Descriptive characteristics of included participants of the ESTHER study with coronary heart disease at the 8-year follow-up (2008–2010) (N=1280)

	Female Freq. (col %)	Male	Total	Missing Freq. (% of N)
Individual-level characteristics				
Age group				
55–64	33 (6.9)	132 (16.5)	165 (12.9)	
65–74	241 (50.4)	386 (48.1)	627 (49)	
75–84	204 (42.7)	284 (35.4)	488 (38.1)	
N (%)	478 (100)	802 (100)	1280 (100)	0 (0)
Highest educational attainment*				
Level I (lowest)	402 (84.1)	591 (73.7)	993 (77.6)	
Level II	56 (11.7)	84 (10.5)	140 (10.9)	
Level III (highest)	20 (4.2)	127 (15.8)	147 (11.5)	
N (%)	478 (100)	802 (100)	1280 (100)	0 (0)
Immigration background				
Yes	45 (9.5)	60 (7.5)	105 (8.2)	
N (%)	475 (100)	798 (100)	1273 (100)	7 (0.5)
Lifetime prevalence of physician-reported CHD defining morbidities/index diseases				
Myocardial infarction				
Yes	118 (26.3)	346 (44.1)	464 (37.6)	
N (%)	448 (100)	785 (100)	1233 (100)	42 (3.3)
Angina pectoris				
Yes	459 (96)	745 (93.2)	1204 (94.3)	
N (%)	478 (100)	799 (100)	1277 (100)	3 (0.2)
Comorbidities and behavioural risk factors				
CIRS-G—severity index				
M (SD)	1.60 (0.43)	1.61 (0.45)	1.61 (0.44)	
N	394	663	1057	223 (17.4)
Hypercholesterolaemia				
Yes	322 (73.7)	509 (67.2)	831 (69.5)	
N (%)	437 (100)	758 (100)	1195 (100)	85 (6.6)
Smoking status				
Never smoker	270 (72.2)	217 (32)	487 (46.3)	
Former smoker	74 (19.8)	406 (59.9)	480 (45.6)	
Current smoker	30 (8)	55 (8.1)	85 (8.1)	
N (%)	374 (100)	678 (100)	1052 (100)	228 (17.8)
Alcohol consumption in g/day according to the WHO drinking categories‡				
Abstainers	172 (53.9)	152 (24.7)	324 (34.7)	
DI	135 (42.3)	430 (69.8)	565 (60.4)	
DII	11 (3.4)	23 (3.7)	34 (3.6)	
DIII	1 (0.3)	11 (1.8)	12 (1.3)	
N (%)	319 (100)	616 (100)	935 (100)	283 (22.1)
Body mass index				
BMI<25 (underweight–normal)	125 (27.4)	151 (19.3)	276 (22.3)	
BMI 25.00–29.99 (overweight/pre-obese)	191 (41.8)	401 (51.3)	592 (47.8)	
BMI 30.00–39.99 (obese class I+II)	132 (28.9)	212 (27.1)	344 (27.8)	
BMI ≥40 (obese class III)	9 (2)	18 (2.3)	27 (2.2)	
N (%)	457 (100)	782 (100)	1239 (100)	41 (3.2)
Chronic care services utilisation (physician-reported)				
Enrolment in DMP-CHD				
No	372 (77.8)	521 (65)	893 (69.8)	
Yes	106 (22.2)	281 (35)	387 (30.2)	
N (%)	478 (100)	802 (100)	1280 (100)	0 (0)
Duration of enrolment in DMP-CHD				
Low (0.5–3 years)	61 (64.2)	154 (60.4)	215 (61.4)	
High (4–7 years)	34 (35.8)	101 (39.6)	135 (38.6)	
N (%)	95 (100)	255 (100)	350 (100)	37 (9.6)

Continued

Table 2 Continued

	Female Freq. (col %)	Male	Total	Missing Freq. (% of N)
Social situation				
Living in a partnership				
Yes	178 (51.7)	528 (85.3)	706 (73.3)	
N (%)	344 (100)	619 (100)	963 (100)	317 (24.8)
Social contacts (family members/friends whom participants can count on/discuss problems with)				
0–1	48 (14.2)	93 (14.7)	141 (14.5)	
2–4	184 (54.4)	331 (52.2)	515 (53)	
5–10 and more	106 (31.4)	210 (33.1)	316 (32.5)	
N (%)	338 (100)	634 (100)	972 (100)	308 (24.1)
Current economic activity				
Full-time employment	3 (0.8)	32 (4.8)	35 (3.4)	
Minor/occasional employment	4 (1.1)	4 (0.6)	8 (0.8)	
Part-time employment	5 (1.4)	5 (0.7)	10 (1)	
Housewife/domestic activity	129 (35.4)	4 (0.6)	133 (12.8)	
Retired	222 (61)	620 (92.1)	842 (81.2)	
Unemployed	1 (0.3)	8 (1.2)	9 (0.9)	
N (%)	364 (100)	673 (100)	1037 (100)	243 (19.0)
Practice-level characteristics				
Gender of primary care physician				
Male	332 (73.6)	588 (76.9)	920 (75.7)	
Female	119 (26.4)	177 (23.1)	296 (24.3)	
N (%)	451 (100)	765 (100)	1216 (100)	64 (5.0)
Area characteristics				
Regional deprivation of patients' residential areas (GIMD)				
T1 (least deprived)	57 (12)	120 (15.2)	177 (14)	
T2	178 (37.5)	306 (38.7)	484 (38.2)	
T3 (most deprived)	240 (50.5)	365 (46.1)	605 (47.8)	
N (%)	475 (100)	791 (100)	1266 (100)	14 (1.1)
Degree of urbanisation				
Rural	99 (20.8)	175 (22.1)	274 (21.6)	
Urban cluster	288 (60.6)	487 (61.6)	775 (61.2)	
High-density cluster	88 (18.5)	129 (16.3)	217 (17.1)	
N (%)	475 (100)	791 (100)	1266 (100)	14 (1.1)

All data refer to the 8-year follow-up phase (t3: 2008–2010) if not otherwise stated.
*Highest educational attainment: Level I: no degree or minimum of 9 years of education qualifying for professional training (Hauptschule). Level II: minimum of 10–11 years of education qualifying for professional training (Realschule/Mittlere Reife). Level III: minimum of 12–13 years of education qualifying for university entrance (Fachhochschulreife/Abitur).
‡Alcohol consumption in g/day: DI: female: 0–19.99; male: 0–39.99. DII: female: 20–39.99; male: 40–59.99. DIII: female: >40.0; male: >60.0. T1-T3: Tertiles of the German Index of Multiple Deprivation (GIMD).
Col%, column percent; Freq., absolute frequency; M, arithmetic Mean.

indicated a social gradient, but these were not statistically significant as judged by the 95% CIs (table 3).

Models adjusted for individual-level factors and higher level variables

Morbidity-adjusted models—fixed effects

The trends observed in the crude analysis for the effects of educational attainment on DMP enrolment (table 3) were attenuated when adjusting for the severity of comorbidities (CIRS-G), age and sex (table 4, M1). This indicates an equal enrolment in the DMP for equal need (measured by CIRS-G) between patients with different educational attainments.

Additional adjustment for practice-level factors did not change the relationship between educational attainment and DMP enrolment (table 4, M2). The trends observed in the crude analysis for the effects of regional deprivation on DMP enrolment (table 3) were attenuated in the model which adjusted for differences in comorbidities, age, sex, educational attainment and gender of GPs (table 4, M3).

Additional adjustment for differences in the degree of urbanisation further attenuated the deprivation effects in the comorbidity model (table 4, M4). Compared to rural areas, the odds of enrolment in the DMP was 44% lower (OR=0.56 (0.31 to 1.01)) in high-density clusters, and 17% lower (OR=0.83 (0.55 to 1.25)) in urban clusters, adjusted for the other covariables in the model (table 4, M4).

Male patients had significantly higher odds of being enrolled in the DMP-CHD in crude (table 3) and all comorbidity-adjusted models (table 4, M1–4). In the fully adjusted model, the odds for enrolment to the DMP-CHD among men were 2.16 (1.57 to 2.98) times the odds of women adjusted for age, severity of comorbidities, educational attainment and contextual effects at practice-level and municipality-level (table 4, M4).

Morbidity-adjusted models—random effects

The variance in DMP enrolment between practices (MOR=1.74) was larger than the between-municipality variance (MOR=1.30) in the unconditional model (table 4, M0).

Table 3 Crude ORs for the association between enrolment in the Disease Management Programme for coronary heart diseases and individual-level, practice-level and area-level variables obtained from cross-classified multilevel logistic regression models

	Crude OR	95% CI	N*	Practice N
Individual-level exposure				
Education (Ref. I, lowest)				
II	0.98	(0.65 to 1.48)	1241	382
III (highest)	1.45	(0.97 to 2.15)		
Sociodemographics				
Age group (Ref: 55–64)				
65–74	1.33	(0.88 to 1.99)	1241	382
75–84	1.04	(0.68 to 1.59)		
Male (Ref: female)	**1.98**	**(1.50 to 2.62)**	1241	382
Behavioural risk factors				
Hypercholesterolaemia (yes vs no)	1.20	(0.89 to 1.60)	1160	368
Body mass index (Ref: normal/underweight)				
Overweight/preobese	1.11	(0.80 to 1.55)	1202	378
Obese class I+II	0.91	(0.62 to 1.32)		
Obese class III	1.10	(0.44 to 2.79)		
Smoking status (Ref: never smoker)				
Former	1.29	(0.97 to 1.73)	1037	358
Current	1.15	(0.68 to 1.94)		
Alcohol consumption (Ref: abstainers)†				
DI	**1.58**	**(1.15 to 2.17)**	920	335
DII	1.18	(0.53 to 2.66)		
DIII	1.88	(0.52 to 6.76)		
Comorbidities				
Cumulative Illness Rating Scale for Geriatrics—severity index‡	**1.45**	**(1.05 to 2.00)**	1032	334
Ethnicity				
Immigration background (yes vs no)	1.37	(0.86 to 2.18)	1234	381
Social situation				
Certified and approved need of long-term care (yes vs no)	0.49	(0.21 to 1.13)	964	346
Living in a partnership (yes vs no)	1.20	(0.86 to 1.68)	949	347
Social contacts (Ref.: 0–1 contacts)				
2–4	1.36	(0.87 to 2.11)	958	345
5–10 and more	1.15	(0.72 to 1.84)		
Practice-level variables				
Male general practitioner (vs female)	0.97	(0.68 to 1.40)	1204	365
Area-level variables				
Regional deprivation (Ref.: T1, lowest deprivation)§				
T2	0.62	(0.37 to 1.04)	1241	382
T3 (highest deprivation)	0.74	(0.44 to 1.24)		
Degree of urbanisation (Ref: rural)				
Urban cluster	0.90	(0.59 to 1.35)	1241	382
High-density cluster	0.60	(0.28 to 1.30)		

Municipality N=52. N: sample size/individuals. ORs, obtained from bivariate cross-classified multilevel logistic regression models. CI, calculated using SEs that account for the cross-classified nature of the data. Random part omitted. Ref: Reference category. Bold figures: indicate ORs that are significantly different from 1.
*Difference to N=1280 due to missing data in predictors and/or missing data for the cross-classification variable 'GP-practice by municipality'.
†Alcohol consumption in g/day: DI: female: 0–19.99; male: 0–39.99. DII: female: 20–39.99; male: 40–59.99. DIII: female: >40.0; male: >60.0.
‡Cumulative Illness Rating Scale (CIRS)—severity index: The OR shows the effect on the propensity of enrolment of a one unit difference in the CIRS-severity index, comparing patients with a higher index with patients with a lower index.
§Regional deprivation tertiles (T1-T3) refer to the deprivation of the patient-residential area.

Individual-level variables (age, sex, educational attainment) and the severity of comorbidities explained 12.5% of the between-municipality variance. Differences in individual-level variables could thus not fully explain the between-municipality variance in DMP enrolment. Regional deprivation explained 28.6% of the residual between-municipality variance (MOR=1.29) that remained after full adjustment for individual-level variables (table 4, M2). Further adjustment for the degree of urbanisation reduced the residual between-municipality variance by another 71.4%, so that 100% of the (comparably small) between-municipality variance was explained by regional deprivation and the degree of urbanisation (table 4, M4).

Models adjusted for individual-level behavioural risk factors and the social situation

Adjusting the relationship between educational attainment and DMP enrolment for behavioural risk factors and the social situation (see online supplementary file 1, tables S1–S2) attenuated the trends observed in the crude analysis and confirmed the results of the comorbidity-adjusted models. Regional

Table 4 Effect estimates of individual-level comorbidity, practice-level and area-level variables on the enrolment in the Disease Management Programme for coronary heart disease obtained from cross-classified multilevel logistic regression models

	Measures of association/fixed effects—OR (95%CI)							
	M0	M1		M2		M3		M4	
Individual-level variables									
Education (Ref. I, lowest)									
II		1.14	(0.71 to 1.82)	1.14	(0.71 to 1.82)	1.17	(0.73 to 1.87)	1.18	(0.74 to 1.89)
III (highest)		1.16	(0.75 to 1.82)	1.16	(0.75 to 1.82)	1.18	(0.76 to 1.84)	1.2	(0.77 to 1.87)
Sociodemographics									
Age group (Ref: 55–64)									
65–74		1.43	(0.91 to 2.25)	1.43	(0.91 to 2.25)	1.44	(0.92 to 2.27)	1.46	(0.93 to 2.30)
75–84		1.17	(0.73 to 1.88)	1.17	(0.73 to 1.88)	1.18	(0.74 to 1.89)	1.18	(0.74 to 1.89)
Male (vs female)		**2.19**	**(1.59 to 3.01)**	**2.19**	**(1.59 to 3.01)**	**2.17**	**(1.58 to 2.98)**	**2.16**	**(1.57 to 2.98)**
Comorbidities									
CIRS-G—severity index*		**1.51**	**(1.09 to 2.11)**	**1.52**	**(1.09 to 2.11)**	**1.51**	**(1.08 to 2.10)**	**1.52**	**(1.09 to 2.12)**
Contextual variables									
Practice-level									
Male general practitioner (vs female)				0.98	(0.65 to 1.47)	0.98	(0.66 to 1.47)	1.02	(0.68 to 1.54)
Area level									
Regional deprivation (Ref.:T1—least deprived)†									
T2						0.68	(0.41 to 1.15)	0.70	(0.42 to 1.14)
T3 (most deprived)						0.81	(0.48 to 1.35)	0.92	(0.56 to 1.51)
Degree of urbanisation (Ref: rural)									
Urban cluster								0.83	(0.55 to 1.25)
High-density cluster								0.56	(0.31 to 1.01)
Intercept	**0.48 (0.39 to 0.58)**	**0.11**	**(0.05 to 0.24)**	**0.11**	**(0.05 to 0.24)**	**0.14**	**(0.06 to 0.33)**	**0.15**	**(0.06 to 0.37)**
Measures of variation/random effects									
Practice-variance	0.33	0.32		0.32		0.3		0.35	
MOR-Practice	1.74	1.72		1.72		1.69		1.75	
PCV (%) Practice	–	–3.0^{+}		0.0^{++}		–6.3^{++}		9.4^{++}	
Municipality-variance	0.08	0.07		0.07		0.05		0.0	
MOR-Municipality	1.3	1.29		1.29		1.24		1.00	
PCV (%) Municipality	–	–12.5^{+}		0.0^{++}		–28.6^{++}		–100^{++}	
Model fit and sample size									
Wald-χ^2 (df)	14.87 (2)‡	33.17 (6)		33.18 (7)		35.35 (9)		39.2 (11)	
Model-sig. (p value)	0.0006	<0.0001		<0.0001		0.0001		<0.0001	
N	1000	1000		1000		1000		1000	
Practice N	319	319		319		319		319	

Outcome in all models: Enrolment in the disease management programme for coronary heart disease (Yes vs No). M0: Null model without predictors. M1: Final model with individual-level covariables. M2: Extension of M1 additionally adjusting for the practice-level variable 'sex of general practitioner'. M3: Extension of M2 with the area-level variable 'Regional deprivation'. M4: Extension of M3 additionally adjusted for the area-level variable 'Degree of urbanisation'. MOR: Median OR. PCV: proportional change in variance. PCV^{+}: Compares the change in variance between M1 and M0 on municipality-level/practice-level (reference is the M0 variance on municipality-level/practice-level). PCV^{++}: compares the change in variance on municipality-level/practice-level between the models with contextual variables (M2–M4) and the final model containing individual variables (M1), respectively (reference is the M1 variance on municipality-level/practice-level).
*Cumulative Illness Rating Scale (CIRS)—severity index: The OR shows the effect on the propensity of enrolment of a one unit difference in CIRS-severity index, comparing patients with a higher index with patients with a lower index.
†Regional deprivation tertiles (T1–T3) refer to the deprivation of the patient-residential area.
‡Test statistic of a likelihood-ratio test, testing the fit of the null model against a single-level logistic regression model.
Bold figures indicate ORs that are significantly different from 1.

deprivation of the patient-residential area was significantly negatively associated with the odds of DMP enrolment when comparing municipalities with medium deprivation (T2) with the least deprived municipalities (T1) regardless of differences in individual educational attainment, age, sex, individual behavioural risk factors, social situation, migration background, practice-level characteristics and the degree of urbanisation (see online supplementary file 1, tables S1–S2). The association was negative, but in all models not significant when comparing most deprived with least deprived municipalities. The relationship between regional deprivation and DMP enrolment was partly explained by differences in the severity of comorbidities (CIRS-G; table 4, M3).

The strength of association between male gender and DMP enrolment in fully adjusted models (see online supplementary file 1, table S1–S2) was smaller compared to the effects observed in the comorbidity-adjusted model (table 4), but significant and consistent in direction (OR=1.60 (1.08 to 2.36) adjusted for individual-level behavioural risk factors, age, sex, educational attainment, practice-level and municipality-level variables (see online supplementary file 1, table S1) and OR=1.79 (1.23 to 2.61) adjusted for the social situation, age, sex, educational attainment, practice-level and municipality-level variables (see online supplementary file 1, table S2)). Not considering differences in comorbidities thus underestimated the effects of gender on DMP enrolment.

Details on the model specification and regression diagnostics are provided in online supplementary file 1.

DISCUSSION

This is the first study to analyse social disparities in DMP enrolment among elderly people with CHD in Germany, taking into account *both* a wide range of individual-level factors *and* contextual effects at the levels of municipalities *and* primary care practices. We found that female gender and higher regional deprivation at a small-area level (comparing medium with least-deprived municipalities) are negatively associated with enrolment in the DMP-CHD, regardless of individual-level factors and potential confounding by variables at practice-level (physician gender) and/or area-level (degree of urbanisation). Adjustment for differences in severity of comorbidities, however, attenuated the effects of regional deprivation on DMP enrolment.

Our findings provide evidence that the health system allowed marked gender disparities in DMP enrolment that have not been reported as yet.[25 26] Routine evaluations across sickness funds in a large federal state show an imbalanced gender distribution (63% male among approximate 228 000 DMP-CHD participants).[27] These routine DMP evaluation reports, which build on claims data of the SHI, only report the gender distribution *within* DMP participants. As there are no data on non-participants (which would be a natural control group), it is not possible to quantify disparities against an external standard. Routine state-wide evaluations in Saarland do not report sex-stratified data on the approximate 22 100 patients (mean age: 70 years) enrolled in the DMP-CHD in 2010,[28] hampering comparisons with our sample. General claims data of the SHI allow evaluation of the gender distribution between DMP-participants and non-participants among their members, but analysis of disparities are limited by lacking information on individual covariables including SES indicators.

We have shown that the differences in the individual propensity of enrolment in the DMP-CHD between male and female patients could neither be explained by differences in age, individual SES, lifestyle, severity of comorbidity (CIRS-G) and the social situation, nor by differences attributable to physicians' gender and area-level characteristics. The phenomenon of gender differences in prevalence, manifestation, diagnosis, treatment and prognosis of CHD is well known and is often attributed to stereotypes among physicians about the disease as afflicting primarily men.[29]

We found that regional deprivation at a small-area level, comparing medium with least deprived municipalities, is independently associated with enrolment in the DMP-CHD, regardless of the composition of municipalities as far as patient-level factors such as age, sex, educational attainment, behavioural risk factors and social situation/migration (see online supplementary file 1, table S1–S2) are concerned. This effect was not confounded by variables at practice-level (physician gender) and/or area-level (degree of urbanisation). Compositional effects existed as far as comorbidity profiles are concerned. Adjusting for the CIRS-G severity index attenuated the statistical significance of the GIMD effects, while the point estimates still indicated a negative association with DMP enrolment. Additional adjustment for the degree of urbanisation further attenuated the deprivation effects, but a trend indicating a negative association remained.

Contextual disparities in utilisation of DMPs may arise through: differences in (1) enabling municipality resources,[11 14] (2) supply of healthcare services,[11 14] (3) different direct and indirect costs[30] for patients in attending the quarterly GP visits entailed in DMP enrolment, and (4) different perceptions of perceived benefit[30] of enrolment in DMPs depending on the residential environment. Evidence from aggregate data analysis suggests that supply-side determinants indeed have a relevant impact on equity of outpatient care in Germany, including the Saarland.[31] Previous studies among the ESTHER cohort have provided evidence for inequities in out-of-pocket payments among elderly patients when utilising chronic care services.[32] The question whether and how regional deprivation affects the degree to which 'potential access' to the DMP-CHD (guaranteed by the SHI system) is converted into 'realised access'[33] deserves further investigation.

The non-linear relationship between regional deprivation of patient-residential areas with DMP enrolment deserves further investigation, ideally in settings with more clusters (ie, municipalities). The odds for DMP enrolment for most-deprived compared to least-deprived areas were consistently not as low as those for medium-deprived compared to least-deprived areas. Assuming a social gradient related to deprivation, one would expect the enrolment in most-deprived municipalities to be lower than that in medium-deprived compared to the least-deprived municipalities. Barriers may exist in medium-deprived municipalities that are not present in most-deprived municipalities: they may interact with access to DMP enrolment, but remained unmeasured in our study.

We found no evidence for disparities based on the highest educational attainment, despite existing mechanisms which (theoretically) have the potential to create disparities in DMP enrolment. In this respect, access to (or rather utilisation of) the DMP-CHD is equitably distributed. This finding is consistent with two studies that assessed the possibility of selective enrolment in enrolment in DMP-CHD using self-reported[26] and physician-reported[25] enrolment status. It affirms that differences in individual educational attainment do not constitute a barrier in uptake of the DMP-CHD. Only one study focusing on DMPs for diabetes type II found significant differences in educational attainment between DMP participants and non-participants using nationwide claims data of a large sickness fund.[34] None of the other previous studies on DMPs in Germany were able to

assess the possibility of social selection processes between participants and non-participants due to the limited availability of information on SES and/or lack of control groups.[8 9 35 36]

We found a substantial variation in the odds of enrolment between municipalities in unconditional models (range: MOR: 1.30–1.56). In fully adjusted models, the complete residual between-municipality variance (that remained after controlling for individual-level variables) could be explained by differences in two variables: regional deprivation and the degree of urbanisation. This means that small-area variation in enrolment to the programme is to a large extent explained by differences in regional deprivation and degree of urbanisation. This marks out the small-area context as an important factor to be taken into account in future studies on programme effectiveness and its impact on equity and efficiency.

STRENGTHS AND LIMITATIONS

The major strength of our study is that we considered a wide range of individual-level factors in assessing disparities in DMPs, while taking into account that patients are simultaneously clustered in practices and municipalities. This minimised the possibility of biased SEs and inferences,[37] although the number of municipalities was comparably small with large differences in population sizes. Since the number of higher level clusters is the most important criterion for assessing fixed effects of higher level variables,[38] our study is likely to be underpowered as far as the effects of regional deprivation are concerned. This might explain why the comparison 'highest versus lowest deprivation' was not statistically significant, despite the fact that the point estimates (GIMD T3 vs T1) were consistently smaller than 1 in all models, indicating a trend towards a potentially relevant negative association.

In analysing disparities, we adjusted for differences in risk factors and comorbidities[21] to ensure that potential socioeconomic differences in DMP enrolment are corrected for underlying medical needs. In contrast to models adjusting for risk factors, adjustment for the severity of comorbidities attenuated the significance of the deprivation effects. This demonstrates the need for further studies with a larger number of municipalities. Although we considered medical need, we cannot completely rule out that the regional or gender disparities are not (at least partially) due to individual preferences, because no variables captured these tendencies.

As part of a covariable selection process, we built three separate models with different sets of confounders that were considered because of their (hypothesised) relevance to the potential selection process in DMP enrolment. At the end, however, we did not include all covariables in one model, for example, risk factors and social factors together into the model controlling for medical need. The reasons for that are provided in online supplementary file 1.

Our findings are limited by the possibility of attrition bias: no information on DMP status was available for participants who dropped out or died before 2008, since this was not the primary outcome of the cohort study. Compared to the cohort population at t3 (N=7012), the proportion of individuals with lowest educational attainment was significantly higher (about 7 percentage-points) among the individuals (N=2937) who were a priori excluded (see online supplementary file 2). At baseline, those excluded were significantly older and more likely to be retired or pursue domestic activities. The prevalence of self-reported CHD was also significantly higher (about 5 percentage points) among those excluded. Therefore, the finding that educational attainment was not associated with DMP enrolment might be an underestimate of the true effect operating at the individual level. Further details on the non-responder analysis are reported in online supplementary file 2.

Also, GPs reported only about the current enrolment status and no information was available on whether individuals categorised as 'not enrolled' used to be enrolled but dropped out until t3. Furthermore, we did not explicitly address the possibility of cohort effects[15] as far as the effect of education as a measure of SES is concerned, since the meaning of educational attainment varies for different birth cohorts.[39] The majority of our sample was retired or pursued domestic activities. Thus, measuring individual-level SES with wealth-based indicators or measures that reflect household conditions for this age group would have better reflected individual SES[39] and could have thus yielded different results. However, these data were not captured, so the analysis made use of the best available indicators.

Finally, the small average number of patients with CHD per a higher level unit may have limited our aim to comprehensively assess random effects.[38] However, the underlying model assumptions (see online supplementary file 1) regarding the residual variance at a higher level were sufficiently met despite the small average cluster sizes.

CONCLUSION

The individual propensity for enrolment in DMP-CHD among elderly patients with CHD was markedly higher for men compared to women after full adjustment for individual-level, practice-level and area-level variables. Access to or utilisation of

What is already known on this subject

- Disease Management Programmes for patients with coronary heart disease in Germany aim to improve health outcomes and quality of care in terms of stronger guideline-orientation.
- Systematic selection effects in programme enrolment have been found depending on patients' age and (co)morbidity.
- No studies have as yet analysed social disparities in a control-group design taking into account both individual and contextual factors.

What this study adds

- Enrolment in the Disease Management Programme for coronary heart disease suffers from gender disparities, and there is a trend towards small-area disparities, after controlling for possible individual and area-level confounders.
- Small-area variation in enrolment to the programme is to a large extent explained by differences in regional deprivation and degree of urbanisation which marks out the small-area context as an important factor to be taken into account in future studies.
- Individual educational attainment did not constitute a barrier towards uptake of the programme, regardless of differences in behavioural risk factors, comorbidity, social situation, place of residence or gender of patients' general practitioners.

the DMP-CHD was thus inequitably distributed across gender. GPs offering DMPs for patients with CHD should be aware of potential gender stereotypes in their daily practice. No disparities were observed across individual-level educational attainment indicating that the utilisation of the DMP-CHD is equitably distributed in this respect, although this finding needs to be interpreted in the light of the possibility of attrition bias. Regional deprivation was negatively associated with DMP enrolment independent of individual educational attainment and behavioural/social factors. Adjustment for differences in comorbidities attenuated the deprivation effects, but a trend indicating disparities remained which deserves further investigation. Future research on DMPs should consider the small-area context as a relevant factor in its own right.

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Contributors KB conceived the study, analysed the data and wrote the manuscript. WM took part in data collection and analysis of the GIMD and critical revision of the manuscript. HB conceived the cohort study, data collection and critical revision of the manuscript. K-US was involved in data collection and analysis and critical revision of the manuscript. CS gave statistical advice, was involved in important contribution to data interpretation and critical revision of manuscript. AM made important contribution to the study design and critical revision of the manuscript. BH participated in data collection and critical revision of the manuscript. JS contributed to the study design critical and revision of the manuscript. OR made important contribution to the study design and critical revision of the manuscript.

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