RESEARCH REPORT

Places, people, and their physical and mental functional health

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Study objective: To investigate the impact of area of residence on functional health as represented by medical outcomes study SF-36 physical and mental component summary scores.
Design: Multilevel analysis of cross sectional data from the European Prospective Investigation into Cancer and Nutrition in Norfolk, UK (EPIC-Norfolk).
Participants: A community dwelling cohort of 18 399 men and women, aged 41 to 80 and resident in 162 electoral wards in Norfolk, UK.
Main results: Significant residual variation in physical functional health was observed at the area level after controlling for important individual level socioeconomic factors ($p<0.001$). However, the extent of this variation was modest when compared with that at the individual level (representing 0.6% of the total). About half of this variation could be explained by area deprivation. Area deprivation was associated with impaired mental functional health but residual variation at the area level (adjusted for individual level factors) was observed only for men (0.5% of total, $p=0.02$).
Conclusions: Area of residence was associated with physical functional health, albeit with modest effect size. Evidence for an association between area of residence and mental functional health was weak.

Associations between individual level measures of socioeconomic status and health are well established.[1] A focus on area level measures of social context has shown that they can also have an impact on individual health[2–4] and capture information not available at the individual level[5] such as community socioeconomic status, availability and access to services, shared culture, and physical features of the local environment such as pollution.[4 6] While variation in health at the area level could be attributable to social context, it can also reflect a clustering of similar individuals within areas; for example by age, sex, or social class (composition). Therefore, investigation of the impact of social context on health should include thorough adjustment for the effects of individual level factors.[2 3] Joint models for area and individual level effects can be analysed through standard regression methods by constructing covariates to represent both individual and area level characteristics. However, multilevel (or hierarchical) models are now recommended as a more appropriate method of analysis as residual variation can be taken into account (and quantified) at both the individual and area levels, allowing the effects of context to be easily separated from the effects of composition.[2 3 7–9]

Contextual effects (independent of age, sex, and individual level measures of socioeconomic position) have been demonstrated for health behaviours (including smoking, diet, and physical exercise[8 10–14]) and for a range of physical health outcomes (including incident coronary heart disease, long term illness, mortality, and self reported health[8 15–18]). However, the extent of area level relative to individual level variation is usually modest,[2 3] and other studies have produced negative results for similar end points.[12 19] Area based measures of deprivation account for some (but not all) of this area level variation in individual health outcomes.[15 20]

Few studies have investigated the impact of social context on mental health outcomes and these have provided mixed results.[8 21] Positive findings reported in relation to depression, schizophrenia, and substance misuse,[21–24] are in contrast with negative findings reported for depression and for General Health Questionnaire defined psychiatric morbidity.[23 25–27] Strategies to improve the quality of life and functional ability of populations are important public health objectives[28 29] and neighbourhood factors have been shown to be associated with poor physical functioning.[30 31] The Short Form 36 (SF-36) provides a validated generic measure of subjective health status derived from the US Medical Outcomes Study.[32 33] Few studies have investigated contextual effects in relation to SF-36 functional health.[34–36]

A large population based cohort study (the European Prospective Investigation into Cancer and Nutrition in Norfolk, UK (EPIC-Norfolk)[13 37]) now provides an opportunity to examine contextual effects, through multilevel analysis, for physical and mental functional health as represented by SF-36 summary scores. We specifically ask whether there is area level variation in physical and mental functional health that persists after controlling for important individual level socioeconomic factors, and investigate the extent of any area level as compared with individual level variation.

METHODS

During 1993–97, EPIC-Norfolk, a large population based cohort study designed to advance understanding of nutritional and other determinants of chronic disease development, recruited participants by post through general practice age-sex registers in Norfolk, England.[37] In comparison with the general resident population of England, the EPIC-Norfolk cohort is representative in terms of anthropometric variables, blood pressure, and serum lipids, but has fewer current smokers.[37] During 1996–2000 an assessment of social and psychological circumstances (based upon the Health and Life Experiences Questionnaire (HLEQ)[38]) was completed by a total of 20 921 participants, representing a response rate of 73.2% of the total eligible EPIC sample.[39]

Abbreviations: PCS, physical component summary; MCS, mental component summary

Dependent variables

The HLEQ included the anglicised Short Form 36 (SF-36). Eight multi-item independent health dimensions (subscales) are represented in the SF-36, namely: physical functioning, social functioning, role limitations because of physical problems, role limitations because of emotional problems, mental health, energy/vitality, pain, and general health perception. Two higher order summary scores representing overall physical and mental health functioning (the physical component summary (PCS), and mental component summary (MCS)), were derived according to algorithms specified by the original developers (that were based on a factor analysis that captured over 80% of the variance in the eight subscales).[40 41] Subscale scores were based on available data where at least half of the items were entered. Factor score coefficients used to derive the component scores were based upon a US as opposed to a UK population (that produce similar results) on the basis of uniformity for cross national comparisons.[42] PCS and MCS scores are standardised so that the US population has mean 50 and standard deviation (SD) 10.[41] A higher score on both summary scales represents better functional health.

Individual level measures

As part of the HLEQ assessment, details of demographic factors and of either current or prior main work were obtained, enabling standard social class allocation according to computer assisted standard occupational coding.[43] Current employment status was coded as those working (full time or part time) and not working (either unemployed or economically inactive), as defined by the Office of National Statistics.[44] Social class was coded as I (professionals), II (managerial and technical occupations), III non-manual and III manual (skilled workers), IV (partly skilled workers), and V (unskilled manual workers). For both men and women, social class was coded based on the male partner's current or prior occupation (or the female partner's occupation where this was unavailable). If data were not available for either partner social class could not be allocated, see Shohaimi *et al*[13] for further details. Educational attainment was coded in four categories (those with no formal qualifications, those with formal qualifications usually associated with a school age of 16 years, those with formal qualifications (or vocational equivalent) usually associated with a school age of around 18 years, and those with degree level qualifications). These factors, along with marital status, age, and sex were included as individual level confounding variables.

Area level measures

Participants in the EPIC-Norfolk study were recruited from a defined geographical area within East Anglia (UK), centred on the city of Norwich and the surrounding small towns and rural areas, which has little outward migration in the study age group.[37] Area of residence was defined according to the UK electoral register (electoral wards). In year 2000, an overall index of multiple deprivation commissioned by the (then) Department of the Environment, Transport and the Regions, was created for the 8414 electoral wards in England, derived from 32 variables in six domains (income, employment, health deprivation and disability, education skills and training, housing, and geographical access to services).[45] A higher deprivation score represents a more deprived neighbourhood. These data were linked at the electoral ward level to individual level data gathered through the EPIC-Norfolk HLEQ instrument.

Statistical analysis

Variations in PCS and MCS scores are presented for all individual and area level covariates, adjusted for age (in five year bands) and sex (including age-sex interactions), as β coefficients (standard errors) obtained from linear regression models. Area level variation in PCS and MCS scores was assessed through a series of random intercept gaussian multilevel models[46] with individual at level one and electoral ward at level two. The proportion of variance explained at the area level (equivalent to the intra-class correlation (ICC) for random intercept multilevel models), represents the degree of correlation between the health of people within the same area (electoral ward). We present the percentage of residual variation at the area level (100×ICC), unadjusted then adjusted for individual level characteristics, and after additional adjustment for area deprivation. As it was not possible to allocate social class for a sizeable subgroup of participants (see table 1) this subgroup was included in the adjusted analyses as an extra category. Tests of significance of area level variance were obtained from likelihood ratio tests. Analysis was performed in SPlus[47] and MLwiN.[48]

RESULTS

Of the HLEQ sample, PCS and MCS scores and linked data at the electoral ward level were available for 18 399 participants (87.9% of the sample), aged 41 to 80 years, including 8109 men and 10 290 women. Mean scores (standard deviations) for the PCS were 47.8 (9.9) and 47.1 (10.4) for men and women, respectively, and for the MCS were 53.0 (9.0) and 51.6 (9.7). Table 1 shows the sociodemographic composition of the study sample. In this sample, individual SF-36 subscale items had been imputed in the calculation of PCS and MCS summary scores for 2,152 (11.7% of) participants (involving imputation of only one of 35 items for 1475 and more than three items for just 163 participants).

Study participants were resident in 162 electoral wards with a mean of 114 participants per ward (median 77, range 1 to 780). Multiple deprivation scores in the range 5.2 to 58.8 place these 162 wards as ranked between the 7991st and 288th most deprived of the 8414 wards in England, a coverage of 91.5% of the population distribution of deprivation scores. Of the study participants, 90% were resident in wards with multiple deprivation scores in the range 7.4 to 37.2, corresponding to ward level ranks of 7307 and 1321 (and a coverage of 71.1% of the population distribution). The proportion of participants in the non-manual social classes was higher (82.0% versus 58.2%) for those who were resident in the least as compared with most deprived wards, respectively (bottom and top deciles of deprivation scores). Tables 2 and 3 reveal strong age-sex adjusted associations between all individual and area level factors considered and PCS and MCS scores (except for educational attainment and MCS score). Participants who were resident in the more deprived wards reported worse functional health. This association was consistent across the six domain scores of deprivation (except for access to services and PCS score, data not shown). The pattern of associations was generally consistent by sex with the magnitude of associations tending to be greater for men than for women.

Table 4 shows results from multilevel models of PCS and MCS score. Unadjusted for any covariates, significant area level variation was observed for both PCS and MCS scores. Area variation represented 1.1% of the total variation in PCS scores and was consistent for men (1.2%, $p<0.001$) as well as for women (1.0%, $p<0.001$). Area variation was more modest for MCS, representing only 0.5% of total variation and was greater for men (0.9%, $p<0.001$) than for women (0.4%, $p = 0.007$). The percentage variation at the area level in PCS and MCS scores was unchanged after excluding those participants for whom SF-36 scale items had been imputed (remaining sample size, n = 16 247).

Table 1 Sociodemographic composition of the study sample (n = 18399)

	Men		Women		All	
	Number	(%)	Number	(%)	Number	(%)
Social class						
I	719	(8.9)	196	(1.9)	915	(5.0)
II	3163	(39.0)	3119	(30.3)	6282	(34.1)
IIIn	747	(9.2)	3739	(36.3)	4486	(24.4)
IIIm	1886	(23.3)	627	(6.1)	2513	(13.7)
IV	570	(7.0)	1033	(10.0)	1603	(8.7)
V	98	(1.2)	377	(3.7)	475	(2.6)
Not allocated	926	(11.4)	1199	(11.7)	2125	(11.5)
Marital status						
Married/living as married	7078	(87.3)	7662	(74.5)	14740	(80.1)
Never married	310	(3.8)	434	(4.2)	744	(4.0)
Widowed	299	(3.7)	1350	(13.1)	1649	(9.0)
Divorced/separated	404	(5.0)	832	(8.1)	1236	(6.7)
Employment status						
Working	3840	(47.4)	4045	(39.3)	7885	(42.9)
Not working	4240	(52.3)	6177	(60.0)	10417	(56.6)
Educational attainment						
No qualifications	2376	(29.3)	4697	(45.6)	7073	(38.4)
To age 16	713	(8.8)	1724	(16.8)	2437	(13.2)
To age 18	3758	(46.3)	2673	(26.0)	6431	(35.0)
Degree level	1260	(15.5)	1190	(11.6)	2450	(13.3)

After adjustment for all individual level factors, area level variation in PCS score remained significant but was reduced to 0.6% of the total residual variation (0.8%, p<0.001, for men and 0.5%, p<0.001, for women). Area deprivation was associated with PCS score, independent of the individual level factors, and accounted for about half of the remaining area level variation. The magnitude of effect for deprivation was smaller than for the most important individual level factors (employment status and social class), as was the magnitude of the area level residuals (from model B: range −1.3 to 1.4 with 90% in the range −0.5 to 0.4). After adjustment for individual level factors, only a small amount of variation in MCS scores remained at the area level (0.2% of the total, p = 0.05), and was apparent for men (0.5%, p = 0.02) but not for women (0.1%, p = 0.3). Area deprivation was associated with MCS score, independent of the individual level factors, but only accounted for 25% of the remaining area level variation in men. The magnitude of effect for deprivation and the magnitude of the area level residuals (from model B: range −0.5 to 0.4 with 90% in the range −0.2 to 0.2) were again smaller than for the most important individual level factors (marital status and social class).

A final analysis investigated any interaction between social class (as a binary variable; non-manual (I, II, and IIIn) versus

Table 2 Age-sex adjusted associations between individual and area level sociodemographic characteristics and SF-36 physical component summary (PCS) scores (β coefficients (standard errors))

	Men		Women		All	
	β†	(SE)	β	(SE)	β	(SE)
Age						
41–54	–	–	–	–	–	–
55–64	−2.8	(0.3)	−2.2	(0.2)	−2.5	(0.2)
65–80	−6.6	(0.3)***	−6.5	(0.2)***	−6.5	(0.2)***
Social class						
I	–	–	–	–	–	–
II	−0.9	(0.4)	0.2	(0.7)	−0.8	(0.3)
IIIn	−1.7	(0.5)	0.3	(0.7)	−1.0	(0.4)
IIIm	−2.8	(0.4)	−1.3	(0.8)	−2.5	(0.4)
IV	−3.4	(0.5)	−1.0	(0.8)	−2.5	(0.4)
V	−5.4	(1.0)***	−2.0	(0.9)***	−3.6	(0.6)***
Marital status						
Married/living as married	–	–	–	–	–	–
Never married	−0.9	(0.6)	−0.4	(0.5)	−0.6	(0.4)
Widowed	0.1	(0.6)	0.0	(0.3)	0.0	(0.3)
Divorced/separated	0.0	(0.5)	−1.4	(0.4)**	−0.9	(0.3)**
Employment status						
Working	–	–	–	–	–	–
Not working	−5.4	(0.3)***	−3.7	(0.3)***	−4.4	(0.2)***
Educational attainment						
No qualifications	–	–	–	–	–	–
To age 16	2.1	(0.4)	0.9	(0.3)	1.3	(0.2)
To age 18	1.2	(0.3)	0.8	(0.2)	0.9	(0.2)
Degree level	2.7	(0.3)***	1.4	(0.3)***	2.0	(0.2)***
Multiple deprivation						
per SD increase	−0.8	(0.1)***	−0.5	(0.1)***	−0.6	(0.1)***

**p<0.01; ***p<0.001 for *F* test of overall significance; †β coefficients (standard errors) from linear regression adjusting for age and sex; a higher PCS score represents better physical functional health, therefore a positive coefficient implies better health and a negative coefficient implies worse health as compared with baseline.

Table 3 Age-sex adjusted associations between individual and area level sociodemographic characteristics and SF-36 mental component summary (MCS) scores (β coefficients (standard errors))

	Men		Women		All	
	β†	(SE)	β	(SE)	β	(SE)
Age						
41–54	–	–	–	–	–	–
55–64	1.9	(0.3)	2.6	(0.2)	2.3	(0.2)
65–80	3.6	(0.2)***	3.8	(0.2)***	3.7	(0.2)***
Social class						
I	–	–	–	–	–	–
II	−0.3	(0.4)	−0.9	(0.7)	−0.4	(0.3)
IIIn	−0.7	(0.5)	−1.1	(0.7)	−0.7	(0.4)
IIIm	−0.6	(0.4)	−0.9	(0.8)	−0.6	(0.4)
IV	−1.2	(0.5)	−1.8	(0.7)	−1.4	(0.4)
V	−3.5	(1.0)**	−1.9	(0.8)*	−2.0	(0.5)***
Marital status						
Married/living as married	–	–	–	–	–	–
Never married	−1.9	(0.5)	−0.8	(0.5)	−1.3	(0.3)
Widowed	−1.6	(0.5)	−1.4	(0.3)	−1.5	(0.3)
Divorced/separated	−3.4	(0.5)***	−3.0	(0.3)***	−3.2	(0.3)***
Employment status						
Working	–	–	–	–	–	–
Not working	−1.6	(0.3)***	−0.7	(0.3)**	−1.1	(0.2)***
Educational attainment						
No qualifications	–	–	–	–	–	–
To age 16	0.5	(0.4)	0.4	(0.3)	0.4	(0.2)
To age 18	0.3	(0.2)	0.2	(0.2)	0.3	(0.2)
Degree level	0.2	(0.3)	0.8	(0.3)	0.5	(0.2)
Multiple deprivation						
per SD increase	−0.5	(0.1)***	−0.5	(0.1)***	−0.5	(0.1)***

*p<0.05; **p<0.01; ***p<0.001 for *F* test of overall significance; †β coefficients (standard errors) from linear regression adjusting for age and sex; a higher MCS score represents better mental functional health, therefore a positive coefficient implies better health and a negative coefficient implies worse health as compared with baseline.

Table 4 Individual and area level variation in SF-36 physical component summary (PCS) and mental component summary (MCS) scores (parameter estimates (standard errors)); A: unadjusted; B: adjusted for individual level characteristics (age, sex, social class, marital status, employment status, and educational attainment, all as categorical variables) and; C: with additional adjustment for area deprivation (continuous)

	PCS						MCS					
	A		B		C		A		B		C	
Fixed effects			β†	(SE)	β	(SE)			β	(SE)	β	(SE)
Social class												
I			–	–	–	–			–	–	–	–
II			−0.2	(0.4)	−0.2	(0.4)			−0.4	(0.3)	−0.3	(0.3)
IIIn			0.0	(0.4)	0.0	(0.4)			−0.7	(0.4)	−0.7	(0.3)
IIIm			−1.4	(0.4)	−1.4	(0.4)			−0.5	(0.4)	−0.5	(0.4)
IV			−1.2	(0.4)	−1.2	(0.4)			−1.2	(0.4)	−1.2	(0.4)
V			−2.1	(0.6)	−2.1	(0.6)			−1.8	(0.5)	−1.7	(0.5)
Marital status												
Married/living as married			–	–	–	–			–	–	–	–
Never married			−0.2	(0.4)	−0.1	(0.4)			−1.2	(0.4)	−1.2	(0.4)
Widowed			0.1	(0.3)	0.1	(0.3)			−1.4	(0.3)	−1.4	(0.3)
Divorced/separated			−0.8	(0.3)	−0.7	(0.3)			−3.1	(0.3)	−3.0	(0.3)
Employment status												
Working			–	–	–	–			–	–	–	–
Not working			−4.3	(0.2)	−4.3	(0.2)			−1.0	(0.2)	−0.9	(0.2)
Educational attainment												
No qualifications			–	–	–	–						
To age 16			0.9	(0.2)	0.8	(0.2)						
To age 18			0.5	(0.2)	0.5	(0.2)						
Degree level			1.1	(0.3)	1.1	(0.3)						
Multiple deprivation												
per SD increase					−0.5	(0.1)					−0.3	(0.1)
Random effects	σ^2	(SE)	σ^2	(SE)	σ^2	(SE)	σ^2	(SE)	σ^2	(SE)	σ^2	(SE)
Individual variation	102.9	(1.08)	91.2	(0.96)	91.2	(0.96)	88.8	(0.93)	84.7	(0.89)	84.7	(0.89)
Area variation	1.10	(0.25)***	0.53	(0.16)***	0.30	(0.12)***	0.44	(0.14)***	0.15	(0.09)*	0.05	(0.07)
% Area variation‡	1.1		0.6		0.3		0.5		0.2		0.1	

*p<0.05; **p<0.01; ***p<0.001 for likelihood ratio test of area level variance; †β coefficients (standard errors) from random intercept gaussian multilevel models; higher PCS and MCS scores represent better functional health, therefore a positive coefficient implies better health and a negative coefficient implies worse health as compared with baseline; ‡equivalent to 100×the intraclass correlation (ICC).

Key points

- Contextual effects have been demonstrated for a range of physical health outcomes but results from the few studies of mental health outcomes have been mixed.
- This study has provided evidence for area level variation in physical functional health, independent of individual level socioeconomic factors.
- The combination of low social class and living in a deprived area resulted in especially low levels of reported physical functional health.
- Evidence for an association for mental functional health was weak.
- In agreement with previous studies, the magnitude of the association observed at the area level was modest.

manual (IIIm, IV and V)) and multiple deprivation, adjusted for all other individual level covariates. Some evidence for an interaction was found for PCS ($p = 0.05$) but not for MCS score ($p = 0.13$). Figure 1 shows adjusted mean PCS scores by social class across the range of multiple deprivation scores and reveals that the disparity in functional health between social classes widens with increasing area deprivation.

DISCUSSION

This study has provided evidence for an association between area of residence and self reported physical functional health. Those participants who were resident in the more deprived neighbourhoods reported worse physical functional health than residents of the less deprived neighbourhoods. However, the extent of variation at the area level, after controlling for important individual level socioeconomic factors, was modest in comparison to variation at the individual level. About half of this association could be accounted for by an index of multiple deprivation that combined area level domain scores of income, employment, health deprivation and disability, education skills and training, housing, and geographical access to services. There was some evidence of an interaction effect between social class and area deprivation such that the combination of low social class and living in a deprived area resulted in especially low levels of reported physical functional health. While area deprivation was associated with poor mental functional health, residual variation at the area level, after adjusting for individual level socioeconomic factors, was modest and was observed for men but not for women.

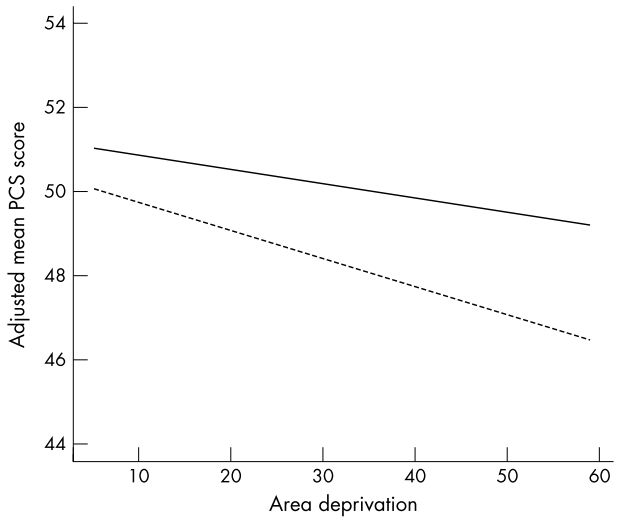

Figure 1 Interaction between social class and area deprivation; mean SF-36 physical component summary (PCS) score (adjusted for individual level covariates) by increasing area deprivation and by social class (non-manual; I, II and IIIn—solid line: and manual; IIIm, IV, V—dashed line).

The results from this study were obtained from a multilevel analysis of individual and area level socioeconomic factors. Multilevel models have a number of advantages over more traditional (single level) regression approaches.[2 3 7 9] However, the results obtained are necessarily limited by the quality of the data to which they are applied,[3] and the power to detect variability at the area level depends both on the number of areas and on the average number of people within each area.[2 3] Although, there was wide variation in the number of people across the 162 electoral wards, the size of this study cohort is a major strength. However, evidence for residual variation in mental functional health at the area level was weak and inconsistent despite a significant association for an area level covariate (multiple deprivation). While this indicates that power to detect variation at the area level remains an issue, given the large sample the effect size for the association between area and mental functional health is arguably too small to be of practical importance in this study.

A number of other important limitations warrant further comment. Firstly, the data used for this study were cross sectional and we are therefore unable to comment on the direction of causation. While area of residence could adversely affect physical functional health, a person's functional health might also influence (or limit) their choice of area of residence. Secondly, the specification of areas is based on administrative boundaries (driven by practical considerations) and therefore has no explicit theoretical justification. This may have compromised the capacity of these data to detect variation at the area level. Thirdly, while we have included adjustment for individual level social class, marital status, employment status, and educational attainment, the presence of significant variation at the area level could be attributable to the omission of other important individual level covariates. However, as the distinction between individual and area level factors is not always clear (for example, individual social class can be influenced by the availability of work or other local area economic factors),[49 50] it also possible that we have underestimated the impact of area through overadjusting for individual level socioeconomic status. No adjustments were made in this study for individual level behavioural measures (for example, smoking and physical activity) or for cardiovascular risk factors (for example, blood pressure and cholesterol). As previous studies have provided evidence of contextual effects for these measures,[8 10 14 51] they were considered as potential mediators and therefore not included as confounders.[2 5] Fourthly, the age range (41–80), social class distribution (predominantly non-manual), and type of geographical area studied may limit the generalisability of results. However, deprivation scores from the 162 electoral wards in this study did cover 90% of the range of deprivation scores for all 8414 wards in England, although it remains possible that results will not be generalisable for residents of areas that are either extremely deprived or extremely affluent.

Few studies have investigated contextual effects in relation to SF-36 functional status. A recent UK study of 2190 people, aged 18 to 75 and resident in 15 neighbourhoods (electoral wards)[35] reported appreciable differences between areas for seven of the eight SF-36 subscale scores and concluded that the relation between material deprivation and functional health was strong enough to be of practical importance. However, area level results from this study were based on an

aggregate analysis and did not include simultaneous adjustment for individual level socioeconomic factors. A study of Canadian adults reported a multilevel analysis of SF-36 subscale and summary scores and concluded that variation between nine sites was not clinically important.[36] Our findings are broadly in line with those from a recent large scale study of US veterans in a primary care setting.[34] Based on a single level analysis of 17 234 people across seven geographical sites, the study reported substantial variation between sites for both the SF-36 physical and mental component summary scores. However, after adjustment for individual level factors, geographical site accounted for only a small percentage of explained variation in physical functional health and an even smaller percentage of variation in mental functional health.

The joint investigation of social context and individual level variables can provide a more complete understanding of the determinants of disease[5] as well as a basis for planning improvements in public health.[6] Most previous studies have shown some evidence for the impact of social context on physical health outcomes and behaviours, whereas only a few studies have investigated the impact of social context on mental health outcomes, and with mixed results.[8] This study has provided evidence for an association between social context and physical functional health, independent of individual level socioeconomic factors, whereas evidence for an association between social context and mental functional health was weak. In agreement with previous studies, the magnitude of the association observed at the area level was modest when compared with the magnitude of associations at the individual level. At a public health policy level these results imply that while improvements in health might be achieved at both the individual and area levels, greater rewards might be gained from interventions targeted at the person rather than the area.

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ECHO

Incidence of cancer among UK Gulf war veterans: cohort study

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Objectives: To determine whether incidence rates of cancer are higher in UK service personnel who were deployed in the Gulf war than in those not deployed and whether any increased risk of cancer is related to self reported exposures to potentially hazardous material during the period of deployment.
Design: A cohort study with follow up from 1 April 1991 (the end of the Gulf war) to 31 July 2002.
Participants: 51 721 Gulf war veterans and 50 755 service personnel matched for age, sex, rank, service, and level of fitness who were not deployed in the Gulf (the Era cohort).
Main outcome measures: Incident cancers, identified on the NHS central register.
Results: There were 270 incident cancers among the Gulf cohort and 269 among the Era cohort (incidence rate ratio 0.99, 95% confidence interval 0.83 to 1.17). There was no excess in site specific cancers among the Gulf cohort. Adjustment for lifestyle factors (smoking and alcohol consumption) did not alter these results. In the Gulf cohort, risk of cancer was not related to multiple vaccinations or exposure to pesticides or depleted uranium during deployment.
Conclusion: There is no current excess risk of cancer overall nor of site specific cancers in Gulf war veterans. Specific exposures during deployment have not resulted in a subsequent increased risk of cancer. The long latent period for cancer, however, necessitates the continued follow up of these cohorts.

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