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Pathways from deprivation to health differed between individual and neighborhood-based indices

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Abstract

Objective: To explore the role of behavioral and psychosocial factors in explaining the social gradient in self-rated health as defined either by an individual or a neighborhood deprivation index.

Study Design and Setting: Data were from the baseline survey of the UK Flexible Sigmoidoscopy trial. Recruitment through general practices was stratified to generate a socioeconomically diverse sample ($N = 5,253$, aged 55−64). Assessments included an individual and neighborhood deprivation index, each of which were categorized in four levels; three behavioral and three psychosocial factors; and self-rated health.

Results: Neighborhood deprivation was more strongly related to behavioral than to psychosocial factors, whereas individual deprivation was strongly related to both. The social gradient in poor self-rated health (odds in most compared to least deprived group) was 6.5 for individual and 4.2 for the neighborhood deprivation index. Behavioral and psychosocial variables explained, respectively, 7% and 11% of the individual deprivation gradient and 11% and 4% of the neighborhood gradient. The psychosocial pathway did not significantly mediate the neighborhood deprivation effect on self-rated health.

Conclusion: Intermediary pathways of the social gradient in self-rated health differed between individual and neighborhood-based deprivation indices, suggesting at least partly independent influences on poor health of individual and neighborhood-level deprivation.

Keywords: Social gradient; Socioeconomic status; Self-rated health; Health behavior; Psychosocial vulnerability; Neighborhood

1. Introduction

The association between low socioeconomic status (SES) and poor health is well established. Both individual-level indicators (income, occupation, educational level) and neighborhood-level characteristics show a graded relationship to health outcomes [1−3]. There is continuing debate in the literature over whether the neighborhood effect is independent of individual SES [4,5]. In general, successive adjustment for individual-level markers of SES progressively reduces the magnitude of the association between neighborhood-level SES and health [6−8]. It is therefore unclear whether there is a real independent neighborhood effect or if incomplete adjustment for individual SES explains the residual modest differences in health between residential areas. If it could be shown that there were different pathways explaining individual and neighborhood SES effects, this would contribute evidence for genuinely different mechanisms at work.

A number of different etiological pathways for the social gradient in health have been shown to be important. Suggested intermediary factors include unequal distribution of health risk behaviors (e.g., smoking, exercise) and differences in psychosocial vulnerability (e.g., perceived stress, personal control, social support) (see Model). The SES gradient in health behaviors and psychosocial vulnerability is described in many studies, showing disadvantageous characteristics in lower socioeconomic groups [1,9−11]. The association between these factors and health has also been repeatedly described [11,12]. Strong evidence that both of these pathways contribute to translating social position into ill health comes from Whitehall studies [1,13] and the GLOBE study [14]. However, conclusions about the relative importance of the two pathways are inconsistent, which might be related to different measures of socioeconomic status [11,15].

The present analyses compared an individual-level deprivation index with a neighborhood-based deprivation index of SES, and examined two pathways through which health

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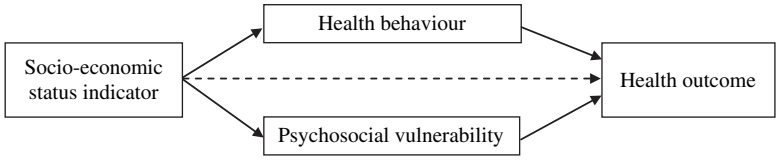

Model. Possible pathways explaining the social gradient in health.

might be affected: i) health related behaviors and ii) psychosocial factors such as stress and a lack of social support. Evidence for differential pathways for individual and neighborhood measures of deprivation may add information to our understanding of the social gradient in health. This is important because inequalities in health between rich and poor areas in Britain continue to increase and are particularly large in Scotland [4,16,17].

2. Materials and methods

2.1. Study sample

Data were collected as part of the UK Flexible Sigmoidoscopy (FS) Trial [18], which was set up to assess the efficacy of FS screening in preventing bowel cancer in adults aged 55–64. It also incorporated extensive assessment of behavioral and psychosocial characteristics as part of the baseline assessment [18,19]. In the Scottish center of the FS trial, 53 general practices were identified from records held by the Greater Glasgow Health Board and all adults aged 55–64 were contacted. Practices from more socioeconomically deprived areas were over-sampled to compensate for anticipated differential response rates. The sampling frame for the present study comprises those ($n = 10,650$) who were randomized to be sent the longer questionnaire that included questions on a range of health and psychosocial factors. A total of 6,383 (60%) returned the questionnaire. Those with missing data ($N = 1,130$) were excluded (i.e., 427 with missing deprivation, 82 self-rated health, 523 health behaviors, 88 psychosocial factors, and 10 marital status) leaving 5,253 respondents for the final analyses (49% of source population, and 82% of responders).

2.2. Measures

Self-rated health was assessed with a single item "Would you say that for someone of your age, your health in general is … excellent/good/fair/poor" [20]. The answers were categorized to (0) excellent or good and (1) fair or poor, in future referred to as "good" and "poor" self-rated health respectively.

The following two SES indicators were included: individual deprivation and neighborhood-level deprivation. *Individual deprivation* was assessed with three simple items included in the questionnaire: educational qualifications (passed public examinations within schools: yes-0, no-1), housing tenure (owing-0, renting-1), and car ownership (yes-0, no-1). An index was created by summing the scores on these three questions to create a scale from "0" (less deprived) to "3" (more deprived). The index has been used in other research studies [21]. An index of individual deprivation was included in our study instead of a single measure, because different markers have been shown to have independent effects on health [15,22], and an index based on education paired with material deprivation indicators was found to be the best approach to study health inequalities among older adults [23]. *Neighborhood deprivation* was assessed using a Glasgow-specific measure based on cluster analysis of 29 key deprivation indicators drawn from the 1991 census (e.g., unemployment, housing tenure, car access, social class, and overcrowding) [24]. The measure differentiates the neighborhoods in greater Glasgow according to level of deprivation. Postcodes were used to allocate each participant to an eight-level Neighborhood Type category which we combined to four levels ranging from less (0) to more (3) deprived areas. This and other neighborhood deprivation measures based on census data have been found to provide a good representation of material deprivation and are associated with a variation in health outcomes [25].

Health behaviors included exercise, smoking, and fruit intake. Research into major causes of morbidity and mortality emphasize the importance of these health behaviors [26]. Health behaviors were assessed as follows: "Do you take regular exercise each week" (yes, no); "Do you smoke cigarettes at all nowadays" (yes, no), and "About how many servings of fruit do you eat (fresh, frozen, or canned)" (at least one serving per day versus less than one serving per day). These questions were based on items used in the European Health Survey [27]. Simple self-assessment tools like these have been widely used and have been shown to be valid [27–29].

Psychosocial factors included perceived stress, optimism, and social support. Perceived stress was assessed with the four-item version of the Perceived Stress Scale (range 4–20). The scale is designed to measure the degree to which situations in one's life are appraised as stressful, but also refers to feelings of control in life and feeling confident to handle personal problems [30]. Optimism was assessed with the eight-item Life Orientation Test (range 0–32) [31]. Social support was indexed with scores from an abbreviated seven-item version of the Interpersonal Support Evaluation List (range 7–28) [32]. Higher scores indicate higher levels of perceived stress, higher optimism, or

more social support. Cronbach's alphas of the scales in the present sample were 0.72, 0.79, and 0.77, respectively. Each psychosocial factor was dichotomized to allow for easier comparison with the behaviors, which were all scored dichotomously. The 33rd or 66th percentiles were used to distinguish high perceived stress (⩾11), low optimism (<18), and low social support (<23).

Demographic factors included age, gender, and marital status. Age and gender were known from the Health Board records. The age range (55−64 years) was dichotomized at age 60. Marital status was self-reported and dichotomized to married (or living as married) versus not married. Because 98% of the sample was white, ethnicity was not included in the analyses.

2.3. Statistical analysis

We used a multilevel logistic model to allow for the nonindependence of participants clustered within general practices (STATA 8.2). Multiple logistic regression analyses were used to calculate odds ratios (OR) for the risk of poor self-rated health in the more deprived compared to the least deprived group. Four models were constructed to estimate independent intermediary effects of behavioral and psychosocial groups of factors: model 1 (demographics), model 2 (demographics and behaviors), model 3 (demographics and psychosocial factors), and model 4 (demographics, behaviors, and psychosocial factors). All models included both individual and neighborhood deprivation to make allowance for overlapping effects. Standard errors and 95% confidence intervals are adjusted for clustering within general practices. The intermediary effects of the groups of behavioral and psychosocial factors are quantified by the percentage change in β-coefficients for both deprivation indices, as behavioral and psychosocial factors are included in the model, an approach that has been used elsewhere [33,34]. The chi-square statistic of each logistic regression model is calculated to assess the significance of the intermediary effects across all four levels of each deprivation index. Analyses were carried out with STATA 8.2, and a *P*-value of <0.05 was considered significant.

3. Results

The characteristics of the sample ($N = 5{,}253$) are shown in Table 1. More than a third (39%) of respondents reported poor self-rated health. Male gender and being unmarried were significantly related to poor self-rated health. In this sample with a small age range (55−64 years), age was unrelated to self-rated health. There were significant associations between older age and higher individual deprivation, and between being unmarried and higher deprivation (both indices) (data not shown). The two deprivation indices were significantly correlated (Spearman rank $r = 0.45$, $P < 0.001$), but nevertheless a substantial number of participants were discordant on the two measures. For example, 716 people (14%) within the less-deprived individual categories (0−1) lived in a neighborhood classified as more deprived (2−3); and 1,009 (19%) people from the more-deprived individual categories (2−3) lived in less-deprived neighborhoods (0−1) (data not shown).

Table 1
Sample characteristics and association with self-rated health

		N (%)	% with poor self-rated health[a]
Demographics			
N		5,253 (100)	39.0
Age	55−59 yr	2,556 (48.7)	39.3
	60−64 yr	2,697 (51.3)	38.7
Gender	Female	2,877 (54.8)	36.5
	Male	2,376 (45.2)	42.0
Marital status	Married/living as married	3,659 (69.7)	36.6
	Not married	1,594 (30.3)	44.5
Deprivation			
Individual	0 (less deprived)	1,196 (22.8)	18.9
	1	1,667 (31.7)	33.3
	2	1,668 (31.8)	50.0
	3	722 (13.7)	60.1
Neighborhood	0 (less deprived)	1,129 (21.5)	22.4
	1	2,027 (38.6)	35.7
	2	935 (17.8)	45.7
	3	1,162 (22.1)	55.6
Behavior			
Exercise	Yes	3,227 (61.4)	30.0
	No	2,026 (38.6)	53.3
Smoking	No	3,567 (67.9)	34.1
	Yes	1,686 (32.1)	49.4
Fruit intake	Daily	1,626 (31.0)	30.8
	Less than daily	3,627 (69.0)	42.7
Psychosocial			
Perceived stress	Low (4−10)	3,648 (69.4)	30.5
	High (11−20)	1,605 (30.6)	58.3
Optimism	High (18−32)	3,661 (69.7)	31.6
	Low (0−17)	1,592 (30.3)	56.1
Social support	High (23−28)	3,631 (69.1)	33.0
	Low (7−22)	1,622 (30.9)	52.5

[a] All chi-square tests significant at $P < 0.001$, except for age ($P = 0.651$).

3.1. Social gradient in health

The (unadjusted) gradient in self-rated poor health was significant for both deprivation indices (Table 1). The percentage of people with poor self-rated health is significantly higher among the most deprived groups (60.1% for individual and 55.6% for neighborhood deprivation), compared to 18.9% and 22.4%, respectively, among the less-deprived groups. Rates of poor self-rated health were graded across the intermediate deprivation categories.

3.2. Potential intermediary groups of variables

To make the case that potential intermediary variables are on the pathway from deprivation to health, they should be associated both with self-rated health and deprivation. Table 1 shows that unhealthy behaviors (no exercise, smoking, and less than daily fruit intake) and unfavorable psychosocial characteristics (high perceived stress, low optimism, and low social support) were significantly related to poor self-rated health (Table 1). All potential intermediary factors were therefore significantly related to self-rated health in the expected directions.

The deprivation gradient in behaviors and psychosocial vulnerability is presented in Table 2 and Fig. 1. The percentage of people with unhealthy behaviors and unfavorable psychosocial characteristics was progressively higher for more-deprived groups (Table 2). Adjusted analyses (for demographics and both deprivation indices) indicated differential effects of the deprivation indices (Fig. 1). While individual deprivation showed similar associations with both behavioral and psychosocial factors, neighborhood deprivation was more strongly related to behaviors than to psychosocial variables.

3.3. Intermediary pathways of the social gradient in health

Table 3 shows different multiple logistic regression models, which were constructed to estimate independent intermediary effects of the groups of behavioral and psychosocial factors on the deprivation gradients in self-rated poor health. The first model included only demographics and each deprivation index separately (model 0). This showed a significant individual deprivation effect on self-rated health (OR = 6.5 for most deprived compared with the least deprived group) and a smaller but also highly significant neighborhood deprivation effect (OR = 4.2 for the most deprived area). When both deprivation indices were simultaneously included (model 1), the ORs were attenuated due to the overlap of the two deprivation indices, but both indices remained significantly related to self-rated health. Model 2 shows the effect of including behavioral factors in the model. Not taking regular exercise and smoking were significant predictors of poor self-rated health in the model, whereas fruit intake was not. After adjusting for behavioral factors, the effect of deprivation was somewhat attenuated compared to model 1, but still highly significant. Model 3 shows the effects of psychosocial factors. All psychosocial variables were significant predictors in the model. Model 4, includes both behavioral and psychosocial factors. This elaborated model explains 25% of the variance in self-rated health (Nagelkerke $R^2 = 0.25$). After adjusting for both groups of intermediary variables, the effect of both deprivation indices remains significant, but is reduced compared with earlier models.

The reductions in β-coefficients from the logistic regression models are shown in Table 4. Results for the most versus the least deprived are discussed in detail, keeping in mind that the effect is consistently graded across levels of deprivation. Among the most deprived, β-coefficients were reduced by 10% (individual) and 14% (neighborhood) when behavioral factors were added (model 2), and by 14% and 7% when psychosocial factors were added (model 3), and both groups of factors together lead to a 21% and 18% reduction of the social gradient in health (model 4). Clearly, the intermediary effects of behavioral and psychosocial factors overlap. In the last two columns, the independent effects are distinguished from the overlapping. The independent (intermediary) behavioral effect indicates the effect of behavioral factors that is not due to worse psychosocial factors. Correspondingly, the independent (intermediary) effect of psychosocial factors is the effect of psychosocial factors that is not due to unhealthy behavior. The change in chi-square statistic summarizes the intermediary effects across all four deprivation levels (also shown in Table 4). The last two columns in Table 4 show that the individual deprivation gradient in health is mediated both by behaviors (changes in β-coefficients are 5–7%;

Table 2
Association of deprivation indices with behavior and psychosocial vulnerability

	% no exercise	% smoking	% less than daily fruit intake	% high perceived stress	% low optimism	% low social support
Individual deprivation[a]						
0 (less deprived)	30.9	18.2	56.1	20.9	20.0	18.9
1	37.1	26.4	66.0	25.4	25.7	27.5
2	40.8	41.0	76.4	36.8	36.8	37.0
3	49.4	47.6	80.3	44.0	42.9	44.5
Neighborhood deprivation[a]						
0 (less deprived)	31.2	18.5	57.5	22.0	23.5	22.0
1	38.3	29.6	68.2	28.7	27.7	28.0
2	38.4	34.3	72.0	32.6	34.5	36.8
3	46.4	47.8	79.4	40.4	38.1	39.8
Total	38.6	32.1	69.0	30.6	30.3	30.9

[a] All chi-square tests significant at $P < 0.001$.

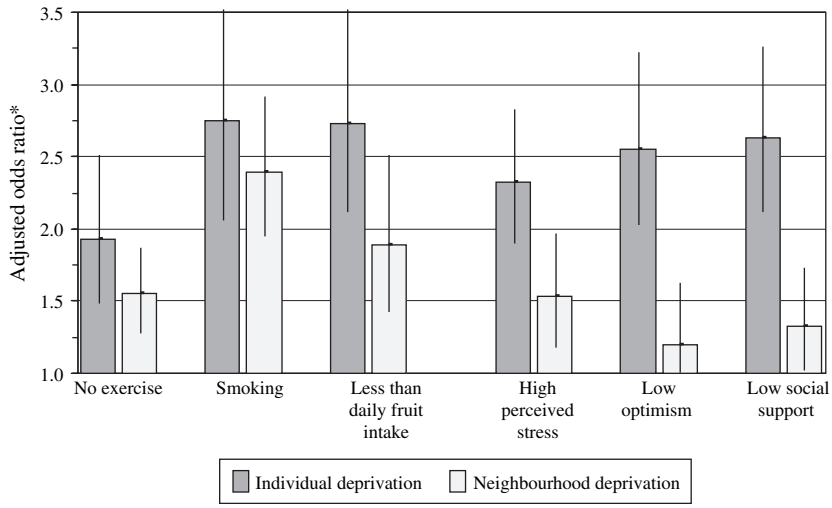

Fig. 1. Associations of deprivation indices with behaviors and psychosocial vulnerability, adjusted for demographics and both deprivation indices. *Odds ratios for most versus least deprived group; bars represent 95% CI. The 95% CI are adjusted for clustering on general practices.

χ^2 $P < 0.001$) and psychosocial factors (6–11%; χ^2 $P < 0.001$). The neighborhood deprivation gradient in health was particularly mediated by behaviors (3–13%, χ^2 $P < 0.01$) and less by psychosocial factors (0–4%; χ^2 P = not significant).

4. Discussion

Our results indicated, in line with many other studies, graded associations between deprivation and self-rated health. The effects were strong whether deprivation was indexed by individual circumstances or neighborhood characteristics. Each deprivation index had independent effects, with greater neighborhood deprivation increasing the risk of poor self-rated health moderately even after adjustment for individual deprivation and vice versa. Both behavioral and psychosocial pathways appeared to contribute to explaining the social gradient in health. However, there was some evidence that the psychosocial pathway was relatively less important when a neighborhood measure of deprivation is used, whereas both pathways were equally important for the individual-level measure. These observed differential intermediary pathways have potentially important implications for the discussion over whether neighborhood deprivation affects health independently of individual deprivation [2,4,5,7,35]. The present results add to the case that the moderate effect of neighborhood type is indeed an independent neighborhood effect and not due to incomplete adjustment for individual SES.

Our individual index included educational qualifications, housing tenure, and car ownership. The neighborhood index included housing tenure and car ownership in the area, in addition to age distributions, ethnicity, marital status, family structure, and employment. The two therefore cover similar ground, varying only in whether they concern assessment on an individual or neighborhood level. The correlation between the two indices is 0.45, which is highly significant but may be lower than expected. However, a similar correlation is reported for an individual deprivation

Table 3
Logistic regression models predicting poor self-rated health (95% confidence intervals [CI] are adjusted for clustering on general practices)

	Model 0: demographics[a]; OR (95% CI)	Model 1: demographics; OR (95% CI)	Model 2: demographics + behavior; OR (95% CI)	Model 3: demographics + psychosocial; OR (95% CI)	Model 4: demographics + behavior + psychosocial; OR (95% CI)
Individual deprivation					
0 (less deprived)	1	1	1	1	1
1	2.2 (1.8–2.6)	1.9 (1.6–2.3)	1.8 (1.5–2.2)	1.8 (1.5–2.2)	1.7 (1.5–2.1)
2	4.3 (3.6–5.2)	3.4 (2.8–4.0)	3.1 (2.6–3.6)	2.9 (2.4–3.4)	2.7 (2.3–3.2)
3	6.5 (5.2–8.1)	4.7 (3.8–5.8)	4.0 (3.3–4.9)	3.8 (3.1–4.8)	3.4 (2.8–4.2)
Neighborhood deprivation					
0 (less deprived)	1	1	1	1	1
1	1.9 (1.5–2.3)	1.4 (1.2–1.8)	1.4 (1.1–1.7)	1.4 (1.1–1.8)	1.4 (1.1–1.7)
2	2.8 (2.3–3.5)	1.9 (1.6–2.4)	1.8 (1.5–2.3)	1.8 (1.5–2.3)	1.8 (1.4–2.2)
3	4.2 (3.4–5.2)	2.3 (1.8–2.9)	2.0 (1.6–2.6)	2.2 (1.7–2.8)	2.0 (1.5–2.6)

[a] Model 0 includes each deprivation index separately; all other models include both deprivation indices simultaneously to adjust for their overlapping effect.

Table 4
Intermediary pathways of the social gradient in health; according to percentage reductions in β-coefficients and changes in chi-square from logistic regression models

	Model 1: demographics	Model 2: demographics + behavior		Model 3: demographics + psychosocial		Model 4: demographics + behavior + psychosocial		Intermediary behavior effect[b] (%)	Intermediary psychosocial effect[c] (%)
	β	β	Δ[a] (%)	β	Δ[a] (%)	β	Δ[a] (%)		
Individual deprivation									
0 (less deprived)	—								
1	0.65	0.60	8	0.60	8	0.56	14	6	6
2	1.21	1.13	7	1.06	12	1.01	17	5	10
3	1.55	1.40	10	1.34	14	1.23	21	7	11
$\Delta\chi^2$	246.0[d]	189.8[d]		167.4[d]		137.7[d]		29.7(3df) $P < 0.001$	52.1(3df) $P < 0.001$
Neighborhood deprivation									
0 (less deprived)	—								
1	0.37	0.31	16	0.36	3	0.31	16	13	0
2	0.66	0.61	8	0.61	8	0.59	11	3	3
3	0.83	0.71	14	0.77	7	0.68	18	11	4
$\Delta\chi^2$	76.0[d]	55.5[d]		60.6[d]		47.9[d]		12.7(3df) $P < 0.01$	7.6(3df) NS

[a] Percentage reduction in β-coefficient, calculated by (β model 1)−(β model 2, 3 or 4)/(β model 1).
[b] Percentage reduction in β-coefficient due to inclusion of behavioral factors (model 4) to a model already containing psychosocial factors (model 3): (% model 4)−(% model 3). Idem $\Delta\chi^2$ (model 4−model 3).
[c] Percentage reduction in β-coefficient due to inclusion of psychosocial factors (model 4) to a model already containing behavioral factors (model 2): (% model 4)−(% model 2). Idem $\Delta\chi^2$ (model 4−model 2).
[d] Increase in chi-square statistic due to inclusion of the deprivation marker of interest to the model; $P < 0.001$ for all models.

index and the neighborhood-based Townsend Index ($r = 0.42$) in a school based survey in England [36]. For the majority of people, the individual deprivation category corresponds with their neighborhood deprivation category, but a number of people with a relatively high individual deprivation group live in lower rated deprivation areas and vice versa. This may be more common among older adults, because mobility reduces with increasing age and people may stay in their neighborhood even though their individual characteristics deviate from the neighborhood deprivation level.

This study suggests that individual deprivation and neighborhood deprivation affect health through partly differential pathways. Individual deprivation may affect health because of its association both with increasingly unhealthy behaviors and more unfavorable psychosocial characteristics. Although higher deprivation does not force an individual to smoke, eat less fruit, or take less exercise, it appears that individuals are affected by adverse social circumstances in a way that makes it harder to invest in their own health and increases their psychosocial vulnerability [37]. The psychosocial pathway seems less important from the neighborhood perspective. Neighborhoods may influence health behaviors because of shared norms governing activities in social groups [2], whereas neighborhoods may have smaller effects on psychosocial characteristics of their inhabitants.

This study did not aim to explain the complete social gradient in health, but rather to compare two possible pathways that have shown to be relevant in previous research [1,13,14]. Other intermediary pathways explaining part of the social gradient in health have been described in the literature, for example, interactions with health care, income, environmental influences, or life course effects [37–40]. The fact that we did not include these factors does not mean we do not think that they are relevant; we rather aimed at exploring differential pathways for different deprivation indices with the available data on two pathways. The causal chains involved are likely to be complex.

Important advantages of our study include the availability of 5,253 participants from a wide range of the socioeconomic spectrum. General practices from more socioeconomically deprived areas were over-sampled to compensate for anticipated differential response rates. In addition, this study includes a wide range of data, allowing us to study different deprivation indexes and different potential intermediary groups of variables in one analysis. The assessment of psychosocial variables was based on well-validated questionnaires. The scores on these questionnaires were dichotomized in the analyses to allow for easier comparisons with behavioral factors, although using available continuous scores in the analyses did not affect the conclusions. By including three dichotomous behavioral factors and three dichotomized psychosocial factors, comparison of both groups of factors is unaffected by statistical effects of distribution differences. In addition, both deprivation indices are based on several correlated variables and both indices were categorized in four classes. There is therefore no bias related to different degrees of freedom required when entering the two variables into the model.

Moreover, additional analyses showed that our conclusions are not affected by gender specific analyses or by using ordinal logistic regression models including all four levels of self-rated health (data not reported).

Some limitations of our study need to be mentioned, including the cross-sectional design. This design does not allow us to make causal interferences, but cross-sectional studies can add important information by studying associations between variables, without claiming causal relationships. The response rate (60%) in our population-based study is comparable with other (epidemiological) studies. Due to missing values, our analyses included 49% of the source population. Nonresponse analyses showed that, as in many studies, the analysis included a more ''healthy'' subgroup with significantly better self-rated health, more beneficial health behaviors, better psychosocial resources, and lower deprivation compared to nonresponders. This may have biased our results toward an under-estimation of the social gradient in health. However, it is unlikely that the observed associations of the social gradient with health behaviors and psychosocial factors are influenced to a great extent, since similar trends of nonresponse were found for health behaviors and psychosocial factors (i.e., responders reported more beneficial scores on both groups of factors). Another limitation concerns the simplistic measures of health behaviors, which may promote over-reporting and would certainly limit precision. However, simple measures have been shown to have reasonable validity [27–29], and in large sample, a simple division into higher and lower levels probably provides acceptable accuracy for interpreting group differences. Finally, all analyses of the relative contribution of individual and neighborhood deprivation may be compromised by inadequate measurement at both levels. However, our neighborhood deprivation measure aggregates individual characteristics over areas using census data of the total population living in the study area, and is not limited to the study sample.

The use of self-rated health as our health outcome is a limitation. Although, convincing evidence is available of the association of self-rated health with other health outcomes, including mortality [41], it is still unclear what exactly it measures [42]. In addition, there is a debate over whether it is a good measure for this type of research because associations between self-reported explanatory variables and self-rated health might be confounded by type of assessment (i.e., self report) leading to exaggerated associations. Indeed, the social gradient in more objective measures of health (e.g., mortality) might be smaller, and the same may hold for the intermediary effect of health behaviors and psychosocial factors. So the absolute contributions of these factors might be smaller in other more objective measures of health. However, the relative contribution of health behavioral and psychosocial factors to the social gradient in health is not expected to differ with other health outcomes. Therefore, we believe that the observed differential pathways of individual deprivation and neighborhood deprivation on self-rated health may also be relevant to the social gradient in other health outcomes.

In conclusion, this study indicates that intermediary pathways of the social gradient in self-rated health differ between individual and neighborhood-based deprivation indices, suggesting that there are at least partly independent health gradients of individual and neighborhood deprivation. Potential interventions to reduce the social gradient in health are a priority in many countries, including Scotland, and a role for clinical epidemiology has been acknowledged [43]. Indeed the design of policy initiatives depends on a more detailed understanding of the social gradient. The present study suggests that such interventions may need to combine person-centered approaches, with approaches aimed at changing residential environments.

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