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The impact of limiting long term illness on internal migration in England and Wales: New evidence from census microdata

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ABSTRACT

Previous research has suggested that poor health is associated with reduced migration; this knowledge stems from models based on past censuses, or longitudinal studies which imply that the factors influencing migration are the same between those in good and poor health. This paper addresses these issues by utilising health-stratified analyses on the 2011 Census Individual Secure Sample for England and Wales. Multilevel models predict the odds of moving for working age adults, controlling for key predictors of migration, estimating the effect of health status on the odds of moving and the destination-specific variance in migration. We find that those in poor health are less likely to move, after controlling for individual level characteristics. In contrast with expectations, economic inactivity, marriage and being in African, Caribbean, Black, Other or Mixed ethnic groups were not significant predictors of migration among the unhealthy sample, but were for the healthy sample. We conclude that migration is health-selective and propose implications for understanding area level concentrations of poor health in England and Wales.

1. Introduction

Measures of self-rated health from population censuses serve as convenient indicators of health needs as they are predictors of morbidity (Tamayo-Fonseca et al., 2015) and mortality (Gana et al., 2016). International literature has repeatedly reported regional inequalities in the distribution of poor self-rated health which are independent of sociodemographic characteristics, for example in Brazil (Barros et al., 2009), England and Wales (Wiggins et al., 1998) and among older women in Turkey (Ergin and Kunst, 2015). It has long been thought that such regional inequalities in the prevalence of ill-health are the result of health-selective migration (Hill, 1925). The healthy are, all things being equal, more likely to move and, among those who move, those in good health are more likely to move into affluent areas (Boyle et al., 2002). The relative mobility of the healthy may mask or exaggerate regional health inequalities (Norman and Boyle, 2014). In the UK, these understandings are based on results that are over a decade old. In this paper, we use the latest available census microdata for England and Wales to examine how health status relates to migration propensity and whether the areas individuals move within or to varies by health status.

The structure of this paper is as follows. First, we detail general theories of migration decision processes and the role of health as a mediating factor in those processes. From this, we elucidate the key aims of our study. We then discuss census microdata and its relevance to our research questions, the measures of health provided, how migration is defined and our analytical approach. We then present our findings and conclude on policy implications.

2.1. Background

In general there is a consensus that people who are younger, more affluent and better educated are more likely to move, as these groups tend to search more widely when evaluating alternative residences (Clark and Huang, 2003). There are underlying processes encouraging or discouraging migration. One factor for couples is household size: often the planning or arrival of children leads to an increased demand for space and a subsequent move out of the parental home. Growing families may then move to another area where more spacious housing is readily available (Clark and Huang, 2003), or desirable schools are found (Smith and Jons, 2015). Smith et al. (2015) list the most common triggers for moving as a desire for more spacious housing, ‘moving up the housing ladder’, and job

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transfers. According to the same list, having health problems is another common trigger for moving.

2.2. Regional health inequalities

The well-documented existence of regional health inequalities (Fang et al., 2010; Pradhan et al., 2003; Zatonski, 2007) raises an important question: are these inequalities evidence of place-specific effects on health (Kawachi et al., 2002; Smith and Easterlow, 2005)? It is widely held that rates of poor health in a given area can be explained by the characteristics of individuals living in them (composition) and place-specific conditions such as regional patterns in access to healthcare (context; Smith and Easterlow, 2005). Yet neither of these adequately clarify the role of migration flows (and conversely the role of immobility) and their effect on area rates of poor health (Brimblecombe et al., 1999; Norman et al., 2005; Smith and Easterlow, 2005). If the health of migrants differs from that of non-migrants and the destinations of healthy and unhealthy migrants vary, then health-selective migration may explain some of the compositional variations in regional health inequalities (Norman and Boyle, 2014). Thus there is a need for further investigation of the relationships between health and migration.

2.3. Health and migration

The relationship between health and migration flows is complex (for a comprehensive review, see Darlington et al., 2015). Traditionally studies have focused on immigrants, particularly those moving from developing to more developed countries. Immigrants are typically found to be healthier than a random sample from their origin countries. This finding underpins the 'healthy migrant theory': within a given origin the residents who are more likely to migrate are those with greater health advantages (Marmot et al., 1984). The healthy migrant theory has less relevance to internal (intra-country) migration flows (Larson et al., 2004). Though generally internal migrants tend to be healthier than non-migrants (Boyle, 2004; Cox et al., 2007), among specific subsets of the population, migrants have worse health than non-migrants such as older adults (Bentham, 1988) and pregnant women (Jelleyman and Spencer, 2008). Additionally, internal migrants are more likely to report mental health problems after moving than non-movers (Chen, 2011; Tunstall et al., 2014).

Attempting to explain the causal mechanisms underpinning the relative mobility of the healthy is a complex task as there are several compositional characteristics, which bias those in good health towards migration. First, migrants tend to be young, which exaggerates their relative health advantages (Norman and Boyle, 2014). Among the elderly those in relatively poor health tend to be more likely to move (Bentham, 1988; Champion, 2005). Given that changes in employment often result in the need to change residence, and that those likely to receive job offers are the relatively healthy, then logically movers are more likely to be healthy (Gatrell, 2011). Higher rates of migration among the sick elderly are likely to be a result of healthcare related migration into care facilities, into their children's homes or into homes near their children (Tyrell and Kraftl, 2015). The differences suggest that separate analyses of those in good and poor health may provide more accurate estimates of the influences on migration behaviour; however this approach was not adopted in any of the above studies.

Research on migration and migration destinations within the UK, using data from the 2001 census, suggests that health-selective migration changes the geographical distribution of poor health. Norman et al. (2005) found evidence for two forms of health-selective migration: migrants from deprived areas moving to more affluent areas had significantly lower rates of limiting long term illness (LLTI) than the stationary population whilst migrants who move from relatively affluent areas to the most deprived areas had significantly higher rates of LLTI. Norman and Boyle (2014) using migration data from the 1991 and 2001 censuses concluded that the movement of healthy, young adults (mainly for education) masks underlying regional health inequalities. Additionally, areas with high proportions of in-migrants are associated with lower rates of LLTI (Boyle et al., 2001). These findings together suggest that those in poor health are less likely to move; their immobility and the relative mobility of the healthy shifts the geographical distribution of health. In other words, the association between areas and health is potentially confounded by health-selective migration between areas.

The above studies are based on data that are now over a decade old. It is reasonable to suspect that the interrelations between migration and health may have changed between the 2001 and 2011 censuses. The proportion of individuals changing address in 2000/01 was 16.5%, falling to 11% in 2010/11 according to Office for National Statistics (ONS, 2014) figures (2014); Campos et al. (2011) propose that the 2007/08 economic recession had a slowing effect on migration. Migration intensity, spatial variation in flows and distance moved were at their lowest in 2010/11 compared to figures from 2000/01 to 2010/11 (Lomax et al., 2014). Trends from the Health Survey for England over the same period present a picture of improving health; the proportion of individuals who rate their health as good and free from longstanding illness has increased (Health & Social Care Information Centre, 2012). Are those moving still relatively healthy, given that the health of the nation has improved and the mobility rate has decreased?

In summary, there are regional variations in the distribution of poor health, which are not adequately explained by compositional differences in sociodemographic profiles. Authors such as Norman and Boyle (2014) and Brimblecombe et al. (1999) propose that health-selective migration may help explain such regional patterns of poor health. The literature specific to England and Wales is primarily based on data from previous Censuses, whilst evidence suggests that migration and health trends have shifted since 2001. In this context, we turn to a reassessment of the role that health plays in migration patterns. We aim to test whether health is associated with migration. From previous research, we expect that i) healthy individuals have a higher propensity to migrate and that ii) healthy migrants and unhealthy migrants move within or to different areas.

3. Methods

3.1. Data

In the UK, research access to individual and household level microdata was introduced following the 1991 census. Microdata has been utilised extensively by human geographers to identify the association of socioeconomic factors and place with morbidity rates (Li, 2004). The present study uses data from the 2011 individual census microdata file for England and Wales, which is a 10% sample of all 2011 census returns for England and Wales. The UK census is a mandatory decennial questionnaire for all residents of the UK; the England and Wales version of the 2011 census (ONS, 2011a) contains 56 questions on residence, work and other sociodemographic characteristics. Ten percent of individuals within each Census Output Area (181, 406 geographical units, nested within Local Authorities and having a mean of 309 residents) are randomly selected into the microdata sample to ensure that all members of the usually resident population had an equal chance of being included (ONS, 2011b). There are 348 Local Authorities (LAs) in

England and Wales each containing an average of 120,000 individuals. The individual file contains individual level data for 3,437,349 working age adults (ONS, 2011b).

We exclude children (<16 years old) and adults aged 65 years old and over from our sample as our primary interest lies in the migration decision process in the working age population. When children move, the decision-making process is often undertaken by parents or carers, rather than the individual themselves (Dobson, 2009). The migration patterns of retirement age adults differ from the working age population, as their place of residence is not tied to their place of employment (Philip et al., 2013).This group are more likely to move into their families' homes (Al-Hamad et al., 1997) or care environments as their health deteriorates (Litwak and Longino, 1987).

3.2. Access

The census individual secure sample (CISS) microdata for England and Wales are accessed at the Office for National Statistics Virtual Microdata Laboratory. Access to Census microdata is granted only to Approved Researchers on a project specific basis, with each project running for a pre-specified period of time (ONS, 2011b). There is a risk of disclosure from individual level microdata, so all outputs from software are vetted for clearance by the ONS before release.

3.3. Measures

The outcome measure used in this analysis is whether an individual migrated in the year preceding the census. On census day (27 March 2011), individuals' current addresses were recorded and they were asked to provide the address they were living at one year previously (27 March 2010). Individuals whose address was the same at the two dates were coded as a non-mover and those whose address differed were coded as movers. (Boyle and Shen, 1997).

Our exposure variable was *Limiting Long Term Illness* (LLTI). We hypothesise that those with relatively poor health would be less likely to move than those who were relatively healthy (Boyle, 2004; Cox et al., 2007; Norman et al., 2005). In the 2011 Census LLTI was measured by the question: "Are your day-to-day activities limited because of a health problem or disability which has lasted, or is expected to last, at least 12 months? Include problems related to old age" (recoded as 0 = no and 1 = yes, limited a little or yes, limited a lot). An individual reporting an LLTI is considered to be in poor health (Smith and Grundy, 2011).

Self-reported health questions are often used as proxies of 'true health' in social surveys (Curtis et al., 2009). Critics of the validity of self-reported health point to evidence from the 1991 Census that morbidity (LLTI) rates were higher in Wales and lower in Scotland than predicted using a GB-wide regression model (Senior, 1998), which suggests that there may be cultural differences in the interpretation and responses to the question. The time-frame of 12 months may lead to misclassification due to 'recall bias' i.e. being unable to correctly recall their length of exposure (Raphael, 1987). Despite these concerns LLTI is strongly associated with self-rated health, serious and less serious conditions, and has been shown to accurately reflect changes in health among individuals over time (Manor et al., 2001). Analyses of self-rated health measures show that they are reliable measures of health status (Lundberg and Manderbacka, 1996) and other research has shown a lack of differences in reporting patterns among socio-economic (Macintyre et al., 2005) and ethnic (Chandola et al., 2005) groups. Finally, 'true' health is understood in health geography research as a broad definition which cannot be wholly described as the absence of illness or disease and is reflective of individual interpretation (Curtis, 2010).

We include 10 covariates in our analysis, which we anticipate to be related to migration propensity, to control for factors confounding the association between mover/stayer status and LLTI (Table 1).

3.4. Analytical approach

We use multilevel modelling (Goldstein, 2011). Multilevel models allow for processes at the individual level to be modelled within 'contexts' (Duncan et al., 1998), in our case LAs. Such models are vital to correctly apportion variance and estimate standard error, when analysing processes which tend to be concentrated within higher levels such as LAs in order to make accurate inferences (Goldstein, 2011). We expect that migration behaviour is clustered within LAs, as the turnover rate (per thousand resident population) due to internal migration varied from 43.5 to 234.9 by LA in 2011 (Office for National Statistics, 2015a). We proceed with individuals (level one) nested within destination LAs (level two).

In this part of our analysis we explore the associations between individual level factors and migration. Migration is measured as a binary variable, so we use binary logistic multilevel models (Guo and Zhao, 2000) to predict the odds of migration during the year preceding the census. We include both inter and intra-LA movers in our definition, as the majority of migration occurs within LAs (Boyle and Shen, 1997). We assess the effect of LLTI on migration propensity by stratifying the sample into those with an LLTI and those without. This stratified approach allows the associations between sociodemographic characteristics and migration to be tested for those in good and poor health separately. The base respondent (the characteristics of an individual when all coefficients equal zero) in both models is a single white male aged 16–25 living apart from their family in a privately rented property with no educational qualifications, working full time with no access to a car.

Our stratified approach allows the coefficients and LA residuals to be estimated independently. Norman and Boyle (2014) utilised this approach as they hypothesised that the factors influencing migration amongst age groups differ; similarly we expect the factors underpinning migration in the healthy and unhealthy groups to vary. We specifically test the following hypothesis in this part of our analysis: that, after controlling for predictors of migration, having an LLTI is associated with lower odds of having moved in 2010/11.

Multilevel models allow the average odds of migration to vary by LA at the time of the 2011 Census, LA residuals (U_{0j}) are calculated, with a mean of 0 and a standard deviation (σ_u^2), so that the proportion of individuals who migrated can vary across LAs (Goldstein, 2011). We estimate models using the *xtmelogit* command in Stata 12.1 (Statacorp LP, 2013). Fixed effect coefficients are estimated in a similar manner to standard logistic regression whilst random effects coefficients and log-likelihood values are estimated using Laplacian approximation (adaptive quadrature), the distribution of which is assumed to be Gaussian (Statacorp LP, 2015).

In the latter part of our analysis we investigate area level patterns through residual analysis. LA residuals are mapped using ArcMap 10.2.2 (ESRI, 2014) separately for the samples with and without an LLTI. We then link LA residuals to the 2011 Area Classifications for Local Authorities (Office for National Statistics, 2015b), an LA-based geodemographic classification scheme which classifies LAs in eight Supergroups (clusters). We test whether there is a relationship between *migration propensity* (residuals), *health* (LLTI stratified models) and *area typology* (using the 2011 Area Classification for Local Authorities) as fixed effects for residuals associated with our healthy and unhealthy samples using seemingly unrelated regressions (Zellner, 1962). Seemingly

Table 1
Covariates included in the analysis and their relationship to migration.

Variables	Groupings	Expectations
Sex	0 = male & 1 = female	Men to be more mobile (Champion, 2005)[a]
Age	0 = 16–24 1 = 25–34 2 = 35–44 3 = 45–54 & 4 = 55-64	Younger adults to be more mobile (Bartel, 1979; Clark and Huang, 2003; Dieleman, 2001)
Age and sex interaction	Four gender-specific age groups	Younger women to be more mobile (Finney, 2011)
Ethnicity	0 = White, 1 = Indian, Pakistani or Bangladeshi, 2 = Chinese or other Asian, 3 = African, Caribbean or Black, 4 = Other or Mixed	All non-White groups to be more mobile, except Indian, Pakistani or Bangladeshi (Finney et al., 2015)[a]
Marital status	0 = single, 1 = married or civil partners, 2 = divorced, separated or widowed	Married to be the least mobile (Feijten and van Ham, 2010; Geist and McManus, 2012; Tucker et al., 1998)
Family status	0 = no family or household, 1 = in a couple or married family, 2 = in a lone parent family	Lone parents to be the least mobile due to reliance on public assistance, couple or married families to be less mobile than childless families (Astone and McLanahan, 1994; Cho and Whitehead, 2013; South and Crowder, 1998)
Employment status	0 = employed, 1 = unemployed, 2 = economically inactive	Economically inactive to be least mobile, unemployed to be more mobile than the employed (Böheim and Taylor, 2002; Cho and Whitehead, 2013)
Nativity	0 = UK born 1 = Non-UK born	Those immigrating to the UK post-2001 to be more likely to move than the UK born (Sapiro, 2016)
Educational qualifications	0 = none, 1 = GCSE or apprenticeship, 2 = A level, 3 = Degree or higher	Higher education to be more mobile (Duke-Williams, 2009 [a]; Hughes and McCormick, 1985; Liaw, 1990)
Tenure	0 = private renter, 1 = social housing, 2 = owner	Owners and LA or charity renters to be less mobile (Böheim and Taylor, 2002; Cho and Whitehead, 2013; Hughes and McCormick, 1985)
Car access	0 = none, 1 = one car, 2 = two or more cars	Proxy for income, car access expected to be associated with higher mobility (Macintyre et al., 1998; Ullman, 1954)

[a] Study did not control for potential confounders of the association between characteristic and migration.

unrelated regressions are appropriate when we expect the errors in two (or more) models to be correlated (*ibid*), and are estimated using the *sureg* command in STATA 12.1 (Statacorp LP, 2013). In this section we test whether the underlying propensity to migrate by LA Supergroup differs between those with and without an LLTI. The equations are as follows, where α_n refers to dummy variables indicating supergroup membership.

$$\textit{No LLTI residual} = \beta_0 + \beta_n \alpha_n$$

$$\textit{LLTI residual} = \gamma_0 + \gamma_n \alpha_n \quad (1)$$

4. Results

In this section we examine the relationship between health status and migration propensity. Table 2 is a tabulation of mover status stratified by health status. Approximately one in eight individuals moved in 2010/11. There is an association between health status and migration propensity.The odds ratio (OR) row displays the odds for the sample with an LLTI over the odds for the sample without an LLTI; those with an LLTI are less likely to have moved ($OR = 0.6$, $p < 0.001$) than those in good health and more likely to be stayers ($OR = 1.7$, $p < 0.001$), this association is significant at the 0.99 level.

To establish whether there is geographical variation in migration behaviour, Table 3 shows the results of a null model for the sample nested within LAs with migration as the outcome.

We calculate the 1-year probability of migration using the following formula:

$$P(y = 1|X) = \frac{\exp(\beta_0 + \beta_n X_n)}{(1 + \exp(\beta_0 + \beta_n X_n))} = \frac{\exp(-1.99)}{(1 + \exp(-1.99))} = 12\% \quad (2)$$

where β_0 is the constant and $\beta_n X_n$ is a vector of covariates which are set to zero for our base respondent. We include individual level sociodemographic variables (results not shown). The inclusion of sociodemographic variables improve the fit of the model (log likelihood = −1,035,526; difference = 240,486 30 d.f p=<0.0001), those with an LLTI were less likely to move; this relationship was significant at the 0.99 level.

4.1. Stratified models

With sufficient evidence that LLTI is a significant predictor of migration behaviour we proceed with health stratified models (equation (3)). Model 2 includes only the sample in good health, whilst model 3 includes only those in poor health, the results are displayed in Table 4.

Table 2
Cross tabulation of LLTI and mover status.

	Stayer		Mover	
	n	%	n	%
Frequency	3,065,247	87.1	456,369	12.9
Has an LLTI	417,112	91.4	39,257	8.6
Does not have an LLTI	2,651,599	86.5	413,648	13.5
OR for those with an LLTI[a]	1.7		0.6	

[a] OR = odds(LLTI)/odds(no LLTI).
Source: CISS (ONS, 2011b), author's own calculations.

Table 3
Multilevel logistic regression predicting whether an individual migrated in 2010/11.

	Model 1 – Null model	
Sample size	3,521,616	
	Logit	95% Confidence interval
Constant	−1.99	[−2.02; −1.97]
Level 2 variance	0.26	[0.24; 0.28]
Predicted probability	11.98%	[11.68%; 12.27%]
Log likelihood	−1334005	

Source: CISS (ONS, 2011b), author's own calculations.

$$Logit(Mover_{ij}) = CONS + AGE_i + SEX_i + ETHNIC_i + MARITAL_i + FAMILY_i + NATIVITY_i + EDU_i + TENURE_i + CARS_i + EMP_i + AGE{*}SEX_i + U_{0j} + \varepsilon_i \quad (3)$$

Model 2 is a multilevel logistic regression based only on the sample who did not report an LLTI whilst model 3 replicates the procedure on the sample who did report an LLTI. The estimates of the constant for model 2 show the odds of moving in 2010/11 for a reference category individual with an LLTI are 0.53 whilst the odds for an individual without an LLTI are 0.65 (OR = 0.64). Comparatively the OR of 0.83 is closer to 1 than the effect estimated in the unadjusted odds ratio (0.6, see Table 2), suggesting that the 'true' effect of health on the odds of migrating is smaller than the observed difference between the two groups. Observed differences between the two groups exaggerate the effect of health status on migration propensity, yet controlling for mediating sociodemographic variables there is evidence that those with an LLTI are less likely to move.

The relationship between sociodemographic variables and migration propensity is largely as predicted. Those who are young, white, separated, living apart from their children or parents, foreign born, educated, private renting, without access to a car, unemployed and healthy are more likely to move. The relationship between car access and mobility is the inverse of our expectation, suggesting that access to a car allows individuals to adapt to changing circumstances (e.g. a change in place of employment) more readily, and therefore reduces the need to migrate. The interaction terms for gender and age confirm our expectation that younger women (16–34) are more mobile than men; whilst at older ages (35+) men tend to be more mobile.

The significance of factors on migration propensity tend to be similar between the two groups with the exception of employment, marital status and ethnicity. For those in good health, being economically inactive, in a marriage or civil partnership, African, Caribbean, Black, other or mixed are associated with reduced migration, whilst these variables have no significant association with mobility among the sample with an LLTI. The size of sociodemographic influences on migration propensity vary between the two groups as the confidence intervals for several ORs did not overlap in the healthy and unhealthy samples. Compared to adults aged 16–25, older working age adults (46–55 & 56–65) in poor health are relatively more likely to move compared to those in good health (ROR = 1.19 & 1.28 respectively). Similarly, among those who are unhealthy, women (ROR = 1.1), couples or lone parents (ROR = 1.36 & 1.18), non-UK born (ROR = 1.11), LA or charity renters (ROR = 1.19) and having access to one or more than one cars (ROR = 1.07 & 1.1) are associated with higher propensity to migrate than compared to those in good health. Conversely, among those in poor health, the effect of being separated or widowed (ROR = 0.90), an A Level or Degree holder (ROR = 0.83 & 0.85) and a home owner (ROR = 0.90) is associated with reduced mobility compared to those in good health.

4.2. Analysis of residuals

We calculate residuals for 2011 LA at destination from models 2 and 3; the geographical distribution of these residuals is shown in Fig. 1(a) and (b). The residuals are the difference between observed and predicted values for migration propensity in each LA. Thus, these residuals are unexplained variance after controlling for individual sociodemographic characteristics, with positive values indicating more migrants than expected.

Stratified analysis allows us to calculate the residuals separately for the sample with an LLTI and the sample without an LLTI. Fig. 1(a) shows that there are many coastal areas in Southern England and Western Wales where the odds of migrating either within or to these areas are higher than expected for the healthy sample. Fig. 1(b) shows that there are areas in Central and Eastern England where the odds of migrating for the unhealthy sample are higher than expected. Areas with higher odds than expected in both samples (hatched) are concentrated in the South West of England. The results suggest that there are spatial variations in the destinations of healthy and unhealthy migrants in 2010/11.

We test whether the area typology fixed effects vary between the LA destinations for LLTI and non-LLTI samples, the results are shown in Table 5.

Coefficients are the average differences in residuals between areas and LAs categorised in the typology as 'English and Welsh Countryside'. Residuals greater than zero indicate LAs where migration propensity is higher than average. Among variables significant in both models the healthy sample had higher propensities to migrate within and into 'London Cosmopolitan' areas, whilst those with an LLTI had higher propensities to migrate within and into 'Suburban Traits' and 'Mining Heritage and Manufacturing' areas. Notably in the healthy model there is no association between 'Business and Education Centres', 'Prosperous England' and migration propensity, whilst in the LLTI model these areas are associated with lower than average migration propensity (p = 0.02 and p=<0.01 respectively).

Using the seemingly unrelated regression coefficients in Table 5 allows us to test whether the effect of area typology is the same in both the healthy and LLTI models, using a Wald test. Significant values indicate that the effect of area typology differs between the two samples, i.e. the average migration propensity to move for that subgroup differs between the two samples. The Wald test column of Table 5 displays the results. With the exception of 'Business and Education Centres' there are significant differences in the effect sizes of area typologies on overall migration propensity. Combined with regression results we conclude that 'Mining Heritage and Manufacturing' and 'Suburban Traits' areas are associated with higher migration propensity in the LLTI sample, this difference is significant at the 0.99 level.

5. Discussion and conclusions

This paper is the first to assess the relationship between health and migration in England using newly available 2011 census data. We have extended previous studies by using a health-stratified analysis that better reflects the complex relationship between migration propensity and health status across geographical regions. We show that ethnicity, marital status and car access help explain the variation in migration among those with good health but offer less explanatory value in predicting the migration of those with poor health. Residuals associated with our stratified models suggest that, whilst there are commonalities in areas with greater or fewer migrants in total, there are variations in the spatial distribution of movers with different health statuses. Movers in good health tend to move within and into the South and East coasts, whilst movers in poor health tend to move within and into the Midlands and central East England. Regression analysis of level two residuals reveals that those in poor health are more likely to move into 'Mining Heritage and Manufacturing' and 'Suburban Traits' areas than those in good health.

Our findings reinforce past work suggesting that those in poor health tend to be less mobile (Champion, 2005; Norman et al., 2005). The finding that African, Caribbean, Black, Other and Mixed ethnic groups were less mobile than the White group was

Table 4
Multilevel logistic regressions stratified by LLTI status predicting whether an individual migrated in 2010/11.

	Model 2		Model 3		
	Sample with no LLTI		Sample with an LLTI		
Sample size	3,034,555		450,814		
	Odds	CI	Odds	CI	
Constant	0.65	[0.64; 0.67]	0.53	[0.50; 0.56]	
	OR	CI	OR	CI	RORs
Age (ref 16-24)					
25–34	0.77	[0.76; 0.78]	0.78	[0.73; 0.83]	1.01
35–44	0.43	[0.43; 0.44]	0.45	[0.42; 0.48]	1.03
45–54	0.26	[0.25; 0.26]	0.31	[0.29; 0.32]	1.19[a]
55–64	0.17	[0.17; 0.18]	0.22	[0.21 ; 0.23]	1.27[a]
Sex (ref Male)					
Female	1.21	[1.19; 1.23]	1.33	[1.25; 1.41]	1.10[a]
Ethnicity (ref White)					
Indian, Pakistani or Bangladeshi	0.81	[0.79; 0.82]	0.81	[0.76; 0.86]	1
Chinese or other Asian	1.02[n.s]	[1.00; 1.04]	1.03[n.s]	[0.94; 1.13]	1.01
African, Caribbean or Black	0.91	[0.89; 0.93]	1.05[n.s]	[0.99; 1.13]	1.16[a]
Other or Mixed	0.95	[0.93; 0.97]	1.03[n.s]	[0.97; 1.10]	1.08
Marital status (ref Single)					
Married or Civil Partners	0.91	[0.90; 0.92]	1.02[n.s]	[0.98; 1.06]	1.12[a]
Separated or Widowed	1.6	[1.58; 1.63]	1.45	[1.41; 1.50]	0.91[a]
Family status (ref Couple or Married)					
In a lone parent family	0.69	[0.68; 0.70]	0.79	[0.76; 0.82]	1.14[a]
No family or household	1.67	[1.65; 1.68]	1.38	[1.34; 1.43]	0.83[a]
Nativity (ref UK born)					
Non-UK born	1.04	[1.03; 1.05]	1.14	[1.10; 1.19]	1.10[a]
Education (ref None)					
GCSE or apprenticeship	1.12	[1.11; 1.14]	1.1	[1.07; 1.13]	0.98
A Level	1.57	[1.55; 1.60]	1.29	[1.23; 1.34]	0.82[a]
Degree	1.75	[1.73; 1.78]	1.45	[1.40; 1.50]	0.83[a]
Tenure (ref Private renter)					
Social housing	0.32	[0.31; 0.32]	0.38	[0.37; 0.39]	1.20[a]
Owns	0.2	[0.19; 0.20]	0.17	[0.17; 0.18]	0.89[a]
Number of cars (ref None)					
One	0.88	[0.87; 0.89]	0.94	[0.91; 0.97]	1.07[a]
Two or more	0.81	[0.80; 0.82]	0.88	[0.85; 0.92]	1.09[a]
Employment (ref Working)					
Unemployed	1.13	[1.11; 1.15]	1.2	[1.15; 1.26]	1.06
Economically inactive	1.19	[1.17; 1.20]	1.01[n.s]	[0.99; 1.04]	0.85[a]
Students	0.83	[0.82; 0.85]	0.8	[0.76; 0.84]	0.95
Interactions					
Female 25–34	0.79	[0.77; 0.80]	0.72	[0.67; 0.78]	0.92
Female 35–44	0.71	[0.71; 0.73]	0.67	[0.62; 0.72]	0.94
Female 45–54	0.76	[0.74; 0.78]	0.7	[0.65; 0.76]	0.93
Female 55–64	0.77	[0.74; 0.79]	0.75	[0.70; 0.81]	0.98
Level 2 variance	0.14	[0.13; 0.15]	0.16	[0.14; 0.18]	
Predicted probability (%)	39.5	[38.9; 40.1]	34.6	[33.3; 35.9]	
Log likelihood	−971259		−114602		

n.s = not significant at the 0.99 level. ORs = odds ratios, CI = 95% confidence interval RORs = ORLLTI (model 3)/ ORnoLLTI (model 2).
[a] Non overlapping OR 95% confidence intervals for those without (model 2) and with an LLTI (model 3). Log likelihood values cannot be used to compare models from different samples and are provided for illustrative purposes only.
Source: CISS (ONS, 2011b), author's own calculations.

contrary to previous research (Finney and Simpson, 2008). Our results suggest that ethnic differences in the odds of migration are less pronounced among individuals with an LLTI. Interestingly, car access was not included in any of the previous research we identified. Our models suggest that access to a car is associated with reduced migration for both the healthy and unhealthy groups. Car access, as a proxy measure, suggests that individuals with greater income are less likely to move; contrary to past research (Smith and Finney, 2015). However, weaknesses in car access as a proxy for income may explain the disparity between our findings and that of previous research. At the time of the 2011 Census 74% of households had access to a car or van (Office for National Statistics, 2011c), urban areas tended to have lower rates than average (e.g. Inner London at 43%) compared to rural areas (e.g. Cumbria at 79%); as our model does not control for rurality this effect may reflect urban-rural differentials in migration propensity.

Our research extends Cox et al. (2007) concept of 'selective immobility' to LLTI in England. Individuals with an LLTI are less likely to have moved in the year preceding the 2011 Census, independent of common factors influencing migration. The greater propensity of healthy individuals to move, coupled with the understanding that those in good and poor health are moving to different regions and area types in England, reinforces Norman and Boyle (2014) and Brimblecombe et al. (1999) theories of health-selective migration redistributing the spatial pattern of LLTI. That there are health-selective differences in migratory flows suggests that concentrations of LLTI in certain areas (Gould and Jones, 1996; Shouls et al., 1996) may be artefacts caused by the flows of healthy

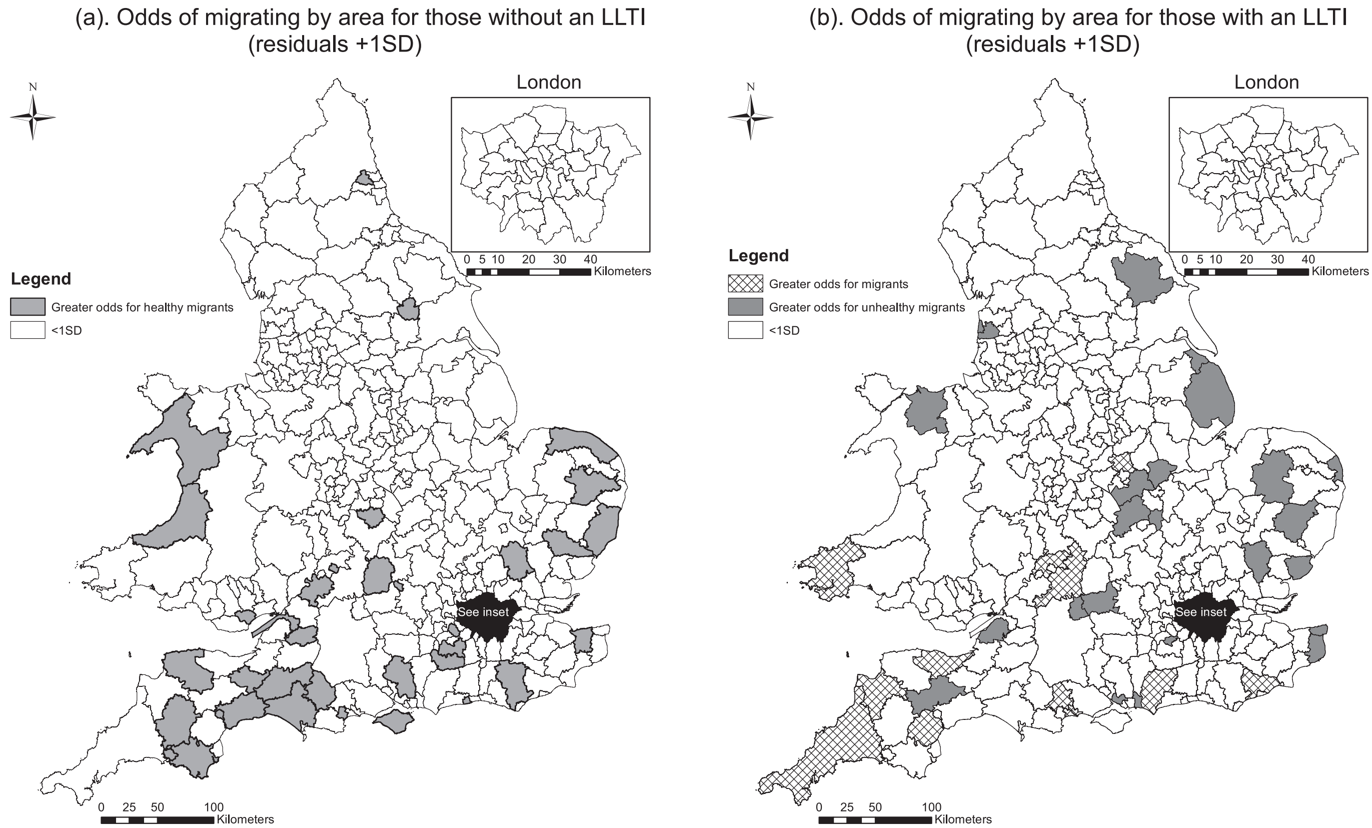

Fig. 1. (a) & (b) – Odds of migrating by area and LLTI (residuals +1SD).

Table 5
Seemingly unrelated regressions predicting level two residuals in the healthy and LLTI samples.

	Healthy residuals			LLTI residuals			X^2 value[a]
Sample size	346			346			
	Coef.	LB	UB	Coef.	LB	UB	
English and welsh countryside	0.06	0.04	0.08	0.06	0.04	0.08	61
London cosmopolitan	−0.24	−0.28	−0.20	−0.25	−0.30	−0.21	193
Suburban traits	−0.09	−0.12	−0.06	−0.04	−0.07	−0.01	42
Business and education centres	0.08	0.05	0.12	−0.01[n.s]	−0.05	0.03	28
Coast and Heritage	0.12	0.08	0.15	0.08	0.04	0.12	49
Prosperous England	0.07	0.05	0.10	0.02[n.s]	−0.01	0.04	41
Mining Heritage and Manufacturing	−0.10	−0.12	−0.08	−0.02[n.s]	−0.04	0.00	91
Total							189[b]
R2	0.55			0.35			

n.s = not significant at the 0.99 level.
[a] Chi squared test for the hypothesis coefficient modela-modelb = 0, with 2 degrees of freedom.
[b] a chi squared test that modela-modelb = 0 for all coefficients, with 7 degrees of freedom.
Source: CISS (ONS, 2011b), author's own calculations.

migrants into the South West and flows of unhealthy migrants into the Midlands. We extend Norman and Boyle (2014) argument for health selective migration distorting the spatial patterning of regional inequalities. We demonstrate that the movement of unhealthy migrants into industrial and suburban areas and the flow of healthy migrants into southern prosperous regions are likely to exaggerate underlying health inequalities.

We acknowledge limitations in our research. Our sample selection design excludes individuals living in communal residences and recent immigrants, whom we would expect to be concentrated in urban centres, particularly London. Thus our design may overemphasise the strength of counter-urbanisation. Our study included only those of working age at the time of the 2011 Census. As LLTI is more common and migration is less common among the elderly population, it is likely that the association between health and migration differs for this group. Further, age-stratified analyses have shown that the drivers of migration differ across the lifecourse (Thomas et al., 2015), and our implicit assumption that influences are constant across working age adults is unlikely to hold. A key shortfall of our analysis is that the Census is a cross-sectional data source; thus we could not control for multiple moves or return migration within the year preceding the census. Furthermore, key interactions which we presume would have large effects on migration propensity (age and LLTI, ethnicity and tenure) were not feasible to model under our strategy; due to the large sample size the computational time for model convergence for these parameters were too great, although LLTI interactions were indirectly modelled using stratified modelling.

In terms of policy, our findings suggest that long-term health service planning should consider health-selective migration. In line with other research (Brimblecombe et al., 1999; Norman and Boyle, 2014) we demonstrate that concentrations of poor health in regions of England are influenced by the relative mobility of healthy individuals. Specifically, in our case we show that in 2010/11 there were greater flows of healthy migrants into and within the South West than expected.

Disclaimer

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