The impact of area deprivation on differences in health: does the choice of the geographical classification matter?

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Abstract

***Objective*—Many studies show the average health status in deprived areas to be poorer and the use of health care to be higher, but there is hardly any information on the impact of the geographical classification on the size of these differences. This study examines the impact of the geographical classification on the clustering of poor health per area and on the size of the differences in health by area deprivation.**

***Design*—Data on self reported health regarding 5121 people were analysed using three classifications: neighbourhoods, postcode sectors and boroughs. Multilevel logistic models were used to determine the clustering of poor health per area and the size of the differences in health by area deprivation, without and subsequently with adjustment for individual socioeconomic status.**

***Setting*—General population aged 16 years and over of Amsterdam, the Netherlands.**

***Main outcome measures*—Self rated health, mental symptoms (General Health Questionnaire, 12-item version), physical symptoms and long term functional limitations.**

***Main results*—The clustering of poor health is largest in neighbourhoods and smallest in postcode sectors. Health differences by area deprivation differ only slightly for the three geographical classifications, both with and without adjustment for individual socioeconomic status.**

***Conclusions*—In this study, the choice of the geographical classification affects the degree of clustering of poor health by area but it has hardly any impact on the size of health differences by area deprivation.**

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Many studies have shown the average health status to be poorer,[1–27] and the use of health care to be higher in deprived areas.[21 28–30] The size and the homogeneity of the areas included in these studies vary considerably, however. Regarding size, several authors argue that smaller areas should result in a more valid,[31–33] or a more stable[33–35] measurement of area deprivation. A disadvantage of the use of smaller areas may be, however, that measurement error will increase.[33] Available studies show that health differences by area deprivation differ only slightly if smaller areas are used. This holds for (larger/smaller unit and population size) mortality in Great Britain (electoral ward (EW): 25 000/enumeration district (ED): 500)[32 36]; mortality in Perth, Australia (zip code: 2500/collector district: 500)[25]; and self rated health in the USA (zip code: 25 000/census tract: 5000).[27] Furthermore, smaller areas do not yield better results if compared with individual socioeconomic data, if EDs are compared with EWs,[28] or census tracts with zip codes.[27]

Regarding homogeneity, contextual, area bound, factors may have a greater impact on health if an area relates to a socioculturally homogeneous, "real", community. Macintyre and coworkers divide such contextual factors into five broad groups: physical features, quality of the domestic and working environment, the provision of various services, sociocultural features, and the reputation of areas.[37 38] If a geographical categorisation is solely logistic (like postcodes, which were derived from walking routes of postmen), the resulting areas will mostly be heterogeneous socioculturally. In that case, contextual factors that lead to area health differences are unlikely. Of course, homogeneity and size are often inversely associated, but smaller randomly composed areas can still be socioculturally heterogeneous.

Most of the discussion regarding the impact of the geographical classification on area differences has focused on the situation in the United Kingdom, usually in relation to deprivation payments for general practitioners (GPs). In the UK three distinct geographical classifications are of interest: the EW, the ED and the postcode sector (PS). At present, the Jarman remuneration system in England, Wales and Northern Ireland is based on EWs, albeit with different thresholds and indicators.[39] In Scotland, it is based on PSs (average population: 5000),[40] but in Scotland these are more socioculturally homogeneous than elsewhere in the UK. In the Netherlands deprivation payments for GPs have been introduced recently.[41] For practical reasons, this system is based on PSs,[41 42] though research on differences in health and use of health care by area deprivation almost entirely concerns neighbourhoods or combinations of neighbourhoods (boroughs).[4 7 14 20 21 24]

No information exists on the impact of the geographical classification on the degree of clustering of poor health and little information is available on its impact on the size of area health differences in health and use of health care.[25 27 36] This study therefore examines the impact of the geographical classification on the

degree in which poor health clusters per area as well as its impact on the size of health differences by area deprivation. It further examines whether the contribution of contextual factors to area health differences, over and above that of individual socioeconomic factors, depends on the geographical classification.

Methods

This study concerns a multilevel analysis of health differences between areas within the city of Amsterdam, the capital of the Netherlands, using three different types of small area classifications: neighbourhoods, PSs and boroughs. Previous studies have shown rather large differences in health by area deprivation in Amsterdam.[7 14 20 21]

INDIVIDUAL DATA

Data on health and socioeconomic status (SES) were collected on 5121 residents. Details of the survey have been reported elsewhere.[20 21 43–45] In short, respondents were sampled randomly from the municipal population register after restriction to those living outside care institutions and after stratification by age (16–34, 35–64 and 65+ years) and borough. They were interviewed at their homes by trained interviewers in Dutch, English, Turkish or Moroccan-Arabic (response: 61.4%).

Poor health was measured by four indicators that were all dichotomised on the basis of the usual cut off points for community surveys (cut off point; prevalence of the adverse outcome among the population): self rated health ((very) good/fair or worse; 29.8%),[44 46] physical symptoms (0–4/5–20 symptoms; 36.3%),[20 47] mental symptoms—that is, score on the 12-item version the General Health Questionnaire (GHQ) (0–1/2–12 symptoms; 32.3%),[21 48 49] and long term physical limitations measured by the OECD indicator (0/1–7 limitations; 23.0%).[20 47 50] The GHQ-questionnaire and the OECD-indicator both comprise four answering categories for each item; respondents were considered to have a symptom and a limitation, respectively, if they gave one of the two least favourable answers, as is usually done in community surveys.[47–50]

Table 1 Characteristics of units regarding three geographical classifications for the city of Amsterdam, the Netherlands

Characteristic	*Neighbourhoods*	*Postcode sectors*	*Boroughs*
Number (populated/unpopulated)	92/1	76/3	22/0
Population			
mean	7 850	9 504	32 828
standard deviation	5 420	6 237	7 849
maximum	28 260	23 420	51 680
Mean income*			
least deprived	32 488	32 004	32 022
intermediate	27 134	27 271	27 497
most deprived	24 773	25 111	25 342
Percentage dependent on benefits*			
least deprived	23	23	24
intermediate	34	34	32
most deprived	41	41	40
Percentage low incomes*			
least deprived	35	35	37
intermediate	45	45	45
most deprived	52	52	50

*The categories "least deprived", "intermediate", and "most deprived" concern the tertiles of the population who live in the most favourable, intermediate and least favourable areas, respectively, regarding each deprivation measure.

Individual SES was measured by its traditional indicators: income, occupational status and educational level.[21 46 51] Income concerned household income in five levels, adjusted for the number of persons who depended on it (one or more). Occupational status concerned the present occupation of people in five levels,[52 53] or, if none, the main activity as a measure of economic position.[46 54] Educational level concerned the highest degree taken, in four levels.[46 55] The categories used are presented in table 2. When looking at these indicators of individual SES, strong individual SE health differences were found. Population attributable risks,[56] compared with the most favourable SES category, varied from 34% to 57%, after adjustment for differences in age and gender between SES categories.

AREA DATA

Measures of area deprivation came from income taxation data of Statistics Netherlands regarding 1994.[57 58] The data we looked at were the mean income after taxes, the proportion of earners who were dependent on benefits and the proportion of earners with a low income. The earners who are dependent on benefits are people aged 16–65 years who have social benefits as their main source of income, and the earners with a low income are those whose net income is within the lowest three deciles of the net-income distribution of the entire Dutch population.

All measures of area deprivation were available for three geographical classifications: neighbourhoods, PSs and boroughs. Neighbourhoods are areas with a similar type of building, often delineated by natural boundaries. Because of this, they are socioculturally rather homogenous but their population size varies a great deal. In the planning of health and other local services, neighbourhoods are usually the lowest level that is considered; these neighbourhoods are often used as equivalents for local communities.[59] In contrast, PSs have a logistic origin, adequate post delivery, and were designed at a national level. They had to comprise similar numbers of addresses and therefore, their average population size varies less. PSs do not have a further (emotional) meaning to most of their residents.[59] In the Netherlands in 1995, the mean population size (standard deviation) of PSs and neighbourhoods was 3923 (3927) and 1485 (2160), respectively.[57 58] Finally, boroughs concern aggregates of socioeconomically comparable neighbourhoods[7 14 20 21]; they mostly exist in urban areas. In some of the bigger cities of the Netherlands they have their own public administration.

On the basis of these differences between the three categorisations, it might be expected that the clustering of poor health and the health differences by area deprivation is largest for neighbourhoods and smallest for PSs. In table 1, we present some demographic and socioeconomic key figures regarding these three geographical categorisations, for Amsterdam.[57 58]

ANALYSIS

We analysed whether the clustering of poor health per area and the differences in health by area deprivation differed for the three geographical classifications. The analyses were performed using multilevel logistic modelling,[60 61] because of the hierarchical nature of the data. Characteristics of areas and communities have a potential impact on all residents, whereas an individual characteristic of a resident only affects that person. This implies that the individual responses may cluster by area—that is, their variability because of area characteristics may be smaller than their variability because of individual characteristics. Random variables at both levels were modelled to take this into account.

We started by comparing the degree of area clustering in the three geographical classifications for each outcome, firstly after adjustment for differences in age and gender and secondly after additional adjustment for a combination of three measures of individual SES—that is, income, occupational status and educational level. Because our data were correlated across the models for the three geographical categorisations (that is, concern the same population and the same outcomes), we also assessed the relative degree of area clustering using cross classified models to assess the independent effect of each categorisation. In these models, we had three strictly hierarchical levels: individuals nested within neighbourhoods nested within boroughs. As a fourth pseudo-level we added PSs, pseudo because people who live in the same neighbourhood and borough, can live in different PSs.[60 61]

Next, we compared the size of the health differences by area deprivation for the three geographical categorisations, separately. We therefore computed ratios of the age/gender adjusted odds of poor health for three categories of increasing deprivation, using the most affluent category as reference. We again repeated this analysis with additional adjustment for individual SES, to examine whether the impact of contextual factors on differences in health by area deprivation, over and above individual factors, differed for the three geographical categorisations. Finally, we repeated these analyses using cross classified models, though mutually adjusted effects of area deprivation are of only limited interest for the design of a deprivation payment system.

To obtain comparable results regarding both fixed and random effects, we divided areas into tertiles of increasing deprivation on each of the deprivation measures. Each tertile comprised about one third of the respondents. Regarding the random effects, this solves a problem that is inherent to multilevel logistic models. In these models random variances are estimated at different measurement scales regarding the area and the individual level. The ratio of these scales depends on the prevalence of the outcome. By dividing the population into tertiles of increasing deprivation for each of the geographical classifications, comparisons of the size of the random variances regarding the same outcome across classifications can be interpreted.

Table 2 Random variance components by level for neighbourhoods, postcode sectors and boroughs, regarding four health outcomes, age and gender adjusted and additionally adjusted for individual SES: effects for the three geographical classifications, separate (a), and mutually adjusted (b)*

	Poor self rated health		*Physical symptoms*		*Mental symptoms*		*Long term limitations*	
a: separate effects (2 level models)								
Age and gender adjusted								
Neighbourhoods								
Area level random variance *(SE)*	0.0743	*0.0265*	0.0591	*0.0214*	0.0493	*0.0202*	0.0966	*0.0339*
Individual level random variance *(SE)*	0.9913	*0.0201*	0.9913	*0.0197*	0.9926	*0.0202*	0.9618	*0.0193*
Postcode sectors								
Area level random variance *(SE)*	0.0676	*0.0252*	0.0581	*0.0211*	0.0391	*0.0178*	0.0589	*0.0263*
Individual level random variance *(SE)*	0.9930	*0.0201*	0.9918	*0.0197*	0.9943	*0.0202*	0.9771	*0.0196*
Boroughs								
Area level random variance *(SE)*	0.0525	*0.0237*	0.0328	*0.0162*	0.0263	*0.0145*	0.0579	*0.0272*
Individual level random variance *(SE)*	0.9970	*0.0202*	0.9965	*0.0198*	0.9969	*0.0202*	0.9733	*0.0195*
Age, gender and SES adjusted*								
Neighbourhoods								
Area level random variance *(SE)*	0.0364	*0.0200*	0.0233	*0.0150*	0.0268	*0.0162*	0.0497	*0.0256*
Individual level random variance *(SE)*	0.9847	*0.0200*	0.9862	*0.0196*	0.9939	*0.0203*	0.9359	*0.0188*
Postcode sectors								
Area level random variance *(SE)*	0.0298	*0.0180*	0.0214	*0.0140*	0.0201	*0.0142*	0.0296	*0.0205*
Individual level random variance *(SE)*	0.9865	*0.0200*	0.9868	*0.0196*	0.9954	*0.0202*	0.9403	*0.0189*
Boroughs								
Area level random variance *(SE)*	0.0183	*0.0133*	0.0128	*0.0102*	0.0099	*0.0095*	0.0211	*0.0159*
Individual level random variance *(SE)*	0.9888	*0.0200*	0.9885	*0.0195*	0.9970	*0.0202*	0.9428	*0.0189*
b: mutually adjusted effects (cross classified 4 level models)								
Age and gender adjusted								
PS level random variance *(SE)*	0	*0*	0.0182	*0.0205*	0	*0*	0	*0*
Borough level random variance *(SE)*	0.0362	*0.0236*	0.0179	*0.0173*	0.0140	*0.0156*	0.0222	*0.0253*
Neighbourhood level random var. *(SE)*	0.0371	*0.0239*	0.0197	*0.0213*	0.0347	*0.0212*	0.0705	*0.0349*
Individual level random variance *(SE)*	0.9949	*0.0202*	0.9923	*0.0198*	0.9937	*0.0202*	0.9652	*0.0192*
Age, gender and SES adjusted*								
PS level random variance *(SE)*	0	*0*	0	*0*	0	*0*	0	*0*
Borough level random variance *(SE)*	0.0070	*0.0147*	0.0079	*0.0114*	0.0009	*0.0111*	0.0070	*0.0184*
Neighbourhood level random var. *(SE)*	0.0303	*0.0229*	0.0146	*0.0162*	0.0261	*0.0194*	0.0428	*0.0295*
Individual level random variance *(SE)*	0.9861	*0.0200*	0.9866	*0.0196*	0.9944	*0.0202*	0.9382	*0.0188*

*Individual socioeconomic status; this concerned: income in five levels (<1400; 1400–1900; 1900–2750; 2750–4000; >4000 Dutch guilders net per month; all categories subsequently split into two on the basis of the number of persons which depend on it (1 *v* 2 and over); 1 Dutch guilder = 0.45 Euro); present occupation in five levels following the schema of Erikson, Goldthorpe and Portocarero (I/II, professionals/managers; III, routine non-manual workers; IV, proprietors, including farmers; V/VI, skilled manual workers; VII, semi/unskilled manual workers)[52]; if no job: unemployed and looking for work, student, long term disabled, housekeeping, and retired; highest degree earned in four levels: primary school, lower secondary school, higher secondary school, post-secondary education.

All analyses were performed using MLwiN,[62] except for the cross classified models for which MLn was used,[63] because MLwiN appeared to be too unstable for these analyses. All models were fitted using the most accurate procedure available,[60] that is, using a predictive quasi-

Table 3 Odds ratios (OR) and 95% confidence intervals for the age and gender adjusted prevalence of four measures of poor health by area deprivation, regarding neighbourhoods, postcode sectors and boroughs

a Poor self rated health	*Neighbourhoods*			*Postcode sectors*			*Boroughs*		
Mean income (OR, *CI*)									
least deprived	1			1			1		
intermediate	1.45	*1.19*	*1.76*	1.38	*1.13*	*1.69*	1.35	*1.08*	*1.67*
most deprived	1.59	*1.31*	*1.92*	1.50	*1.23*	*1.82*	1.57	*1.27*	*1.95*
Area level random variance *(SE)*	0.0298	*0.0179*		0.0309	*0.0175*		0.0177	*0.0127*	
Individual level random variance *(SE)*	0.9957	*0.0203*		0.9947	*0.0202*		1.0010	*0.0203*	
Percentage low income (OR, *CI*)									
least deprived	1			1			1		
intermediate	1.48	*1.22*	*1.79*	1.45	*1.19*	*1.78*	1.40	*1.12*	*1.75*
most deprived	1.61	*1.32*	*1.96*	1.38	*1.11*	*1.72*	1.52	*1.22*	*1.89*
Area level random variance *(SE)*	0.0298	*0.0180*		0.0380	*0.0191*		0.0199	*0.0134*	
Individual level random variance *(SE)*	0.9971	*0.0203*		0.9963	*0.0202*		0.9994	*0.0202*	
Perc. dependent on benefits (OR, *CI*)									
least deprived	1			1			1		
intermediate	1.15	*0.93*	*1.43*	1.32	*1.08*	*1.61*	1.33	*1.07*	*1.64*
most deprived	1.43	*1.18*	*1.74*	1.49	*1.22*	*1.81*	1.60	*1.30*	*1.97*
Area level random variance *(SE)*	0.0466	*0.0212*		0.0313	*0.0176*		0.0150	*0.0118*	
Individual level random variance *(SE)*	0.9939	*0.0202*		0.9953	*0.0202*		1.0000	*0.0203*	

b Long term limitations	*Neighbourhoods*			*Postcode sectors*			*Boroughs*		
Mean income (OR, *CI*)									
least deprived	1			1			1		
intermediate	1.26	*1.02*	*1.57*	1.17	*0.95*	*1.43*	1.49	*1.22*	*1.81*
most deprived	1.75	*1.41*	*2.17*	1.60	*1.31*	*1.95*	1.75	*1.44*	*2.13*
Area level random variance *(SE)*	0.0381	*0.0225*		0.0165	*0.0171*		0.0038	*0.0098*	
Individual level random variance *(SE)*	0.9571	*0.0193*		0.9761	*0.0196*		0.9760	*0.0196*	
Percentage low income (OR, *CI*)									
least deprived	1			1			1		
intermediate	1.51	*1.22*	*1.88*	1.44	*1.18*	*1.75*	1.54	*1.28*	*1.85*
most deprived	1.80	*1.45*	*2.24*	1.67	*1.36*	*2.05*	1.83	*1.53*	*2.18*
Area level random variance (*SE*)	0.0350	*0.0220*		0.0135	*0.0164*		0.0000	*0.0000*	
Individual level random variance (*SE*)	0.9631	*0.0194*		0.9791	*0.0197*		0.9783	*0.0197*	
Perc dependent on benefits (OR, *CI*)									
least deprived	1			1			1		
intermediate	1.15	*0.92*	*1.44*	1.26	*1.03*	*1.54*	1.46	*1.22*	*1.76*
most deprived	1.73	*1.40*	*2.12*	1.60	*1.31*	*1.96*	1.81	*1.51*	*2.18*
Area level random variance *(SE)*	0.0402	*0.0230*		0.0177	*0.0174*		0.0000	*0.0000*	
Individual level random variance *(SE)*	0.9597	*0.0193*		0.9776	*0.0197*		0.9757	*0.0196*	

c Physical symptoms	*Neighbourhoods*			*Postcode sectors*			*Boroughs*		
Mean income (OR, *CI*)									
least deprived	1			1			1		
intermediate	1.23	*1.05*	*1.45*	1.22	*1.03*	*1.45*	1.20	*1.01*	*1.43*
most deprived	1.61	*1.37*	*1.89*	1.53	*1.29*	*1.80*	1.43	*1.21*	*1.70*
Area level random variance *(SE)*	0.0133	*0.0125*		0.0157	*0.0123*		0.0075	*0.0081*	
Individual level random variance *(SE)*	0.9961	*0.0198*		0.9954	*0.0198*		0.9985	*0.0198*	
Percentage low income (OR, *CI*)									
least deprived	1			1			1		
intermediate	1.21	*1.02*	*1.44*	1.23	*1.03*	*1.48*	1.17	*0.95*	*1.44*
most deprived	1.54	*1.29*	*1.84*	1.45	*1.19*	*1.77*	1.30	*1.06*	*1.59*
Area level random variance *(SE)*	0.0252	*0.0150*		0.0315	*0.0158*		0.0189	*0.0118*	
Individual level random variance *(SE)*	0.9943	*0.0198*		0.9939	*0.0198*		0.9972	*0.0198*	
Perc dependent on benefits (OR, *CI*)									
least deprived	1			1			1		
intermediate	1.18	*0.97*	*1.43*	1.32	*1.10*	*1.59*	1.26	*1.04*	*1.54*
most deprived	1.42	*1.19*	*1.69*	1.36	*1.13*	*1.64*	1.34	*1.10*	*1.63*
Area level random variance (*SE*)	0.0358	*0.0171*		0.0315	*0.0157*		0.0146	*0.0105*	
Individual level random variance (*SE*)	0.9937	*0.0198*		0.9937	*0.0198*		0.9980	*0.0198*	

d Mental symptoms	*Neighbourhoods*			*Postcode sectors*			*Boroughs*		
Mean income (OR, *CI*)									
least deprived	1			1			1		
intermediate	1.22	*1.01*	*1.47*	1.09	*0.91*	*1.30*	0.97	*0.79*	*1.20*
most deprived	1.31	*1.09*	*1.58*	1.27	*1.06*	*1.51*	1.15	*0.93*	*1.41*
Area level random variance *(SE)*	0.0323	*0.0170*		0.0223	*0.0143*		0.0195	*0.0124*	
Individual level random variance *(SE)*	0.9944	*0.0203*		0.9961	*0.0203*		0.9975	*0.0202*	
Percentage low income (OR, *CI*)									
least deprived	1			1			1		
intermediate	1.25	*1.04*	*1.50*	1.15	*0.96*	*1.38*	1.05	*0.85*	*1.30*
most deprived	1.34	*1.11*	*1.62*	1.20	*0.98*	*1.46*	1.18	*0.96*	*1.45*
Area level random variance (*SE*)	0.0323	*0.0170*		0.0305	*0.0161*		0.0196	*0.0124*	
Individual level random variance (*SE*)	0.9943	*0.0203*		0.9951	*0.0202*		0.9974	*0.0202*	
Perc dependent on benefits (OR, *CI*)									
least deprived	1			1			1		
intermediate	1.14	*0.93*	*1.39*	1.27	*1.06*	*1.52*	0.98	*0.79*	*1.21*
most deprived	1.15	*0.96*	*1.39*	1.12	*0.93*	*1.35*	1.14	*0.92*	*1.41*
Area level random variance *(SE)*	0.0420	*0.0189*		0.0266	*0.0152*		0.0201	*0.0126*	
Individual level random variance *(SE)*	0.9934	*0.0202*		0.9953	*0.0202*		0.9974	*0.0202*	

likelihood procedure in combination with a second order Taylor expansion series. The random variation at the individual level was assumed to be binomially distributed. However, we allowed for deviations from the binomial distribution in the modelling and assessed their size separately.[60]

KEY POINTS
- In deprived areas, health is poorer and use of health care is higher.
- Little is known on the impact of various geographical classifications on the size of these area health differences.
- This study shows that the clustering of poor health is largest for neighbourhoods and smallest for postcode sectors.
- Despite this, the choice of the geographical classification has hardly any impact on the size of the health differences by area deprivation.

Results

AREA EFFECTS ON THE OCCURRENCE OF POOR HEALTH

Statistically significant effects of the area level on the age and gender adjusted occurrence of poor health are found for all three geographical categorisations (table 2a, upper rows). These area effects are largest for neighbourhoods and smallest for boroughs as is shown by the somewhat larger random variance at the level of neighbourhoods. In table 2, the size of the individual level random variance cannot be compared with the area level random variances because the latter is based on a different measurement scale. The individual level random variance is arbitrarily fixed at about 1. (If it is really "1", this indicates that the random variation at the individual level follows a strictly binomial distribution; deviations indicate extra-binomial variation.[60]) Additional adjustment for individual SES shows the size of the area level random variances to decrease by about a half, especially regarding boroughs, and none of them remains statistically significant. Both without and with adjustment for individual SES, the random effect compared with its standard error is largest for long term limitations and smallest for physical symptoms.

We subsequently fitted cross classified multilevel models in which the size of the random variances for all three geographical categorisations was assessed simultaneously. The results of these analyses show that the independent (that is, mutually adjusted) effect of neighbourhoods on the age and gender adjusted occurrence of poor health is generally largest, but only statistically significant differing from zero regarding long term limitations (table 2b). PSs mostly have no independent effect on the occurrence of poor health, except regarding physical symptoms, and boroughs have only a small independent effect. Individual SES partially explains the independent (random) effect of neighbourhoods, and most of the

Table 4 Odds ratios (OR) and 95% confidence intervals for the prevalence of a poor self rated health and of long term limitations by area deprivation, adjusted for differences in age, gender and individual SES between areas, regarding neighbourhoods, postcode sectors and boroughs*

a Poor self rated health	*Neighbourhoods*			*Postcode sectors*			*Boroughs*		
Mean income (OR, *CI*)									
least deprived	1			1			1		
intermediate	1.20	*0.98*	*1.47*	1.15	*0.94*	*1.41*	1.24	*1.02*	*1.51*
most deprived	1.09	*0.89*	*1.34*	1.06	*0.86*	*1.29*	1.17	*0.96*	*1.43*
Area level random variance *(SE)*	0.0288	*0.0185*		0.0249	*0.0169*		0.0076	*0.0098*	
Individual level random variance *(SE)*	0.9862	*0.0200*		0.9872	*0.0200*		0.9912	*0.0200*	
Percentage low income (OR, *CI*)									
least deprived	1			1			1		
intermediate	1.21	*0.99*	*1.48*	1.20	*0.99*	*1.45*	1.22	*1.00*	*1.49*
most deprived	1.17	*0.95*	*1.43*	1.01	*0.82*	*1.24*	1.18	*0.97*	*1.44*
Area level random variance *(SE)*	0.0265	*0.0180*		0.0208	*0.0160*		0.0083	*0.0100*	
Individual level random variance *(SE)*	0.9880	*0.0200*		0.9885	*0.0201*		0.9912	*0.0200*	
Perc dependent on benefits (OR, *CI*)									
least deprived	1			1			1		
intermediate	0.96	*0.78*	*1.19*	1.06	*0.87*	*1.30*	1.20	*0.99*	*1.46*
most deprived	1.04	*0.86*	*1.27*	1.11	*0.91*	*1.35*	1.21	*1.00*	*1.48*
Area level random variance *(SE)*	0.0345	*0.0196*		0.0252	*0.0170*		0.0075	*0.0097*	
Individual level random variance *(SE)*	0.9852	*0.0200*		0.9876	*0.0200*		0.9915	*0.0200*	
b Long term limitations	*Neighbourhoods*			*Postcode sectors*			*Boroughs*		
Mean income (OR, *CI*)									
least deprived	1			1			1		
intermediate	1.00	*0.80*	*1.26*	0.91	*0.73*	*1.13*	1.35	*1.11*	*1.63*
most deprived	1.15	*0.92*	*1.45*	1.07	*0.86*	*1.33*	1.23	*1.01*	*1.49*
Area level random variance *(SE)*	0.0423	*0.0241*		0.0261	*0.0198*		0.0004	*0.0089*	
Individual level random variance *(SE)*	0.9370	*0.0188*		0.9436	*0.0189*		0.9417	*0.0188*	
Percentage low income (OR, *CI*)									
least deprived	1			1			1		
intermediate	1.20	*0.96*	*1.50*	1.13	*0.91*	*1.40*	1.28	*1.06*	*1.56*
most deprived	1.26	*1.00*	*1.58*	1.17	*0.93*	*1.48*	1.36	*1.12*	*1.64*
Area level random variance (*SE*)	0.0360	*0.0228*		0.0246	*0.0194*		0.0000	*0.0000*	
Individual level random variance (*SE*)	0.9359	*0.0188*		0.9393	*0.0188*		0.9506	*0.0190*	
Perc dependent on benefits (OR, *CI*)									
least deprived	1			1			1		
intermediate	0.93	*0.74*	*1.17*	0.96	*0.77*	*1.18*	1.27	*1.04*	*1.55*
most deprived	1.22	*0.98*	*1.51*	1.14	*0.92*	*1.41*	1.29	*1.05*	*1.58*
Area level random variance *(SE)*	0.0355	*0.0228*		0.0215	*0.0188*		0.0032	*0.0099*	
Individual level random variance *(SE)*	0.9392	*0.0189*		0.9435	*0.0189*		0.9439	*0.0189*	

*Individual socioeconomic status; see table 2 for the categories that were used.

already small effects of boroughs and PSs, as is shown by the reduction of its coefficients.

HEALTH DIFFERENCES BY AREA DEPRIVATION

The analyses on health differences by area deprivation show that health is poorer in more deprived tertiles of areas regarding both the neighbourhood, PS, and borough level (table 3). The size of the health differences between the most and least deprived tertile of areas is rather similar for the three geographical classifications, although for the PS level they are never the largest. For all three categorisations, area differences by deprivation are largest for long term limitations and smallest for mental symptoms. The size of the random variance at area level—that is, the unexplained effect of the area level on the age and gender adjusted occurrence of poor health, decreases considerably after the introduction of area deprivation in the models. In all cases, it is smallest for the borough level.

Additional adjustment for individual SES shows that for each geographical categorisation most of the differences in health by area deprivation can be explained by (differences in) the individual socioeconomic position of the residents concerned. Statistically significant differences by area deprivation remain only when the borough level is used, regarding long term limitations and regarding self rated health (table 4). Regarding physical and mental symptoms, none of the differences by area deprivation remains statistically significant then, with ORs for the most deprived tertiles ranging from 1.01 to 1.16 and from 0.94 to 1.08, respectively (not shown). After adjustment for individual SES, the random variance at area level for all health indicators remains larger regarding neighbourhoods and PSs than regarding boroughs.

Regarding the occurrence of long term limitations, some indications exist for extra-binomial variation at the individual level, as is shown by an individual level random variance that differs from one with statistical significance, after adjustment for individual SES (table 4). This indicates that there may be an individual bound factor that is associated with the occurrence of long term limitations and is unequally distributed across areas.[60]

Finally, we fitted cross classified multilevel models in which the effect of area deprivation was assessed for all three geographical categorisations simultaneously. The results of these models were difficult to interpret, however, because of collinearity between the area deprivation measures. In general, only the effect of deprivation at neighbourhood level is statistically significant (and always in the expected direction). Only, regarding long term limitations this holds for both the neighbourhood and the borough level (results not shown). Cross classified models including both area deprivation and individual SES could not be fitted.

Discussion

The results of this study show that neighbourhoods, PSs and boroughs have effects on the age and gender adjusted occurrence of poor health, but that the independent area effect on the clustering of poor health is largest for neighbourhoods. A large part of these area effects can be explained by differences between areas in the socioeconomic composition of their population; remaining independent area effects are by far largest for the neighbourhood level. The size of the differences in health by area deprivation differs rather little by geographical categorisation. This holds both for the prevalence of poor health after adjustment for (differences in) age and gender and after additional adjustment for individual SES.

Regarding long term physical limitations, our study shows indications for extra-binomial variation. Though possibly attributable to chance, it completely disappears if the analysis is restricted to Dutch born residents. Previous analyses have shown that non-Dutch born residents report a lot more limitations,[63] and also that they concentrate in specific areas. After this restriction of the analysis, health differences by area deprivation somewhat decrease, but the overall pattern across the various geographical classifications remains unchanged (results not shown).

Selective non-response, lack of statistical power of the study, and the approximate character of the estimation procedures that we used might potentially offer an explanation for a lack of statistically significant differences between various geographical classifications, especially regarding the effect of area deprivation. However, neither of these explanations seems to apply to our study. Selective non-response could only affect our findings if it especially concerned people who otherwise cause differences in the clustering of poor health for the geographical classifications that were used. Such a selective non-response is unlikely: previous analyses have shown that differences in response were small for gender, age, country of birth, year of settlement in Amsterdam, marital status, family type, and month of interview.[43–45 64 65] Additional analyses show that area deprivation also has no impact on differences in health care utilisation between respondents and non-respondents.[66]

Secondly, regarding a lack of power to detect differences, the number of units at the borough level is rather small (22). This may hamper the detection of effects at this level. However, most health differences by area deprivation are of a comparable size for the three classifications, indicating that even with a much higher power few additional differences would have been detected.

Thirdly, all results on the basis of multilevel logistic regression are somewhat approximate because distributional assumptions may not entirely hold. This especially applies to cross classified models and small samples.[60 61] To improve our estimates, we used the most valid procedures that are available,[60 61] and a rather large sample (5121; mean number of respondents for the most detailed geographical categorisation: 56). Because of the instability of the software concerned, we were not able to implement other methods to estimate variance

components, like Markov Chain Monte Carlo methods and bootstrapping,[60 62] but it seems unlikely that these would yield largely different results.

The size of the health differences by area deprivation as found confirms the results of previous studies on area health differences within cities. Differences in self reported health of similar size have been found in a number of urban areas, mainly in Britain and in the Netherlands (for an overview, see Reijneveld[20] and Reijneveld and Schene[21]). Despite these similarities, you cannot automatically assume that results regarding the comparison between neighbourhoods and PSs also hold for other cities and other countries. This depends on the way in which geographical classifications have been designed in the various countries.

Regarding the choice of a geographical classification to distribute deprivation payments across GPs, the results of our study slightly favour the use of neighbourhoods. For this classification, the age and gender adjusted health differences are somewhat larger than for the other levels. For all classifications, however, most health differences by area deprivation can be explained by individual health differences that are associated with individual SES. This indicates that individual measures of SES should be preferred above area-based measures of deprivation to identify those in poor health because of deprivation. However, practical problems may prevent that deprivation payments are based on individual characteristics. Furthermore, area characteristics may highly contribute to GP workload, even if they do not lead to a poorer individual health. Other health services may well be overloaded because of the concentration of health problems in deprived areas, even if these are mainly attributable to individual characteristics. Such a concentration of health problems in deprived areas may equally overload GPs themselves. In fact, this was the main impetus in the Netherlands for a deprivation payment system.[41 42] This system is based on PSs because patient PS data are widely available whereas patient neighbourhood data are not. It may be questioned whether the slightly larger health differences between neighbourhoods would outweigh this administrative advantage.

After adjustment for individual SES, the only remaining statistically significant differences by area deprivation concern the borough level. Though chance and lack of statistical power to detect random effects are possible explanations for this finding, it is interesting that this is the only geographical classification that is related to a distinct public administration. Some unmeasured underlying factors that have their own impact on health differences by area deprivation may also have lead to the division of the city in these separate administrations.

Regarding the contribution of various contextual (area bound) factors to a clustering of poor health per area, the results of our study indicate that neighbourhoods have the largest independent effect on area health. Probably most relevant is that neighbourhoods are relatively small and that they are socioculturally rather homogenous—that is, relate to "real" communities. Future studies should thus best be directed at neighbourhoods. Regarding the effect of size, even the neighbourhoods included in our study are rather large. In the Netherlands, neighbourhoods in the big cities are rather large and area deprivation data at a smaller level are not available. However, elsewhere such data are available at a more detailed level.[25 27 28 36] Future studies might further concern the various contextual area factors that may contribute to area health differences.[37 38] Here it should be kept in mind that our study only leaves room for a limited contribution of these contextual factors to area health differences. In contrast, a recent study on the city of Rotterdam, the second largest city of the Netherlands, showed a much larger contribution of contextual factors to health differences by neighbourhood deprivation,[24] though we could not confirm these results at PS level.[42] Further comparisons are thus needed regarding the effect of contextual area factors on health differences by area deprivation, both between and within countries.

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