Recession, local employment trends and change in self-reported health of individuals: a longitudinal study in England and Wales during the 'great recession'

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Acknowledgement

The permission of the Office for National Statistics to use the Longitudinal Study is gratefully acknowledged, as is the help provided by staff of the Centre for Longitudinal Study Information & User Support (CeLSIUS). CeLSIUS is supported by the ESRC Census of Population Programme (Award Ref: ES/K000365/1). This work contains statistical data from ONS which is Crown Copyright. The use of the ONS statistical data in this work does not imply the endorsement of the ONS in relation to the interpretation or analysis of the statistical data. This work uses research datasets which may not exactly reproduce National Statistics aggregates.
The authors also acknowledge help from the ONS NOMIS centre, Durham University in accessing data on employment rates for local authorities. The authors are solely responsible for the interpretation of the data presented in this paper.
The authors also gratefully acknowledge Professor Mylene Riva, Institute for Health and Social Policy and Department of Geography, McGill University, Montreal, Canada, for her contributions to earlier published work using this data set, which provided the grounding for the new analyses presented here.

Abstract

Our research examines how local labour market trends during the early stages of the 'great recession' (in the period 2007-2011) related to change in individuals' self-reported illness. We report results from analyses of a dataset drawn from the Longitudinal Study (LS) for England and Wales (source: Office of National Statistics), a very large longitudinal sample of individuals from the population census, followed up over time at each decennial census. These were linked to employment trend data for Local Authority Districts for the period 2007-2011, based on employment statistics for Local Authority Districts (LAs) in England and Wales. Controlling for various individual attributes, the risk of development of a 'new' long term illness during the 'great recession' was greater for those living in LAs where levels of employment were persistently low or declining to relatively low levels.

Introduction

This paper contributes to a growing international literature on the relationships between economic recession and health outcomes, which has become particularly pertinent during the recent 'great recession', affecting many countries around the world in the period since 2008. The study is situated within the interdisciplinary field of research concerned with the wider determinants of health, and relates to an expanding series of publications in health geography (e.g., reviewed by Pearce, 2018, Pearce et al., 2018) concerned with the significance of changing environments over the *lifecourse of places* and how these relate to variability in health among individual residents. We report here on an analysis that combines information from two datasets produced by the Office of National Statistics: data for Local Authorities (Local Government units in Britain), on trends over time in economic conditions; and data from the Longitudinal Study (LS) for England and Wales, providing information on individual's health and other personal characteristics for two time points, before and after the onset of recession. We present results from analyses of data on very large samples of individuals, drawn from the LS, which are derived from the population census and followed up over time at each decennial census. As discussed below, evidence from this kind of approach has been identified in reviews of research in the field as relatively unusual and necessary in order to understand the relationships involved and identify the populations most at risk of deteriorating health during recession. Our conclusions consider the implications for policy during this continuing period of economic volatility and austerity.

Background

Conditions of employment or unemployment are considered to be an important part of the processes that are often referred to in the public health literature as 'wider determinants of health' (Bambra et al., 2010, Dahlgren and Whitehead, 1991, WHO, 2008). These are especially important to tackle in order to reduce health inequalities and prevent illness in the population. It is well established that employment and health are associated though a range of causal pathways and that stressful conditions in the workplace or difficulties in finding employment are likely to show significant links with detrimental health outcomes (Astell-Burt and Feng, 2013, Bambra, 2011, Burgard and Kalousova, 2015, Carls et al., 2015, Copeland et al., 2015a, Faculty_of_Public_Health, (undated), Maynou and Saez, 2016, Moeller et al., 2013, Parmar et al., 2016; Benach et al. 2014). Some of this literature suggests that these associations may be exacerbated during periods of economic recession and other research suggests that the health impacts for individuals may be long lasting (Curtis et al., 2003). It is argued that difficult conditions in the labour market are significant for health for many groups in the population, not only for those who are unemployed and seeking work. For example, precarious and stressful employment may damage health of those who are in work (Benach et al., 2014, De Moortel et al., 2017, Dirlam and Zheng, 2017, Heyes et al., 2017, Laaksonen et al., 2009, Lopez et al., 2016). The impacts of economic recession may be significant for health of people in different age groups, not only those often described as 'of working age' (when they might expect to be established in employment). Detrimental effects may also be experienced by young people and adolescents who are on the point of transitioning into work (Di Blasi et al., 2016, Huegaerts et al., 2017, Rathmann et al., 2016) and also by older people who have reached retirement age (Fenge et al., 2012, Pruchno et al., 2017). Other individual characteristics such as gender and family status may influence the experience of economic recession (Gili et al., 2016, Wu et al., 2014). The impacts of recession may also be significant for a range of health conditions. A growing literature has focussed on mental

health outcomes (Corcoran et al., 2015, Curtis et al., 2018, Faculty_of_Public_Health, (undated), Frasquilho et al., 2016, Gronowski and McNicol, 2017, Huegaerts et al., 2017, Laaksonen et al., 2009, Ntountoulaki et al., 2017, Reeves et al., 2015, Reibling et al., 2017, Wilkinson, 2016, Zissi and Stalidis, 2017, Zivin et al., 2011). The wider literature also includes reference to physical health problems such as cardiovascular disease (Carls et al., 2015, Sigursteinsdottir et al., 2017).

Theoretically, the associations between economic recession and health outcomes for individuals will result from processes operating via complex causal pathways (e.g. Bacigalupe et al., 2016). Some of these may be damaging for health, due to increased stress, reduced affordability of healthy dietary behaviours, and difficulty accessing health and welfare support. Some behavioural changes in response to recession may, conversely, have more positive impacts (for example by reducing affordability of unhealthy commodities such as tobacco or alcohol products), although there is evidence that some health behaviours revert to previous levels once the economic circumstances improve (Ásgeirsdóttir et al 2016). There is also some evidence that periods of economic recession may have population-level benefits for traffic fatalities and physical activity, although the findings are equivocal. Psychosocial stressors, due to pressures and precarity in the workplace, and the psychological impact of loss of income and declining value of assets, may operate upon physical as well as mental health (for example, via physical morbidity known to be associated with increased allostatic load). This may explain why, for example, research from Italy indicates that, even in the relatively short term, increasing risk of cardiovascular mortality has been observed during a period of recession (Mattei et al, 2014). Related research (Mattei, et al, 2015) also found that reporting of other health conditions that are likely to become chronic and restrictive, such as irritable bowel syndrome and back pain, also become more frequent during recession. Other research suggests that increased levels of tobacco use, as a response to the psychological pressures of financial strain, may also worsen risks for physical health (Mckenna et al, 2017). Some published research suggests that the health impacts of recession and stresses in the labour market may also operate indirectly via effects on other health determinants, such as cost, affordability and security of housing (Downing, 2016, Dwyer et al., 2016, Pevalin, 2009, Tsai, 2015) and food (Garthwaite et al., 2015). The growing body of research therefore suggests that, even in the relatively short term, risks of developing chronic physical as well as mental health morbidity may change in response to conditions prevailing during an economic recession. More generally, lower state revenue and spending that result from an economic downturn may affect the resources available for public health expenditure, social care and welfare benefits with wide-ranging implications for population health, particularly for already disadvantaged groups (Burgard & Kalousova 2015). Importantly, for more vulnerable populations, the strong social safety nets in some European countries may buffer against many of these detrimental pathways (Margerison-Zilko et al., 2016).

Much of the literature cited above has focussed on evidence assessed at the national scale (or, in the case of qualitative research, within particular localities). A smaller number of publications on this question examine evidence relating to variable trends across different areas within countries, such as the UK. For example, a study of health trends in the UK during the recession (Astell-Burt and Feng, 2013) reported results suggesting some regional differences in health trends. Research on variation in self-reported mental health for a large sample in Scotland (reported at one time point, in 2011) considered differences related to variation of employment conditions at the level of local authorities (Curtis et al., 2018). Other studies have examined change in the 'north/south divide' in health at regional level in England during the recent recession (Copeland et al., 2015b, Moeller et al., 2013).

A recent review of longitudinal studies in Europe of health outcomes during the 'great recession' (Parmar et al., 2016) indicated that many published research studies were limited because they were unable to control for individual attributes of the populations concerned and they were based on data for relatively limited periods of time (less than 10 years) and for periods of less than 3 years since the start of the crisis.

The research reported below aimed to address these limitations using longitudinal data (including self-reported ill-health) for very large and representative longitudinal samples of individuals, derived from the UK population census, which were linked with area level data on employment trends over time in local authority areas across the country. While the analysis has some limitations (considered in the concluding discussion) it makes an original contribution to knowledge by demonstrating the relationships between change in individuals' self-reported illness 2001 - 2011 and change in employment conditions in local labour markets during the recession over the period from 2007-2011. The analysis controls for individual attributes and for local neighbourhood conditions. The methods used include the use of trajectory group modelling (Jones & Nagin, 2013) to classify the 'economic lifecourse' of different across England and Wales during the recession. Although similar applications of trajectory modelling have been used in some studies of health and place (Riva and Curtis, 2012; Curtis et al., 2018; Shackelton et al, 2018) this technique has not been widely used in previous research in this field. We conclude with a discussion of the implications of the findings in terms of the significance of local labour market trends for health and how this may relate to welfare policies introduced during the period of austerity associated with the 'great recession'.

Methodology

In this section we describe the data sources used in this study, the derivation of individual and geographical data used in the analysis, and the approach to modelling that was used.

Data derived from the Longitudinal Study

The data on individuals that were used for the analyses reported below were derived from a national longitudinal study of the population in England and Wales, based on a large longitudinal dataset drawn from the decennial population census. The Longitudinal Study (LS) (https://www.ons.gov.uk/aboutus/whatwedo/paidservices/longitudinalstudyls#about-the-longitudinal-study-ls) is based on a 1% sample of the population of England and Wales. It contains linked census and life events data and is the largest longitudinal data resource on individuals in England and Wales. The LS has linked records from each census since the 1971 Census, for individuals born on one of four selected dates in a calendar year. These four dates were also used to update the sample at the 1981, 1991, 2001 and 2011 Censuses.

The LS data are anonymized and can only be accessed in strictly controlled conditions within secure laboratories. Results of analyses on these data can only be published after assessment by the data governors who control the outputs to avoid any risk of disclosure of individual's identity. The research reported here was also approved by the relevant research ethics committee at University of Durham.

The LS is especially interesting for the work reported here because it includes census data on self-reported long term illness (and a number of other individual attributes likely to be relevant to health). These data are well suited to analysis of sub-national geographical

variability, since they are for very large samples, representative of the whole population living in all parts of the country in the years for which the samples were taken.

The LS data used in this research were collected in 2001 and 2011 (before and after the beginning of the 'great recession' in 2008). The analysis focussed on people who were aged over 16 years and under 70 years in 2011. Most of this group would have been of 'working age' during the recession so most likely to be impacted by labour market trends. Those who were teenagers may have been transitioning into the labour market, while others aged over 65 would have reached retirement age during the period studied, and (as explained in the preceding review) they might also be impacted by recession conditions. The analysis does not include those in the oldest age groups (over 70 years), who would be most likely to report long term illness due to the 'normal' health effects associated with aging.

As described below, these LS data were also linked to geographical variables based on data from other sources.

Variable definitions and model design

The aim of the analysis was to test the relationship between self-reported health and recent employment trends in the LA where the individual was living in 2011. The analysis was conducted using multilevel logistic regression with two levels, representing the individual and the Local Authority area where they were living.

The dependent variable in the model is a binary indicator of the individual health outcome of interest, indicating whether the person reported a 'new' long term illness (NLTI) that would have developed between 2001 and 2011. This variable was derived from the census question which asked whether the person had 'any long term illness, health problem or disability' that limited their daily activities or the work they could do. The dependent variable was based on individual's self-reports of long term limiting illness in the 2001 and 2011 censuses, and is coded 1 for those who had reported *no* long term illness in 2001, but *did* report such illness in 2011. For these individuals, a 'new' case of long term illness was likely to have occurred during the period of interest. This group were compared with those (coded 0) who either had no long term illness at either date, or had already reported long term illness in 2001, so that their condition was very long standing.

The associations between the health outcome, NLTI, and various predictor/control variables were modelled as 'fixed effects', expressed as odds ratios (calculated relative to a 'reference category' for categorical variables).

The predictor variable of particular interest in this study is an indicator of recent trends in employment rate in the person's area of residence, which was linked to the LS sample. (The linkage of area data was approved by the data governors and carried out under very secure conditions by the LS data managers; personal information on precise residential location is not disclosed to researchers.) This is based on data relating to employment trends between 2007 and 2011 for 340 Local Authority Districts (LAs) in England and Wales. The population size of Local Authority Districts in mainland England and Wales averaged about 162,000 in 2011, so that the 1 % Longitudinal Study sample provides sufficient numbers to conduct multilevel analyses using these Local Authority units as a hierarchical level. The original employment data were sourced from the NOMIS service provided by the Office of National Statistics UK, which provides labour market statistics from official sources. Quarterly data on employment rates for the population aged 16-64 in LAs is produced by NOMIS (https://www.nomisweb.co.uk/) from national survey data. We calculated 3 year moving averages from these data for the period 2007- 2011, covering the period during which the 'great recession' began to take effect. Trajectory group modelling (Nagin and Odgers, 2010;

Jones and Nagin, 2013) was used to identify groups of areas with differing employment trends during this time. This trajectory modelling technique can be applied using varying specifications which do not produce identical solutions. There is discussion in the statistical literature regarding which statistical criteria are most suitable to use when selecting among alternative solutions, as well as the limitations of these selection criteria. We tested results from a number of alternative trajectory model solutions with relatively low Bayesian Information Criterion (BIC) scores. We also noted that there is some discussion in the statistical literature regarding whether the BIC is always the best indicator to use (Speigelhalter, D. J., Best, N. G., Bradley, P. C. & Van Der Linde, A. 2002, Speigelhalter et al. 2014) Here we report results using a trajectory model solution which appears to have theoretical relevance to our research as well as statistical rigour, since it highlights trends which are variable in terms of direction, as well as level of employment rates over the period studied, and therefore seemed theoretically most relevant to the research question. This showed that trends in employment in local authorities had been geographically variable in different parts of the country, comprising 9 groups of areas in England and Wales (Figure 1). These are geographically distributed as shown in Figure 2. These groups of areas are not all geographically coterminous, so that, for example, the grouping does not correspond to the administrative Regions in Britain that were analysed in other published research reviewed above (Astell-Burt and Feng, 2013).
The regression models reported below included the employment trajectory category of the local authority where the person was living by 2011. In this analysis, area category number 6 was taken as the reference (shown by the trend line labelled '6' in Figure 1) This group was chosen as the reference because it included a relatively large proportion of the total population studied (15.5%: source ONS LS, combined with data from ONS NOMIS) and it was a group of areas where employment levels remained comparatively high and stable throughout the period (see Figure 1).

Control variables included in the regression models (as shown in Table1) represent individual risk factors expected to be associated with self-reported illness: sex, age (expressed as age in years squared, to control for non-linear rate of increase in risk of long term illness associated with aging), ethnic group, and (as recorded in 2011) marital status, employment status (controlling for whether the person was unemployed and seeking work, as opposed to employed or economically inactive in 2011), housing tenure 2011 and occupational social class category in 2011. In some cases the reference category used for modelling the association between the outcome and a predictor is not at the extreme of the range (eg we used social class 2 as the reference, rather than social class 1 or class 5). This was done because the reference category was one with relatively large numbers of individuals, providing a more statistically powerful analysis.

Another control variable in the models is based on the Carstairs indicator of multiple deprivation for the neighbourhood where the person had lived in 2001. This indicator was measured in 2001, for Census Area Statistical Wards as defined in 2001. Deprivation is categorized in decile ranges across wards in England and Wales. There are over 8,850 of these small areas in England and Wales, so they are much smaller geographical units than Local Authority Districts. These Carstairs indicators for areas in England and Wales were derived from a data set compiled by Paul Norman (https://census.ukdataservice.ac.uk/get-data/related/deprivation), which provides information on areas with consistently defined area boundaries during the period studied. Using ONS data from the 2001 Census and accessed via CASWEB, we calculated Carstairs scores and percentiles. The 2001 wards nest into the 2011 local authority geography and can be directly allocated to the trajectory groups.

The Carstairs indicator provides a composite measure of various dimensions of relative neighbourhood deprivation (including information on male unemployment among the local

population), but it does not include information on health of the local population, which avoids confounding with the outcome variable in the model. The control variable used in the analysis was based on decile groupings of wards in England and Wales according to rank of the Carstairs indicator, where the highest decile is the most deprived group of wards. The decile category for the ward of the person's place of residence in 2001 was used to control for 'baseline' socio-economic conditions that the person would have experienced in their neighbourhood before the onset of the great recession in 2008, and for more local variations in socio-economic conditions within Local Authorities, which may have influenced their experience of the labour market during the period studied. The Carstairs indicators include components measuring the following population characteristics of wards in 2001: male unemployment rate; % of households in overcrowded housing; % lacking a car; % categorised in low social class.). The information on male employment rate included in the Carstairs measure results in some correlation between ward level Carstairs decile and employment levels at Local Authority level. However, it does not reflect *trend* in employment over time in the same way as the trajectory groups for employment rate at the local authority level, and it does not include female unemployment, so that the two indicators are independent to a degree. To illustrate how Carstairs indicators relate to the trajectory groups considered here, we include Figure A (Electronic appendix). This graph illustrates, for wards in England as a whole, how wards in different quintile groups of Carstairs in 2001 were distributed across the trajectory groups analysed here. The trajectory groups show some variability in the concentration of more and less deprived neighbourhoods, as measured by Carstairs quintile indicators. However, the employment trajectory groups all include wards in each Carstairs deprivation quintile. The same conclusion applies if Carstairs deciles are considered. This underlines that employment rates at the scale of LAs captured by trajectory groups are measuring rather different aspects of socio-economic conditions than those reflected in the Carstairs measures.

Findings from multiple regression analysis of risk of 'new' long term illness

A first point to note is that the trajectory modelling of employment rates, summarising change in local employment conditions over time, demonstrated considerable variability between LAs across the country, as shown in Figure 1, presenting trajectory groups for employment rates 2007-2011 in LAs in England and Wales. For example, in areas classed in groups 1 and 2 employment trajectories remained fairly stable at a relatively low level throughout the period 2007-2011, while the groups of areas labelled 9 and 6, maintained relatively high rates of employment throughout the period. Groups 4 and 5 had similar levels of employment at the start of the period, but followed different trajectories thereafter, with employment rising in group 4 and falling in group 5. Areas in group 3 showed an upward employment trajectory from a relatively low rate in 2007 and by 2011 had employment rates similar to those in group 5, where rates had fallen over the period.

We now turn to results of modelling individual NLTI. Data on reported long term illness were recorded in both 2001 and 2011 for a total of 313,319 individuals in the LS for England and Wales who were aged under 70 in 2011, and of these 9% reported a 'new' long term illness (NLTI) in 2011 which had not been reported in 2001. Table 1 presents results of multivariable, multilevel logistic regression analysis of varying risk of reporting a NLTI for a total of 304,565 individuals in England and Wales from the LS (those for whom we have complete data on all the variables included in the model, and who were aged under 70 in 2011). The associations between the outcome and the predictor variables are expressed as odds ratios (OR). For categorical predictor variables, the OR is calculated relative to one

'reference' category of that variable, as indicated in the table. An OR that is significantly different from the 'reference group' is indicated by the probability of a non-random difference between the categories, (measured by 'P>|z') and by the '95% confidence interval'). Those groups with OR and confidence interval values greater than (or less than) 1 and a probability of a random association less than 0.05 are treated as having a risk of 'new' longterm illness that is significantly different from the reference group.

The individual control variables included in the model in Table 1 all show some significant associations with the outcome, independently of the other variables included. The OR of a NLTI is greater for women than for men and increases significantly in association with increasing age in years. For those who were unemployed in 2011, the OR of a NLTI is significantly higher than for those who were in employment, retired or not seeking work. Those who were separated or divorced have higher ORs than those who were married in 2011. Compared with those of 'White' ethnicity, the OR for a NLTI, is relatively high for those in a group identifying with 'Indian', 'Pakistani', 'Bangladeshi' or 'other Asian' ethnicity and relatively low for the group comprising 'Black African', 'Black Caribbean' or other 'Black' ethnicity. Compared with those who are outright owners of their homes, the OR of a NLTI is lower for those who are home owners with mortgaged properties and higher for those who are tenants in the socially or privately rented sectors or live rent free. Regarding individuals' socio-economic category (compared with the reference category, class 2), there is a clear social class gradient in the OR of a NLTI, increasing from the most advantaged class (1) to the most disadvantaged class (5). The decile classification of neighbourhood deprivation in 2001, based on the Carstairs indicator, also showed a significant 'gradient' with progressively increasing OR associated with higher (more disadvantaged) decile groups ranked 4-10.

After controlling for all of these factors, we found significant associations between the OR of NLTI and the employment rate trajectory of the LA where the person was living (as shown in Table 1 and in Figure 3). Compared with those in living in LAs in trajectory group 6 (the reference category, where employment rates were high and stable), people living in LAs classed in groups 1 or 2 (with persistently low employment rates) and group 5 (declining employment rates) showed significantly higher risks of a NLTI. As noted above, areas in trajectory group 4 initially had rates of employment similar to those in trajectory group 5 but subsequently improved to approach the levels in group 6, so it is interesting that people living in area groups 4 and 6 did not have significantly different OR of NLTI. Also areas in group 3 had initially low employment rates, which trended upwards 2007-2011 and for people in these areas, the risk of NLTI was not significantly different than for the population of areas in category 6. Two other groups of areas (7 and 8) also showed a downward employment trajectory, but did not reach levels as low as group 5 and people living in these areas the risk of NLTI is not significantly different from group 6.

We carried out a sensitivity test to check whether the findings would be different if we controlled for marital status, housing tenure and social class as reported in 2001, before the onset of recession, rather than at 2011 when NLTI was reported. (Data are not available on these characteristics for 2007, between census dates, although this would be the most suitable control.) The results (shown in Electronic Table A) show that, with respect to the association with employment trajectory groupings for place of residence in 2011, associations with risk of NLTI were very similar to those shown in Table 1. We also tested, as far as the data allow, for the possible effects of health selective migration between 2001 and 2011. This was done by running a model similar to the one shown in Table 1 for a smaller subset of the LS population who, in 2001 and in 2011 lived in LAs classed in the same 2017-2011 employment trajectory group. The resulting coefficients relating to trajectory groups (Electronic appendix Table B) are similar to those in Table 1 (particularly

for groups 1,2, and 5 which show statistically significant associations with P below 0.05. However the significance of the associations is weaker than for the model shown in Table 1, which might be partly because the sample analysed was smaller (Table B relates to 83% of those reported in Table 1), but may also suggest that health selective migration accounts for some of the association between risk of NLTI and LA trajectory group reported in Table 1).

Discussion

The findings reported here support the growing international literature (reviewed above) suggesting links between individual health outcomes and labour market trends during the 'great recession' that started in 2008. Our results make an important original contribution to this debate because they relate to very large and representative samples from the population in Britain, and the data used allowed us to control for a number of other risk factors at the individual and neighbourhood level. The approach used here also contributes to research in health geography by demonstrating the potential of research which examines spatio-temporal change in socio-economic conditions in *places* that may operate as determinants of change in individual health outcomes.

The results reported above suggest that people living in areas with persistently low or steeply declining employment levels during the 'great recession' had a higher risk of a 'new' long term illness in 2011 than those in areas where employment had been consistently higher or improving. It is interesting that those living in areas in trajectory group 5 had a greater risk of a 'new' long term illness than those in group 6, but this was not the case for people from areas in groups 7 or 8, although employment rates were also declining there. These results are suggestive of a 'threshold' effect; employment rates that were initially close to the national average, then declined to levels below the national average, seem to have been detrimental for health, but health seems to have been more 'resilient' in areas where relatively high employment levels only declined to rates around or above the average.

It is important to note that our analysis controls for individual employment status, and these results support other research, discussed above, that suggests that the impact of area labour market trends may be important for health of those who are still in employment, or were not active in the labour market, not only for those who become unemployed.

Some caveats may apply to these findings because of certain limitations of this research. We note that, in our analysis, the most 'dominant' predictors are individual and local 'neighbourhood' factors, which are statistically more powerful and significant for the health outcome considered than are employment trends at local authority district level. It is possible that the relationship with area employment trajectories reported here might be due to other characteristics of areas, not included in our analysis. (However, we do include the Carstairs indicators for neighbourhood of residence, which control for some other area attributes prior to the onset of recession.) The full complexity of causal pathways is difficult to express in detail in the types of models used here. For example, the models used may not fully control for social variability in the typical age of onset of long term limiting illness, or for other variations in the person's attributes which might have occurred over the period of interest, 2007-2011. We do report above on some tests regarding sensitivity of the model to change in personal attributes between 2001 and 2011, when census data were collected. We have also considered the possible effects of health selective migration, and, while the available data do not make it possible for analyse this in detail, we report above a sensitivity test regarding migration. The data on long term illness are based on self-reported health status, which may be subject to variable perceptions and interpretations. Also, the onset of 'new' long term illness reported in 2011 might have been during the period 2002-2007, predating the economic recession.

Conclusions

Our findings seem to support the case for public health policy to be sensitive to the likely health impacts of the recent economic downturn in countries like England and Wales. They may also have implications for the increased cost to society of treating and supporting people with chronic illness that impacts on their activities. Additional resources for care of chronic illness may need to be directed particularly to those localities where members of the population are at greatest risk of developing new cases of long term illness and demand for care will have increased most rapidly. Our findings suggest that there may be a 'threshold' effect, such that these risks were significantly greater in areas where employment rates dropped to around 75% during the recession, or were below this level throughout the period studied. Our findings control for individual unemployment and suggest that there may be a need for more effective interventions to protect the health of those in work, as well as those who are unemployed. This may require action both in the workplace and in the wider community, especially during periods of economic recession. The 'great recession' impacted on other factors likely to be relevant to health, and, for example, future research based on the 2021 census might consider how local reductions in public expenditures due to introduction of austerity measures (mainly implemented since 2011) may relate to changes in reported long term illness. Furthermore, if subsequent austerity measures have impacted most strongly in areas where employment rates have also dropped to below average levels during the recession, it may be particularly important to consider the findings reported here, since the populations in these areas will have seen the greatest increase in long term health problems, likely to be associated with need for welfare support. More generally, this research is innovative in demonstrating the use of statistical methods such as trajectory group modelling to capture trends in the 'economic lifecourse' of places residence, analysed in combination with information on individual resident's attributes and outcomes. By adding to a small but growing body of research in this field, this paper illustrates the potential of this methodology for examination of complex relationships between people and places operating across time to influence the development of people's health and the pattern of health inequality.

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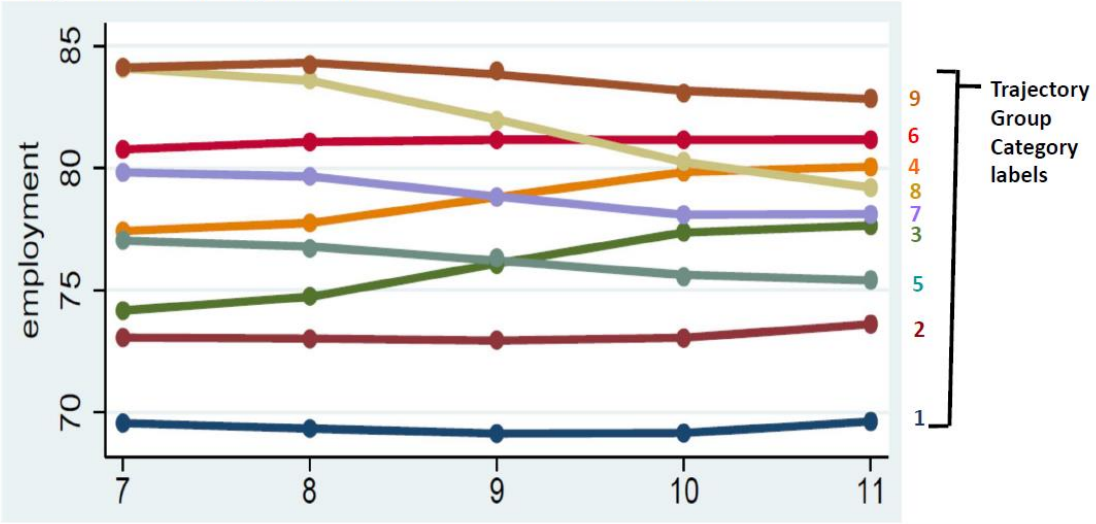
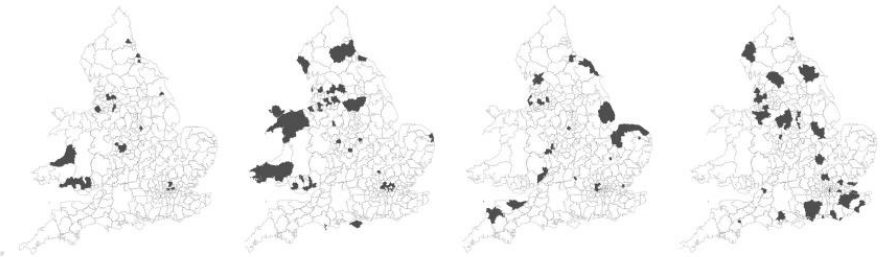
Figure 1 Graph of trend in employment rate 2007-2011 for 9 trajectory groups of Local Authority Districts in England and Wales. Source: ONS NOMIS



Years 2007 – 2011



Trajectory Group 1 Trajectory Group 2 Trajectory Group 3 Trajectory Group 4

Trajectory Group 5 Trajectory Group 6 Trajectory Group 7 Trajectory Group 8 Trajectory Group 9

Figure 2:
Maps showing the geographical distribution of Local Authority Districts in each trajectory group

Figure 3 Odds ratio of reporting a new long term illness by Local Authority trajectory (controlling for other variables in model reported in Table 1). Odds ratio is relative to group 6 (represented by vertical line). Source ONS LS

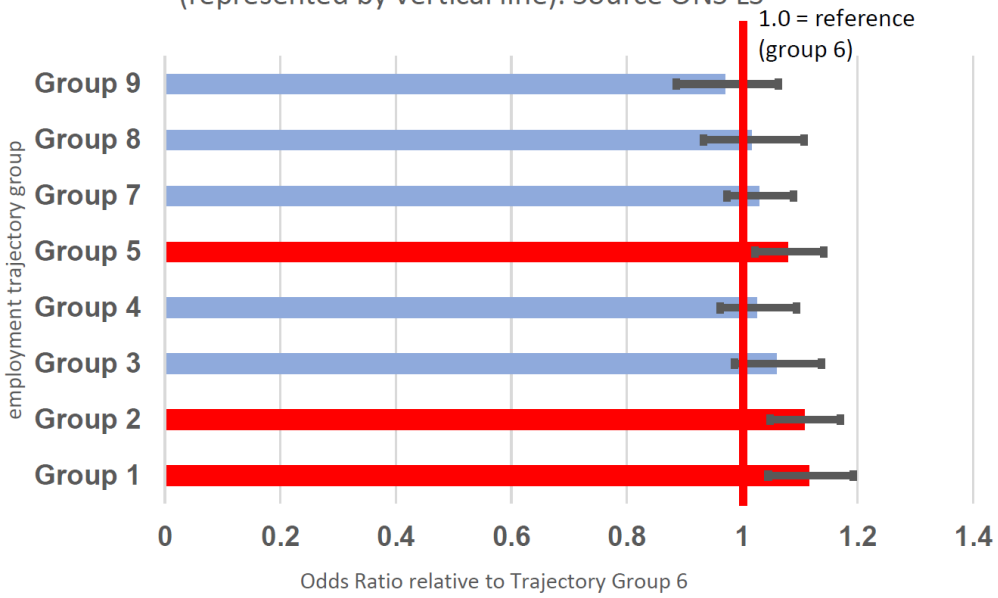


Table 1 Results of a multilevel logistic regression model for 304,565 members of the Longitudinal Study for England and Wales. Predictor variables include individual characteristics, deprivation of small area of residence in 2001 and employment trajectory group for place of residence in 2011
Dependent variable is risk of the individual reporting in 2011 a 'new' longstanding illness (not reported in 2001).
Source: ONS LS

predictor variable	reference category	category	Odds Ratio	Std. Error	z	P>|z| *	95% confidence interval	
Sex	Male	Female	1.13	0.016	8.48	**0.000**	1.10	1.16
Age in Years squared (continous variable)			1.00	0.000	65.74	**0.000**	1.00	1.00
Whether unemployed in 2011	Not unemployed	Unemployed	1.07	0.036	2.07	**0.039**	1.00	1.15
Maritalstatus in 2011	Married	Never married	0.96	0.019	-1.98	**0.048**	0.92	1.00
		Widowed	0.95	0.032	-1.53	0.127	0.89	1.01
		Separated/divorced	1.19	0.022	9.55	**0.000**	1.15	1.24
Ethnic Group as reported in 2001	White'	'Indian, Pakistani, Bangladeshi, Other Asian'	1.35	0.038	10.49	**0.000**	1.27	1.42
		' Black caribbean, Black African, Other Black'	0.76	0.040	-5.13	**0.000**	0.69	0.85
		'mixed '	0.93	0.048	-1.47	0.143	0.84	1.03
Housing tenure 2011	Owns outright	owns with mortgage	0.89	0.016	-6.88	**0.000**	0.86	0.92
		socially rented	1.78	0.036	28.48	**0.000**	1.71	1.85
		privately rented	1.29	0.033	10.26	**0.000**	1.23	1.36
		lives rent free	1.26	0.068	4.24	**0.000**	1.13	1.40
Social Class group recorded 2011	Social class 2	unclassified/armed forces	1.74	0.047	20.60	**0.000**	1.65	1.84
		Social class 1 (most advantaged)	0.83	0.031	-4.94	**0.000**	0.77	0.89
		Social class 3a	1.22	0.024	9.80	**0.000**	1.17	1.27
		Social class 3b	1.37	0.029	14.82	**0.000**	1.31	1.42
		Social class 4	1.44	0.030	17.24	**0.000**	1.38	1.50
		Social class 5 (least advantaged)	1.51	0.047	13.25	**0.000**	1.42	1.60
Carstairs indicator for ward of residence in 2001	Decile 1 (least deprived)	Decile 2	1.03	0.041	0.77	0.444	0.95	1.11
		Decile 3	1.08	0.042	1.95	0.051	1.00	1.16
		Decile 4	1.18	0.044	4.45	**0.000**	1.10	1.27
		Decile 5	1.16	0.043	4.08	**0.000**	1.08	1.25
		Decile 6	1.18	0.043	4.65	**0.000**	1.10	1.27
		Decile 7	1.26	0.045	6.44	**0.000**	1.17	1.35
		Decile 8	1.31	0.046	7.59	**0.000**	1.22	1.40
		Decile 9	1.36	0.048	8.68	**0.000**	1.27	1.46
		Decile 10 most deprived	1.42	0.051	9.71	**0.000**	1.32	1.52
Employment Trajectory Group 2007-2011 of Local Authority of residence in 2011	Group 6	Group 1	1.12	0.038	3.27	**0.001**	1.04	1.19
		Group 2	1.11	0.031	3.62	**0.000**	1.05	1.17
		Group 3	1.06	0.038	1.59	0.111	0.99	1.14
		Group 4	1.03	0.034	0.76	0.444	0.96	1.09
		Group 5	1.08	0.030	2.72	**0.007**	1.02	1.14
		Group 7	1.03	0.029	1.03	0.303	0.97	1.09
		Group 8	1.02	0.044	0.37	0.713	0.93	1.11
		Group 9	0.97	0.045	-0.65	0.517	0.89	1.06
constant			0.02	0.001	-91.75	**0.000**	0.02	0.02

* **bold font indicates P < 0.5**

LR test vs. logistic model: chibar2(01) = 7.54 Prob >= chibar2 = 0.0030
Mixed-effects logistic regression Number of observations = 304,565
Group variable: la_code_2011 Number of groups = 340
Obs per group: min = 172 avg = 895.8 max = 5,166
Integration points = 7 Wald chi2(36) = 11181.57
Log likelihood = -86178.426 Prob > chi2 = 0.0000

Table A Results of a multilevel logistic regression model for 303,456 members of the Longitudinal Study for England and Wales.
Dependent variable is risk of the individual reporting in 2011 a 'new' longstanding illness (not reported in 2001).
Model similar to Table 1 but includes maritial status, social class and housing tenureas recorded in 2001 instead of 2011
Source: ONS LS

predictor variable	reference category	category	Odds Ratio	Std. Error	z	P>|z| *	95% confidence interval	
Sex	Male	Female	1.14	0.016	9.49	**0.000**	1.11	1.17
Age in Years squared (continous variable)			1	0.000	63.7	**0.000**	1.00	1.00
Whether unemployed in 2011	Not unemployed	Unemployed	1.33	0.043	8.99	**0.000**	1.25	1.42
Maritalstatus in 2001	Married	Never married	0.92	0.018	-4.21	**0.000**	0.88	0.96
		Widowed	0.99	0.048	-0.3	0.767	0.90	1.08
		Separated/divorced	1.14	0.023	6.58	**0.000**	1.10	1.19
Ethnic Group as reported in 2001	White'	'Indian, Pakistani, Bangladeshi, Other Asian'	1.29	0.036	9.05	**0.000**	1.22	1.36
		' Black caribbean, Black African, Other Black'	0.78	0.041	-4.73	**0.000**	0.70	0.87
		'mixed '	0.93	0.048	-1.34	0.180	0.84	1.03
Housing tenure 2001	Owns outright	owns with mortgage	1.01	0.018	0.73	0.465	0.98	1.05
		socially rented	1.56	0.035	20.1	**0.000**	1.50	1.63
		privately rented	1.26	0.039	7.49	**0.000**	1.19	1.34
		lives rent free	1.35	0.051	8.09	**0.000**	1.26	1.46
Social Class group recorded 2001	Social class 2	unclassified/armed forces	1.46	0.035	15.6	**0.000**	1.39	1.53
		Social class 1 (most advantaged)	0.79	0.032	-5.84	**0.000**	0.73	0.85
		Social class 3a	1.17	0.024	7.47	**0.000**	1.12	1.22
		Social class 3b	1.39	0.030	15.4	**0.000**	1.33	1.45
		Social class 4	1.43	0.032	16.3	**0.000**	1.37	1.50
		Social class 5 (least advantaged)	1.55	0.048	14.3	**0.000**	1.46	1.65
Carstairs indicator for Ward of residence in 2001	Decile 1 (least deprived)	Decile 2	1.04	0.041	0.97	0.332	0.96	1.12
		Decile 3	1.08	0.042	1.97	**0.049**	1.00	1.17
		Decile 4	1.19	0.044	4.62	**0.000**	1.10	1.28
		Decile 5	1.18	0.043	4.51	**0.000**	1.10	1.27
		Decile 6	1.21	0.044	5.2	**0.000**	1.12	1.30
		Decile 7	1.28	0.046	6.98	**0.000**	1.20	1.38
		Decile 8	1.34	0.047	8.26	**0.000**	1.25	1.44
		Decile 9	1.4	0.049	9.47	**0.000**	1.30	1.50
		Decile 10 (most deprived)	1.47	0.053	10.8	**0.000**	1.37	1.58
Employment Trajectory Group2007-2011 of Local Authority of residence in 2011	Group 6	Group 1	1.12	0.036	3.46	**0.001**	1.05	1.19
		Group 2	1.1	0.030	3.58	**0.000**	1.04	1.16
		Group 3	1.05	0.036	1.4	0.163	0.98	1.12
		Group 4	1.02	0.032	0.58	0.560	0.96	1.08
		Group 5	1.07	0.029	2.52	**0.012**	1.02	1.13
		Group 7	1.02	0.028	0.82	0.410	0.97	1.08
		Group 8	1.02	0.043	0.37	0.713	0.93	1.10
		Group 9	0.98	0.044	-0.51	0.612	0.90	1.07
constant			0.02	0.001	-88.1	**0.000**	0.02	0.02

* **bold** text indicates P < 0.05

Mixed-effects logistic regression Number of obs = 303,456
Group variable: la_code_2011 Number of groups = 340
Obs per group: min =173 avg =892.5 max = 5,155
Integration points = 7 Wald chi2(36) = 10053.69 Log likelihood = -86473.871 Prob > chi2 = 0.0000

Table B Results of a multilevel logistic regression model for 251,725 members of the Longitudinal Study for England and Wales, who, in 2001 and 2011, lived in Local Authorities in the same employment trajectory group.
Dependent variable is risk of the individual reporting in 2011 a 'new' longstanding illness (not reported in 2001).
Predictor variables include individual characteristics, deprivation of small area of residence in 2001 and employment trajectory group for place of residence in 2011
Source: ONS LS

predictor variable	reference category	category	Odds Ratio	Std. Error	z	P>|z| *	95% confidence interval	
Sex	Male	Female	1.11	0.017	7.01	**0.000**	1.08	1.15
Age in Years squared (continous variable)			1.00	0.000	59.89	**0.000**	1.00	1.00
Whether unemployed in 2011	Not unemployed	Unemployed	1.05	0.039	1.39	0.166	0.98	1.13
Maritalstatus in 2011	Married	Never married	0.97	0.021	-1.51	0.131	0.93	1.01
		Widowed	0.96	0.034	-1.10	0.270	0.90	1.03
		Separated/divorced	1.20	0.024	8.78	**0.000**	1.15	1.24
Ethnic Group as reported in 2001	White'	'Indian, Pakistani, Bangladeshi, Other Asian'	1.37	0.041	10.58	**0.000**	1.29	1.45
		' Black caribbean, Black African, Other Black'	0.79	0.045	-4.21	**0.000**	0.71	0.88
		'mixed '	0.93	0.053	-1.35	0.178	0.83	1.04
Housing tenure 2011	Owns outright	owns with mortgage	0.91	0.017	-5.31	**0.000**	0.87	0.94
		socially rented	1.72	0.037	25.43	**0.000**	1.65	1.80
		privately rented	1.32	0.039	9.64	**0.000**	1.25	1.40
		lives rent free	1.24	0.076	3.51	**0.000**	1.10	1.40
Social Class group recorded 2011	Social class 2	unclassified/armed forces	1.69	0.050	17.84	**0.000**	1.60	1.79
		Social class 1 (most advantaged)	0.86	0.035	-3.62	**0.000**	0.79	0.93
		Social class 3a	1.20	0.026	8.15	**0.000**	1.14	1.25
		Social class 3b	1.35	0.031	13.17	**0.000**	1.29	1.41
		Social class 4	1.40	0.032	14.89	**0.000**	1.34	1.47
		Social class 5 (least advantaged)	1.47	0.049	11.78	**0.000**	1.38	1.57
Carstairs indicator for ward in 2001	Decile 1 (least deprived)	Decile 2	1.02	0.044	0.52	0.602	0.94	1.11
		Decile 3	1.08	0.046	1.75	0.080	0.99	1.17
		Decile 4	1.20	0.049	4.37	**0.000**	1.10	1.30
		Decile 5	1.17	0.047	3.88	**0.000**	1.08	1.27
		Decile 6	1.19	0.048	4.38	**0.000**	1.10	1.29
		Decile 7	1.28	0.051	6.22	**0.000**	1.18	1.38
		Decile 8	1.35	0.053	7.55	**0.000**	1.25	1.46
		Decile 9	1.38	0.055	8.19	**0.000**	1.28	1.49
		Decile 10 most deprived	1.45	0.059	9.17	**0.000**	1.34	1.57
Employment Trajectory Group 2007-2011 of Local Authority of residence in 2011	Group 6	Group 1	1.09	0.038	2.50	**0.012**	1.02	1.17
		Group 2	1.07	0.031	2.43	**0.015**	1.01	1.14
		Group 3	1.03	0.039	0.86	0.388	0.96	1.11
		Group 4	1.01	0.035	0.38	0.707	0.95	1.08
		Group 5	1.06	0.031	1.98	**0.048**	1.00	1.12
		Group 7	1.02	0.030	0.64	0.523	0.96	1.08
		Group 8	1.00	0.046	0.01	0.989	0.91	1.10
		Group 9	0.97	0.048	-0.63	0.532	0.88	1.07
constant			0.02	0.001	-83.92	0.000	0.02	0.02

* **bold** text indicates P < 0.05

Mixed-effects logistic regression Number of obs = 251,725
Group variable: la_code_2011 Number of groups = 340
Obs per group: min =124; avg =740.4 max =4,696
Integration points = 7 Wald chi2(36) = 8931.85
Log likelihood = -73621.458 Prob > chi2 = 0.0000

Figure A Distribution of wards located in each trajectory group according to their national quintile ranking on the Carstairs Indicator of Deprivation 2001.
Source: ONS via Casweb|UK Data Service Census Support