Place and preference effects on the association between mental health and internal migration within Great Britain

Abstract

Individuals with mental health needs are more likely to migrate than the general population, but the effects of migration preference and place of residence are often overlooked. These issues are addressed through the application of a novel origin and destination multilevel model to survey data. In comparison to those with good mental health, individuals with poor mental health are more likely to make undesired moves and this is moderated, but not explained by place of residence. Implications for understanding the mental health and migration relationship, and its impact on service provision are then proposed.

Keywords: health-selective migration; mental health; internal migration; multilevel modelling.

Introduction

Poor physical health has been shown to be associated with low likelihoods of internal (within-country, over any distance) migration in Europe (Westphal, 2016), Northern America (Curtis *et al.*, 2009) and Australia (Larson *et al.*, 2004). Less attention has been paid to the influence of mental health on migration behaviour. In contrast to physical health, internal migrants are more likely to self-report mental health problems than non-migrants (Larson *et al.*, 2004; Tunstall *et al.*, 2014). Extant research is primarily drawn from populations with severe and rare mental health conditions (Harvey *et al.*, 1996; Ngamini Ngui *et al.*, 2013), although analyses using instruments designed to measure common mental disorders find similar associations between moving and mental health (Tunstall *et al.*, 2015). Although the mental health of internal migrants is well studied, the majority of research compares the health of recent internal migrants to that of non-movers, so it is unclear whether mental health affects the likelihood of migration, or migration affects mental health.

The desire to migrate or stay (migration preference) and ability to meet this preference may confound the relationship between mental health needs and high rates of internal migration, and Great Britain (GB; England, Scotland and Wales) provides an interesting case study to test this hypothesis. There is evidence of undesired staying (i.e. not moving when one would like to) and undesired migration (i.e. moving when one would not like to) among the population of GB (Coulter and van Ham, 2013). Mental health needs are associated with a desire to migrate regardless of whether an individual has recently moved, but not with undesired migration. In addition, undesired staying and undesired migration are associated with worsening mental health over time, after controlling for baseline mental health (Woodhead *et al*., 2015). Mental health status may act as a barrier to realising migration preferences, as mental health problems are associated with relatively low levels of psychosocial resources, educational attainment, employment and financial capital (Fryers *et al*., 2003; Weich & Lewis, 1998), all factors that are drawn upon in the search for alternative residences (Lee, 1966). A realistic estimation of the influence of mental health on internal migration must control for interactions with migration preference, but this relationship is largely overlooked in the literature.

In addition to ignoring mental health associations with migration preference, place of residence effects are rarely accounted for in migration literature (Thomas *et al*., 2015). Previous (origin) and current (destination) place of residence likely moderates (i.e. affects the strength of) the association between mental health and migration. Individuals with mental health needs have been found to migrate into deprived and urban areas in GB shortly before the onset of severe mental health problems (Harvey *et al*., 1996; Ngamini Ngui *et al*., 2013; Taylor, 1974). This has been explained through the social selection or 'drift' theories, where the onset of mental health problems leads to reductions in earning capacity or unemployment, and then a reduced ability to remain in or move to affluent neighbourhoods (Lowe *et al*., 2014). In the context of rising house prices and rental rates in GB over the 1990s and 2000s (Dorling, 2015), we might expect individuals with mental health needs may be less able to afford to stay in desirable homes and neighbourhoods, and less able to afford to move out of undesirable homes and neighbourhoods (Smith & Easterlow, 2005), in comparison to the general population. Such place moderation effects have been observed for physical health limitations, where the overall positive association between good physical health and migration was reversed in the Midlands of England in the 2011 Census (Wilding *et al*., 2016).

When place effects are explored, the characteristics of the place of residence post-move (destination) are usually used. The dominance of destination effects is challenged by established migration models such as the gravity model (Flowerdew & Aitkin, 1982) and developments in multilevel modelling showing that it is important to consider previous and current place of residence in migration models (Thomas *et al.*, 2015). Specifically, the association between mental health and migration may differ for an area as an origin and destination respectively, as in the 'drift' framework we would expect mental health to be associated with moves into deprived urban areas (destination), but low rates of moves out of these areas (origin).

In summary, individuals with poor mental health are more likely to become internal migrants (over any distance) than the general population. This association is confounded by migration preference, as those with poor mental health are more likely to want to move, and wanting to move appears to be harmful to mental health. The extant evidence fails to adequately account for the potential moderation effect of place on this relationship, and there are theoretical reasons for expecting the relationship between mental health and migration to vary by area. The aims of this study are to test i) if poor mental health is associated with internal migration ii) if the association between poor mental health and internal migration differs between those who prefer to move, and those who prefer to stay and iii) if the association between poor mental health and internal migration varies by place of origin and destination. The rest of this paper addresses these issues, using data from two major surveys, utilising a cross-classified multilevel model to test whether mental health predicts internal migration, and if this explained or moderated by origin, destination and migration preference effects.

Methods

Data

This analysis uses panel data from the British Household Panel Survey (BHPS) and its successor, Understanding Society (USoc). The BHPS is an annual longitudinal survey which ran from 1991-2008, collecting information on the socioeconomic characteristics of individuals and households across GB (England, Wales and Scotland). The original sample (wave one) was comprised of 10,264 individuals

within 5,505 households across GB. Booster samples were added for Scotland and Wales in 1999 and these samples are incorporated in this analysis. Members of these samples are known as Original Sample Members (OSMs), and their children become OSMs as they reach the age of 16. Data collection for USoc started in 2009, and BHPS sample members were included in USoc from 2010 onwards.

Observations are included for all BHPS OSMs present in any two adjacent waves of the BHPS (1-18) and USoc (2-6). At each survey wave (time t), migration is measured as a change in address since the previous wave (time t-1), this framework is often used in migration research using panel data to boost effective sample sizes (Coulter *et al*., 2011). The Local Authority (LA; large administrative areas with an average population of 120,000) in which an individual lives at the current survey wave (time t) is referred to as the *destination*, and the LA where the individual was present in the previous survey wave (time t-1) is referred to as the *origin*. There are 378 LAs in GB. Observations from 11 LAs which contain fewer than 10 observations are excluded from the sample. All predictors, including mental health, are lagged by one survey wave (i.e. measured at time t-1).

This process is repeated for each pair of waves of the BHPS and USoc. Respondents who appear in only one wave for each two-wave sequence are excluded. There are 18 (1991-2008) waves of the BHPS, and 6 waves of USoc which include the BHPS sample (2010-2015). For the remainder of this paper, each observation in the dataset is referred to as the 'occasion' (denoted by subscript i), occasions are nested within individuals (j), LA (origin) at time *t-1* (k) and LA (destination) at time *t* (l). To maximise the sample size eligible for this analysis, intra-LA movers are retained, as 65% of movers are classified as intra-LA movers.

Migration

In this analysis, the outcome of interest is individual internal migration within GB. Currently, migration research combining the BHPS and USoc is flawed by inconsistencies in how migration is measured in the BHPS and USoc surveys. In the BHPS, individual migration is measured by whether the interview was carried out at the same address as the previous wave. The USoc survey does not collect an equivalent measure, as migration status is assigned at the household level (Understanding Society User Support, 2016).

To construct a consistent migration measure, the secure access version of both surveys are used, which contain the Ordnance Survey Grid Reference for the centroid of the postcode where each individual lived at each occasion (*t* and *t-1*). Grid references are cross-referenced by the annual release of the ONS National Postcode Directory closest to the year of the survey wave. The spatial resolution of the postcode directory has improved over time. In the early 1990s, postcode centroids were provided at a 100-metre resolution (Martin, 1993). Centroids later became available at a 1-metre resolution (Rabe, 2009). Internal migrants are defined as individuals whose grid reference at time *t* and *t-1* differ by more than 100 metres, if the pair of grid references are identical or differ by 100 metres or less then the observation is coded as a non-mover. A 100-metre cut-off is used as this is the coarsest resolution for postcode grid references found in the postcode directory over the study period, and it is assumed that postcode adjustments over consecutive waves are unlikely to be of greater distances than 100 metres.

Mental health

The 12-item General Health Questionnaire (GHQ) is used to measure mental health status in this analysis. The GHQ was designed to measure the risk of common mental disorders in observational studies (Goldberg, 1978). Each item has four possible answers in a Likert scale design. Responses in the two lower categories are coded as 0 for each item, and the two higher categories are coded as 1. This coding system is known as the 'GHQ method' (Hankins, 2008). The sum of item scores is calculated (with a minimum of 0 and maximum of 12); sums of 3 or more are considered to be indicative of poor mental health, and sums less than 3 are indicative of good mental health (Shelton & Herrick, 2009). The 12-item GHQ has been shown to be a strong predictor of common mental disorders in a range of contexts, and is robust to gender, age and educational differences in reporting of symptoms (Goldberg *et al.*, 1997). In line with past research, individuals with poor mental health (as measured by high GHQ scores) are expected to be more likely to move than those with good mental health (Larson *et al.*, 2004), and this association will differ in strength between those who prefer to move, and those who prefer to stay (Woodhead et al., 2015).

Contextual measures

Local (or neighbourhood) characteristics used in this analysis (deprivation and population density) are known predictors of migration behaviour and relate to mental health. Residents in urban and deprived parts of Britain experience higher rates of common mental disorders and depressive symptoms (Mair et al., 2008; Weich et al., 2006), and these areas experience higher levels of population turnover (Bailey and Livingston, 2005; Champion, 2005). Area-level confounders must therefore be controlled for in order to make inference on the relationship between mental health and internal migration. Data on the four components of the Townsend deprivation index (% in unemployment, non-home ownership, no access to a car and household overcrowding; Townsend *et al.*, 1988) and Persons per Hectare (PPH) recently became available for consistent small areas used to represent neighbourhoods between 1971 and 2011 (Norman, 2017). Townsend components and PPH data are available from the 1991, 2001 and 2011 Censuses for 2011 Middle layer Super Output Areas (MSOAs; middle-sized statistical units with populations between 5,000 and 15,000) in England and Wales and Intermediate Zones (IZs; middle-sized statistical units with populations between 2,500 and 6,000) in Scotland.

The Censuses were administered by the Office for National Statistics in England and Wales, and National Records Scotland in Scotland. In the years 1991-1995, sample members are associated with neighbourhood (MSOA/IZ) data drawn from the appropriate 1991 Census, 1996-2005 from the 2001 Census and 2006-2014 from the 2011 Census. Quintiles for the Townsend score are then constructed from the 1991, 2001 and 2011 Censuses separately, such that an area's quintile is relative to all MSOAs/IZs in GB at the same Census year.

Definition of control variables

Potential area and individual confounders of migration behaviour are controlled for at time *t-1* (table 1). Migration preference is measured by the question 'if you could choose, would you stay here in your present home or would you prefer to move somewhere else', and the possible responses include 'stay here', 'prefer to move' and 'don't know'. Past research using this question does not distinguish between those who respond with 'don't know' and 'stay here' (Coulter & Scott, 2014; Woodhead *et al.*, 2015). The 'don't know' preference category is separated in this analysis to control for ambiguity in preference, as there are complex

processes involved in shaping migration preferences which have implications for later mobility (Lu, 1998). Those who are certain they would like to stay or move are likely different from those who have no strong preference, and the latter group may develop a desire to migrate (or stay) after the survey is conducted. The Townsend quintile and PPH are treated as time-variant independent variables in this analysis, as these values can change over time for individuals residing in the same MSOA/IZ, or individuals moving between these areas. Interaction terms between mental health status and migration preference are included to test whether the association between mental health and migration differs between those who prefer to move, and those who prefer to stay (confounding). From extant research, it is hypothesised that individuals with poor mental health are more likely to move between survey waves, this association differs between those who prefer to move and prefer to stay, and varies by place of residence.

Variable	Grouping	Time-variant?	Which group(s) are more likely to move
Migration preference	0 = prefers to stay; 1 = prefers to move; 2 = doesn't know	Yes	Prefer to move (Coulter *et al.*, 2011)
Mental health & migration preference interactions	Additional parameters for: High GHQ and wants to move (mental health = 1 & migration preference = 1) and High GHQ, doesn't know migration preference (mental health = 1 & migration preference = 2)	Yes	High GHQ to be more likely to move, and this association will be stronger for those with prefer to move (Woodhead *et al.*, 2015)
Sex	0 = male; 1 = female	No	Men (Champion, 2005)

Age	0 = 16-24; 1 = 25-34; 2 = 35-44; 3 = 45-54; 4 = 55-64; 5 = 65+	Yes	Young adults (Champion, 2005; Clark & Huang, 2003; Dieleman, 2001)
Educational qualifications	0 = degree; 1 = A/AS level; 2 = GCSE/CSE/O level; 3 = Other; 4 = None	Yes	Higher educated (Duke-Williams, 2009; Smith & Jons, 2015)
Employment	0 = employed; 1 = economically inactive; 2 = unemployed; 3 = FT student	Yes	Unemployed (Cho & Whitehead, 2013)
Tenure	0 = owner; 1 = private renter; 2 = social renter	Yes	Private renters (Rabe & Taylor, 2010; Thomas *et al.*, 2016)
Marital status	0 = married; 1 = widowed; 2 = divorced/separated; 3 = never married	Yes	All relative to married (Cooke *et al.*, 2016; Feijten & van Ham, 2010; Geist & McManus, 2012; Tucker *et al.*, 1998)
Ethnicity	0 = white; 1 = black; 2 = Indian, Pakistani or Bangladeshi; 3 = Chinese/other/mixed	No	Black and Chinese / other / mixed (Finney and Simpson, 2008)
Income quartile (relative to other sample members at time *t-1*)	0 = lowest quartile - 3 = highest quartile	Yes	Lowest quartile (Thomas *et al.*, 2016)

Car access	0 = none; 1 = yes	Yes	No car access (Author *et al*, 2016)
Nativity	0 = UK-born; 1 = non-UK born	No	Non-UK born (Sapiro, 2016)
Area Townsend Index (at MSOA/IZ level)	0 = least deprived – 4 = most deprived	Yes	Most deprived (Bailey and Livingston, 2005)
Area population density (Persons per Hectare at MSOA/IZ level)	Continuous	Yes	Lower density (Champion, 2005)

Table 1 Covariates and their relationship to internal migration

Analytical approach

Individual behaviours and outcomes (micro) are influenced by the environment in which individuals live (macro). In multilevel models, the variance in outcomes is apportioned between factors which operate at different 'levels'. Multilevel models are used to analyse outcomes at the occasion level (level-1 units), nested within individuals (level-2 units) within areas (level-3 units). In this hierarchical multilevel framework, models can test whether individuals are more likely *to move* (based on origin areas) or more likely to *have moved* (based on destination areas), but the two effects cannot be explored simultaneously. In order to do so, a particular type of multilevel model is required, known as the Cross-Classified Model (CCM). CCMs are pertinent for modelling the relationship between mental health and migration at the individual and area levels, where individuals with poor mental health may be drawn away from and to different areas than the general population (moderation). Figure 1 is an illustration of the CCM used in this paper, predicting migration at each time *t* as a function of lagged characteristics from time *t-1*, and place of residence at times *t* and *t-1*; with the design being replicated for each pair of *t* and *t-1* occasions over the BHPS and USoc surveys.

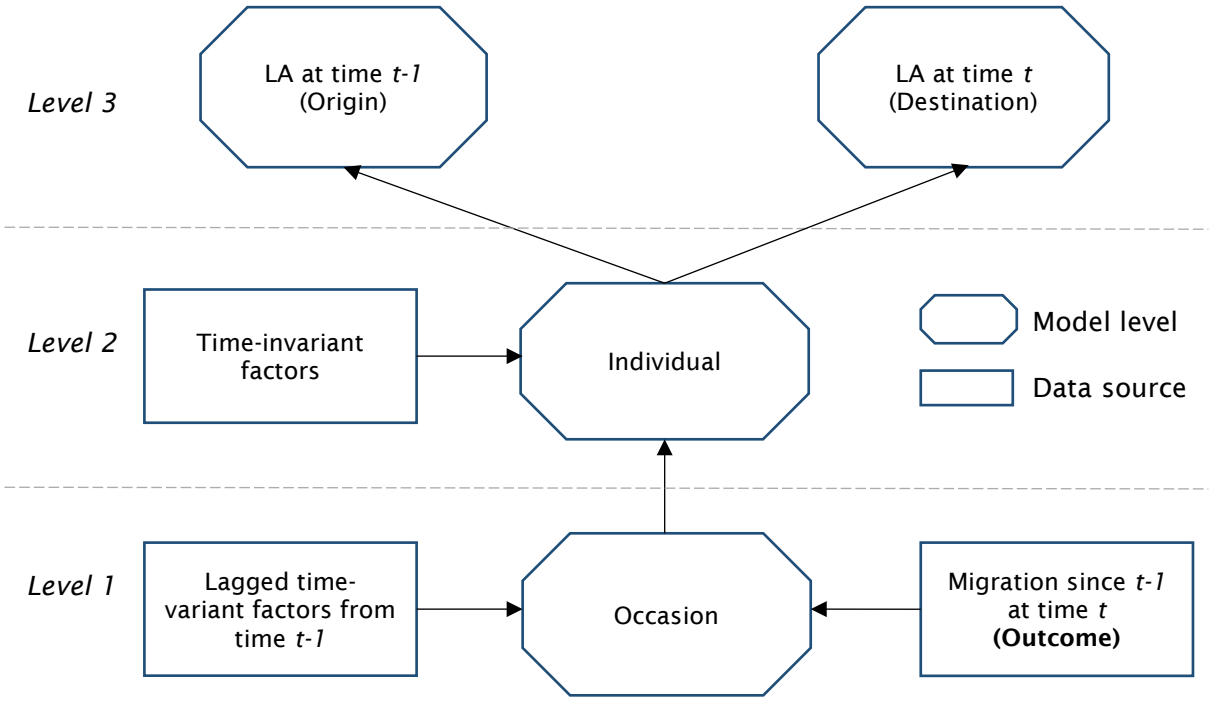

Figure 1 Illustration of cross-classified panel model of migration

The outcome (migration) is a binary no/yes measure, so a longitudinal CCM is estimated with a probit link function. To test whether the relationship between mental health and migration varies across origins and destinations, random slopes based on the effect of having poor mental health at time *t-1* are estimated (equation 1):

$$y^*_{ijkl} = \beta_0 + \beta_n X_n + mental\ health + migration\ preference + mental\ health * migration\ preference + \sigma_{0j\ individual} + \sigma_{0k\ destination\ (t)} + \sigma_{1k\ destination\ (t)} + \sigma_{0l\ origin\ (t-1)} + \sigma_{1l\ origin\ (t-1)}$$

Equation 1 Model structure

In this framework, migration is predicted at occasion *i* for individual *j* living in destination LA *k* at *t* and origin LA *l* at *t-1*. y^* is the estimate for the predicted probability of moving according to the cumulative distribution, such that when y^*=0 the predicted probability is 50%. Values of y^* greater than zero indicate a greater than 50% probability of moving, and the opposite is true for values less than zero. β_0 is a fixed constant, $\beta_n X_n$ is the vector of covariates outlined in table 1 which are measured at time *t-1*, $mental\ health$ is a fixed effect associated with having poor mental health at time *t-1*, $migration\ preference$ is a fixed effect associated with migration preference at time *t-1*, and interaction terms between mental health and migration preference are included. The interaction terms

estimate the additional effect of having poor mental health on the probability of migration for those who prefer to move or don't know their preference.

The individual-specific random intercept is given by the parameter $\sigma_{0j\ individual}$. The destination-specific random intercept is given by the parameter $\sigma_{0k\ destination\ (t+1)}$, and an additional slope for individuals with poor mental health at time *t-1* is given by the parameter $\sigma_{1k\ destination\ (t)}$; these two parameters are also estimated at the origin level ($\sigma_{0l\ origin\ (t-1)}$ & $\sigma_{1l\ origin\ (t-1)}$). The random effects approach is used, where the random effects (σ) are assumed to be normally distributed, have a mean of zero and a constant variance. The variance of each parameter (σ^2) and the covariance between intercepts and slopes ($cov_{\sigma_{0l},\sigma_{1l}}$ & $cov_{\sigma_{0k},\sigma_{1k}}$) are estimated directly by the model.

Estimates of y^* may be transformed into probabilities of migration (expressed as percentages) using equation 2, where θ indicates the probability of the value of y^* according to the normal cumulative distribution function.

$$probability\ of\ moving_{ijkl} = \theta(y^*_{ijkl}) * 100$$

Equation 2 Calculating the probability of migration, expressed as a percentage

Coefficients with Bayesian credible intervals which do not cover zero are considered to indicate that the population effect is not zero, with 95% certainty. All models are estimated in MLwiN 2.29 (Rasbash *et al*, 2014). Initial parameter starting values are estimated using maximum-likelihood methods, these starting values are then used in Bayesian Markov Chain Monte Carlo estimation, run for 50,000 iterations, confirmed as adequate according to Raftery-Lewis diagnostics (Browne, 2016). The Deviance Information Criterion (DIC) is used to compare the fit of models; similar to likelihood-based criterions like the AIC, models with smaller DIC values are preferred (Spiegelhalter *et al*, 2014).

In order to answer the third research question (whether the association between poor mental health and internal migration varies by place of origin and destination), the ratio for the probability of migration by mental health is calculated by each LA as an origin (the probability of future migration) and destination (the probability of having moved). The predicted probability of migration for the population with good and poor mental health in each origin LA is calculated using the random intercept ($cons + \sigma_{0l}$) for the former, the intercept and slope ($cons + \sigma_{0l} + \sigma_{1l}$) for the latter. The ratio of probabilities for the

population in poor mental health, relative to the population in good mental health is then calculated (termed the 'mental health migration ratio') and this ratio is compared over the percentage of the population with good mental health predicted to move. This process is repeated for each destination LA ($cons + \sigma_{0k}$) and ($cons + \sigma_{0k} + \sigma_{1k}$).

Results

The first aim of this analysis was to test if poor mental health is associated with internal migration. In the cross-tabulation (table 2) the overall between-wave migration percentage is 9.2%, the percentage for the population with good mental health is lower than this average (8.5%) and it is higher than average among the population with poor mental health (11.3%). There is significant evidence for this association, according to the chi-square statistic (X^2 = 330.9 df = 1, p<.01).

	Mover status		
	Non-mover	Mover	Total
Good mental health	126,072	11,697	137,769
(row %)	91.5%	8.5%	100
Poor mental health	41,132	5,247	46,379
(row %)	88.7%	11.3%	100
Total	167,204	16,944	184,148
(row %)	90.8%	9.2%	100

X^2 = 330.9, p<.01. Source: British Household Panel Survey and Understanding Society Secure Access datasets. Good mental health is defined as General Health Questionnaire summary scores of 0-2, and poor is a score between 3 and 12. Author's own calculations.

Table 2 Tabulation of mental health and migration status

Table 3 shows the results for a CCM, predicting the probability of migration by mental health and migration preference, accounting for all control variables. The inclusion of the two interaction terms between mental health and migration preference led to a 31 unit decrease in the DIC, suggesting that the interaction terms improve the overall model fit (results not shown). Holding all other factors constant, those with poor mental health are more likely to move (an increase in the z-score probability of moving of 0.162, 95% credible interval 0.125 – 0.199)

than those with good mental health. Expressed as percentages, 11.3% of those with poor mental health are predicted to move, compared to 8.5% of those with good mental health.

	Coefficient		CI (2.5%)	CI (97.5%)
Constant	-1.350		-1.447	-1.260
Poor mental health (GHQ 3+)	0.162	*	0.125	0.199
Preference (ref prefers to stay)				
Prefers to move	0.695	*	0.670	0.721
Doesn't know	0.400	*	0.294	0.506
Interactions				
Poor mental health & prefers to move	-0.138	*	-0.181	-0.094
Poor mental health & doesn't know	-0.091		-0.284	0.101
Male (ref female)	0.000		-0.027	0.026
Age (ref 16-24)				
25-34	-0.247	*	-0.284	-0.211
35-44	-0.594	*	-0.638	-0.550
45-54	-0.827	*	-0.876	-0.777
55-64	-0.894	*	-0.949	-0.840
65+	-0.973	*	-1.032	-0.914
Qualifications (ref Degree)				
A/AS-level	0.031		-0.005	0.067
GCSE/CSE/O level	-0.128	*	-0.160	-0.096
Other	-0.101	*	-0.167	-0.036
None	-0.098	*	-0.136	-0.061
Employment (ref Employed)				
Economically inactive	0.044	*	0.010	0.078
Unemployed	0.044		-0.007	0.093
FT student	0.038		-0.005	0.082
Tenure (ref Owner)				

	Coefficient		CI (2.5%)	CI (97.5%)
Private renter	0.941	*	0.907	0.976
Social renter	0.114	*	0.080	0.148
Marital status (ref married)				
Widowed	0.231	*	0.171	0.291
Divorced/separated	0.215	*	0.177	0.253
Never married	0.152	*	0.118	0.185
Ethnicity (ref White)				
Black	-0.169	*	-0.310	-0.028
IPB	-0.270	*	-0.388	-0.154
Chinese/Other/Mixed	-0.098	*	-0.248	0.049
Income quartile (ref 1st)				
2nd	0.016		-0.016	0.048
3rd	0.035	*	0.001	0.068
4th	0.057	*	0.018	0.097
Has access to a car (ref no)	0.060	*	0.032	0.088
Non-UK born (ref UK born)	0.056		-0.010	0.123
Townsend quintile (ref Quintile 1)				
Quintile 2	-0.005		-0.043	0.032
Quintile 3	-0.050	*	-0.090	-0.010
Quintile 4	-0.003		-0.047	0.040
Quintile 5	0.009		-0.044	0.063
PPH (ref 24.366)	0.001	*	0.000	0.002
Variance of random parameters				
Origin				
Constant (σ_{0l}^2)	0.201		0.159	0.252
Covariance (σ_{0l}^2,σ_{1l}^2)	-0.006		-0.022	0.011
Slope (σ_{1l}^2)	0.003		0.001	0.008
Destination				
Constant (σ_{0k}^2)	0.348		0.285	0.421

	Coefficient	CI (2.5%)	CI (97.5%)
Covariance (σ^2_{0k},σ^2_{1k})	-0.013	-0.039	0.010
Slope (σ^2_{1k})	0.005	0.001	0.012
Individuals			
Constant (σ^2_{0j})	0.142	0.128	0.156
DIC	82,346		
Pseudo degrees of freedom	4,237		
Origin LAs	367		
Destination LAs	367		
Individuals	17,302		
Occasions	176,237		

CI = credible interval, DIC = deviance information criterion, GHQ = 12-item General Health Questionaire, PPH = Persons Per Hectare (centred on its mean, 24.366), IPB = Indian, Pakistani or Bangladeshi, * = credible interval does not contain zero. Source: British Household Panel Survey and Understanding Society Secure Access datasets. Author's own calculations.

Table 3 Cross-classified probit model predicting the probability of moving between survey waves

Interaction effects

The second aim of this analysis was to test if the association between poor mental health and internal migration differs between those who prefer to move, and those who prefer to stay. The interaction terms between mental health and migration preference in table 2 represent the additional change in the z-score for the probability of migration among those with poor mental health within that specific migration preference group. As both interaction terms are negative, this indicates that the association between mental health and migration is less positive among those who prefer to move or don't know their migration preference, compared to those who prefer to stay. The probabilities of migration by mental health and migration preference are then calculated in MLwiN's prediction window, with simulated 95% confidence intervals (figure 2). This figure displays that mental health is associated with migration only among those who

prefer to stay, providing evidence of confounding.

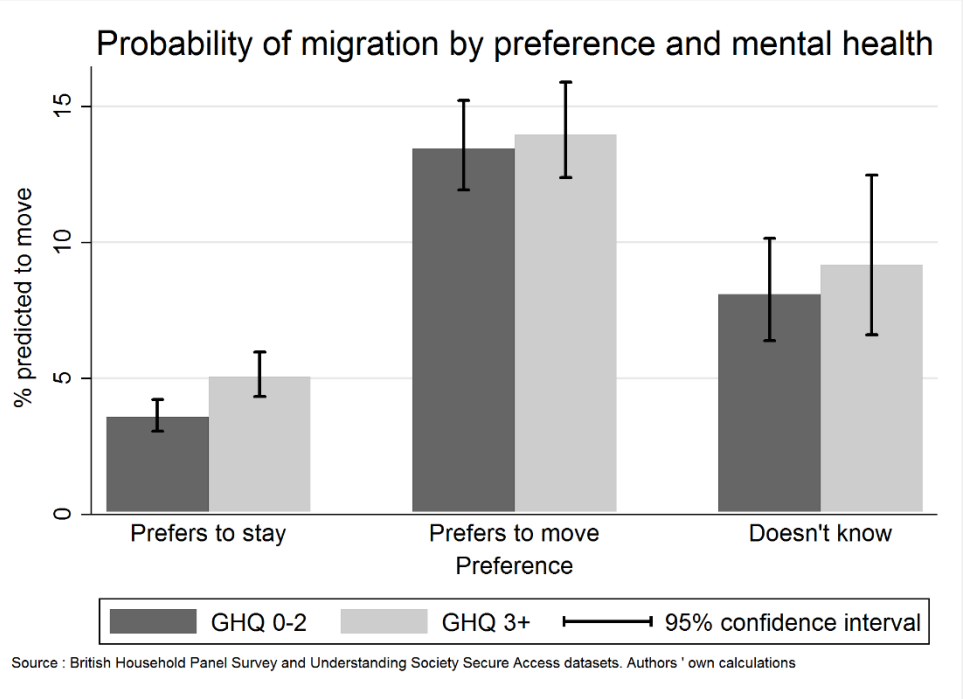

Figure 2 Probability of migration by mental health and migration preference

Area effects

The third research aim is to test whether the effect of mental health on migration varies by place of origin and destination. For illustration, the mental health migration ratio (% with poor mental health predicted to move / % with good mental health) is plotted on the y axis and the migration rate for those with good mental health on the x axis in figure 3. If the Y axis ratio is greater than one this indicates that the population in poor mental health are more likely to move, and vice versa if the ratio is less than one. For example, if the mental health migration ratio for an origin LA is 2, then the population with poor mental health are twice as likely to move by the next survey wave, relative to those in good mental health in this LA.

If there was no evidence of place moderating the association between mental health and migration, then the mental health ratio would be consistent in each LA. The mental health migration ratio is particularly high in areas where relatively small proportions of the population in good mental health are moving, and the ratio decreases as the proportion of the population moving in good mental health increases, although this ratio is always greater than one. The same distribution is observed at the origin and destination levels, although the ratios are

comparatively higher for destinations with low migration rates.

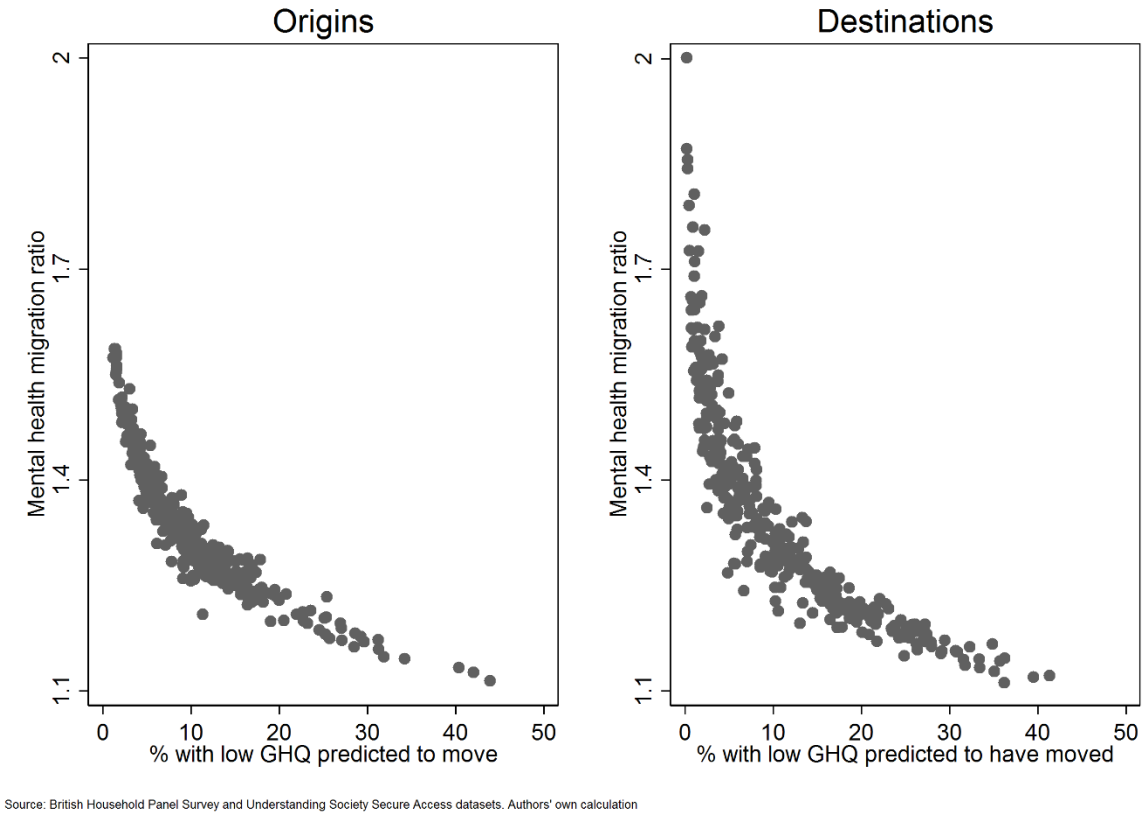

Figure 3 Ratio of predicted probabilities for migration by health status for each LA

Non-response analysis

Non-response (not participating in a survey wave) and attrition (permanent non-response) have the potential to affect the generalizability of findings from panel survey data, if population subgroups are particularly likely to not respond (Mostafa & Wiggins, 2015). In the BHPS and USoc, however, there is no prior evidence that GHQ scores are associated with non-response, although internal migration and preferring to move are (Lynn *et al.*, 2012; Uhrig, 2008). As a result, non-response is unlikely to affect estimates of the association between mental health and migration in this analysis, unless there is a relationship between mental health, migration preference and non-response. In our own analysis (results not shown), those who prefer to stay and have a low GHQ score more likely to respond in the following survey wave (95% CI 91.5%-91.8%) than those who prefer to move and have a high GHQ score (95% CI 87.6%-89.6%). As a result, selective attrition may explain the lack of difference in migration probabilities between those who prefer to move and have high and low GHQ scores.

Discussion

This analysis set out to test three research questions: i) if poor mental health is associated with internal migration; ii) if the association between poor mental health and internal migration differs between those who prefer to move, and those who prefer to stay and iii) if the association between mental health and internal migration varies by place of origin and destination. The findings for each research question are discussed in turn.

In the cross-tabulation (table 2), poor mental health was associated with a greater probability of migration, and this association persisted after controlling for potential confounders in the probit model (table 3). This finding corroborates with previous research indicating that common predictors of migration do not explain the association between mental health and internal migration (Tunstall *et al*, 2014).

The overall effect of poor mental health appears to differ by migration preference in this analysis (research aim 2), however. Through interaction terms (figure 2), we find that mental health is only associated with migration among those who prefer not to move (displacement), not for those who prefer to move (desired migration) or those who do not know their migration preference. There are several plausible mechanisms behind the elevated probability of undesired migration among the population in poor mental health shown here, the identification of which lie outside the scope of this paper. Drawing on the place utility framework (Lee, 1966), individuals in poor mental health may be drawn away from areas where they prefer to stay in order to gain greater access to healthcare (Moorin *et al*, 2006), or in order to escape discrimination (Lewis *et al*, 1992). Alternatively, those with poor mental health may be being priced out of desirable homes through rising rental rates (Dorling, 2015). Quantitative analyses can inform on what is happening and where, but complementary person-focused research is needed to understand why such processes occur. Collaborative work with mental health needs groups is required to assess the challenges related to retaining residence faced by those with mental health needs to further understand the elevated rates of undesired migration among this group.

The third research aim explored whether the association between poor mental health and migration varied by place. The ratio for the probability of moving between those in poor and good mental health was consistently positive in all

origin and destination LAs, but the ratio was greater in areas where migration is less prevalent among those in good mental health. This is evidence of place moderation in the mental health and migration relationship (otherwise the ratio would be consistent across LAs), and this was not explicitly discussed in any of the referenced papers. This moderation effect may be due to the 'drift' or selection hypotheses, wherein those with mental health needs are selected into specific areas with cheaper housing (Lowe et al., 2014), however the drift theory does not adequately explain why the mental health ratios were consistently positive. The curvilinear distribution of ratios may be explained by high rates of intra-LA migration (churn) among those with mental health needs, which has been found in specific pockets of North America (DeVerteuil et al., 2007).

There are limitations to the data and methods used in this analysis. The BHPS sample was broadly representative of the population of GB when the survey began (Taylor *et al*, 2010) and has an impressively high follow-up rate (Coulter *et al*, 2011); less work has been conducted on whether the sample remains broadly representative after several waves of attrition. Longitudinal weights are provided to control for selective attrition over time, however these weights equal zero if a sample member misses a survey wave, regardless of whether they later return to the sample. In the interest of statistical power, longitudinal weights are not used in order to retain these members. As noted earlier, selective attrition may explain the lack of differences in migration probabilities among those who prefer to move. Another issue relating to the sample is that among the 378 LAs in GB, 11 LAs are excluded from the study to meet guidelines on disclosure set by the data holder, as they contain fewer than 10 observations. The findings cannot be generalised to these excluded LAs, however it is unlikely that the inclusion of these areas would influence the effect sizes found here, given that this excluded number is relatively small. The area measures used in this analysis (deprivation and PPH) are highly correlated, and this may have affected the effect sizes of these parameters in the model.

No distinction is made between intra and inter-LA migration in this analysis, and that has likely affected the results at the LA level. If an LA has a relatively high rate of intra-migration, then this LA will have a positive residual both as an origin and a destination. As 65% of internal migrants in the sample moved within their LA, intra-LA migration likely had a greater effect on area variance parameters than inter-LA migration. In order to distinguish between the two, a 'multiplicative' cross-classified model would need to be used, where a residual is estimated for

each origin and destination pair. In this study, this would require the estimation of 367^2 LA residuals, which is likely to cause problems with model convergence, as opposed to the 367*2 residuals calculated by the 'additive' cross-classified model. A potential avenue for future research would be to use the approach outlined in this only for inter-LA moves, although this will lead to a large reduction in the eligible sample size, and likely zero counts within many LAs, where alternative regression methods such as Poisson models are required.

Conclusion

The findings of this analysis have implications for several stakeholders. For future academic work, this paper demonstrates that cross-classified models can test whether health has associations with demographic processes whilst controlling for past and current place of residence effects, and a framework is provided for how such models can include a time component. For agencies involved in supporting groups with mental health needs, enabling housing security should become a priority, given the evidence that this group are at risk of making undesired moves. Considering that performing undesired moves tends to lead to deteriorations in mental health (Woodhead *et al*., 2015), enabling this population to remain where they desire to stay has implications for human rights and burden on health services. For health service provision, the population with mental health needs are found to be particularly likely to move to areas where migration is relatively uncommon, and this movement may lead to growing demand for mental health services in these areas.

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