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Community-level socio-economic status and cognitive and functional impairment in the older population

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Background: This study aimed to determine if people living in communities with higher socio-economic deprivation are at an increased risk of cognitive and functional impairment even after controlling for the effects of individual socio-economic status. **Methods:** We analysed cross-sectional data from the Medical Research Council Cognitive Function and Ageing Study which consists of a community-based sample of Cambridgeshire, Gwynedd, Newcastle, Nottingham and Oxford. The study included 13 004 men and women aged 65 years and over who were randomly selected from Family Health Services Authority computerized records after being stratified to ensure equal numbers of those aged 75 years and over and those under 75 years. The outcome measures were cognitive impairment (Mini-Mental State Exam 0–21) and functional impairment (Instrumental Activities of Daily Living and/or Activities of Daily Living disability). **Results:** Individuals living in more deprived areas, as measured by the Townsend deprivation score, were found to have a higher prevalence of cognitive impairment [odds ratio (OR) (most deprived versus least deprived quintile) = 2.3; 95% confidence interval (CI)1.8–3.0; $P < 0.001$] and functional impairment [OR (most deprived versus least) = 1.6; 95% CI 1.4–1.9; $P < 0.001$] after controlling for age, sex, centre effects, education and social class. **Conclusions:** There is a significantly higher prevalence of cognitive impairment and functional impairment in elderly individuals living in socio-economically deprived areas regardless of their own socio-economic status. This evidence is of relevance for informing public health policy and those allocating resources for the long-term care of the elderly.

Keywords: area-effects, cognitive impairment, functional impairment, MRC CFAS, socio-economic status

Research has shown that low individual socio-economic status (SES), as defined by educational attainment and social class based on occupation is a significant risk factor for a number of negative health outcomes, including cognitive and functional impairment.[1–6] Yet these indicators of individual SES do not fully account for the trends observed across regions of varying levels of SES.[4]

Recently, greater attention has focused on community-level SES as researchers have hypothesized that area characteristics such as access to health care, availability of community resources, social dynamics and networks, attitudes and beliefs about health practices and stress could account for the variation in the risk of morbidity and mortality observed.[7,8] Studies have indicated that living in areas of low SES increases the risk of morbidity and mortality for many health outcomes including long-term limiting illness,[9–11] long-term disability[12] and poor self-reported health[13–15] after controlling for individual SES.[16]

The evidence of this relationship is not entirely consistent, though, and methodologies vary widely. Some researchers report no significant association between area-based SES and long-term limiting illness,[17] poor self-rated health[12] and common mental disorders.[18] However, because area-effects on health may act as proxies for various community-level characteristics, it is likely that these relationships operate differently depending upon the measure of community SES used, the characteristics with which they are associated, and how they relate to the outcome of interest.[8,19–21]

The aim of this study is to determine if community-based SES is associated with an increased risk of cognitive impairment and functional impairment in those 65 years and older after accounting for individual SES, which is a known predictor of these health outcomes. While numerous studies have focused on the association between community deprivation and health in younger age groups, this relationship has not been examined in detail in the elderly, possibly due to the difficulty in defining individual SES in the older population.[22]

Because population projections indicate a continuous, substantial rise in the number of older individuals, with a corresponding increase in the proportion suffering from cognitive and functional impairment,[23] it is important to determine the extent to which community-level deprivation is associated with these outcomes. Health declines with age and, additionally, vulnerability and the need for services increases with poor health, making the elderly more likely to be dependent on local resources and the local environment.[24]

Identifying the relationship between community-level SES and health will prompt further studies aimed at understanding the specific mechanisms by which this association operates.

* MRC CFAS (www.cfas.ac.uk) is the name of the study, and the authors would like it to be included as an author as agreed by the Management Committee of the study.

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In addition, it will provide evidence for community-level interventions intended to improve overall health and well-being.

Methods

The Medical Research Council Cognitive Function and Ageing Study (CFAS) is a population based multi-centre longitudinal study of cognitive and physical functioning in the elderly which began in 1991.[25] The initial, cross-sectional data from individuals sampled at five centres in England and Wales (Cambridgeshire, Gwynedd, Newcastle, Nottingham and Oxford) has been used here. CFAS data is released in versions at fixed times. Version 7.0 was the basis for this analysis.

Participants

Residents and institutionalized individuals aged 65 years and over were identified from Family Health Services Authority computerized files, except in Gwynedd where general practice files were searched manually. Eligible individuals were stratified into those under 75 years and those 75 years and over. Participants were randomly selected from these two subsets to ensure equally sized groups. Of those invited, 13 004 completed the initial interview, representing a response rate of 80% overall.[25,26] Further details of the study design can be found in previous publications and online (http://www.cfas.ac.uk). [25,26]

Individual socio-economic status

Trained interviewers recorded participants' age, sex, years of full-time education and occupation. Age was categorized into 5-year bands. Education was dichotomized, separating those with nine or fewer years of education (the statutory for this generation) and those with >9 years. The longest occupation was coded according to the Registrar General's occupation-based social class divisions using Computer Assisted Standard Occupational Classification software (HMSO Publications Centre, London).[27] Women were categorized based on their partner's occupation unless they were divorced or single, in which case their own occupation was used. Social class I denotes professionals, II managerial and technical workers, III Non-Manual (IIINM) non-manual skilled workers, III Manual (IIIM) manual skilled workers, IV partly skilled workers and V unskilled manual workers. These social classes were dichotomized into non-manual (classes I–IIINM) and manual (classes IIIM–V) for this analysis. Sensitivity analysis to the education and social class groupings has been undertaken.

Area-level socio-economic status

The Townsend deprivation score[28] accounts for the proportion of unemployed individuals aged 16–59/64 (f/m), the proportion of households without a car, with more than one person per room and that are not owner-occupied. The higher the score, the more deprived the area. Scores for the population of England and Wales range from −7.55 to 11.65, with an average of 0. Complete postcodes from 1991 for 12 548 (96%) participants were obtained from the initial interview or by entering the address into the Royal Mail Postcode Finder website (www.royalmail.co.uk).

Postcodes were mapped to the appropriate enumeration district (ED), which contains about 200 households (approximately 400 individuals) using the Manchester Information and Associated Services (MIMAS) website (http://convert.mimas.ac.uk/matchgoes.cfm) conversion feature. 1810 EDs were represented in this data set with, at most, 60 individuals within one ED. Based on the 1991 census, a Townsend deprivation score has been calculated for each ED. Participants were assigned Townsend scores based on the ED in which they lived.

The Townsend scores in this data set (range: −6.67 to 10.56, mean: 0.64, median: 0.10, SD: 3.13) reflect the range of the whole of England and Wales. For these analyses, the Townsend score was divided into quintiles, with 1 being the least deprived and 5 being the most.

Outcome variables

The level of cognitive functioning was determined by the Mini-Mental State Examination.[29] Those with a score of 0–21 were classified as cognitively impaired, while those scoring 22–30 were classified as not cognitively impaired. If individuals did not answer all of the questions, but would have clearly fallen to one side regardless of their answers, they were assigned to the appropriate group.

The level of physical functioning was determined by the activities of daily living (ADL) self-reported scale.[30,31] Individuals were classified as functionally impaired if they showed evidence of (i) Instrumental activities of daily living (IADL) disability which indicates some difficulty with shopping or heavy housework or (ii) ADL–IADL disability which indicates that they require assistance with bathing, cooking or putting on shoes and socks or that they have limited mobility and are not able to move around unaided. Individuals with no ADL or IADL disability were classified as not functionally impaired.

There was a small amount of missing outcome information (2% for cognitive impairment and 1% for functional impairment; table 1). Sensitivity analyses to missing values were used to investigate potential biases. Two additional analyses were undertaken, including the missing data as impaired and as not impaired. The effect sizes in the regression model were then checked against the complete case analysis.

Statistical analyses

Statistical analyses were performed using STATA 9.2.[32] Hierarchical logistic regression models for each outcome were used to determine the association between the Townsend deprivation score (at ED level) and cognitive impairment or functional impairment (at an individual level). In each case, age, sex, centre effects and the individual indicators of SES (education and social class) were included in the model (using both univariable and multivariable methods). The hierarchical structure was investigated for both fixed and random effects. Interactions between individual and area level SES have been investigated using likelihood ratio tests.

Results

The distributions of age, education, social class, MMSE score, ADL score and Townsend deprivation score are shown in table 1. The prevalence of cognitive impairment is 16% in women and 10% in men, of functional impairment is 37% in women and 23% in men.

The Townsend deprivation quintiles were developed from the entire data set, however each centre may represent a different level of overall population deprivation. This pattern of deprivation by centre is shown in table 2, where the proportion of that centre in each of the quintiles is compared together with the median of the deprivation score. The least deprived centre is Cambridgeshire, where 36% of respondents are in the least deprived quintile and none in the most deprived, then Gwynedd, Oxford and finally Newcastle and

Table 1 Distribution of baseline characteristics for men ($n = 5157$) and women ($n = 7847$) who participated in the initial interview for the Cognitive Function and Ageing Study

	Men		Women		Total	
	n	(%)	*n*	(%)	*n*	(%)
Age group						
65–69	1442	28	1742	22	3184	25
70–74	1386	27	1764	23	3150	24
75–79	1159	23	1747	22	2906	22
80–84	779	15	1477	19	2256	17
85–89	301	6	791	10	1092	8
90+	90	2	326	4	416	3
Education						
0–9 years	3263	63	4747	61	8010	62
10+ years	1811	35	2846	36	4657	36
Missing	83	2	254	3	337	3
Social class						
I	242	5	352	5	594	5
II	1320	26	1869	24	3189	25
III Non-manual	496	10	938	12	1434	11
III Manual	2024	39	2608	33	4632	36
IV	726	14	1172	15	1898	15
V	218	4	414	5	632	5
VI	52	1	129	2	181	1
Missing	79	2	365	5	444	3
MMSE score						
Missing	63	1	197	3	260	2
0–17	186	4	518	7	704	5
18–21	297	6	681	9	978	8
22–25	1035	20	2052	26	3087	24
26–30	3576	69	4399	56	7975	61
ADL–IADL disability						
None	3954	77	4865	62	8819	68
IADL only	452	9	1311	17	1763	14
ADL	694	14	1565	20	2259	17
Missing	57	1	106	1	163	1
Townsend deprivation score (quintiles)						
1 (−6.67 to −2.16)	1033	20	1514	19	2547	20
2 (−2.15 to −0.64)	1058	21	1430	18	2488	19
3 (−0.63 to 1.03)	956	19	1539	20	2495	19
4 (1.04 – 3.61)	969	19	1548	20	2517	19
5 (3.62 – 10.56)	967	19	1534	20	2501	19
Missing	174	3	282	4	456	4

Table 2 The distribution of Townsend deprivation scores between the centres

	Cambridgeshire	Gwynedd	Newcastle	Nottingham	Oxford
Median	−1.73	−0.55	2.38	2.49	0.66
Min	−5.74	−6.67	−6.49	−5.52	−5.67
Max	3.14	6.61	10.56	9.07	6.91
Deprivation quintile (Proportion from each centre)					
1	36	20	16	13	12
2	32	24	10	12	17
3	20	23	13	12	28
4	10	21	18	23	25
5	0	4	38	38	17
Missing deprivation	2	7	5	2	1

Nottingham are the most deprived (38% from both centres in the most deprived quintile).

The models for these factors' unadjusted and adjusted odds ratios (OR) for each of the variables in relation to cognitive and functional impairment are shown in table 3. The multivariable adjusted model has been undertaken both adjusting for centre (providing an estimate of area deprivation after controlling for the gross geographical circumstances) and not adjusting for centre (where the assumption is that a given level of deprivation would be similar wherever in the country it occurs).

Cognitive impairment

The unadjusted risk of cognitive impairment is increased for women, older individuals, those with less education, and those in the manual social classes (table 3). The risk of cognitive

Table 3 Logistic regression analyses of association between cognitive and functional impairment, and selected demographic characteristics

	Cognitively impaired versus not impaired		Functionally impaired versus not impaired	
	Unadjusted OR (95% CI)	**Adjusted OR (95% CI)**	**Unadjusted OR (95% CI)**	**Adjusted OR (95% CI)**
Sex				
Women versus Men	1.8 (1.6–2.0)	1.5 (1.3–1.7)	2.0 (1.9–2.2)	1.7 (1.6–1.9)
Age groups				
65–69 years	1.0	1.0	1.0	1.0
70–74 years	1.6 (1.2–2.0)	1.6 (1.2–2.0)	1.3 (1.2–1.5)	1.4 (1.2–1.6)
75–79 years	2.8 (2.3–3.5)	2.8 (2.2–3.6)	2.4 (2.1–2.7)	2.3 (2.0–2.7)
80–84 years	6.3 (5.1–7.8)	5.8 (4.5–7.2)	5.2 (4.5–6.0)	4.9 (4.3–5.6)
85–89 years	14.3 (11.4–18.0)	12.4 (9.4–15.9)	13.1 (11.0–15.5)	11.8 (9.9–14.1)
90+ years	36.5 (27.3–49.0)	26.2 (19.0–36.2)	39.2 (28.4–54.1)	29.1 (20.8–40.5)
Centre				
Cambridgeshire	1.0	1.0	1.0	1.0
Gwynedd	0.9 (0.7–1.1)	0.9 (0.7–1.1)	1.6 (1.4–1.9)	1.8 (1.5–2.1)
Newcastle	0.8 (0.6–1.0)	0.5 (0.4–0.6)	1.3 (1.1–1.5)	1.1 (0.9–1.3)
Nottingham	0.9 (0.7–1.1)	0.5 (0.4–0.6)	1.3 (1.1–1.6)	1.1 (0.9–1.3)
Oxford	0.8 (0.7–1.0)	0.7 (0.5–0.8)	1.1 (0.9–1.2)	0.9 (0.8–1.1)
Education				
≤9 years versus >9 years	3.0 (2.6–3.5)	2.2 (1.9–2.7)	1.4 (1.3–1.5)	1.2 (1.1–1.3)
Social class based on occupation				
Manual versus non-manual	2.5 (2.2–2.8)	2.0 (1.9–2.7)	1.4 (1.3–1.5)	1.4 (1.2–1.5)
Townsend deprivation quintiles		(Centre adjusted)		(Centre adjusted)
1	1.0	1.0	1.0	1.0
2	1.4 (1.1–1.8)	1.5 (1.2–1.9)	1.1 (1.0–1.3)	1.1 (1.0–1.3)
3	1.6 (1.3–2.0)	1.5 (1.2–1.9)	1.2 (1.1–1.4)	1.1 (1.0–1.3)
4	2.0 (1.6–2.4)	1.8 (1.4–2.4)	1.4 (1.2–1.6)	1.3 (1.1–1.5)
5	2.3 (1.9–2.9)	2.3 (1.8–3.0)	1.7 (1.5–2.0)	1.6 (1.4–1.9)
Townsend deprivation quintiles		(Not adjusted for centre)		(Not adjusted for centre)
1		1.0		1.0
2		1.4 (1.1–1.8)		1.1 (1.0–1.3)
3		1.4 (1.1–1.8)		1.1 (1.0–1.3)
4		1.7 (1.3–2.1)		1.3 (1.1–1.5)
5		2.0 (1.6–2.6)		1.7 (1.4–1.9)

The effects of sex, age, education and social class are only presented for the model that includes centre. When centre was not included, the effects of these demographic variables were almost identical to the ones presented in the table.

impairment increases across the Townsend quintiles, culminating in an increase of 2.3 times [95% confidence interval (CI) 1.9–2.9] the risk for the most deprived compared to the least (p trend < 0.001).

The adjusted OR was 2.3 (95% CI 1.8–3.0) for those living in areas of greatest deprivation compared to those living in the most affluent areas after controlling for age, sex, centre, social class and education. There is a significant linear trend in the association between Townsend score and cognitive impairment across the deprivation quintiles ($p < 0.001$), even when not adjusting for centre ($p < 0.001$). There was no evidence of an interaction between area deprivation and centre ($p > 0.2$).

There was evidence of some interaction between area deprivation and education ($p = 0.03$, p trend $= 0.02$), though only weakly for area deprivation and social class ($p = 0.06$, p trend>0.2). The interactions were such that the gradient of increasing cognitive impairment by increasing area deprivation was less steep in individuals with less education, such that individuals in the two most deprived quintiles had an OR of 2.5 (95% CI 1.3–3.1) for low education, but in the two highest quintiles this had decreased to 1.8 (95% CI 1.3–2.2). The differentials have not been presented in the table as the effect of the interaction on the estimates is very small.

Functional impairment

The OR for the Townsend deprivation quintiles on functional impairment increases with deprivation in both unadjusted and adjusted analyses. The unadjusted OR was 1.7 [95% CI (1.5, 2.0)] for those in the most deprived areas compared to those in the least (p trend < 0.001).

After controlling for age, sex, centre, social class and education, this was relatively unchanged at 1.6 [95% CI (1.4–1.9)]. There is a significant linear trend in the association between Townsend deprivation score and functional impairment across the deprivation quintiles ($p < 0.001$). The OR remains unchanged when not adjusting for centre, suggesting an overall difference in deprivation level relative to the gross geographical regions. There was no evidence of an interaction between area deprivation and centre ($p > 0.2$).

There appeared to be no evidence of interactions between individual and area deprivation measures for functional impairment ($p > 0.2$ for social class and $p > 0.2$ for education).

For both outcomes, the results of the area deprivation estimates changed little with adjustment for individual demographic factors (including social class and education), suggesting that whilst individual level of social class and education are important risk factors for impairment, area deprivation could have additional risk.

Sensitivity analysis

The sensitivity analysis recoding missing cognition and disability to impaired gave consistent estimates with those presented (results not shown). Increasing the number of groups for social class and education did not alter the estimates of the quintiles, nor did using socio-economic group rather

than social class. This suggests that the results are robust to the measure of individuals' SES.

Discussion

These results demonstrate a significant association between area-based SES and cognitive and functional impairment even after adjusting for individual socio-economic measures indicative of early life (education) and midlife (social class) advantage. Individuals living in deprived areas are at greater risk of cognitive and functional impairment compared to those living in affluent areas. Furthermore, this effect is not confined to the extremes; those living in even mildly deprived conditions have a slightly greater risk of cognitive and functional impairment than those in more affluent communities. There was some evidence of a differential effect of area deprivation most marked across the educational groups for cognitive impairment, but also for social class. There is a steeper deprivation effect for better educated individuals; this effect is in the opposite direction than suggested by previous investigations, though in our study the effect is small.[33] Functional impairment did not demonstrate this effect, indicating that community SES impacts individuals similarly regardless of individual social class and education. This result has been reported previously for general mental health and self-rated health.[33] These effects may be in cognitive impairment which is itself a marker of earlier cognitive status, unlike functional impairment.

In a review of 25 studies on the effects of community-based SES on various health outcomes, 23 reported at least one statistically significant association.[16] Risk ratios for the association between low area SES and mortality were consistent, though modest. The evidence for morbidity was more heterogeneous. Few studies have examined the relationship between area-based SES and cognitive or functional impairment in the elderly.[16] There is longitudinal evidence that SES differentials persist after retirement, at least for mortality.[34] Previous studies of the elderly have found an association between area and individual indicators of SES and poor functioning,[35] cardiovascular death[36] and physical and mental functioning.[37]

The magnitude of the association between community SES and both cognitive and functional impairment seen here is larger than reported previously.[16,37] This is not surprising given the broad distribution of Townsend deprivation scores in our sample, resulting in a greater distinction between the most affluent quintile and the most deprived. In addition, the use of enumeration districts, the smallest geographic classification in England and Wales, may lower the likelihood of misclassification and may more accurately represent the immediate environment. In contrast, some of the area-effect evidenced by this analysis could be explained by residual confounding by individual SES. Here, behavioural covariates such as smoking and alcohol consumption were not included, as other have argued that they are likely on the pathway between the predictor and outcome variables.[37,38,39]

The range of deprivation within the enumeration districts demonstrates that the population sample was not biased by the use of the family health service lists as the population base. In the older age groups these lists are relatively complete and include those living both in the community and institutions, therefore random sampling from these lists captures both groups in their proper population proportions.

Measuring individual SES in retired elderly individuals is difficult as education is a proxy for early life SES and social class based on occupation indicates socio-economic conditions experienced in adulthood. Neither may accurately reflect SES in old age.[22,39] Here, we incorporate both measures into our analysis on the premise that early and mid-life SES can have significant impacts on preventative activities and resource availability, both of which may later impact functioning.[20] One study that looked at multiple indicators of individual and area SES recommended a combination of occupational social class, education, Townsend score and/or a combined household resource/Townsend indicator.[22] To further increase the precision of defining individual SES in the elderly, there is evidence that income support may be useful, though this information was not available for this study.[39]

While selective migration of the least healthy individuals to the most deprived areas is plausible, we found that the distribution of Townsend quintiles across the age groups was similar for both men and women. Because those in the oldest age groups are most likely to be cognitively and functionally impaired, we would expect a differential distribution of area-based deprivation across the age groups if selective migration had occurred, but this was not seen. This is consistent with recent findings that migration does not impact the relationship between community deprivation and poor health, as previously thought.[40]

Some argue that Townsend scores are biased towards urban areas due to the inclusion of car ownership.[41] This could explain why the rural CFAS centres (Cambridgeshire and Gwynedd) are considered less deprived than the urban areas; however, the trends between the deprivation categories within the centres were similar. A recent study reported no disturbance between a health behaviour outcome and the Townsend deprivation score, the car ownership component, or unemployment when comparing urban and rural areas, suggesting that the relationship may be stable.[42]

There is concern that boundaries based on 'convenient' divisions such as enumeration districts may not accurately represent categories important to studies of ill-health.[16,37] However, one study found that the association between self-reported health and neighbourhoods, postcodes and boroughs were similar across all three measures.[43] To increase the likelihood that the area-based measure reflects an individual's immediate environment, we chose the smallest geographic category available.

This analysis relies on cross-sectional data and a global measure of area deprivation; it is not possible to elucidate the mechanism or determine the direction of the association. Our findings establish a significant association, which is an important first step that prompts further studies intended to identify specific area characteristics that are theoretically consistent with mechanisms that could lead to these outcomes.[22] For instance, one study of self-rated health found an association between poor health and neighbourhood characteristics such as high unemployment, poor physical environment and limited access to private transportation, but found no association with public recreation facilities, crime and health service provision.[44] With respect to cognitive and functional impairment, there is evidence that lack of social engagement and lack of social support may increase the risk.[45,46] Future studies could investigate how these contextual factors relate to area-deprivation and the results could lead to the formulation of a plausible mechanism. Ultimately, area-effects on health are likely to be complex and interconnected.[47] We encourage further studies that bring a more narrow focus to identify the mechanism by which this relationship operates.

This study has the advantage of having drawn a large, representative, community-based sample, indicating strong generalizability of the results. The outcome measures were based on standard questionnaires conducted by trained interviewers, minimizing many potential sources of bias. Furthermore, the Townsend deprivation score does not include the measures of individual SES used in these analyses, thus avoiding co-linearity between the variables.

In conclusion, cognitively and functionally impaired individuals have less independence and often require extensive long-term care. Understanding the role of socio-economic factors in determining health in the elderly is essential in allocating resources appropriately.[48] Identifying that community-based SES is associated with an increased risk of negative health outcomes in the older population provides further evidence for the need to address community characteristics associated with deprivation.

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Conflict of interest: None declared.

Key points

- Evidence indicates that there is an additional risk of all-cause mortality, cardiovascular disease mortality, long-term limiting illness and other health outcomes for those living in areas of low socio-economic status even after controlling for individual socio-economic status.
- This relationship has not been explored in detail with respect to cognitive and functional impairment for those over the age of 65 years.
- After controlling for age, sex, centre effects and individual socio-economic status, we found a significant increased risk of both cognitive and functional impairment for the elderly living in deprived areas.
- This study provides further evidence for policy makers to improve community characteristics associated with deprivation for the improvement of the health of the elderly, a particularly vulnerable population.

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