Limiting long term illness and its associations with mortality and indicators of social deprivation

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Abstract

Study objective – To examine geographical variation in limiting long term illness in England and Wales and assesses the extent of its similarity with the distribution of mortality rates and of deprivation.

Design – A geographically based study using data from the 1991 census on limiting long term illness. Maps and regression analysis are used to compare the distribution of standardised illness ratios with standardised mortality ratios and indicators of social deprivation.

Setting – A total of 401 local authority districts in England and Wales.

Participants – The population of England and Wales enumerated in the 1991 census.

Main results – The geographical pattern of limiting long term illness shows many similarities with that of mortality but there are also some differences. Both are positively associated with indicators of social deprivation, with limiting long term illness tending to show stronger correlations, particularly in the elderly. Most of Wales and many industrial areas of northern England have higher rates of long term illness than would be expected from their mortality rates, while much of south eastern England has lower than expected rates.

Conclusions – Moves towards using data on limiting long term illness instead of standardised mortality rates would have important implications for NHS resource allocations. Further assessment of the reliability of these data on self reported morbidity is required. In particular, there is a need to assess how much they reflect real differences in ill health rather than the influence of socioeconomic or cultural factors affecting the likelihood of a positive answer to the census question on limiting long term illness.

(J Epidemiol Comm Health 1995;49(Suppl 2):S57-S64)

the absence of an explicit measure of morbidity at the local level before the 1991 census there has been a tendency to rely on mortality rates as a proxy measure of morbidity. Of particular interest, therefore, is the extent to which patterns of LLTI differ from those for mortality. LLTI should give a better guide to illnesses which are non-fatal and, as such, may produce a more reliable measure of morbidity among younger age groups. Analysis of self reported long term illness data from the general household survey has also shown that this is a good predictor of utilisation of health services.¹ On the other hand, the data on LLTI are based on self reporting and are less objective than mortality rates. Patterns of LLTI may not necessarily indicate additional “needs” over and above mortality rates, but could reflect socioeconomic and cultural factors influencing answers to the census question. These possibilities need to be investigated, particularly in view of the proposed use of these data for allocating resources in the NHS.²

Another area of interest is the association between health status and social deprivation. The Townsend, Jarman, Department of Environment (DoE), and Carstairs indices of social deprivation have each achieved some currency in the assessment of health needs and in resource allocation. The manner in which these composite indices and their constituent variables, notably unemployment, are associated with the different measures of health status requires investigation. The close relationship between mortality and social deprivation has been particularly well documented since the Black report.³ Mortality also varies regionally; and it has been shown that, after accounting for social deprivation, premature mortality tends to be higher in the northern regions of England than in the south.⁴ However, the relationships between morbidity, deprivation, and region are less well established. A particular issue is whether the associations between LLTI and deprivation are stronger, weaker, or the same as those for deprivation and mortality.

This study examines geographical variations in LLTI across the local authority districts of England and Wales and compares them with the distribution of mortality rates. It then examines the association between these indicators of health status and measures of social deprivation. Finally, it considers the extent to which the relationship between LLTI and deprivation varies in relation to levels of deprivation and region, after accounting for the pattern of mortality.

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The 1991 census has generated a wealth of demographic and socioeconomic data relevant to the assessment of health needs and, for the first time, it included information on “limiting long term illness” (LLTI) in the community. The data on LLTI were responses to the census question: “Does the person have any long term illness, health problem, or handicap which limits his/her daily activities or the work he/she can do? Include problems due to old age.” In

Table 1 Variability of the measures of health status at local authority district level (minimum, maximum and standard deviation) and simple associations between standardised illness ratios (SIRs) and standardised mortality ratios (SMRs) (%²)

	SIRs		SMRs		Association* between SIRs and SMRs (% ²)
	Min, max	SD	Min, max	SD	
Males					
<65	50–236	31.05	62–160	17.60	62.2
65–74	65–180	19.26	66–130	13.26	68.6
75+	82–136	8.91	78–124	8.05	48.4
Females					
<65	56–248	28.16	65–155	15.54	63.1
65–74	71–162	16.20	57–139	14.66	66.3
75+	84–123	7.57	81–134	7.66	34.4

* Based on log–log regressions.

Data sources and methods

Data were collected for the 401 local authority districts in England and Wales after excluding the City of London and the Isles of Scilly because of their small populations.

Two main measures of health status were calculated. All cause mortality statistics for 1990–92 were obtained from VSTATS available at Manchester Computing Centre. Data on LLTI for all residents was derived from the 1991 census local base statistics (LBS). Both measures were indirectly standardised using age and sex specific rates for England and Wales. These standardised mortality ratios (SMRs) and standardised illness ratios (SIRs) were calculated separately for males and females in three age groups (under 65, 65–74, and 75+). Six indicators of social deprivation were calculated. Percentage unemployment for males and for both sexes combined was taken from the 1991 census. Four composite indices of deprivation were calculated using the 1991 census as a source: the Townsend index,⁵ the Jarman UPA8 index,⁶ the Carstairs index,⁷ and the DoE index.⁸ These were calculated using data on the means and SDs for the 401 districts. Critics have pointed to the arbitrary selection of variables in the compilation of these indices and the lack of theoretical understanding of the links between health and aspects of social disadvantage.^{9–11} However, all four of the indicators used in this study have been used in the health field and have been selected as alternative but overlapping definitions of social deprivation. The Townsend and Carstairs indices were specifically designed to measure material deprivation and its link with health. On the other hand, the DoE index was devised for use in urban policy, while the Jarman index strictly represents a measure of factors identified by GPs as affecting their workloads.

Results

Table 1 shows that there were substantial differences in SIRs between districts within England and Wales. This variation differed by age with the greatest range being for the 0–64 age group and the least for the over 75s. Substantial differences were also apparent for SMRs, which also showed a similar age gradient. However, table 1 shows that geographical variations in SIRs tended to be greater than in SMRs, particularly for the 0–64 age group.

Figure 1 maps SIRs for males aged 0–64 and figure 2 those for females in the same age group. They show a clear regional divide in SIRs, with the highest ratios mostly concentrated in the north and Wales – with the exception of parts of inner London. There are indications of relatively high values in some industrial and mining districts and some coastal resort and retirement areas, while the lowest SIRs are concentrated in the affluent districts of the Home Counties. Maps for the older age groups are not shown for the sake of brevity.

The degree of similarity between the geographical distribution of SIRs and SMRs was assessed by simple regression analysis. Transformation of both variables into logarithms was found to give the highest coefficients of determination. Table 1 shows that variations in SIRs were associated with over 60% of the variation in SMRs for the 0–64 and 65–74 age groups. For the over 75s the relationship was weaker, especially among females. Therefore, the geographical patterns of SIRs and SMRs at the district level show considerable similarities, but they are by no means identical.

Simple regression analysis was also used to examine the relationships between SIRs, SMRs, and the six deprivation indicators. Transformation of all variables into logarithms was found generally to give the best fit, measured by the coefficient of determination. Since some of the deprivation indices included negative values, constants were added to make them positive, thereby making it possible to take their logarithms. Table 2 shows the standardised regression coefficients and their SEs for these relationships. These standardised regression coefficients are equivalent to simple correlation coefficients. The strongest associations were for the 0–64 age group. The relationships between the deprivation indicators and SIRs and SMRs were weaker for the 65–74 group, and weakest for the over 75s, with the declines being greater for SMRs. The strength of the relationship with health status also differed for the six deprivation indicators. Of the composite indices, the Carstairs index was the best predictor of both SIRs and SMRs. The Townsend index was the next best predictor, while the Jarman and DoE indicators tended to be the poorest performers. The relative weakness of the Jarman and DoE indices results from their inclusion of demographic variables which show weaker associations with health status. As has been suggested previously¹² unemployment rates provide an alternative and simpler way of measuring deprivation. Unemployment undoubtedly provides a good measure of access to material resources which may directly and indirectly affect health. In this analysis, male unemployment was found to “explain” slightly more of the variation in SIRs than the best composite measure, the Carstairs index, for all age/sex groups except females under 65. On the other hand, unemployment did not show such a strong association with mortality, the Carstairs index showing a stronger correlation for all age/sex groups, except females aged ≥ 75.

Figure 1 Standardised illness ratio for males under 65 years.

The next step in the analysis was to pursue further, and more directly, the differences between the patterns of health status portrayed by the LLTI and mortality data. The geographical patterns of SIRs and SMRs were compared by calculating the difference between observed SIRs and estimated SIRs (“SIR residuals”), using SMRs as the predictor in simple log–log regression analysis. These residuals indicate the

variation in LLTI which cannot be “explained” by mortality patterns. The residuals for the 0–64 age group are illustrated in figures 3 and 4, which show the quartiles of the log SIR residuals. Positive values indicate areas where SIRs were higher than expected from their SMRs and negative values indicate areas which had lower SIRs than predicted from their SMRs. Most of Wales emerged as having higher

Figure 2 Standardised illness ratio for females under 65 years.

morbidity than expected. Industrial areas in the north stood out clearly as having relatively high SIRs even after allowing for mortality rates. Of particular note was the presence of districts in the southern half of England with higher SIRs than expected, particularly in the East Anglian and South West Regions. Districts where morbidity was lower than expected included parts of London, particularly for males,

and the affluent districts of the Home Counties. Certain parts of the north showed lower SIRs than would be expected including parts of North Yorkshire, Humberside, Cumbria, and Northumberland. Multiple regression analysis was used to examine whether this pattern of SIR residuals showed any associations with levels of deprivation and with region. In view of the earlier

Table 2 Standardised regression coefficients (SEs) for simple associations between standardised illness ratios (SIRs), standardised mortality ratios (SMRs), and measures of deprivation

Deprivation indicator	SIRs		SMRs	
	Males	Females	Males	Females
Age group <65:				
Carstairs	0.806 (0.029)	0.840 (0.027)	0.870 (0.025)	0.782 (0.031)
Townsend	0.704 (0.036)	0.751 (0.033)	0.836 (0.027)	0.724 (0.034)
Jarman	0.639 (0.039)	0.681 (0.037)	0.786 (0.031)	0.658 (0.038)
DoE	0.688 (0.036)	0.716 (0.035)	0.779 (0.031)	0.634 (0.039)
Unemployment	0.798 (0.030)	0.822 (0.028)	0.811 (0.029)	0.722 (0.035)
Male unemployment	0.816 (0.029)	0.836 (0.027)	0.808 (0.030)	0.724 (0.035)
Age group 65–74:				
Carstairs	0.716 (0.035)	0.737 (0.034)	0.727 (0.034)	0.677 (0.037)
Townsend	0.604 (0.040)	0.636 (0.039)	0.675 (0.037)	0.620 (0.039)
Jarman	0.493 (0.044)	0.505 (0.043)	0.554 (0.042)	0.498 (0.043)
DoE	0.518 (0.043)	0.514 (0.043)	0.539 (0.042)	0.467 (0.044)
Unemployment	0.708 (0.035)	0.730 (0.034)	0.685 (0.036)	0.638 (0.039)
Male unemployment	0.727 (0.035)	0.743 (0.034)	0.689 (0.036)	0.639 (0.038)
Age group 75 +:				
Carstairs	0.631 (0.039)	0.537 (0.042)	0.451 (0.045)	0.152 (0.050)
Townsend	0.539 (0.042)	0.432 (0.045)	0.387 (0.046)	0.094 (0.050)
Jarman	0.409 (0.046)	0.297 (0.048)	0.243 (0.049)	−0.022 (0.050)
DoE	0.413 (0.046)	0.308 (0.048)	0.221 (0.049)	−0.021 (0.050)
Unemployment	0.636 (0.039)	0.544 (0.042)	0.425 (0.045)	0.147 (0.050)
Male unemployment	0.653 (0.038)	0.565 (0.041)	0.434 (0.045)	0.157 (0.049)

Note: based on log–log regressions.

Table 3 Regression models for the relationship between standardised illness ratio residuals, percentage male unemployment, and standard region (regression coefficients and %R²)

Explanatory variables	Age <65 y		Age 65–74 y		Age 75 + y	
	M	F	M	F	M	F
Constant	−0.279	−0.377	−0.163	−0.218	−0.170	−0.204
Log male unemployment	0.076	0.152	0.052	0.087	0.070	0.082
Region:						
North	0.183	−0.015	0.053	−0.026	0.000	0.015
Yorkshire & Humberside	0.108	−0.018	0.061	0.048	0.043	0.056
East Midlands	0.076	0.008	0.042	0.033	0.018	0.040
East Anglia	0.137	0.093	0.071	0.031	0.003	0.000
South West	0.140	0.061	0.072	0.029	0.006	0.004
West Midlands	0.116	0.012	0.025	0.062	0.010	0.038
North West	0.127	0.041	0.040	0.000	0.016	0.032
West	0.398	0.266	0.183	0.113	0.064	0.063
R ² (%):						
Log male unemployment only	8.5	18.5	7.8	14.6	23.8	34.1
Log male unemployment + Regions	43.5	41.4	31.4	30.3	33.5	47.9

Notes: SIR residuals are the difference between observed SIRs and estimated SIRs from log–log regression with standardised mortality ratios.
Bold indicates significance (p = <0.05).

results showing that male unemployment rates had stronger associations with SIRs than most of the composite indicators, this was used as the measure of deprivation. Regions were entered as dummy variables. Table 3 shows the amount of variation explained as log unemployment rate and the regional dummy variables were introduced into the model. Unemployment showed a significant association with the SIR residuals for each age/sex group with the strongest relationship being for the over 75s. However, the explanatory power of the regression model increased substantially with the addition of the dummy variables for regions. Table 3 also shows the partial regression coefficients for the full models for each age/sex group. The South East Region was chosen (arbitrarily) as the reference category for the regional dummy variables and it can be seen that the other regions tended to show a higher, positive level of residual variation in SIRs particularly for males. The most striking excess was in Wales, which showed a higher level of SIR residuals than any other region for all age/sex groups. East Anglia and the South

West had raised SIRs among the under 65s and males aged 65–74, while Yorkshire and Humberside had an excess for males and females 75 and over.

Discussion

This study shows that while the patterns of SIRs and SMRs display substantial similarities, there are also differences. Like mortality rates, the geographical pattern of LLTI is positively correlated with deprivation but the strength of the association varies considerably depending on the indicator of deprivation that is used. Of the four composite indices considered here the Carstairs index tends to show the strongest association with SIRs and the Jarman index the weakest. However, the correlation of SIRs with male unemployment rates is generally stronger than with any of the more complicated composite indicators.

There is evidence that the strength of the association with deprivation is greater for long term illness than it is for mortality rates, particularly for the older age groups. For SMRs, the strong associations with deprivation apparent in the under 65 age group are greatly weakened among the over 75s. The strength of the correlations between SIRs and deprivation also decline with age, but not to the same extent. For mortality rates, such weakening of the association with deprivation has been attributed to the earlier deaths of more vulnerable individuals and the selective survival of those who are fitter.¹³ If such processes are operating it seems that their effects on LLTI are less than on mortality rates. The result is that the geographical pattern of SIRs in the over 75s shows a closer association with deprivation than is the case for SMRs. Similar patterns were also found in the analysis of SIR residuals from the regression on SMRs. After accounting for SMRs the SIR residuals showed positive associations with male unemployment rates, with the strongest relationships being found in the over 75 age group. Care must be taken to avoid the ecological fallacy when interpreting associations based on district data.¹⁴ While this particular finding might be explained by individual level associations between health and past employment status, it could also be the result of indirect processes working at an aggregate level.

When the geographical patterns of LLTI and mortality were compared by mapping the residuals from the regression of SIRs and SMRs, some interesting patterns emerged. Many districts in the south east of England, including parts of London, had lower rates of LLTI than would be expected from their mortality rates. The opposite was the case for many industrial and mining areas in the north of England and for most of Wales. These results were confirmed by the regression analysis using regional dummy variables, which showed that, for all age groups, Wales had significantly more LLTI than would be expected from its mortality rates. This finding is consistent with high values of LLTI in Wales reported in the general household survey since 1971.¹⁵ Other evidence on

Figure 3 Residual of log standardised illness ratio from regression on log standardised mortality ratio for males <65 y.

the geographical pattern of morbidity is limited, although a survey of adults in Great Britain¹⁶ found the highest prevalence of disability in Wales and the north. Respondents were asked whether they could perform specific activities without limitations, reducing somewhat the scope for subjective bias in responses. A measure of the severity of disability was also recorded

and it is notable that Wales had the highest rates of disability at all levels of severity. A previous study¹⁷ has shown that the choice of deprivation indicator can have a marked impact on resource allocations. The differences between the picture of health status provided by data on LLTI and mortality could also have important implications for health needs

Figure 4 Residual of log standardised illness ratio from regression on log standardised mortality ratio for females <65 y.

assessment and for resource allocation in the NHS. The greater area inequalities in LLTI would lead to wider differences in budget allocations than if mortality rates were used to define “need”. The pattern of resource allocation would also change, of course, with areas such as Wales gaining additional resources and other areas, such as a large part of the Home Counties, losing them. This suggests

that the extent to which LLTI reflects “real” patterns of ill health requires further investigation. There is a need to examine the extent to which the excess of reported LLTI in Wales reflects an actual high prevalence of ill health or some social or cultural factors affecting the answers given to the census question. There is also a need to explore whether reported levels of LLTI vary between areas experiencing

different labour market conditions. Deprivation associated with economic problems in some areas may have a real impact on morbidity in their population, but also people may be more likely to declare themselves as having LLTI in areas of high unemployment where they have little prospect of work.

We thank the Economic and Social Research Council for supporting this research as part of the ESRC/UFC ISC 1991 Census of Population Programme. We also acknowledge our use of data from the 1991 Census Crown Copyright ESRC purchase.

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Open discussion

BITHELL – Does your model assume that dependent variables are normally distributed?

LOVETT – We tried to look at that in terms of carrying out log transformations etc. We experimented with a number of transformations to identify the best linear relationship within our regression model.

BITHELL – Did you take into account the fact that those residuals would have different variances because of the different sizes?

LOVETT – Not in this study.

BITHELL – With districts you would get away with the idea that residuals should be normal. The fact that they are likely to have different variances would, I think, give you a suboptimal analysis.

LOVETT – What would you do to try and rectify that? We are a third of the way into our research.

BITHELL – You could do weighted least squares, or you could use a generalised linear model which would take care of it for you.

DIGGLE – There is an important paper by Breslow and Clayton¹ which provides a very general framework for dealing with exactly this issue.

LOVETT – Do you think that kind of difference in method would be sufficient to counteract some of the effects that you see here?

DIGGLE – It depends on how small the area is. As Bithell says, the larger the region the less the problem. There are two issues. The first is the inferential issue which is very seriously affected by the discreteness of the small counts and the spatial correlation, which you have not mentioned. But there is also the substantive issue as to what regression coefficients mean in causal terms. Regression coefficients at different levels of spatial aggregation mean different things.

JOSHI – It is very interesting to look at the variation in sickness that is not associated with mortality, because we have had data on mortality for a long time. But I think we really want to look at the variation in mortality that is not explained by sickness. You want to put the sickness first.

LOVETT – Thank you for the idea, we will go away and work on it. You have to appreciate it has taken quite a while to get the data to this stage.

JOSHI – It is impressive that you have got it this far.

BEN SHLOMO – I was interested that unemployment was such a good predictor and I wondered if this could be an example of reverse causality because having chronic illness may well be the reason for unemployment. Secondly, I am always slightly worried about long term illness questions because, rather like all cause mortality, they cover a very heterogeneous group of conditions. In one Dutch survey they had exactly that problem, and then asked individual people, “what is your long term illness?” The list was wide – from chronic eczema to chronic back pain. The researchers also showed that the social class relationships varied. For manual type work related illnesses, of course, there was a very strong social gradient for chronic back pain or locomotor problems, but for other conditions there was a reverse gradient. I am not really surprised that you have a number of unexplained residuals in associating your mortality data with chronic sickness because you are looking at a very wide spectrum. I think that it is important to remember what you are looking at . . . what is long term illness?

LOVETT – Part of the project, which I have skipped over for this presentation, is simply trying to validate exactly what sort of information we are getting from the census, how interpretable it is, and, for instance, how useful it might be for resource allocation.

BEN SHLOMO – Do you know exactly what the long term illness is from the census data?

LOVETT – No.

BEN SHLOMO – That is a problem. In the Dutch survey they had specific information and it was quite fascinating what people had picked out.

GORDON –

The long term illness question prevalence rates are very similar to the rates from the OPCS disability survey which aimed to objectively measure disability.²³ Except for the elderly who always underestimate their illness.

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