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Does social cohesion modify the association between area income deprivation and mental health? A multilevel analysis

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Background Despite the increasing belief that the places where people live influence their health, there is surprisingly little consistent evidence for their associations with mental health. We investigated the joint effect of community and individual-level socio-economic deprivation and social cohesion on individual mental health status.

Methods Multilevel analysis of population survey data on 10 653 adults aged 18–74 years nested within the 325 census enumeration districts in Caerphilly county borough, Wales, UK. The outcome measure was the Mental Health Inventory (MHI-5) subscale of the SF-36 instrument. A social cohesion subscale was derived from a factor analysis of responses to the Neighbourhood Cohesion scale and was modelled at individual and area level. Area income deprivation was measured by the percentage of low income households.

Results Poor mental health was significantly associated with area-level income deprivation and low social cohesion after adjusting for individual risk factors. High social cohesion significantly modified the association between income deprivation and mental health: the difference between the predicted mean area mental health scores at the 10th and 90th centiles of the low income distribution was 3.7 in the low cohesion group and 0.9 in the high cohesion group (difference of the difference in means = 2.8, 95% CI: 0.2, 5.4).

Conclusions Income deprivation and social cohesion measured at community level are potentially important joint determinants of mental health. Further research on the impact of the social environment on mental health should investigate causal pathways in a longitudinal study.

Keywords Mental health, social medicine, social environment, epidemiology, models, statistical

There is emerging evidence that the places where people live are an important factor in determining and sustaining inequalities in health outcome between individuals.[1–3] Although there is substantial geographical variation and inequality in mental health status[4–6] there is no consistent evidence from studies of places, people and mental health that the socio-economic characteristics of places are independently associated with individual mental health, after accounting for individual level socio-economic variables.[7–18]

The social environment is one aspect of place that has an important influence on health and well-being,[1] but it is not

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clear how to conceptualize, define, operationalize and measure specific factors and pathways within the social environment that can be hypothesized to be related to health outcome.[3] One much debated aspect of the social environment is the concept of social capital as a possible determinant of population health.[19–21] Putnam[19] defines social capital as 'features of social organisation, such as trust, norms, and networks, that can improve the efficiency of society by facilitating coordinated actions'. A useful model of social capital recognizes two components, structural and cognitive.[22] The cognitive component, labelled 'social cohesion', is conceptualized as a collective community-level characteristic measured by the levels of trust, norms of reciprocity and the formation of strong social bonds within the local social structure.[20,23,24] There is some evidence to suggest that this concept of community-level social cohesion is useful in investigating the determinants of general health status.[24–26] However, there is a substantial critique and debate in the literature on the concepts and measurement of social capital,[21,22,27–31] with disagreement on whether social capital is a function of individuals and their social interactions within social networks or whether it is a collective attribute of communities and societies.[32] But this may be a false dichotomy; it is argued that social capital should be measured and analysed in empirical studies of social capital and health at both individual and contextual levels in a multilevel framework, so that joint individual- and group-level mechanisms can be explored.[32–34]

A recent review has shown that many studies have investigated associations between mental health and social cohesion measured at the individual level, but none have investigated the joint effect of community and individual level measures.[35] It has also been suggested that the social cohesion of communities could influence associations between potentially adverse factors such as area income deprivation on the mental health of individuals.[20,36,37] We tested this hypothesis using survey data from the Caerphilly Health and Social Needs Study, a community study of health inequality set in a deprived post-industrial area of south Wales, UK.[38–40]

Methods

Participants

We carried out a cross-sectional postal questionnaire survey of the 132 000 adult population aged $\geqslant$18 years resident in Caerphilly county borough, Wales, UK.[39,40] Of the 22 236 questionnaires posted, 12 408 were returned, giving an adjusted and representative response of 62.7% after removal of questionnaires not delivered due to incorrect addresses. Individual records were linked to the 1991 census enumeration district of residence using the postcode with a mean of 40 respondents in each of 325 enumeration districts. This data set was large enough to meet the suggested 'rules' published on sample sizes for multilevel analyses.[41]

Mental health outcome measure

We used the Mental Health Inventory (MHI-5) subscale of the SF-36 version 2 health status questionnaire as the measure of mental health status.[42] The validity and reliability of the MHI-5 is well established and measures the continuously distributed nature of mental health status in the population.[43,44] Studies have shown that it is at least as good a measure of mental health status as the 12-item General Health Questionnaire (GHQ-12).[45,46] Survey responses were transformed to a scale ranging between 0 and 100 using the standard linear transformation.[42] Lower scores indicate lower mental health status.

Social cohesion data

We derived a social cohesion subscale from an adapted version of the Neighbourhood Cohesion Scale.[47,48] Different combinations of the scale items have been included in previous UK

Box 1 Neighbourhood Cohesion Scale questions contributing to the social cohesion and neighbourhood belonging subscales

Social cohesion

1. I visit my neighbours in their homes
2. The friendships and associations I have with other people in my neighbourhood mean a lot to me
3. If I need advice about something I could go to someone in my neighbourhood
4. I believe my neighbours would help in an emergency
5. I borrow things and exchange favours with my neighbours
6. I would be willing to work together with others on something to improve my neighbourhood
7. I rarely have a neighbour over to my house to visit[a]
8. I regularly stop and talk with people in my neighbourhood

Neighbourhood belonging

- Overall, I am attracted to living in this neighbourhood
- I feel like I belong to this neighbourhood
- Given the opportunity, I would like to move out of this neighbourhood
- I plan to remain a resident of this neighbourhood for a number of years
- I like to think of myself as similar to the people who live in this neighbourhood
- Living in this neighbourhood give me a sense of community
- Overall, I think this is a good place to bring up children

[a] Reverse coded.

studies with evidence for their validity and reliability.[49–51] In this version, 15 question items were asked (box). The original scale was reported to be unidimensional,[47] and so to identify question items relating to the concept of cognitive social cohesion we used factor analysis with principal components analysis followed by a varimax rotation to identify a set of underlying common factors. Two components were extracted with eigenvalues >1, explaining 55% of the variance. Using a factor loading of $\geqslant 0.5$ as the criterion for inclusion, eight question items which related to social cohesion were identified in one component (box). The second component identified questions that related to neighbourhood belonging (box), but these were not considered further in this study. Each question consisted of a five-point response scale, where 'strong disagreement' was scored as 1 and 'strong agreement' as 5. Summing the responses to these eight questions with equal weighting created a social cohesion subscale ranging from 8 to 40 (mean 29.2, SD 5.5, median 30.0, interquartile range 26.0, 33.3). The Cronbach's alpha value for split-half reliability of 0.81, and the magnitude of the inter-item and item-scale correlations, suggested the subscale achieved an acceptable degree of reliability[52] (see supplementary Tables 1 and 2), and an ecometric analysis suggested that the subscale was an appropriate measure of social cohesion at small-area level.[53]

Individual exposure measures

We selected variables that were significantly associated with the mental health score in univariable analyses. Age was modelled as a continuous variable, using a cubic function, and the following as categorical variables (Table 1): gender, occupational social class, gross household income, employment status, housing tenure and the council tax valuation band of residence, obtained by matching the sample frame to the local authority council tax register using the address.[40] Residential properties were divided into two categories—the lowest two council tax valuation bands A and B, in one, and the remaining six bands C–H in the other. We categorized gross household income into three groups of 'high', 'medium' and 'low', based on cut-offs of £215 and £95 per week. Both 'medium' and 'low' categories are classified as 'poverty' under the UK definition of a gross household income of <60% of median income, after housing costs.[54]

We modelled individual social cohesion as an ordinal categorical variable because the social cohesion subscale scores were based on a constructed scale and had no absolute interpretation. We chose two cut-points on the subscale so that the reference category of low social cohesion reflected an average level across the questions of 'strong disagreement' or 'disagreement' on the original Likert scale, with a scale cut-point of $\leqslant 16$, and the high category reflected 'strong agreement' or 'agreement', cut-point $\geqslant 32$. The third category of medium was defined as the range of scores between the low and high categories.

Area exposure measures

In the absence of routinely available income data at enumeration district level, we used validated gross household income estimates for 2001 from a commercial data set.[55] Based on the UK definition of poverty,[54] we calculated the area income deprivation variable as the percentage of households in each enumeration district with gross household income of less than £10 000 per annum. We categorized each enumeration district into one of three levels of low, medium and high social cohesion by dividing the distribution of the mean scores of respondents into tertiles. We could not use the same cut-points for the area scores as for individuals. The area score, as the average of the individual values, varies much less than the individual scores and all areas would fall in the middle category.

Table 1 Mean (SD) mental health scores for the categorical individual variables

Variable	Parameter	*n* (%)	Mean mental health score	SD
Gender	Male[a]	4770 (44.8)	71.86	20.79
	Female	5883 (55.2)	67.44	22.20
Social class	I & II[a]	2407 (22.6)	74.35	19.38
	IIINM	2103 (19.7)	70.75	20.84
	IIIM	2171 (20.4)	71.13	21.31
	IV&V	2647 (24.8)	66.45	22.01
	Other	635 (6.0)	57.38	25.33
	Missing	690 (6.5)	65.20	21.72
Employment status	Employed[a]	5507 (51.7)	74.38	18.23
	Unemployed:	4665 (43.8)		
	Seeking work	286 (2.7)	64.53	22.92
	Home or carer	804 (7.5)	67.12	22.06
	Student/training	190 (1.8)	71.62	20.82
	Disabled	1274 (12.0)	48.75	23.55
	Retired	2111 (19.8)	71.78	20.49
	Missing	481 (4.5)	62.77	22.53
Household income	High[a]	5158 (48.4)	74.48	18.76
	Medium	3810 (35.8)	65.16	22.77
	Low	960 (9.0)	58.81	24.56
	Missing	725 (6.8)	69.79	21.54
Tenure	Owner occupier[a]	8562 (80.4)	71.25	20.86
	Not owner occupier	1943 (18.2)	61.78	23.64
	Missing	148 (1.4)	63.72	19.53
Council tax band	A&B	6314 (59.3)	66.74	22.62
	C–H[a]	3262 (30.6)	73.74	19.55
	Missing	1077 (10.1)	72.04	19.80
Social cohesion	High	3469 (32.6)	73.62	20.18
	Medium	6388 (60.0)	68.04	21.69
	Low[a]	185 (1.7)	52.91	28.04
	Missing	611 (5.7)	64.98	22.70

[a] reference category in multilevel model.

Analysis

Multilevel modelling strategy

We restricted the analysis to respondents aged under 75 years, because the MHI-5 is less reliable in elderly populations.[56]

Table 2 Modelled associations between mental health and area-level variables[a]

		Null model		Model A (null model plus individual covariates		Model B (Model A plus area-level covariates)	
Variable	**Parameter**	Estimate	SE	Estimate	SE	Estimate	SE
	Constant	69.47	0.31	66.59	0.86	65.68	1.50
Area:							
Income deprivation	Percent low income households[b]					−1.584	0.350
Social cohesion:	Social cohesion: medium					0.291	0.479
	Social cohesion: high					1.074	0.513
Interaction:	Percent low income households[b] medium social cohesion					0.535	0.512
	Percent low income households[b] × high social cohesion					1.129	0.515
	Random Parameters:						
	Level 1 variance:						
	Intercept	454.6	6.35	369.7	5.14	369.3	5.15
	Level 2 variance:						
	Intercept	16.2	2.47				
	Low individual income:						
	Intercept variance			1.17	0.61	0.37	0.25
	Slope variance			39.48	12.65	41.84	12.12
	Covariance			2.04	2.00	2.99	1.32
	−2 × log likelihood	95420.8		93219.5		93105.4	
	Intra-class correlation coefficient (%) (2.5th–97.5th quantile credible estimates)	3.44 (2.51, 4.51)		0.32 (0.09, 0.71)		0.10 (0.03, 0.28)	

[a] Adjusted for age, gender, social class, employment status, household income, housing tenure and council tax band, and individual-level social cohesion
[b] Modelled as a z-score.

The MHI-5 was modelled as a continuously distributed dependent variable in a linear multilevel regression model of individuals nested within enumeration districts, using the iterative generalized least squares procedure of MlwiN version 1.10.07.[57] Credible estimates for the 2.5th–97.5th quantiles for the random parameters and the intra-class correlation (ICC) were obtained using Markov Chain Monte Carlo (MCMC) methods. The modelling strategy started with the 'null' two-level variance components model, with random terms for both enumeration districts and individuals. Model A then fitted the individual-level covariates. To minimize data loss, we modelled missing data for each categorical variable as a separate category.

In model B, we investigated the study hypothesis by entering the enumeration district terms for social cohesion and income deprivation, and their area-level interaction, to the model. To quantify the effect of social cohesion on the relation between income deprivation and mental health, we calculated the difference between the model predicted mean area mental health scores at the 10th and the 90th centiles of the distribution of area income deprivation and compared these between high and low social cohesion groups. We also investigated whether individual-level social cohesion was an effect modifier of the association between mental health and area income deprivation by modelling the cross-level interaction.

Assessment of model validity

Variables were selected for inclusion in the model by assessing the resulting change in the deviance.[57] The validity of the final model was assessed using standard diagnostic plots of individual and enumeration district residuals. To assess the possibility of affect bias, since the measurement of mental health and social cohesion was made on the same respondents, we performed a cross-validation analysis. We split the data set into two parts at random and calculated social cohesion scores from one sub-data set. We then added these scores to the second sub-data set and repeated the analyses on these respondents who did not contribute to the calculation of social cohesion scores.

Results

The mental health score was available for 10 653 (97.8%) respondents, mean = 69.5 (SD = 21.7, inter-quartile range 55.0, 85.0). The distribution of the area income deprivation variable was approximately normal (mean = 31.3%, SD = 13.0%, 10th–90th centiles 15.4%, 49.2%).

Null model

Table 2 shows the majority of the random variation, 96.6%, occurred at the individual level with 3.4% (credible estimate

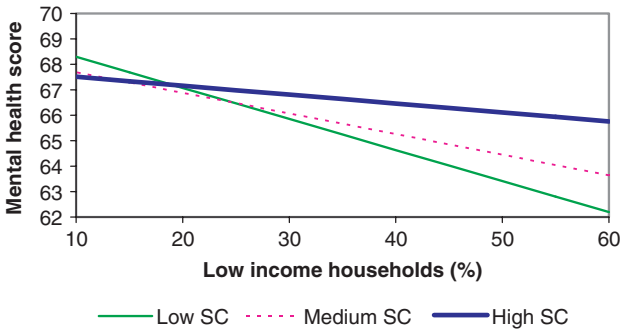

Figure 1 Relation between model predicted mental health scores, social cohesion (SC) and area income deprivation

2.5, 4.5), at enumeration district level. The intercepts for the 325 enumeration districts varied around the mean intercept of 69.5 with a variance of 16.2 (SE = 2.47).

Individual level associations

In model A (see supplementary Table 3), compared with the reference categories shown in Table 1, lower scores were significantly associated with female gender, lower social class, medium and low household income, not being employed (permanent sickness or disability, seeking work and retired) and living in non-owner occupied housing in the lowest value council tax bands. Medium and low social cohesion scores at the individual level were significantly associated with lower mental health scores, with the strongest association for the low cohesion group. The largest parameter estimate was for the permanent sickness or disability category of employment status, which represented 37/185 (20%) of the lowest social cohesion group and 348/3469 (10%) of the highest social cohesion group.

To further investigate possible contextual effects of low income, we allowed the coefficient measuring the association between mental health and the low household income parameter to vary randomly between enumeration districts. Table 2 shows that this variation was significant (difference in the deviance, $\chi^2 = 16.3$, df = 2, $P = 0.003$). After fitting the individual parameters, the enumeration district level random intercept variance was substantially reduced from 3.4% (credible estimate 2.5, 4.5), in the null model to 0.32% (credible estimate 0.09, 0.71).

Enumeration district level associations

In model B, low mental health scores were significantly associated with higher levels of area income deprivation and lower levels of social cohesion, after adjusting for individual level variables (Table 2). The interaction between income deprivation and social cohesion was statistically significant (Wald test $\chi^2 = 4.5$, df = 1, $P = 0.03$), suggesting that living within income deprived areas with high levels of social cohesion was associated with better mental health than living within income deprived areas with low levels of social cohesion (Figure 1). The parameter estimate for the interaction, representing the difference in slopes between the low and high social cohesion groups shown in Figure 2 was 1.129 (SE = 0.515). Equivalently, the difference between the predicted mean enumeration district mental health scores at the 10th and 90th centiles of the area low income distribution was 3.7 in the low cohesion group and 0.9 in the high social group (difference of the difference in means = 2.8, 95% CI: 0.2, 5.4). The cross-level interaction between area income deprivation and individual-level social cohesion was small in magnitude and non-significant.

Model checking

The cross-validation analysis found no substantive differences in parameter estimates between the models (estimate for the interaction = 1.281, compared with 1.129 in model B). The distributions of MHI-5 scores and individual-level residuals were negatively skewed. To test the validity of the results we repeated the analysis using the square transformation for the MHI-5 scale, which gave the closest approximation to Normality,[58] and also found no substantive differences between the models.

Discussion

Main results

Understanding the role of the social environment in the aetiology of poor mental health status is important for prevention of this important disease burden in the community. To our knowledge, we are the first to show that income deprivation and social cohesion measured at small-area level are significantly and independently associated with poor mental health status. Furthermore, the results suggest effect modification of the association between poor mental health and area income deprivation by social cohesion; the effect of deprivation is significantly reduced in areas of high social cohesion and is greater in areas of low social cohesion. We found this effect modification operated at the community-level; social cohesion measured at the individual-level was not an effect modifier of the association between area income deprivation and mental health. The large contextual social cohesion effect size[59] in this study suggests that in deprived areas, high levels of community social cohesion based on friendships, visiting and borrowing and exchange of favours with neighbours is potentially of importance in protecting mental health.

Possible mechanisms linking social cohesion to mental health

Several plausible pathways for a positive effect of social cohesion that could explain our results have been reviewed by Kawachi and Berkman.[60] Social cohesion may lead to better health through influencing health-related behaviours by the adoption of health promoting activity and healthy norms, and exerting social control over deviant behaviour. A second pathway is that higher levels of community cohesion result in higher degrees of social organization that enhances access to services that influence health. For example, Kawachi suggests that the ability to arrange childcare at short notice depends on the level of trust between neighbours and the expectation that a good deed will be reciprocated in the future.[61] This seemingly small favour in a deprived area could make the difference

between accessing preventive and therapeutic health services, or prevent worries about not being able to go to work, and translate into better health outcomes. Thirdly, social cohesion might influence health through psychosocial processes such as through the provision of affective support and enhancing self-esteem and mutual respect.[60] Being able to depend on neighbours for help may attenuate the adverse effects on mental well-being of living in socioeconomically deprived neighbourhoods.

Comparison to other literature

Studies from The Netherlands[7,8] and the US[9,10] have modelled similar area measures of income deprivation in a multilevel analysis of population mental health. These studies used much larger geographical units and found no conclusive evidence for area-level associations. No previous studies have modelled mental health and an area measure of social capital. Our study provides evidence that there are potentially important small-area effects of both social cohesion and income deprivation on mental health.

Strengths and limitations

In contrast to many previous studies which have carried out secondary analyses of national data sets with small sampling fractions, the main strength of our study arises from the in-depth sampling of a geographically defined area of socio-economic contrast, with detailed exposure data on respondents linked to the smallest 1991 census area level. This data set gives a rare opportunity to investigate the joint effect of individual and collective measures of social cohesion. We derived a social cohesion scale that was a reliable measure of a single concept,[21,53] and the cross-validation analysis suggested that affect bias would not explain the associations found in this study. The main limitation is that no inferences about causal pathways can be made from a cross-sectional study. Thus an alternative interpretation of our main finding is that the adverse effect of low social cohesion is significantly reduced in areas with low levels of low income deprivation and health selection could be a possible explanation for geographical effects.

We have assumed that the administratively defined census enumeration district is a proxy for 'community'. We found a lack of variability in these area social cohesion scores, suggesting that the areas were not homogeneous with respect to social cohesion. Despite this modest variation, we found large parameter estimates for area social cohesion. If the study areas had been more homogeneous then it is likely that there would have been a wider range of area cohesion scores and so the effects could have been even greater; indeed, the general problem of using non-homogeneous areas that result from administrative boundaries is a tendency to lead to conservative estimates.[62] Therefore it is unlikely that our results over-estimated the associations between mental health, social cohesion and income deprivation. The measure of mental health was derived from a simple five-item scale with inevitably some error in individual scores. Lower response rates from some subgroups are an unavoidable feature of population surveys[63] and can lead to bias in either direction if the relationships between the variables are substantially different in those subgroups from the rest of the population.

Conclusions

Our results suggest that high levels of community social cohesion could mitigate the adverse effects of small-area deprivation on mental health. This could have important implications for reducing the major community burden of poor mental health and a longitudinal follow-up study is required to investigate possible causal pathways.

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Conflict of interest: None declared.

KEY MESSAGES

- It has been hypothesized that the social cohesion of communities could influence associations between potentially adverse factors such as area deprivation and the mental health of individuals.
- After adjusting for individual-level confounding variables, including social cohesion, small-area level income deprivation and low levels of social cohesion were independently associated with poor mental health; high levels of social cohesion attenuated the association between mental health and income deprivation.
- This study gives evidence that in deprived areas, high levels of community social cohesion based on friendships, visiting and borrowing and exchange of favours with neighbours is potentially of importance in protecting mental health.

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Commentary: Area social cohesion, deprivation and mental health—Does misery love company?

Stephen R Zubrick

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Fone and his colleagues[1] ask us to consider the relationship between area-level social cohesion and individual mental health. At the outset readers should appreciate that population measures of mental health distress, similar to the one used by Fone *et al*. have been shown to be significantly related to measures of serious mental health disorders.[2] While there are variations in the quality of these measures, with some providing greater efficiency than others, the emergent evidence suggests that brief, structured screening scales of mental health distress can reproduce classifications based on lengthier clinical interviews of mental disorders.[3] Such measurement studies are important in 'cross-walking' the findings between routine community surveys of mental health distress with the less frequent and more intense efforts of clinical epidemiology to estimate the prevalence of specific mental health disorders in population surveys.

These mental health measures provide an important indication of population well-being. In global burden of disease parlance, mental health disorders are prevalent and associated with a substantial personal, social and economic burden.[4,5] In developed countries, their share of the global burden of disease is predicted to increase. When they occur they tend to be persistent across the lifecourse,[6–8] are largely untreated,[9] costly when they are treated,[10] and associated with inequities in the delivery of health care that lead to significantly higher levels of physical health morbidity and mortality in individuals with mental health disorders.[11]

Of the many determinants of mental health status studied to date most have been estimated at the individual level with little

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