**UNIVERSITY OF SOUTHAMPTON**

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# (Un)healthy Migrants: Unpacking the Relationship Between Health and Migration Within Great Britain

by

**Sam Wilding**

Thesis for the degree of Doctor of Philosophy (PhD)

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## ABSTRACT

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This thesis is the first attempt at creating a comprehensive geographical understanding of the relationship between health and internal migration within Great Britain for working age adults. Drawing on international literature, theories and mechanisms driving the high rates of internal migration among those with poor mental health, and the low rates among those with poor physical health are assessed, and these are then tested in three distinct empirical analyses. Previous attempts at modelling these interrelationships fail to account for realistic place influences on migration behaviour, which are also known to affect health behaviours and outcomes, and this shortfall is overcome with the use of multilevel modelling. Throughout, evidence is presented that, although moderated by place of residence, both physical and mental health have an effect on the likelihood of moving and of long-distance migration within Great Britain, and further avenues for research are suggested.

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# Declaration of Authorship

I, Sam Wilding declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

Thesis title: (Un)healthy Migrants: Unpacking the Relationship Between Health and Migration Within Great Britain

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
3. Where I have consulted the published work of others, this is always clearly attributed;
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
5. I have acknowledged all main sources of help;
6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
7. Parts of this work have been published as:
8. Wilding S, Martin D, Moon G, 2016, "The impact of limiting long term illness on internal migration in England and Wales: new evidence from census microdata" *Social Science & Medicine* **167** 107–115.
9. Wilding S, Martin D, Moon G, 2017, "How far is a long distance? An assessment of the issue of scale in the relationship between limiting long-term illness and long-distance migration in England and Wales". *Population, Space and Place* (online first). DOI: 10.1002/psp.2090.
10. I confirm that the cited papers were co-authored by myself, and my supervisors David Martin and Graham Moon. The papers were developed by myself following initial discussions in supervisions with David and Graham. David and Graham subsequently advised on the structure and presentation of the papers. David and Graham read and commented on early drafts and advised on how to respond to reviews. I led the submissions, undertaking all empirical work and writing all drafts including the final accepted versions.

Signed:

Date:

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# Abbreviations

**BHPS** British Household Panel Survey

**CISaS** Census Individual Safeguarded Sample

**CISeS** Census Individual Secure Sample

**GB** Great Britain, a geographical area in North-West Europe consisting of England, Scotland and Wales

**GHQ** General Health Questionnaire

**LA** Local Authority (large geographical units with an average population of 120,000)

**LLTI** Limiting Long Term Illness

**LSOA** Lower layer Super Output Area (small geographical units in England and Wales, with a population between 1,000 and 3,000)

**MSOA** Middle layer Super Output Area (medium geographical units in England and Wales, with a population between 5,000 and 10,000)

**NRS** National Records Scotland

**NHS** National Health Service, the free at point-of-use publicly-funded health service covering Great Britain

**SRH** Self-Rated Health

**ONS** Office for National Statistics

**OSM** Original Sample Members (of the British Household Panel Survey)

**UK** United Kingdom

**USoc** Understanding Society

**VPC** Variance Partitioning Coefficient

# Chapter 1 Introduction

In Great Britain (GB), the likelihood and patterns of relocating during the life-course has irrevocably changed due to recent transformation of the economy, culture and society. These changes have ushered in the gig economy, a new era of occupational precarity and freedom. Home ownership is becoming increasingly difficult for working age adults, who are often required to move for study, family formation and employment. All this movement may have notable implications for health and wellbeing, however substantive quantitative research is required to discern such outcomes. The study of internal migration and health is of great significance to both public health professionals and academics, for who it is vital to understand the relationship between place, mobility and health. This is important for effective healthcare provisioning, the forecasting of future health risks and the provision of better public health guidance.

This chapter expands upon the significance of health and internal migration to healthcare. The need for a spatial approach in health and internal migration is delineated. Further to this, geographical inequalities of health in GB are investigated. The chapter concludes with an outline of the scope and structure of this thesis.

Health and social care organisations, urban planners, and other agencies require local statistics on the likelihood of movement for population subgroups to adequately plan and apportion future funding and services. Internal (within-country) migration often has the largest effect on the composition of local populations, compared with other components of demographic change (mortality, births and international migration). This impact is felt in both the areas that internal migrants leave (origins), and those that they move to (destinations).

This thesis focuses on the mechanisms linking internal migration to physical and mental health. Globally, non-communicable diseases which affect physical functioning kill 40 million people per year (World Health Organization, 2017a). In contrast, an estimated 300 million people suffer from depression, a common mental disorder (World Health Organization, 2017b). On average, 14% of the population move within their country of residence every year (Bell *et al.*, 2015). In Europe, North America, South America and Australasia poor physical health is found to be a barrier to internal migration (Curtis *et al.*, 2009; Green *et al.*, 2017; Larson *et al.*, 2004), whereas common mental disorders are drivers of internal

migration in the same regions (Larson *et al*., 2004; Lix *et al*., 2006; Loret de Mola *et al*., 2012; Woodhead *et al*., 2015). Beyond whether individuals move or stay, the distance of internal migration among those with physical and mental health needs are of interest. Long-distance moves are likely to necessitate changes between healthcare providers for those accessing services.

Despite the prevalence of internal migration, little progress has been made in developing theories that aim to understand how migration behaviour is driven by physical and mental health. The literature on health and internal migration uses the dichotomy of 'healthy' and 'unhealthy', but the relationship with internal migration appears to be dependent on whether health is defined as physical or mental. The low rates of internal migration among those with physical health needs have typically been explained by the 'healthy migrant theory'. According to this theory, those with the greatest physical health are better equipped to enact the pre-requisites of migrating, such as finding information on alternative residences and saving money (Fennelly, 2007). Currently, the healthy migrant theory does not apply well to mental health, as those with mental health needs have relatively high rates of internal migration (Larson *et al*., 2004). Those with mental health needs also have higher rates of unemployment and low levels of educational attainment, relative to the general population (Weich and Lewis, 1998). As a result, this demographic lacks access to stable housing, and can become entrapped in a cycle of moving between temporary places of residence (Fryers *et al*., 2003). A theoretical model of migration that can explain the role of physical and mental health is currently absent from the literature.

Development in the understanding of how health affects migration is important for understanding how places affect health and the planning of healthcare services. There is evidence of extensive inequalities in health outcomes globally (Bambra, 2016) and within countries of Europe (Ballas *et al*., 2014). Such inequalities have typically been explained as the result of differences in population makeup (composition), or the result of area-specific conditions affecting health (context; Shouls *et al*., 1996), with little reference to migration (Spallek *et al*., 2011). The idea that individual health affects the likelihood and destination of internal migration is known as 'health-selective migration' (Rogerson & Han, 2002). Internal migration flows may affect, exaggerate or even explain regional health inequalities through health-selective migration. Beyond the effects on health inequalities, understanding health-migration patterns is important for healthcare provision. Health-selective migration will increase

demand in areas that those with health needs move to, and reduce demand in those areas they have left. With knowledge of patterns of these flows, future physical and mental healthcare needs can be more accurately predicted.

This thesis aims to investigate the relationship between physical and mental measures of health and internal migration in GB, with a specific focus on the influence of place. Although there is evidence of interrelations between health and internal migration in other countries, GB is implemented as a case study in this thesis, due to the relatively bountiful availability of data with measures of physical and mental health and migration. Therefore this thesis assesses the extent to which health is associated with probability and distance of internal migration in GB, through three novel empirical papers.

Chapter 1 justifies the need for a geographical perspective in health and internal migration research. The way that this unique research perspective could develop further understanding of health geography is described. Finally, contemporary health trends in GB are explored and the structure of this thesis is outlined.

## 1.1 Why is a geographical approach needed for health and internal migration research?

This section provides justification for a geographical approach to health and internal migration research. Since the 1990s, place has been central to the understanding of health inequalities (Kearns & Moon, 2002). There is evidence of extensive health inequalities between regions of the US (Meyer *et al.*, 2013), UK (Norman & Boyle, 2014), Brazil (Szwarcwald *et al.*, 2016) and Australia (Public Health Information Development Unit, 2017). The 'contextual' explanation for these inequalities is that area conditions enhance or degrade health resilience, which leads to regional differences in health outcomes (Smith & Easterlow, 2005). Conversely, individual characteristics such as age and employment can determine health outcomes, and the distribution of these traits across regions can explain regional health inequalities; this is known as the 'composition' explanation (Sloggett & Joshi, 1994).

Meta analyses and systematic reviews find that a small but significant proportion of regional health inequalities are unexplained by differences in population composition (Meijer *et al.*, 2012). Internal migration is one of the processes that determines regional population composition. There is evidence of health-selective migration, in terms of who moves (Boyle *et al.*, 2002), and where migrants move

from and to (Norman & Boyle, 2014). Despite this, internal migration has been largely overlooked in explanations of regional health inequalities.

In parallel with research on health, place has remained a pertinent factor in understanding migration behaviour. Migrants move from one location to another, and the wider physical and social structure of these places is a key determinant of migration behaviour. In the late 19th Century, Ravenstein (1885) set out his 'Laws of Migration'. The spatial relationship between places was central in these laws, which remain as the foundation of modern migration research. According to Ravenstein, the characteristics of one's current area of residence will influence the likelihood of migration and the relative attractiveness of alternative destinations. In his second law of migration, Ravenstein claims that individuals are drawn from the rural periphery (origins) and into urban towns (destinations). Once this flow is established, a counter-flow occurs, with urban residents moving out into rural-near areas (law four). Space is also presented as a deterrent, with the majority of migration occurring over short distances (law one). Ravenstein based his laws on migration between countries of the United Kingdom (England, Wales, Scotland and Ireland) during the 1871 and 1881 Censuses. Similar patterns were observed in the early 20th Century in Chicago (Burgess, 2008) and the Soviet Union (Wädekin, 1966). Despite the age of Ravenstein's laws, the idea that place affects migration behaviour has remained steadfast in modern migration theory (Thomas *et al.*, 2013).

Later theories of migration behaviour developed Ravenstein's laws, whilst retaining a focus on the relationships between places. The 'gravity model', where the number of migrants between two places is a function of their respective population sizes and the distance between the two locations, was popularised in the mid-twentieth century (Flowerdew & Aitkin, 1982). Lee (1966) developed the spatial dimension by including area factors associated with the area of origin and destination within this framework. Physical and socioeconomic characteristics such as access to good schools, employment or commuting are only attractive to certain groups, and may be considered a nuisance or not beneficial for others. Those entering retirement are less likely to be concerned with access to employment or good schools than working age adults with young children, for example. Development of theory in this area begins to unpick why population subgroups have unique migration patterns, and how these patterns have been linked with health.

The idea that health-selective migration could create spatial variations in health originated in the 19th century. In 1871 Welton claimed "it is obvious that the resort of sick persons to country districts would produce an effect on the mortality in such districts" (Welton, 1871). Welton's claim remains evident, as seaside towns on the south coast of England are popular migration destinations for retirees in GB, which affects the prevalence of health conditions in these areas (Office for National Statistics, 2014a). The 'drift' hypothesis suggests that internal migration is a selection mechanism that is determined by health and wellbeing capital. It suggests that the healthy are more able to move into desirable areas, whereas the infirm and sick are less able to afford to stay in or to move to such areas (Mossakowski, 2014). At the same time, migration to 'undesirable' areas, such as those with limited green space and high levels of socioeconomic deprivation, has been shown to lead to deterioration in wellbeing (Alcock *et al*., 2014; Tunstall *et al*., 2014). The extent to which the environmental and socioeconomic characteristics of areas influence health is unclear, because social drift also contributes to health inequalities. Conversely, the degree of social drift is hard to determine, as places affect health resilience. There is a need for research that explains the migration patterns of those with physical and mental health needs, if geographies of health are to be fully understood. Such research must account for the influence of place, both on health and migration behaviour.

## 1.2 Why is health-related migration relevant to healthcare provision?

Having established the need for a geographical perspective in research on health and internal migration, this section justifies the need for further research to anticipate future healthcare demand.

Migration is linked to changes in health outcomes and behaviours post-move. Regardless of the distance moved, migration necessitates adjustment to a new environment and some level of disruption to established social ties (Astone & McLanahan, 1994). Such changes can result in deterioration in health. Although internal migrants generally display lower mortality rates than non-migrants (Westphal, 2016), internal migration has been linked with negative health outcomes. Children in families who move frequently have relatively high rates of teenage pregnancy, early onset of illicit drug use, adolescent depression and reduced healthcare utilisation (Jelleyman & Spencer, 2008), however these effects are less pronounced among extroverts (Oishi & Schimmack, 2010). Comparative

effects on adults have been uncovered. Adult internal migrants display worsening mental health after moving (Alcock *et al*, 2013; Tunstall *et al*, 2014) and are more likely to smoke (Larson *et al*., 2004). The type of area one moves from and to also affects health trajectories over time, with those moving into deprived areas exhibiting worse post-move mental and physical health, relative to all movers and stayers (Tunstall *et al*., 2014).

Schemes have been developed in the USA to try and counter the generally negative effects of ghettoization and downward mobility. The 'Moving to Opportunity' programme in the USA offered rental subsidies to low-income families to move into high average income neighbourhoods; families in the programme reported improvements in employment, housing quality, alcoholism (Fauth *et al*, 2004), and later improving physical health (Fauth *et al*, 2008). Conversely, without schemes such as this in GB, socially deprived areas with high rates of in-migration may observe increases in healthcare demand over time.

Efficient health service planning requires predictions of where service users are likely to live in the future (prevalence), and where new service users will emerge (incidence). Understanding of *prevalence* necessitates research into the migration patterns of population subgroups with particular health needs. Norman and Boyle (2014) revealed that in England, the movement of healthy young adults into London masks underlying regional health inequalities. These in-migrants are relatively healthy, and their in-migration lowers the prevalence of limiting long-term illness in London. To understand *incidence*, sophisticated models, such as work by Kirkbride (2013) are effective at predicting the incidence of health conditions at small area levels. However, areas with high incidence may not experience high levels of healthcare demand due to internal migration, as in the case of London. Therefore health service providers can improve the effectiveness of planning with information on the migration patterns of individuals with specific health needs. Research on health and internal migration can answer these questions and aid the planning of future healthcare services.

## 1.3 Study region: Great Britain

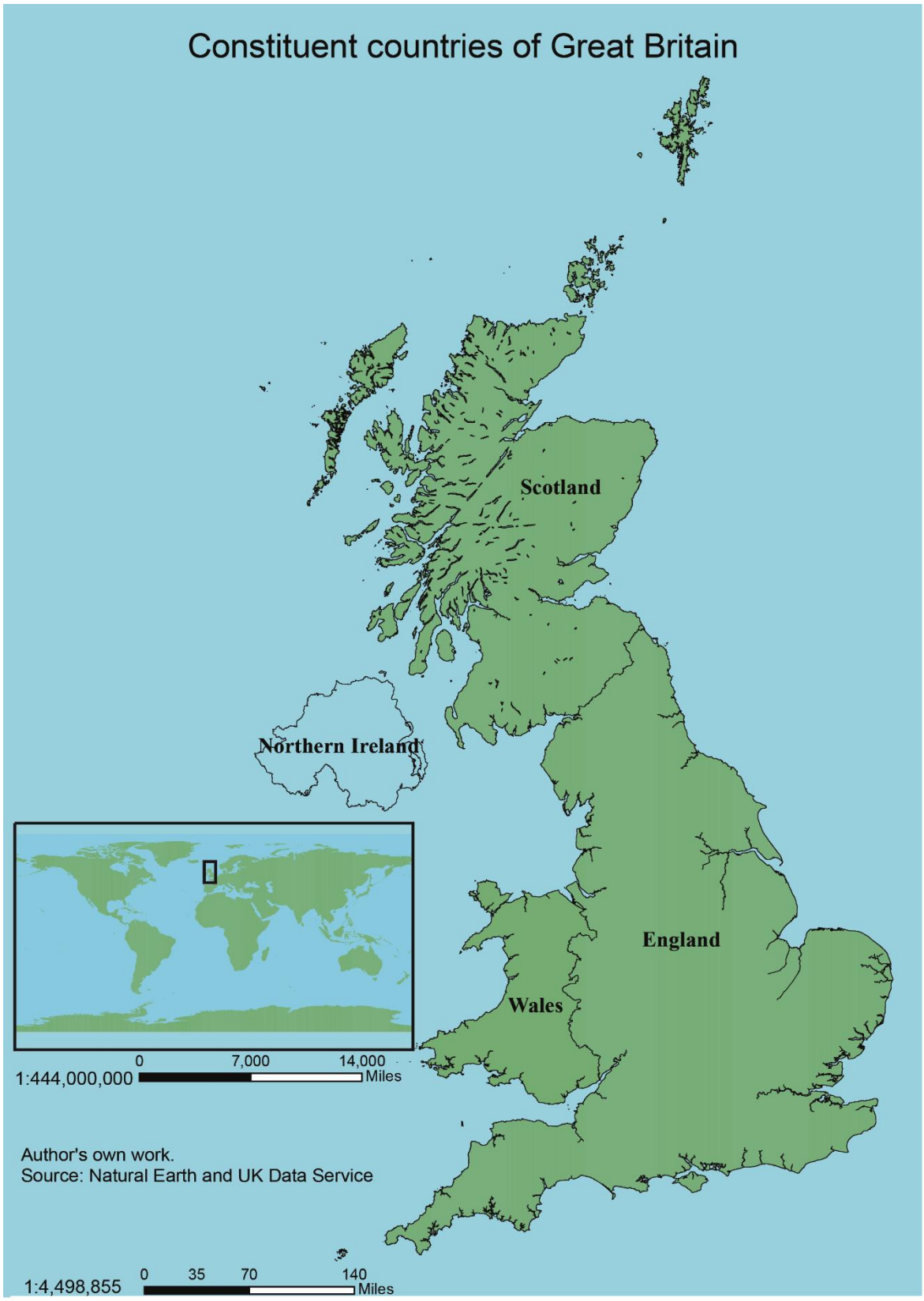
This thesis focuses upon analysis of data for GB. GB consists of three countries that share a monarchy and parliament: England, Scotland and Wales, as shown in Figure 1.1. At the time of the 2011 Censuses, 53 million people lived in England, 5.3 million in Scotland and 3.1 million in Wales (Office for National Statistics,

2012a; World Bank, 2017a). Northern Ireland also shares this monarchy and parliament. However, Northern Ireland does not share a land border with the countries of GB. Therefore the factors determining migration into and out of Northern Ireland from GB are of a different nature to those shaping migration within the landmass of GB.

GB has a predominantly urban population. In England and Wales 82% of the population live in places that are characterised as 'urban', with a similar 79% of the Scottish population residing in towns and cities (National Records Scotland, 2016; Office for National Statistics, 2013a). There is political freedom of movement and residence within GB for its citizens (in contrast to countries such as China, with the *hukou*). This includes no restrictions on migration between the constituent countries for citizens.

There is a notable north-south divide present in GB. Individuals in Scotland, Wales, Northern and Central England face poorer socioeconomic conditions relative to the rest of GB. These lower socioeconomic standards do not just affect property prices, but have an impact upon health, demonstrated by increased morbidity rates (Langford & Bentham, 1996; Rowthorn, 2010). As of the 2011 National Censuses, 65% of persons in GB live in owner-occupied housing, 17% in socially rented properties, and 16% in private rental properties (Nomis, 2014). Purchasing a house is currently more difficult for first-time buyers than in the past. House prices are increasing faster than wages, and the privatisation and wholesale of government-owned housing has reduced the affordability of existing social rental options. This has compounded the issue of property ownership, as private rental has become the predominantly viable housing option for younger people in disadvantaged socioeconomic categories (Dorling, 2015).

Figure 1.1 Constituent countries of Great Britain



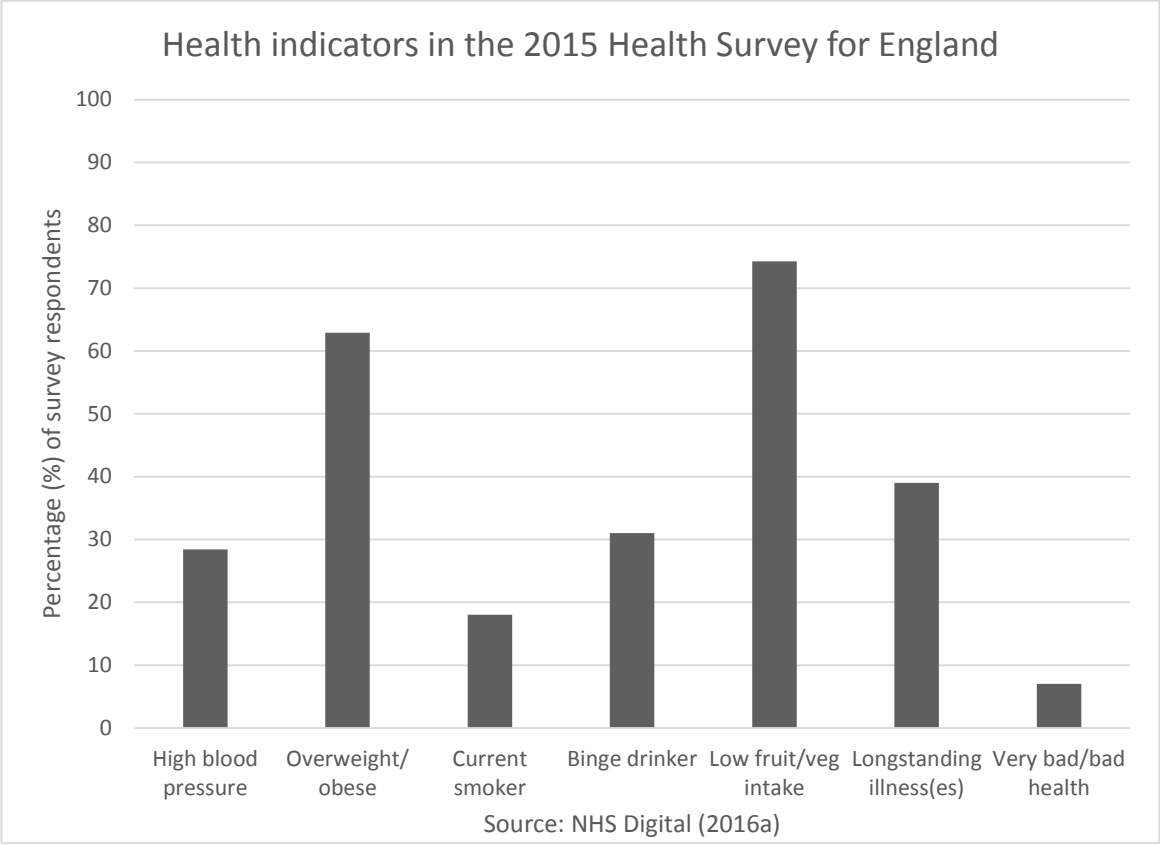
## 1.4 Geographies of health in Great Britain

This section identifies existing estimates of mortality and morbidity in GB. It aims to provide insights into the current state-of-play of health and explores existing geographical linkages. According to World Bank estimates, the expected life expectancy for a resident of GB at birth stands at 82 years of age, as of 2015 (World Bank, 2017b). This is similar to life expectancy in other high-income countries, and considerably higher than middle and low-income countries. Mortality rates refer to the number of deaths per year per 1,000 population. In 2013, the adult male mortality rate in GB was 85, which is relatively low in comparison to the European (99) and World (180) averages (World Bank, 2017c). The adult female mortality rate was 54, which is higher than the European average (50), but lower than the World average (120).

Chronic non-communicable diseases are the leading causes of death in GB. Heart disease is the most common cause of death, followed by late-onset degenerative conditions including Alzheimer's disease and dementia (Public Health England, 2017). Cancers are also a leading cause of death for both men and women. There are age differences in causes of death, with suicide being the leading cause among the under 35s, whereas heart disease and cancer are the leading causes among 35-79 year olds.

Although the population of GB have relatively low levels of mortality, they are not necessarily experiencing good health during their lifespans. For example, Public Health England (2017) figures estimate that English males spend 20% of their lives in poor health (23% for females). These figures have not changed significantly between the years 2000 and 2014, despite improvements in mortality rates and life expectancy over this period. It is also notable that the majority of the respondents to the Health Survey for England, an annual survey commissioned by the National Health Service (NHS), are overweight and have a low intake of fruit and vegetables (Health & Social Care Information Centre, 2012). Harmful lifestyle factors such as these have a negative influence on health and wellbeing.

Figure 1.2 Health indicators in the 2015 Health Survey for England




There is a growing interest in tackling unhealthy lifestyles and mental health issues. Several initiatives have been developed to try and improve GB residents' lifestyle choices and subsequently reduce their long-term poor health. For example, the Healthy Start scheme provides vouchers to low-income families that can be exchanged for milk, fruit or vegetables in England (Department of Health, 2017). The 'Time to Change' campaign aims to destigmatise mental health, as a means to lower suicide rates (Evans-Lacko *et al.*, 2013). To evaluate the success of these campaigns, research on the prevalence and geographical distribution of a variety of health conditions are required, and migration is a key aspect of this work.

There is extensive evidence for spatial variations in health outcomes across GB. Adults living in the most socially deprived areas of England spend twice as much of their lives in poor health, compared to those living in the least deprived areas (Public Health England, 2017). Those living in areas which are closer to the coast, and with higher levels of green space (public parks and gardens) tend to be happier (Wheeler *et al.*, 2012), and those who move into such areas display short term improvements in mental health (Alcock *et al.*, 2014; White *et al.*, 2013). Those living in urban areas of GB have higher mortality rates than those who live

in rural areas, and these differences are not wholly explained by confounding characteristics such as deprivation (Gartner *et al.*, 2011; Levin & Leyland, 2006). These spatial inequalities in health are a major issue of interest for the public and policy makers. The 2010 'Marmot Review', commissioned by the Department of Health, highlighted social and regional inequalities in a variety of health outcomes (Marmot, 2010). It noted that substantial differences existed between the north and south of England, and between Scotland and the rest of GB (Marmot, 2010). These inequalities remain similar to those identified in the 'Black Report' in 1980 (Smith *et al.*, 1990). Public interest in the relationship between spaces and health is expressed through pressure groups such as the Open Spaces Society (OSS). The OSS campaign to protect green spaces, which they describe as "crucial to our health and happiness" (Open Spaces Society, 2016). Media outlets also publish figures on between and within-region disparities in happiness, collected from the Annual Population Survey (The Guardian, 2016, 2017). However, the effects of internal migration on regional health inequalities are notably absent from policy and public discourse - despite this phenomena being well-recognised by academic literature (Smith & Easterlow, 2005).

## 1.5 Thesis scope and structure

This thesis aims to test whether the relationship between health and internal migration is affected by place of residence (origin and destination) effects. Chapter 2 provides a critical review of the literature. Several shortcomings of extant knowledge on health and internal migration are revealed: the lack of focus on place effects; inadequate distinction between physical and mental health effects; and the issue of temporality. Three research questions are identified from this literature review, and are addressed in subsequent original analytical chapters. Chapter 3 assesses the suitability of competing datasets for addressing these questions and identifies Census microdata as the most suitable source for cross-sectional analyses. Administrative data are identified as having research potential for longitudinal analysis, however there are significant barriers to access. The British Household Panel Survey (BHPS)/ Understanding Society (USoc) is found to be a good candidate for longitudinal analysis.

Chapter 4 provides an overview of each research paper and explains how these papers can address gaps in the literature. Chapter 5 utilises Census microdata to test whether the drivers and destinations of internal migration differ among those with, and without, self-reported physical health limitations. This chapter is

substantially based on a paper published by the author in *Social Science and Medicine* (Wilding *et al.*, 2016). Chapter 6 utilises Census microdata to test whether those with self-reported physical health limitations are less likely to have moved long-distance compared to those not reporting such limitations. It also identifies if health varies by definition of long-distance. This chapter is based on a paper published by the author in *Population, Space and Place* (Wilding *et al.*, 2017). In Chapter 7, data from the BHPS and USoc are used to test whether mental health is predictive of internal migration within the following year, controlling for origin and place effects on migration behaviour. This paper is intended for submission to *Health and Place*. Chapter 8 sets out the contributions of these three analytical papers in context of their limitations and suggests several avenues for future research that could build upon these new analyses.

# Chapter 2 Literature review

The purpose of this chapter is to critically review existing work on the relationship between health and internal migration, with specific focus on GB. The structure of this chapter is as follows: in section 2.1 internal migration is defined, the relative prevalence of internal migration in GB is outlined and an argument is set out for the need to understand how health relates to migration behaviour. Section 2.2 sets out the key characteristics associated with internal migration in the literature and explores how these characteristics are also linked to health, setting a case for regression analyses which control for these compositional factors in order to isolate health effects from confounding factors. Section 2.3 assesses extant knowledge of the relationship between physical health and internal migration, building a case for the inclusion of area effects on migration behaviour. Section 2.4 illustrates key gaps in the mental health and migration literature. Section 2.4.5 outlines three research questions which will contribute to the theoretical understanding of the relationship between health and internal migration, which are then addressed in the analytical chapters of this thesis.

## 2.1 Internal migration

### 2.1.1 Definitions and measures of internal migration

Internal migration refers to the movement of primary place of residence for individuals from one location to another within a country (Rees & Wilson, 1977). Internal migration may be operationalized in several ways, including (but not limited to): whether an individual moved within a given period, the number of moves an individual undertook within a given period, the distance between residences and the area characteristics at an individual's origin and destination.

The 'migration transition' concept refers to whether an individual has changed their address between two time points. Boyle *et al* (2002) use the migration transition approach to calculate one-year probabilities of migration, as their dataset contains a measure of whether an individual's current address differs from their address one year ago. There are two shortfalls in this approach. First, return migrants are not covered in the transition. An individual who changed address during the observation period but returned before the end of the observation period will not be considered to have moved, as their addresses are

the same at the two points in time. Secondly, the number of moves are not estimated, such that a simple transition from address A to address B may have included several intermediate residences in-between which are not captured with this measure.

The frequency of migration transitions (or 'events') may be observed over a given time frame. For example, Lix *et al* (2007) utilise the migration events measure to compare the risk of multiple moves between 2005 and 2007. In surveys such as the English Longitudinal Study of Ageing, participants are asked to provide all of the residences they have lived in over their lifetime, allowing the number of migration events to be measured (Falkingham *et al*., 2016). This strand of research is subject to inaccurate recall of past moves, where the true number of moves may be under or over-estimated, a phenomenon known as 'recall bias' (Raphael, 1987). In administrative records, migration events may be measured as individuals re-register with health services after moving (O'Reilly *et al*., 2012), and are therefore not subject to recall bias. These moves may be more accurately captured among specific segments of the population. For example, young men tend to lag in their registration as they utilise health services less often than the general population (Barr & Shuttleworth, 2012). However, such datasets often do not cover measures of individual health.

Migration can also be captured by comparing an individual's place of birth and their current residence. If the two areas differ, then a residential move has occurred at some stage (Brimblecombe *et al*., 1999). Alternatively, time spent at the current address can be used to measure migration. This measure is captured in the Survey of English Housing, allowing recent movers and longer term movers to be distinguished (Champion *et al*., 1998), and for comparisons between migrants at different time points to be clarified (Findlay *et al*., 2003). Time spent at the current address does not reveal information about previous residences. This means that an individual could have moved from an address within the same locale, or the other side of the country, without recognition of the difference between these two forms of migration.

The distance between residences is also of interest and is commonly used in internal migration research. In terms of population change, long distance migration has greater redistributive effects on regional population characteristics, when compared to short distance migration. Research in this area is limited by the availability of current and previous residences at fine geographical scales. Place of residence is often aggregated into geographical 'areas' of various sizes

and only the distance between the centroids of these areas can be used to measure migration distances. The larger the geographical aggregation, the greater the error in the distribution of estimated distances moved by individuals (Stillwell & Thomas, 2016). Distances moved can reveal differences between those who move, but reveal nothing about those who do not move.

The health of movers between areas with differing environmental characteristics has also been a subject of academic research. For example, White *et al* (2013) observe the mental health of internal migrants who are moving to areas with varying degrees of green space. Similar studies can begin to provide evidence of associations between area level characteristics and health outcomes (contextual explanations) by comparing the pre-move and post-move outcomes of those moving between areas in areas with different characteristics. Having briefly outlined the means through which internal migration is measured and operationalized, a brief account of migration patterns in GB are outlined.

### 2.1.2 Internal migration in GB

Official figures of internal migration are collected by the Office for National Statistics (ONS) in England and Wales, and the National Records of Scotland (NRS) in Scotland. The Office for National Statistics (ONS) derive estimates for internal migration within England and Wales from three sources (Office for National Statistics, 2015a): the National Health Service (NHS) Patient Register (released annually), the NHS Central Register (released weekly) and the Higher Education Statistics Agency (released annually). The NRS derive internal migration estimates in a similar manner. A move is registered if an individual re-registers with a GP outside of their previous Local Authority (LA; large geographical units with an average population of 120,000) or if a student in higher education registers a term time address outside of the LA of their permanent address (the final source).

Two weaknesses of these data must be noted before discussing trends. Firstly, young adults, and in particular young adult males take longer to register with health services. Therefore this group are likely to be underestimated in migration statistics (Office for National Statistics, 2013b; Smallwood & Lynch, 2010). Secondly, the choice to define a move as between LAs is arbitrary and under-estimates the number of moves (as intra-LA migration is not captured). This makes time series comparisons difficult, as the number and shape of LAs change over time, and where the boundaries are drawn can significantly change the

distribution of migration rates (this is an example of the 'modifiable areal unit problem' (Openshaw, 1984)).

The ONS (2014b) estimate that there were 2.85 million residential moves between LAs in England and Wales, and from Scotland or Northern Ireland between July 2013 and June 2014. The report also breaks down internal migrants by age, sex and region. Migration rates are highest among 19 year olds (21%), and are lowest among 77 year olds (1.4%). Migration rates are relatively high for very young children. However, rates decline for school-age children, peak again for late teens, and then steadily decline in small increments during proceeding years until age 77. South East England had the largest number of in-migrants (242,300), whilst London had the largest number of out-migrants (273,100). The net gain in population was highest in the South West (4.8 per thousand population) and lowest in London (-8.2 per thousand population). Internal migration has a more pronounced effect at the local level (Bentham, 1988) and net migration rates vary greatly within regions of GB (Lomax *et al.*, 2013). For example, central areas of inner London are net gainers of internal migrants despite an overall net loss for London; thus regional net migration flows mask processes at local level.

One of the problems with the ONS and NRS's time series estimates of internal migration are that these are based on migration events. An individual may be counted several times within the year if they moved on more than one occasion. This is problematic because an increase in the number of moves does not necessarily indicate that the proportion of movers has changed, it may be that the population moving multiple times increased during the observation period. Alternative sources present the number of individuals who made a migration transition (i.e. whether an individual moved once or more often within a set time frame). This allows the proportion of the population moving to be compared over time. The NHS Central Register can be used to calculate the proportion of the population migrating by quarter, and this can be used to assess trends in internal migration. An analysis of the period from 1975-2002 shows that for each quarter, between 3 and 4% of the population move between healthcare areas in GB (Champion, 2005), and there is little change over the period.

All residents of GB are subject to a mandatory decennial Census, which is used to produce population statistics. The Census is carried out by the ONS for those in England and Wales, and NRS for those living in Scotland. The GB Censuses utilise a broad definition of internal migration (Office for National Statistics, 2014b). On the Census day (27 March 2011) respondents were asked to provide their address

one year ago (27 March 2010), if the two addresses differ and are within the UK then the individual is considered to be an internal migrant. 6.8 million (12.1%) individuals had moved from another address within GB in 2010/11, of which 59% moved within the same LA (Nomis, 2015a). Naturally, the limitation of these figures from the Census are that they are only collected decennially, and therefore do not reflect the potentially vast changes that could occur within a decade.

### 2.1.3 International comparisons

Several attempts have been made to draw comparisons between internal migration in GB and elsewhere in the world. The percentage of the population who moved between 1975 and 1976 in the US was proportionally twice that in the UK between 1980 and 1981 (Long *et al.*, 1988). Compared to other European countries, the proportion of the population migrating in the last year in the UK between 1971 and 1991 was among the highest in Europe (Rees & Kupiszewski, 1999). Of the 26 OECD countries, the UK has the 17th highest proportion of households changing residence in the last 2 years (Caldera & Andrews, 2011). The World Gallup Poll contains a question asking respondents aged 15 and over whether they had moved from 'another city or area' over the last 5 years. GB is in the middle quintile of all countries surveyed with rates higher than other mainland European countries, apart from France (Esipova *et al.*, 2013).

Cross-national comparisons of internal migration are problematic as the definition of migration, time intervals and units of measurement can vary between countries (Bell *et al.*, 2002). This makes it difficult to identify how prevalent internal migration is in GB relative to elsewhere. Bell and colleagues have developed a database of census and survey estimates of internal migration using one-year and five-year address changes. This database is known as the IMAGE repository (Bell *et al.*, 2015). In IMAGE, GB migration data are derived from the decennial Censuses that measure migration over a one-year period. In comparison with other countries which contain measures of one-year migration rates (Bell *et al.*, 2015), GB ranks the 13th highest of 45 comparable countries, behind several other European countries, including Switzerland, Denmark, Finland and Iceland.

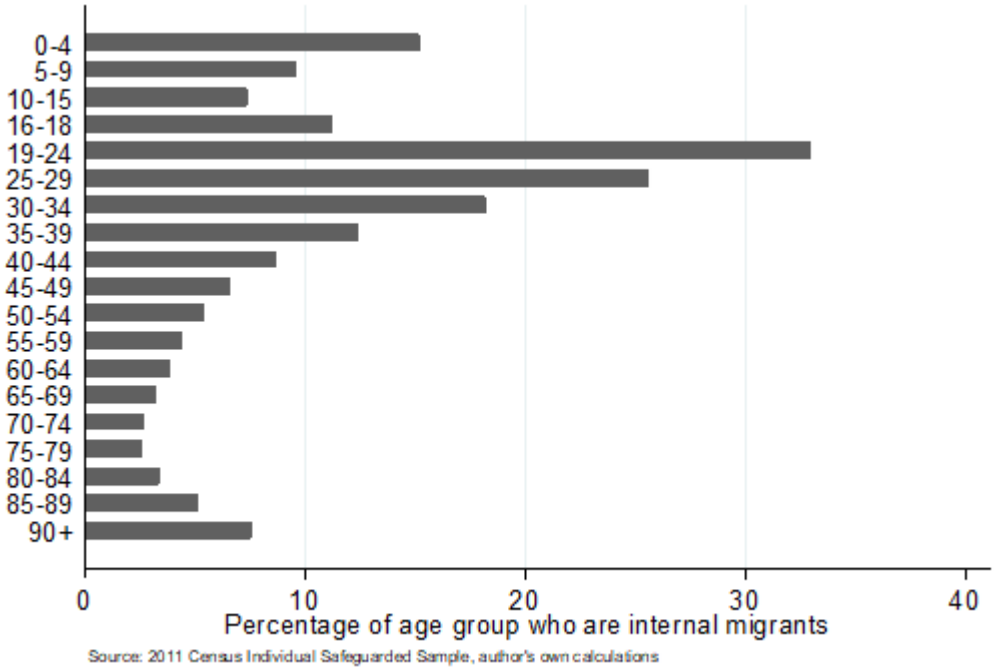
## 2.2 What are the determinants of internal migration, and how do they relate to health?

Having described the definitions, patterns and implications of internal migration research within GB, this section outlines the key determinants of migration that must be controlled for to make inferences about the relationship between health and internal migration. Each subsection explores how these factors are related not just to internal migration, but also to health, and how these factors may create conflated relationships.

### 2.2.1 Life-course

Estimates of the proportion of the population who live at a different address from one year ago measured at the 2011 England and Wales Census are presented by age group in Figure 2.1, derived from the Census Individual Safeguarded Sample (CISaS; Office for National Statistics, 2015b). Differences in age-specific migration rates are common in developed societies (Dieleman, 2001); researchers have begun to explain such age differentials in migration rates through the concept of the life-course (Tyrell & Kraftl, 2015), the idea that life events are driving migration behaviour at different ages. The concept of the life-course can also explain differing rates of migration among demographic groups; men are more likely to move and move over long distance, but this is likely due to the larger proportion of women in older age groups, who are less migratory, for example (Champion, 2005). An evaluation of stages of the life-course and their relationship with migration behaviour follows, adapted from Tyrell and Kraftl (2015).

Figure 2.1 Internal migration between March 2010 and 2011 by age group in England and Wales




The first peak in migration rates are found among very young (<5 years old) children, which then steadily decline for school aged children (5-15 years old). This trend is driven by parents moving into school catchment areas before their children attend school, and the subsequent downturn is attributed to parents being reluctant to change their place of residence once children are studying in schools (Smith & Jons, 2015). Parents generally desire to move with their children into housing within the 'right' neighbourhood and with access to 'good' education establishments (Butler & Robson, 2003; Butler & Hamnett, 2007). Migration rates are highest in the period preceding primary school (0-4) and subsequently before secondary school age (5-9), at which point families are more settled (Dobson, 2008).

Migration rates then increase dramatically for the 19-24 age group. This upturn has been attributed to young adults moving to, within, and subsequently returning from university towns and cities (Duke-Williams, 2009; Office for National Statistics, 2015g). University education has a strong effect on the migration of young adults in GB, with 90% of first-time students being aged 18-24, and the acceptance of places often requiring moves into residences in the vicinity of the university (Duke-Williams, 2009; Statistics Agency, n.d.). This movement has knock-on effects for later mobility. Portuguese university students have been found to lose attachment to their area of origin after living away from

the family home for university (Cicognani *et al*., 2010). This is reflected by high rates of migration in the areas surrounding universities after degree completion in GB (Duke-Williams, 2009).

As young adults aged 25-34 are more mobile than their older adult counterparts, this raises childbearing as a potential driver of migration for couples and single mothers in this group. Moves out of the home for young couples and single mothers are related to family formation, establishing a familial unit separate from the immediate family. This is reinforced by high rates of migration among pregnant mothers in developed societies (Tunstall *et al*., 2010), with pregnant mothers being almost three times as likely to move in comparison to the general population (Champion, 2005). This effect is particularly pronounced for younger pregnant women, understandably given that older pregnant women may already have children, which constrains their ability to migrate (Raynes-Greenow *et al*., 2008).

Another pertinent factor driving migration among working-age adults is employment. Evidence from the US, UK, Australia and New Zealand shows that a sizable minority of internal migrants move for employment reasons, although the themes underpinning such motivations are more complex (e.g. economic stability in the destination area) than the narrative of moving to employment (Morrison & Clark, 2011). Employers may send employees to other locations through secondment or promotion, encouraging migration among the working-age population. Findlay *et al* (2003) found that 31% of English residents in Scottish cities moved in order to take a new job with their employer, compared to 23% of Scots within the same areas. The unemployed (those not in employment but looking for employment) adults may move into more urban regions where there are more employment opportunities (Böheim & Taylor, 2002; Harris & Todaro, 1970), although their motivations are more complex than this narrative suggests (Morrison & Clark, 2011).

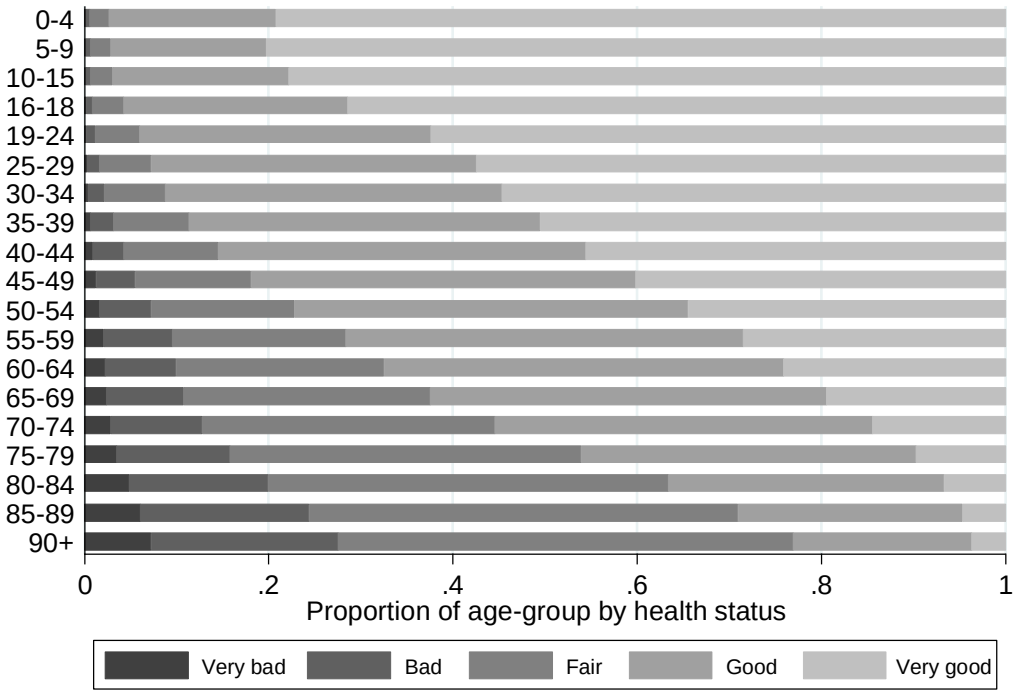
In the latter stages of working life retirement becomes a major theme around migration behaviour. Such movements are driven by two concepts, moving to a ‘relaxing’ (often semi-rural or rural) area, and being in close proximity to children and grandchildren (Tyrell and Kraftl, 2015). This occurs both for practical and preferential reasons. In GB, those aged 55 and over are particularly likely to move to a house with fewer rooms, due to adjusting housing costs relative to retirement income (Ermisch & Jenkins, 1999). This population also tends to move

to areas in closer proximity to their adult children, seeking to maintain family bonds and social contacts (Shelton & Grundy, 2000).

The final life-course stage (termed geriatric dependency) involves the very elderly moving into care homes or to live with family in order to receive care (Tyrell & Kraftl, 2015). Evidence from the 1991 GB Censuses suggests that Limiting Long Term Illness (LLTI) is prevalent among internal migrants aged 65 and over, suggesting that they move to receive informal care (Al-Hamad *et al*., 1997). Alternatively the dependent geriatrics may move into care homes (although these moves are not often registered), where their health needs are managed within these communal establishments (Litwak & Longino, 1987). The flow of the frail elderly into care homes is large enough to have a significant effect on regional mortality inequalities, as shown in the case of Sheffield (Maheswaran *et al*., 2014).

The life-course is related not only to changes in migration behaviour, but also differences in healthiness. In the 2011 England and Wales CISaS (Figure 2.2), the proportion of the population reporting very good health decreases over age, as the proportion reporting very bad health increases. A partial explanation is that young adults tend to view their health more favourably than older adults (Roberts, 1999), but individual self-rated health tends declines over time (Andersen *et al*., 2007). Given that migration rates are particularly high for young working age adults, it follows that life-course stage conflates the relationship between health and internal migration.

Figure 2.2 Self-rated health by age group in England and Wales




Source: 2011 Census Individual Safeguarded Sample, author's own calculations

### 2.2.2 Social class and income

The second determinant of migration behaviour discussed in this chapter is social class. The relationship between social class and internal migration is complex. Using the Standard Occupation Classification scale, those in middle-class occupations have relatively high rates of internal migration, relative to those in the upper and lower classes (Champion *et al.*, 1998). In the 1990 GB Gallup polls, skilled manual workers had the highest migration rates (Halfacree *et al.*, 1992). There are also differentials in the distances moved amongst social classes, those employed in the professional sector are 0.74 times more likely to move between regions than the GB average, whilst those employed in craft and skilled manual sectors are 0.52 times as likely (Champion *et al.*, 1998). Those in the higher managerial, administrative and professional employment groups move 1.1 km further on average within GB (Thomas *et al.*, 2015).

Beyond differences in the probability and distances of internal migration, social class also has associations with migration destinations. The South East of England draws in young adults to work in the financial and service sectors. These workers then leave the region when they retire, a phenomenon known as the 'escalator effect' (Fielding, 1992). In the 2001 GB Censuses, there were net gains of managerial and professional employees in London, the South and East of England,

and net losses elsewhere across GB (Champion, 2005). This suggests that there are differentials in the choice of alternative destinations available to working class migrants, and this is reflected in the degree of lateral moves within poor quality housing in the US (Coulton *et al.*, 2012).

Interlinked with social class are differences by income. In the BHPS, household income is positively associated with the likelihood of moving, but this association bears no significance once mobility desires and expectations are controlled for (Coulter *et al.*, 2011). In contrast, households in the poorest income quintile are the most likely to move when they report desiring a move, among USoc respondents (Woodhead *et al.*, 2015). Those with relatively low incomes are constrained in terms of the housing available to them. The social housing (not for profit) sector in GB is shrinking (Hodkinson & Robbins, 2013). This leads to difficulty in moving into and out of social housing, which drives dissatisfaction with housing (Cho & Whitehead, 2013). In terms of distance, higher levels of household income are associated with longer distance migration (Thomas *et al.*, 2015), supporting the idea that those with relatively low income are constrained in terms of potential migration destinations.

Further to associations with internal migration, social class and income are strongly linked to health. Social class displays a strong gradient in mortality rates. As overall mortality has fallen, the inequality between social classes has risen (Marmot *et al.*, 1997). A similar relationship is found at the area level, where areas with relatively low income have lower average life expectancy (Marmot, 2010). Income and changes in income are associated not only with mortality but also morbidity (Allanson & Petrie, 2013). Work attempting to determine the relationship between internal migration and health therefore needs to control for social class or income, as these effects may be incorrectly attributed as health effects.

### 2.2.3 Education

Higher levels of educational attainment are associated with increasing propensity to migrate within GB (Champion *et al.*, 1998; Hughes & McCormick, 1985; Smith & Jons, 2015), in line with other developed countries such as Canada and the US (Liaw, 1990; Long, 1974). In GB, young adults are drawn to universities from regions surrounding university towns and cities to access higher education (Duke-Williams, 2009), and these university regions also have the highest proportion of intra-area migration (Champion, 2005). In GB, university students usually move

into university-maintained accommodation in their first year of study, before moving out to private-rented accommodation for the remainder of their study (Smith & Holt, 2007). This process leads to high rates of intra-area migration in towns and cities with universities. Graduation from university often leads to further residential moves away from place of study. In GB, large cohorts of university graduates are drawn into London, Bristol, Edinburgh and Glasgow (Smith & Holt, 2007).

Educational attainment has also been linked to a gradient in health. Further and higher education attainment is associated with lower prevalence of unhealthy behaviours and greater self-rated heath (Cutler & Lleras-Muney, 2010; Lynch & von Hippel, 2016). There is a plausible causal pathway, where education leads to fulfilling employment, the development of efficient coping mechanisms, greater knowledge of health risks and better understanding of healthcare procurement. These beneficial life experiences and traits lead to better health among those who spend longer in education (Lynch & von Hippel, 2016). Alternatively, this association may be an artefact of selection, where those with greater health are more likely to apply for and finish higher education than counterparts with relatively poor health (Haas, 2006). A large proportion of this education gradient in health in GB and the US is explained by personality characteristics (Cutler & Lleras-Muney, 2010). Personality is also a dimension which is related to migration behaviour (Balaz & Williams, 2011). As a result, attention needs to be paid to educational attainment when quantifying the relationship between health and migration.

### 2.2.4 Ethnicity

Ethnicity has been linked to internal migration in several respects. Non-white ethnic groups are more likely to move than the majority white ethnic group in GB (Finney *et al.*, 2015). The migration patterns of minority ethnic groups also contribute to the decentralisation of minority ethnicities in GB, as areas receiving large flows in minority ethnic migrants are typically those with high proportions of white residents (Stillwell & Hussain, 2010). These ethnic associations also exist when considering the distance migrants move. In the 2001 GB Censuses, minority ethnic groups were more likely to move short distances when compared to the white group (Finney & Simpson, 2008), with the exception of the Chinese group, who tended to move further (Stillwell & Hussain, 2010). The association between ethnicity and migration may, however, be driven by differences in the

characteristics of ethnic groups. The short distances moved by minority ethnic groups are likely a result of their greater concentration in urban areas, where short distance moves are generally more common (Simpson & Finney, 2009). Further to this, analyses of distances moved which control for demographic characteristics such as age and education find that there are no significant differences between minority ethnic groups and the white group, with the exception of the Chinese ethnic group (Cho & Whitehead, 2013; Thomas *et al*., 2015).

Ethnic differences in health behaviours and outcomes have also been noted in GB. One study reports that minority ethnic groups are more likely to report a LLTI than the White British group (Smith & Grundy, 2011), whilst another study finds that Black and Indian groups are relatively less likely to report poor health (Darlington *et al*., 2015a). This debate mirrors that in the US, with similar findings. However, in the US the focus is on racial rather than ethnic disparities (Williams & Mohammed, 2009). These ethnic inequalities are likely to be influenced by socioeconomic circumstances, with minority ethnic groups often overrepresented in poor quality housing, unemployment, low-paid work, and underrepresented at universities globally (Darlington *et al*., 2015a). Given that ethnicity is related to migration and health, there is a need to control for ethnicity in health migration research.

### 2.2.5 Employment

There are associations between internal migration and employment status. Changes in employment often lead to a move and workers who changed their job in the last year are 0.44 times more likely to have recently moved home (Clark & Davies Withers, 1999). This association is affected by tenure status. Renters who changed job are 0.35 times more likely to have moved, whilst job changes are not associated with migration among owners, suggesting that renters migrate for employment reasons, whilst owners are more likely to stay put. Differences also exist between employment groups; in the BHPS individuals who are unemployed are more likely to move in comparison to those who are employed (Böheim & Taylor, 2002). This is colloquially referred to as the 'Norman Tebbit effect' in GB, after a former Minister of State who implored the unemployed to 'get on their bikes' to find jobs. The unemployed may migrate in order to find employment and may move to regions with greater employment prospects (Böheim & Taylor, 2002; Harris & Todaro, 1970). This association persists among older working age

adults, a study of adults aged 55 and over shows that individuals whose spouse has left their job (but not retired) were more likely to move than those with partners in continuous employment (Ermisch & Jenkins, 1999).

Employment status is also associated with the distance of internal migration. Boyle and Shen (1997) investigated the characteristics associated with distance migrated in the year preceding the 1991 GB Censuses. Controlling for tenure, family status, car access, family status, education, age and gender, self-employed workers migrated over shorter distances (0.9km). However those on a Government scheme (1.5km) and the unemployed (1.3km) migrated over longer distances when compared to full-time employees. Thomas *et al* (2015) found that managerial employees (1.1km), the unemployed (1.2km), students (1.6km) and the retired (1.7km) migrated over longer distances intermediate workers between 2005 and 2007 in GB. Although these variations appear small, they are indicative of wider flows. The unemployed are 0.89 times more likely to move across regions than the employed (Böheim & Taylor, 2002).

Employment, and transitions into and out of employment are also important determinants of health. Generally, those in employment tend to report better health than those in unemployment (Minton *et al*., 2012). The direction of this association is difficult to identify, as poor health is one of the means through which one might become unemployed (Woodall *et al*., 2017). After controlling for baseline health, those who become unemployed are more likely to report psychological distress. Notably, women who move from unemployment to employment are less likely to report distress, whereas men moving from study to employment are less likely to report distress (Thomas *et al*., 2005). As employment is related to migration and health, it is important for employment to be controlled for in health migration research.

### 2.2.6 Place

Thus far, it has been established that migration rates vary across areas. Significant efforts have been made to assess the factors which determine regional migration patterns (e.g. Clark & Ledwith, 2006; Lu, 1999; Rabe & Taylor, 2010). This section will assess whether objective neighbourhood characteristics are associated with migration behaviour, and explore the interactions between neighbourhood satisfaction, characteristics and migration flows.

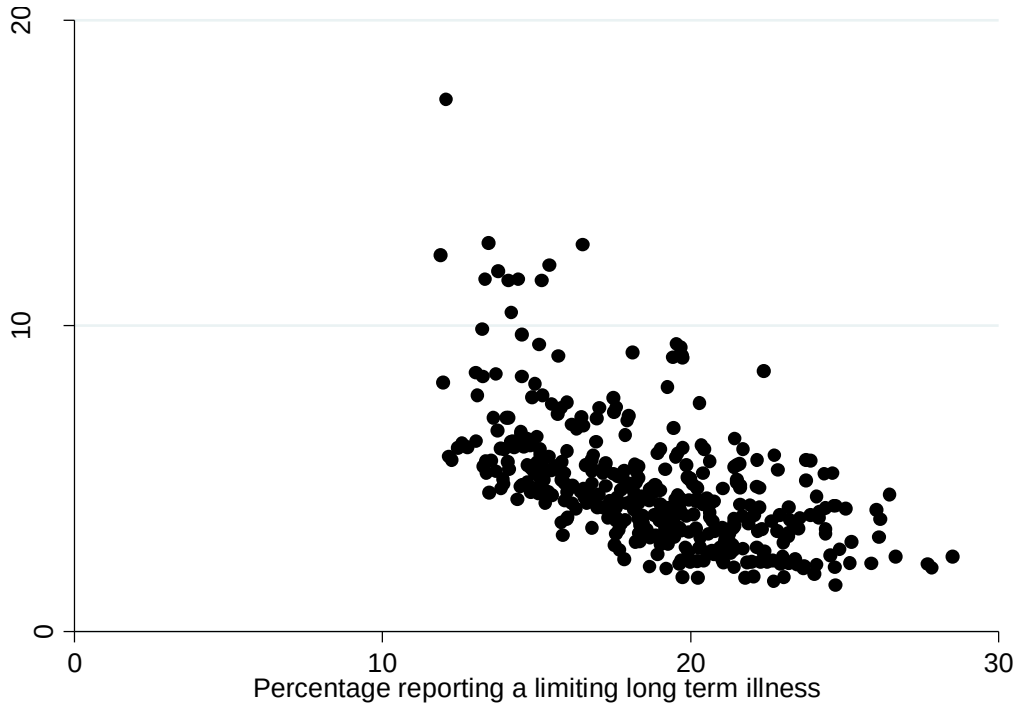
Several measures comparing neighbourhoods have identified area-level characteristics which are associated with migration rates. Internationally, urbanicity is a predictor of mobility. Children born into inner-city Johannesburg perform their first residential move significantly earlier than those born outside of the inner-city, after controlling for demographic characteristics (Ginsburg & Steele, 2011). In GB, relative deprivation is positively associated with migration out of the local area for couples. In particular, high rates of crime and poor quality of the living environment are strong drivers of such migration flows (Rabe & Taylor, 2010). The influence of area characteristics on migration behaviour varies across different demographics, for example there is no association between neighbourhood deprivation and mobility among single adults in GB. Overall, neighbourhood characteristics appear to explain a small proportion of the variance in migration patterns (Clark & Ledwith, 2006).

There are several explanations for the relatively small explanatory power of neighbourhood quality as a driver of migration. Using Hirschman's concepts of 'exit', 'voice' and 'loyalty', leaving the area (exit) is not the only rational reaction to poor neighbourhood quality. Residents of these neighbourhoods may choose to stay (loyalty) because they have ties to the local area, or believe that they can adapt the neighbourhood to meet their needs (Permentier *et al*., 2007). There is also a trade-off between objective characteristics of the neighbourhood and subjective evaluation of the neighbourhood. Factors such as perceived closeness of the community (Clark & Ledwith, 2006), disorder (Kearns & Parkes, 2003) and residential turnover (Lee *et al*., 1994) are drivers of subjective appraisals of the local neighbourhood. These evaluations are not made in isolation: outsiders' views of the neighbourhood and media portrayals have also been shown to affect neighbourhood satisfaction (Tsfati & Cohen, 2003). In general, these subjective evaluations of the neighbourhood are more powerful drivers of migration than objective features of the area (Clark & Ledwith, 2006).

There are complex interactions between health, place and internal migration (Smith & Easterlow, 2005), that cannot be covered in their entirety here. In the 2011 Censuses across the UK, the pairwise correlation between a LA's proportion of the population who are in-migrants from the rest of the UK and proportion who report a limiting long-term illness is significantly negative ($n = 406$, $r = -.57$, $p < .01$; Figure 2.3). This suggests that some of the variance in internal migration that is apparently explained by individual health is the result of area effects - as

internal migration is more prevalent in areas with low rates of limiting long-term illness.

Figure 2.3 Local Authority in-migration and limiting long-term illness in the UK




Source: Nomis (2015) table UKMIG005 - migration by long-term health problem or disability (UK)

Having outlined key determinants of internal migration and their relationship with health, it is clear that aggregate data are insufficient for isolating the effect of health on internal migration. The following section assesses the extent of evidence for a relationship between physical health and internal migration, and clarifies the key research gaps to be addressed by this thesis.

## 2.3 Physical health and internal migration

### 2.3.1 Analogies with international migration

Much of the research into the relationship between migration and health has been centred on the 'healthy migrant theory' (Darlington *et al.*, 2015a). This theory is derived from studies of immigrants, individuals who have moved to live permanently in a foreign country; and focuses primarily on those moving from developing countries to developed countries. The healthy migrant theory is that immigrants are positively selected by health status, because immigrants tend to be healthier than the population at origin (Fennelly, 2007). The healthy migrant

theory was derived from evidence in the 1970s and 1980s. Immigrant groups had lower risks of mortality than the host and sending country populations, despite their relatively low socioeconomic position as recent immigrants in host countries (e.g. Marmot *et al*., 1984). Immigrants have greater than average self-rated health, lower risk of mortality, mortality from cardiovascular disease and myocardial infraction than natives (Malmusi *et al*., 2010; Sohail *et al*., 2015; Vandenheede *et al*., 2015). There is evidence of acculturation effects for immigrant health, whereby immigrants arrive with a health 'advantage' but over time their health becomes similar to that of the host population, as they adapt to the diet and lifestyle of the host culture (Darlington *et al*., 2015a; Sohail *et al*., 2015). This provides a clear framework for interpreting the relationship between health and immigration: individuals with relatively good health are more able to immigrate, and immigrants tend to be healthier than populations in origin and destination countries as a result of this selection process (Darlington *et al*., 2015a).

The healthy migrant theory has been taken from studies of the health of immigrants and applied to internal migration flows by researchers (Larson *et al*., 2004). Internal migrants tend to have better health in comparison to non-migrants (Boyle, 2004; Cox *et al*., 2007); but the usage of the healthy migrant theory for internal migration research has been critiqued on several points. First, the relationship between health and migration propensity is u-shaped across age. Poor health is associated with low migration rates among young adults, whereas poor health is associated with higher rates of migration among older adults (Bentham, 1988; Champion, 2005; Norman *et al*., 2005). This curvilinear association is likely because internal migrants are generally young, and this age-selection exaggerates the association between health and migration rates. The age-variation in the healthy migrant effect is often overlooked in migration studies (Norman & Boyle, 2014), as usually an 'overall' effect of health is estimated, rather than age-specific health effects. Second, the association between health and migration propensity varies by the choice of health indicator. Poor mental health and chronic diseases are associated with greater likelihoods of internal migration within the literature (Tunstall *et al*., 2014), whereas physical conditions such as LLTI are associated with a lower likelihood of internal migration (Norman *et al*., 2005). Third, the choice of comparative group, and when comparisons should be made is not agreed upon in the internal migration literature. If poor health is a selective factor for internal migration, then comparing the migration probabilities of those in good and poor health is the

most logical framework to test this idea. In the literature however, usually the previous-year migration rates of individuals in good and poor health are contrasted (e.g. Boyle *et al*., 2002), or the health of recent movers are compared to those who have not moved (e.g. Tunstall *et al*., 2014a). With these frameworks, the pathway through which health and internal migration are related is unclear. Individual health may affect the decision to migrate, and migration itself likely affects health status, and both of these processes affect the health of migrants relative to non-migrants.

These collective findings have led internal migration scholars to call for the rejection of healthy migrant theory to explain the relationship between health and internal migration (Larson *et al*., 2004; Tunstall *et al*., 2014; Urquia & Gagnon, 2011). The presumption that there is an underlying association between health and internal migration is contentious, as health and migration have common drivers that are evidenced in this chapter. Having set the impetus for research on the relationship between health and internal migration, this section will assess different conceptions and measures of physical health and their associations with internal migration. Subsequently, section 2.4 turns to mental health and internal migration.

### 2.3.2 Objective physical health and migration

Relatively few studies of health and internal migration have utilised objectively measured physically health, due to the difficulty in finding datasets which contain both measures (Boyle, 2004). The main focus of such research has been on internal migration patterns affecting the relationship between incidence (place of residence at time of diagnosis) and prevalence (place of residence at a later point in time). Participants of the BHPS tended to move back to their district of birth in the period preceding mortality, a phenomenon that is known as the salmon bias. This migration flow is a major factor determining regional mortality rates (Brimblecombe *et al*., 1999). Similarly, this health-selective migration accounts for around 30 per cent of urban-rural inequalities in mortality rates in GB at the LA level (Riva *et al*., 2011). Among a Scottish cohort of patients diagnosed with type-2 diabetes between 1985 and 1994, mortality rates were significantly higher among those who did not move by 2002 (Cox *et al*., 2007). This area of research has two points to reflect upon for the understanding of interrelationships between health and internal migration. Firstly, rates of mortality in deprived areas are exaggerated by the selective movement of low-mortality risk patients out of

deprived areas. Secondly, cross-sectional associations between prevalence and area are problematic, because a section of the population will have been exposed to risk or incidence in another area (Spallek *et al.*, 2011).

Turning to whether objective physical health is associated with the probability of becoming an internal migrant, the evidence becomes less clear. In England and Wales, internal migrants who had a different region of residence in 1939 and 1971 had significantly lower mortality rates than non-movers (Strachan *et al.*, 1995). Between 2006 and 2012 in New Zealand, those who were hospitalised with cardiovascular problems were more likely to have migrated than those who were not hospitalised (Exeter *et al.*, 2014). A cohort of patients diagnosed with type-2 diabetes between 1985 and 1994 in Tayside (Scotland) were followed up until 2002 by researchers (Cox *et al.*, 2007). The gradient between health and migration among this cohort is inconsistent with the two previous studies. Cohort members who survived the entire study period were less likely to have moved at least once in comparison to those who died between 1996 and 2002. It is likely that the timescales involved affect the relationship between health and internal migration, and that the size and direction of these relationships depend on the specific construct of health utilised, also this study did not have a comparison group without diabetes to compare migration rates to.

Research on the influence of place on migration behaviour is notably absent from the body of literature that assesses the relationship between objective physical health and internal migration. Socioeconomic deprivation is the only commonly explored area characteristic in health migration literature (Boyle *et al.*, 2002; Exeter *et al.*, 2014), whilst other area aspects such as access to employment, ethnic heterogeneity and the physical environment have been associated with migration decisions (Thomas *et al.*, 2015). As set out earlier in this chapter, place is central to theories of migration processes, with areas being understood to 'push' and 'pull' certain subgroups based on area characteristics (Lee, 1966). The effect of individual factors may be misappropriated, if such area factors are not controlled for in health migration research. Multilevel models were introduced to health geographers as a means to control for area effects on health, whilst testing the relationship between individual factors and health (Duncan *et al.*, 1998). Multilevel models have begun to garner interest in internal migration research (Thomas *et al.*, 2015) but have not been implemented in health migration research.

### 2.3.3 Self-reported health and migration

There is a lack of research on the migration patterns of cohorts with diagnosed physical health conditions (though notable exceptions include Cox *et al.*, 2007 and Exeter *et al.*, 2014). This is due to a lack of appropriate data. Such studies require information on health condition/ diagnosis, migration history that can be linked to geographical regions, and sociodemographic characteristics. As a result, self-reported measures of health are often used as proxies for morbidity. Common measures include self-rated health (SRH) and LLTI. SRH is often measured using a variant of the question "In general, how would you rate your health". LLTI is measured in the 2011 GB Censuses 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?" where responses include "no", "limited a little" or "yes limited a lot". Validation of these measures shows that they are closely related to mortality, chronic heart disease and hypertension, and bear little association with mental and social wellbeing (Cohen *et al.*, 1995; Manor, 2001; Martin & Wright, 2009; Payne & Saul, 2000).

Early studies conducted by epidemiologists concluded that individuals were poor judges of the quality of their own health, with authors calling for objective and clinically assessed measures of health to be used in general population research (Haberman, 1969). Proponents of the validity of SRH pointed to evidence that individual SRH and physicians' evaluations were closely aligned, and that SRH was much quicker to collect in comparison to diagnostic tests (Maddox & Douglass, 1973). Further controversy arose when authors of analyses of the 1991 GB Censuses concluded that LLTI was over-predicted in Wales and under-predicted in Scotland (Senior, 1998), with particularly high levels of over-prediction in traditional working class coalfield areas (Gould & Jones, 1996).

Despite these concerns, self-reported health constructs are commonly used in the health migration literature. In an editorial in the International Journal of Epidemiology, Quesnel-Vallée (2007) presents several arguments in defence of the use of SRH in research. First, the risk of mortality is 1.92 times higher among individuals reporting poor health status when compared to those reporting excellent health status on average (DeSalvo *et al.*, 2006). Even if SRH is not analogous to risk of mortality, there is an underlying association between the two. Second, the use of SRH recognises a wider trend in understanding health not just as the absence of impairment, but as a wider state of wellbeing (Curtis, 2010). In addition, test-retest analyses of SRH have shown that individuals are

consistent in their reporting when the phrasing of the question is changed, and consistent in their reporting over time (Lundberg & Manderbacka, 1996; Maddox & Douglass, 1973; Manor, 2001). Therefore, it is pertinent to view self-reported measures of health in social science research as complimentary to studies using objective measures. Maddox and Douglass (1973: 92) claim that "[self-] ratings clearly measure something more, and something less, than objective medical ratings".

There is a large body of international research linking self-reported health to internal migration. In the Netherlands, internal migrants are more likely to report good health post-move, in comparison to non-movers (Verheij *et al*., 1998). However, this association is conflated by demographic differences between the mover and non-mover populations. When these are controlled for, poor health is associated with reduced probabilities of migration at young ages and increased probabilities of migration in later ages. This finding is echoed by research on internal migration flows in Indonesia (Lu, 2008). Differences in the degree of health selection are evident by the destinations of migrants. Young rural-to-urban internal migrants are more likely to report good health status in comparison to returning rural migrants in China (Nauman *et al*., 2015).

Research on the relationship between SRH and migration in GB is mainly drawn from the 1981, 1991 and 2001 Censuses. Bentham (1988) noted that in the 1981 GB Censuses, those who reported being sick were unlikely to move at young ages, whilst the opposite was true for the eldest working age adults. Areas with high levels of in-migration had lower levels of LLTI at the time of the 1991 GB Censuses, as internal migrants were more likely to be free of LLTI than non-migrants (Boyle *et al*., 1999). The same analysis showed that migration does not fully account for regional morbidity inequalities, as morbidity was over predicted in London and under predicted in Wales, but is a significant contributor to regional morbidity patterns.

Evidence from the 2001 GB Censuses suggests that health-selective migration affects the geographical distribution of self-reported ill health and morbidity. Norman *et al* (2005) find two flows of health-selective migration: residents with low rates of LLTI moving from deprived areas into affluent areas and residents with high rates of LLTI moving from affluent areas into deprived areas. Thus the bivariate association between area-level deprivation and poor health is affected, and perhaps driven, by the selective movement of individuals with different degrees of health into and out of deprived areas (Boyle *et al*., 2002). When

migration flows are disaggregated by age more complex relationships are found; at young ages the movement of healthy adults into deprived areas improves the rates of good health in deprived areas, whereas the movement of middle-aged adults into more affluent areas depreciates rates of good health in less deprived areas (Norman & Boyle, 2014). The association between health and the likelihood of moving is not covered in these studies, which instead focus on contrasting the health of movers and non-movers. One exception is Bailey and Livingston (2005), who find that individuals with an LLTI had lower migration rates (7%) than those without an LLTI (13%) between 2000 and 2001, using data from the 2001 GB Censuses, although these figures do not account for compositional factors. Controlling for compositional differences are key to making accurate inference. When matching methods are used to control for differences in composition between those who report poor and good health, then poor health appears to be a determinant of internal migration (Green *et al*., 2017). As with research on objective health measures, methodologies employed in this area also ignore place effects, with the exception of area deprivation.

The association between self-rated health and migration also varies depending on the destination and origin of migrants. After controlling for socioeconomic and employment status, English-born persons living in Scotland are less likely to report a LLTI than England residents; whereas Scots living in England do not have a health advantage over English residents (Popham, 2006). Similar mechanisms occur within England, migrants with poor health are more likely to move into areas characterised by poor health rates and vice versa (Green *et al*., 2017). Popham's later research (Popham *et al*., 2010) also reveals interactions between LLTI and SRH which are not often noted in the literature, as the SRH of England-born Scottish residents does not differ from England-born English residents. This illustrates that internal migrants retain some form of health (dis)advantage (LLTI) from region of birth even after migrating out of the region, but this effect is not true for SRH.

### 2.3.4 Physical health and long-distance migration

The wealth of research on migration behaviour assessed above focuses primarily on the probabilities of moving between different typologies of areas, discussions of the distance of such flows are notably absent in this debate. When migration is considered as a driver of population change, then a priori long-distance migration flows are of utmost importance. Individuals moving over long-distances may

retain forms of health resilience that were established or reinforced by where migrants lived previously. This point is pertinent when considering Popham's research, which shows that individuals retain health (dis)advantages after migrating from regions of origin (Popham, 2006; Popham *et al*., 2010). To this extent, long distance migration is likely to be a driver of regional health patterns if long distance migration is health-selective.

Good physical health is consistently associated with long distance migration, over a range of measurements of health and definitions of 'long distance'. In the late 19th century, Welton (1871) claimed that there were three groups of migrants whose movements influence regional health patterns: healthy individuals moving out of the local area, unhealthy individuals moving back to their area of origin prior to mortality and town-dwellers moving into the countryside for convalescence. Implicit in Welton's claim is that the healthy choose to move, but the ill are forced into such moves through declining health or the need for recuperation. Later evidence emerged that short distance (within-county) migrants have a higher than average mortality rate, whilst long-distance (between county and region) migrants have a lower than average mortality rate in GB (Fox *et al*., 1982). The authors subsetted by age; mortality was particularly high among women aged 45 and over and men aged 75 and over among short distance migrants and low among long distance migrants aged 45-74, suggesting that compositional difference in the two groups may explain the association between health and distances moved.

These findings are flawed, as long-distance migration is analogised to intra-regional migration. Short-distance migrants living near administrative boundaries can migrate across regional boundaries with relatively short moves, whilst long distance movements across large areas do not necessarily overlap boundaries. The bias on estimates of distances moved grows if larger administrative units are used (Stillwell & Thomas, 2016). Contemporary analyses tend to use distance cut-offs to infer whether a migration was over a long or short distance, although this distinction is still open to interpretation, as the definition of the cut-off point is arbitrary in itself. Boyle *et al* (2001) find that migrants who moved 50km or further in 1990/91 had lower rates of LLTI than those who moved less than 50km, and those who did not migrate. The short-distance migrant and non-migrant groups were lumped into one category in this study, so the relative health of these two groups is not directly estimated. This shortfall is explored in research using the 2001 Censuses, where LLTI rates are lowest for long-distance

(10km+) migrants and highest for short-distance migrants (<10km), suggesting a more complex relationship between health status and distance-moved patterns (Boyle *et al*., 2002). Further work is needed to identify whether the definition of long-distance has an effect on the relationship between health and long distance migration, to assess whether these findings are scale-invariant or scale-specific.

In summary, associations between physical health and internal migration are established within the health migration literature. The relationship between physical health and internal migration is positive among young adults and negative among retirement age adults. This finding justifies separate approaches to understanding health and internal migration associations for working and non-working adults. Those in poor health appear to be drawn into deprived areas over time. For distance, it is unclear at what distances health is selective of for long distance migration, as the literature lacks a consistent definition of long distance. With the exception of area deprivation, the effect of contextual (area) influences on the relationship between health and migration are largely ignored. The following section describes the literature on the relationship between mental health and internal migration, to assess whether the mechanisms and associations are similar to that of physical health.

## 2.4 Mental health and internal migration

### 2.4.1 Deinstitutionalisation – setting the context

Before exploring the interrelations between mental health and migration, it is important to set the policy context which has determined the spatial distribution of individuals with mental health conditions across GB. Before the 1960s, mental health care was delivered in large-scale residential institutions that were often referred to as asylums. The origin of these asylums can be traced back to London's Bethlem hospital, which delivered long-term residential care for patients from the early 15$^{th}$ century, and continues to do so today at a nearby location (Cross, 2012). Although Bethlem was a small institution, only housing up to 30 patients at any one time between the 15$^{th}$ and 18$^{th}$ centuries, the institution was infamously referred to as 'bedlam' and portrayed in popular media and tours as a location where 'ranting, singing and rattling' rang through the halls (Porter, 1987). Wide scale expansion of the asylum system occurred after the 1845 Lunacy Act was passed; asylums became institutions specialising in early intervention. Individuals were involuntarily interred in asylums if they displayed

symptoms of mental disorders (Symonds, 1995). These asylums were situated in rural fringes, segregated from the increasingly urban-dwelling population. Sinclair (2002: 436) refers to London's Horton and surrounding psychiatric hospitals as the 'Epsom gulag', "country estates which were downgraded into prisons for urban inadequates". This segregation was due to beliefs that the urban environment was inherently harmful for mental wellbeing, and that natural surroundings were required for convalescence, in addition to practical concerns around self-sufficiency of these communities through industry or agriculture (Dear & Wolch, 1987).

GB began to move away from residential mental health care in the 1960s (Kearns *et al.*, 2010). De-institutionalisation was accelerated by the National Health Service and Community Care Act (1990), which included provisions for home-based care for those with severe mental disorders. Whilst in-patient care still exists, the scale has been drastically reduced. This form of care is now provided in small units attached to hospitals. Treatment is now provided primarily through out-patient and day care services, with patients living and receiving treatment in the community (Wolch & Philo, 2000). GB has moved away from concerns around separating the mentally 'delinquent' from the general population, to concerns about how well those receiving mental health care can mix with society at large. As a result, questions began to emerge about the degree of social integration that has been realised by those receiving care in the community (Drury, 1983).

GB, like other developed countries, has seen a historical shift from asylum care towards mental health care in the community. As a result, questions about where individuals with mental health needs should live has become an issue. What does the spatial distribution of this population tell us about area influences on mental health, and what role does migration play? The following section assesses the literature on the relationship between mental health and internal migration.

### 2.4.2 Faris, Dunham and Schizophrenia in Chicago

Faris and Dunham shaped the discourse on the role of social context in the aetiology and trajectory of mental health illness. Faris (1934) believed that the lack of success in determining the biological causes of schizophrenia is because ill mental health is driven by social and cultural isolation. Faris reviewed the case notes of patients presenting with schizophrenic symptoms in Chicago; the underlying theme in all case histories were of young individuals who displayed no symptoms until they, for several reasons, began to be rejected by their peers.

Faris and Dunham (1939) then developed this line of argument into the theory that social environment quality is a precursor to the onset of schizophrenic symptoms. Aggregate rates of schizophrenia in Chicago were highest in the central district, with prevalence falling as the distance from the centre increased, leading to the conclusion that residence in the impoverished and isolated central district was conducive to schizophrenic symptoms.

Ensuing work has attempted to understand how the association between urbanicity and schizophrenia arose (Hudson, 2012), and migration has an essential role to play in this association. Theories fall into two broad camps. The first, drawing on Faris and Dunham, proposes that the conditions of urban life are conducive to mental disorder. This is known as the causation or breeder hypothesis (Krabbendam & van Os, 2005). The second, known as the selection or drift hypothesis, posits that those with a propensity to the development of mental disorders migrate into urban areas where cheap housing and mental health care may be found. In short, the causes of regional geographies of mental health can be rooted either in environments (breeder) or migration flows (drift), or a combination of the two. Krabbendam and van Os (2005) suggest that both influence such geographies independently, concluding that migration or 'drift' has the lesser effect has the lesser observable effect on geographies of mental health. It has been shown that there are area effects which influence mental health, and that those with mental health needs are drawn to such areas (Johnson & Cohen, 1999).

The drift hypothesis has been denounced as a driver of the relationship between urbanicity and mental disorder, in favour of the breeder hypothesis in psychiatry and epidemiology (Kirkbride *et al.*, 2010). Those born in urban areas are significantly more likely to develop psychoses in later life (Mortensen *et al.*, 1999), thus it is well established that the association between urbanicity and psychosis cannot be explained solely by selective migration. In assessing the selection hypothesis as a driver of regional patterns of mental health geographies however, the selection hypothesis may still hold merit. In other words, selection does not explain incidence, but may still contribute to prevalence. As the primary interest of this thesis lies in migration, the following sections extant evidence for the breeder hypothesis affecting the spatial distribution of mental health will be assessed in the following section.

### 2.4.3 Mental health disorders and internal migration

Evidence emerged of interlinkages between mental health and internal migration within GB in the 1970s. Giggs (1973) conducted a factor analysis of census tract characteristics in relation to rates of schizophrenia in Nottingham (England). High rates of schizophrenia were present in central areas of the city and low rates in suburban districts, Giggs (1973 :73) noted that "there are pathogenic areas which seem to destroy mental health". Migration likely plays a role, as residential turnover in the area was positively associated with schizophrenia prevalence. Dean (1979) found that deprived inner-city areas had high rates of female readmissions for affective psychoses, and male first admissions and readmissions for depression in Plymouth (England). First admissions among females were randomly distributed across the city, whilst readmissions were concentrated in waterfront areas with high proportions of council housing and one person households, suggesting that individuals who developed mental health problems were drawn towards these areas after first contact with services (Dean & James, 1980). Admission rates for schizophrenia and depression to a local mental health facility on the outskirts of Southampton (England) in the 1970s were concentrated in central areas of the city, yet the majority of admissions were among migrants and immigrants who moved to the area in the last five years (Taylor, 1974: 478-487; 544-546). Building on Giggs' work, a later analysis of migration among a cohort presenting with schizophrenia and living in Nottingham found that the cohort were more likely to be born in deprived areas, and were often living in such areas within 5 years before initial contact with psychiatric services (Dauncey *et al.*, 1993).

From these early investigations, it appeared that mental health may be a driver of internal migration, particularly towards deprived areas. Later research has generally found those with mental disorder(s) to be highly mobile (Dembling *et al.*, 2002), and more likely to move than the general population (McCarthy *et al.*, 2007). Among one cohort of individuals diagnosed with serious mental conditions in England (Tulloch *et al.*, 2010), the annual migration rate was 27% (24% - 31%) between 1994 and 1996, compared to 10% among the general population, according to the England and Wales 1991 Census (tables SAS15 and SAS10). This may be due to a lack of appropriate housing for mental health service users, with 72% of the cohort requiring support with looking after themselves in their home. In one US study it is reported that one in four schizophrenic patients live in unstable housing, which often results in

homelessness (Drake *et al*., 1991). However, it is less clear which forms of mental disorder are associated with migration. Lesage & Tansella (1989) find no differences between the proportion of internal migrants among schizophrenic patients, neurotic patients and the general population, yet schizophrenic patients were more likely to move within the local area than those with neuroses. Abood *et al* (2002) find that bipolar disorder is associated with more frequent post-diagnosis moves when compared with non-schizophrenia psychiatric diagnoses. McCarthy *et al* (2007) find that those diagnosed with schizophrenia are 0.27 times more likely to have moved over a one-year period than those with diagnosed depression. A complementary explanation for the complex variations in migration behaviour between diagnoses is that the severity of symptoms experienced through such disorders causes variance in migration behaviour. For example, psychiatric in-patients were found to be significantly more mobile than patients receiving care in the community during 1994-16 in inner-London (Lamont *et al*., 2000). Consequently, conditions which lead to acute treatment are likely to be associated with increased post-treatment mobility.

In contrast to the fragmented geographies and definitions used in the literature, a series of studies based on administrative health records in Manitoba, Canada offer a clearer and more consistent picture of mental health migration in that region. Those with Schizophrenia were twice as likely to move between 2004 and 2006, in comparison to the general population and those with inflammatory bowel disease (Lix *et al*, 2006). A further investigation revealed that the schizophrenic patients were also more likely to move multiple times over the 3-year period (Lix *et al*., 2007). Focusing on the spatial nature of these flows, the schizophrenic group were more likely to move from the suburbs and into the inner-city areas, whilst the general population were more likely to move in the opposite direction (DeVerteuil *et al*., 2007).

It is complex to determine the mechanisms driving the relatively high rates of internal migration amongst those with mental health disorders. Given that poor physical health is associated with lower probabilities of moving, whereas the opposite is true of mental health, then the mechanisms for physical health (positive health selection, compositional differences) are likely to be different from that of mental health. Among a cohort with serious mental disorders, being aged between 17 and 31, being an inpatient recently, drug or alcohol misuse, and being able to look after the home independently were factors that were positively associated with moving. The authors of this study suggest that this could be due

to forced mobility among those with mental health problems (Tulloch *et al.*, 2010). In this cohort, desiring to move was not associated with later migration, despite the opposite being true in the general population (Coulter *et al.*, 2011). There appear to be high rates of unmet desired moves, in addition to generally high rates of mobility, associated with poor mental health.

A further driver of migration among individuals with mental health disorders may be motivated by relocation to access specialist mental healthcare services, which are generally concentrated in urban areas of GB. This phenomenon is known as 'country drift', where those with mental health problems tend to move towards areas with high concentrations of mental health services over time. This phenomenon has been observed in the US and Australia. Repeat visitors to a psychiatric emergency service in Albany (New York) were found to be mainly moving from regions surrounding the hospital into areas close to the hospital, whilst patients in the outer communities had low rates of migration (Breslow *et al.*, 1998). Among users of Veteran Association hospitals in Virginia, patients with schizophrenia and bipolar disorder tended to move towards hospitals, when compared to hospital users with no mental health diagnoses (McCarthy *et al.*, 2007). In Western Australia administrative records, those presenting to mental health services for the first time tend to be have recently moved from rural to urban areas, which the authors suggest is due to the lack of mental health care in rural areas (Moorin *et al.*, 2006). In the US, mental health service users move significantly shorter distances if their previous residence was in an urban area (McCarthy *et al.*, 2007). It appears that those requiring mental health treatment use migration as a means to manage their health, patients may be moving closer to treatment centres to receive more regular treatment, whilst those who are able to remain in rural areas and still access care are likely to do so. Conversely, moving to these urban areas may lead to deteriorations in mental health, explaining the concentration of service users in these areas. Defining temporality is key to understanding this relationship.

In terms of place effects, the literature on mental health disorders and internal migration focuses primarily on rural/urban and deprived/affluent contrasts. Other aspects of area of residence may hold particular important implications for mental health, for example access to natural space (Alcock *et al.*, 2014; White *et al.*, 2013). These associations between places and health may explain some of the relationship between health and migration. Historically, access to mental health care is not equal between rural and urban areas of GB (Watt *et al.*, 1994).

Between February 2017 and April 2017, 63% of mental health referrals for suspected first episode psychosis in England were seen within two weeks, but the percentage varies widely between some cities. Around 26% of patients are being seen within two weeks in Birmingham's CrossCity Clinical Commissioning Group, in comparison to 100% in the Brighton and Hove Clinical Commissioning Group (NHS Digital, 2017a). Individuals with mental health disorders may be encouraged to leave areas with poor healthcare provision in GB, thus area factors should be taken into consideration when assessing the relationship between mental health and internal migration.

There is a lack of analysis on the distances of internal migration performed by those with mental health disorders, relative to control populations. McCarthy *et al* (2007) separate the distance moved between two years for users of Veteran Association hospitals in the US by diagnosis (schizophrenia, bipolar, depression and a control group with no mental disorders). The median miles moved was similar for schizophrenic (13.3) and the control (13.5) groups, higher among the depression group (15.5) and highest among the bipolar group (18.7). Breaking the figures into categories, schizophrenic patients were more likely to make short distance (0-4 mile) moves than the depression group, whilst the bipolar and depression groups were more likely to move longer distance (20+ miles) than the control group. After controlling for demographic factors, homelessness, service usage and substance abuse, schizophrenic patients moved 95% (91-99) farther than the control group, whilst bipolar patients moved 17% (13-22) farther, and depression patients 20% (16-25) farther, although the confidence intervals suggest that there are no significant differences between the bipolar and depression groups. This review of the literature did not find evidence of analyses of the distances moved among those with mental health disorders in GB, and this is a potential avenue for future research.

### 2.4.4 Self-rated mental health and associations with internal migration

The literature on mental health conditions and migration is primarily drawn from small cohort surveys or administrative data. Research using survey data has focused primarily on self-reported measures of health, rather than diagnostic data (Tulloch *et al*., 2010). Instruments measuring mental health like the General Health Questionnaire (GHQ) are often used as screening tools for mental disorder as they are easy to collect (Jackson, 2007), and have been validated as robust (Goldberg *et al*., 1997). The association between migration behaviour and self-

reported mental health in GB generally concurs with research on studies using clinically diagnosed patients as subjects: those with mental health needs are a relatively mobile group.

Tunstall *et al* (2014) utilised a question on whether respondents consider themselves to have "anxiety, depression or bad nerves [or] psychiatric problems" to define psychiatric morbidity. With the exception of adults aged 30-39, individuals who moved within GB were more likely to report psychiatric morbidity in the preceding survey wave than those who did not move. This relationship may be mediated through mobility preferences, as those with high GHQ scores are particularly likely to want to move in the first two years of USoc (Woodhead *et al*., 2015). It follows then that mental health may be a driver of desiring migration, and this may explain the relatively high rates of migration amongst those with poor mental health, although this effect has not been tested over a long period. These analyses also did not control for place effects, with the exception of deprivation. Those with mental health needs may be concentrated in undesirable areas, and this may explain the relationship between mental health and the desire to move rather than it being the effect of mental health.

The relationship between mental health and migration varies by origin and destination. Those who move to greener areas of GB display improvements in mental health (GHQ) over time, compared with movers to less green areas (Alcock *et al*., 2014). Similarly, poor pre-move mental health is associated with moves into more materially and physically deprived areas over time (Tunstall *et al*., 2014), representing drift into urban and deprived areas for those with relatively poor mental health.

Findings from outside of GB are less consistent. In one Peruvian study, it is reported that rates of psychiatric morbidity (measured by the GHQ) do not differ between rural residents, urban residents and those moving from rural areas and into urban areas (Loret de Mola *et al*., 2012); however this study draws it's sample from one shanty town and its surrounding rural area. In contrast, a systematic review finds that rural to urban migrant workers in China report worse health on the overall SCL-90-R scale and all of its constituent subscales in comparison to the general population (Zhong *et al*., 2013). When internal migrant workers are compared to rural residents, there are no significant differences in the psychological quality of life and suicide risk, although migrant workers had low risks for depression (Dai *et al*., 2014). Comparing urbanicity at birth and current residence, both rural-to-urban and urban-to-rural migrants report higher

rates of mental distress than those with permanent registration in urban and rural areas (Chen, 2011). Outside of the health of migrants themselves, households with out-migration appear to suffer a mental health penalty, which has been attributed to stress caused by household members leaving (Lu, 2008). A partial explanation may lie in the 'salmon bias' (Abraído-Lanza *et al*., 1999), where rural residents become internal migrant workers when they are in good health, but tend to return to their area of origin once they age or develop health problems (Xiang, 2007).

### 2.4.5 Future directions in health and migration research

This section concludes the critical review of literature that is pertinent to health and migration. Several avenues for future research have been identified that could contribute to the overall understanding of the interrelations between health and internal migration. First, multilevel approaches have been under-utilised in the literature. This absence has implications for findings. When multilevel structures are accounted for in migration research, there is substantial variance at the area of destination (Boyle & Shen, 1997). Advances in methodology which control for variance at the area of origin and destination show substantial variance in distance moved at both higher levels (Thomas *et al*., 2015), but this framework has not been used to assess whether individual health is associated with the likelihood of moving, controlling for place of residence. The associations between health and migration may be conflated by such area influences, as rates of poor physical and mental health are not evenly distributed across GB, thus further work is needed to test whether individual health has an effect on the probability of moving within the multilevel framework.

Much of the testing of the 'healthy migrant theory' for physical health in GB has been based on microdata from the 1991 and 2001 Censuses, and does not control for area effects on migration behaviour. At the time of writing, the most recent release of census microdata had not yet been used to assess whether health remains associated with migration behaviour. Between 2001 and 2011 the proportion of the population moving has decreased (Champion & Shuttleworth, 2015), the average distance migrated has fallen, and rates of ill health have also fallen (NHS Digital, 2016a). Within this context, the direction and strength of the associations between health and internal migration may have changed, and thus a re-examination in the multilevel framework is necessary.

The healthy migrant theory for physical health has also been applied to long distance migration within the UK, but the definition of what constitutes a long distance has varied across these studies. There is a need for research in this field which tests the association between physical health and these definitions, to identify at which distances health selection occurs, and whether this relationship is scale invariant.

For mental health, there is evidence of complex linkages with both desiring to move and achieving desired moves, with evidence of both entrapment and displacement amongst those with serious mental health conditions. Mental health has been associated with these forms of internal migration over short intervals and in analyses which have not controlled for place of residence effects, thus further work is needed.

Evidence from Bentham (1988) and later Norman & Boyle (2014) indicates that the health and internal migration relationship is age-specific. This is because the drivers of migration differ during childhood (who are usually not the agent of the migration decision), young adulthood (primarily moving for education and employment), middle-ages (for family and employment) and around or during retirement (amenity, towards family and into care homes). These drivers throughout the lifecourse relate to health in different manners. Health may be a barrier to entering university education or employment, and thus negatively associated with health in young adulthood, whilst the onset of poor health may lead to a necessary move towards the family in pre-retirement. Further research in this area should distinguish between age groups in order to tease out the underlying effect of health on migration behaviour.

On the basis of this review and the identified research gaps, further research is needed on the relationship between migration and health in the UK. In the empirical chapters of this thesis internal migration (Y) will be predicted by mental or physical health status (X), controlling for key sociodemographic mediators (age, social class, education, ethnicity, employment and place) identified in this review.

Three research questions emerged from the literature review, all centred on the relationship between health and internal migration among the working-age population in Great Britain, to control for age-specific variations in this relationship. Each research question will be addressed in the empirical chapters of this thesis:

Q1. Is physical health associated with internal migration, controlling for place of residence?

Q2. Is physical health associated with long-distance migration, and does the definition of long-distance affect this association?

Q3. Is the relationship between mental health and future internal migration explained by ability to meet mobility preferences, independent of place effects?

# Chapter 3 Data landscape

The purpose of this chapter is to assess the data available for exploring the relationship between health and migration in GB. In the absence of a population register containing detailed information on place of residence and characteristics for the population of GB, as seen in many Nordic countries, a wide array of migration data are available within GB, each with their own properties and setbacks. Each country of GB is subject to a decennial Census, which collates limited health and migration data, and such Census data are often the prime source of data on migration patterns (Bell *et al*., 2015). Census data are supplemented by administrative (collected for non-research purposes) data. GB has a wealth of administrative data (Jones & Elias, 2006) which have been underutilised for health and migration research relative to other developed nations such as Finland, Denmark, New Zealand and Australia (Simon, 2014). Survey data are utilised more often in the GB context than administrative data. GB has a wealth of surveys, the UK Data Service holds data from 62 surveys in the UK (UK Data Service, 2017a), and this is not an exhaustive list. Conversely, the availability of (longitudinal) surveys which follow individuals over time is poor relative to the USA (Gershuny, 2002). GB has a relative wealth of birth cohort surveys, where babies born in a particular time period are followed over their lifetime. In context, the UK has a total of 34 birth cohorts (Medical Research Council, 2014) the continent of Africa has an estimated 28 (Campbell & Rudan, 2011), 6 in New Zealand, 17 in Australia (Townsend *et al*., 2016).

The different datasets derived from the Census, administrative sources and survey data which contain data on migration and health are discussed in this chapter, with the aim of identifying sources of data for the three analytical chapters of this thesis. The definition of migration, measures of health, units of observation, temporal release, sample size and level of geography vary between sources, thus a review of sources and their suitability to answering the research questions set in the previous chapter are required.

## 3.1 Definitions

For the purpose of this thesis, internal migration is considered to be a change of permanent residential address within GB (Rees & Wilson, 1977). With this basic working definition, there is a distinction between migration *transitions* (whether

an individual moved within a given period) and *events* (the number of times an individual moved within a given period). The former are usually captured by censuses and surveys, whilst the latter are sourced through population registers (Stillwell *et al*., 2010). In addition to whether an individual moved or not, the place they moved from (*origin*) and where they moved to (*destination*) are also of interest. A further distinction can be made between whether the movement of individuals or households are considered. Many drivers of migration behaviour operate at the household level (Greenwood, 1985), for example the head of the household may decide to relocate their family in order to take up a new job with greater pay (Geist & McManus, 2012). In this framework, household members are seen as 'tied movers', i.e. the head of the household unit determines whether they move or not. As the focus of this thesis is on the relationship between one's health and their migration behaviour, only sources containing measures of individual migration are considered. Finally, the distance of residential moves is also of interest, and contained in relatively few datasets.

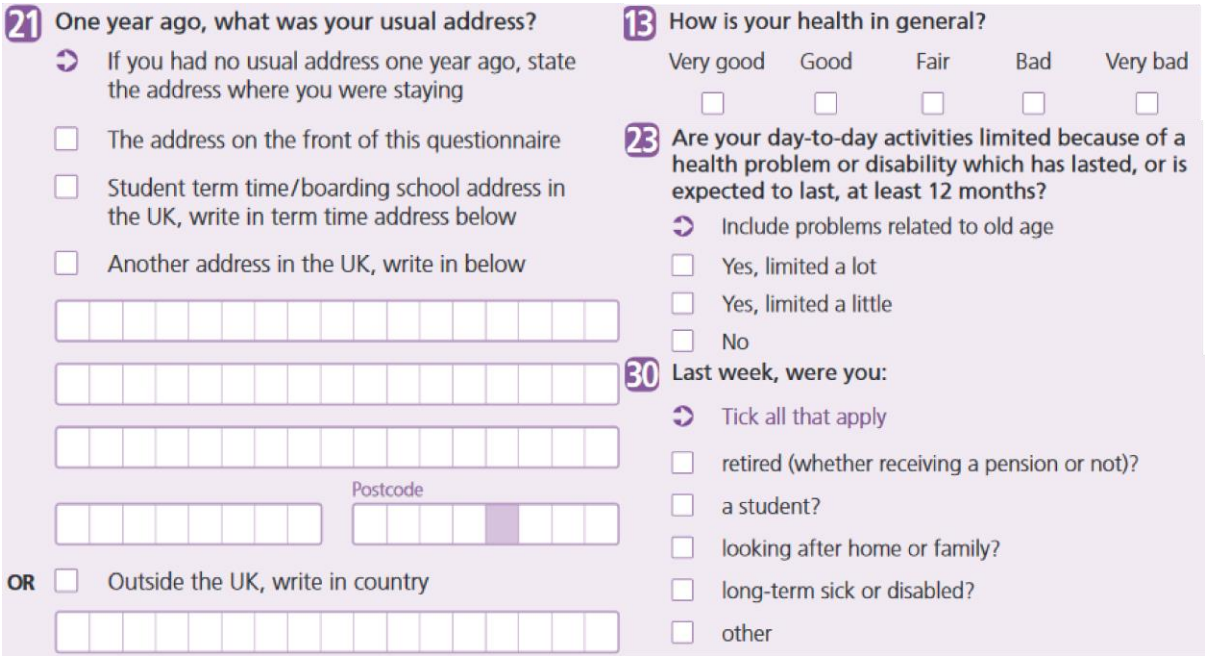
## 3.2 Great Britain's Censuses: definitions and tabular data

In GB, the decennial Censuses are one of the key sources of data on internal migration available to statistical agencies and academia. England and Wales share a common Census, administered by ONS, and Scotland has its own Census, administered by NRS. After Census returns are processed, several different releases of data are prepared, containing differing levels of detail, aggregation and spatial resolution, but all relying on Census-specific definitions of migration and health. The two Censuses utilise the transition definition of internal migration. Question 21 of the England and Wales Census (question 10 in Scotland) form asks 'one year ago, what was your usual address?', the form includes the following responses: 'the address on the front of this questionnaire', 'student term time/ board school address', 'another address in the UK' and 'outside the UK' (see Figure 3.1). Individuals are then asked to provide their address if they lived at another address one year ago, or provide the country if they lived outside the UK.

There are three measures of health captured in each of the Censuses (displayed in Figure 3.1): SRH, LLTI and long-term sickness/disability. Question 13 of the England and Wales census form (19 in Scotland and 24 in Northern Ireland) asks 'how is your health in general', and has five possible responses ranging from 'very good' to 'very bad', similar to items in other instruments of health status,

such as question one of the SF-36 (Ware & Gandek, 1998). The second measure captures the extent of health problems, often referred to as LLTI, as it was known in previous Censuses (Wright *et al.*, 2016). Question 23 of the England and Wales census form (21 in Scotland) asks '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' has three possible responses, 'yes, limited a lot', 'yes, limited a little' or 'no'. The final measure is of long-term sickness or disability. Question 30 of the England and Wales census form (28 in Scotland) asks 'last week were you…', there are five possible responses (and respondents are asked to tick all that apply), and one of the responses is 'long-term sick or disabled'. These self-report measures exhibit strong validity as proxies for chronic morbidity and predictors of future mortality (Manor, 2001), and are suitable for research on physical health and migration. Notably absent in these measures is a construct of mental health, and this is one area where the differences in the Censuses begin to have implications for health and migration research.

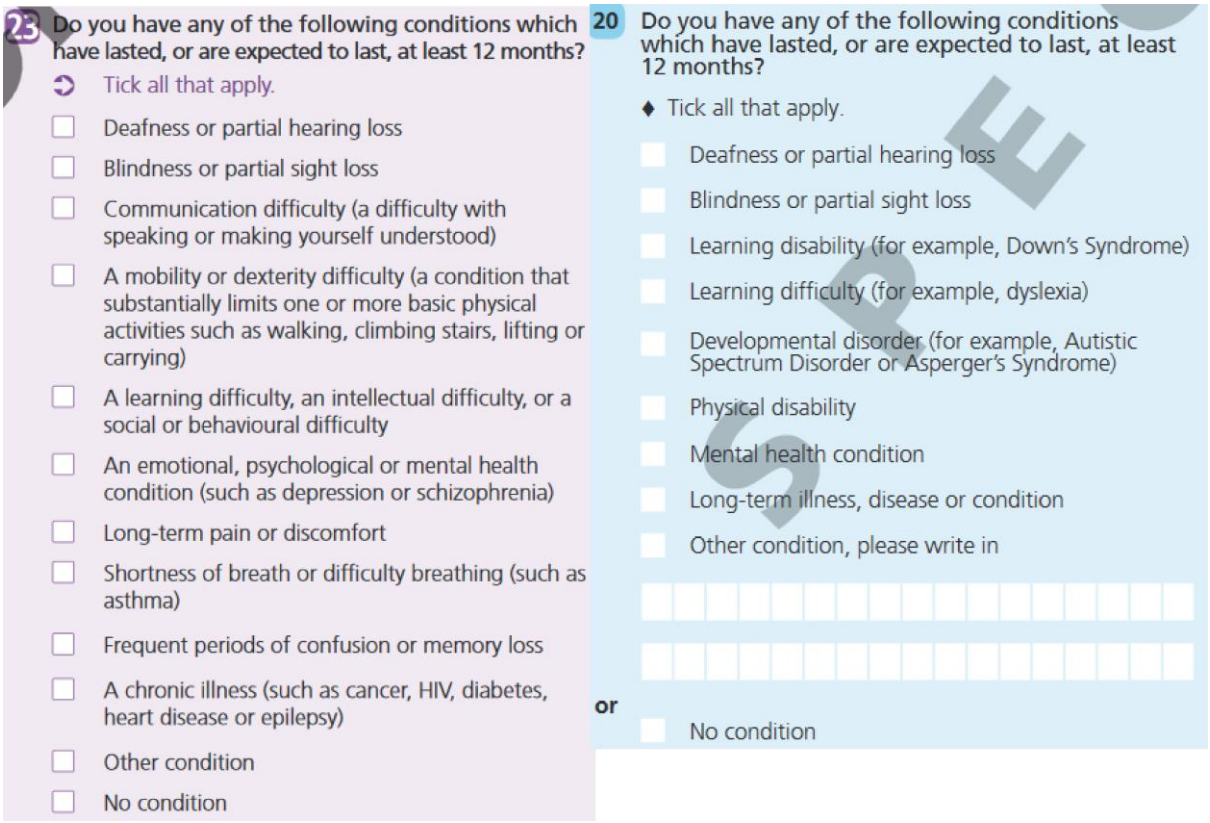
Figure 3.1 Migration and health questions in the 2011 England and Wales census form




The Scottish Census includes a further question asking respondents to indicate one (or more) health conditions which have lasted or are expected to last at least 12 months (question 20), but this question is absent from the England and Wales Census. In the 2011 Scottish Census, one of the responses is '[a] mental health condition'. This question was introduced in the 2011 round of Censuses, and differs from commonly used multi-item instruments such as the General Health

Questionnaire and the Patient Health Questionnaire. A similar question was introduced in the Northern Ireland 2011 Census, and early validation suggests that simple self-report questions are strong proxies for mental health. One third of those who committed suicide in the 33 months following the 2011 Census in Northern Ireland reported an emotional, psychology or mental health condition (Tseliou *et al.*, 2016). Given that the aim of this thesis is to explore mental as well as physical health in GB, the England and Wales Census is insufficient for mental health research, so Scottish Census data or alternative sources will be required to explore mental health effects.

Figure 3.2 Multiple health conditions questions in the 2011 Northern Irish (left) and Scottish (right) Censuses




### 3.2.1 Census tabular data

A limited number of cross tabulations, where counts of individuals in combinations of two or three criteria are presented, are available for the 2011 Censuses. One of the measures of health captured by the 2011 round of Censuses (LLTI) may be tabulated with internal migrant status across the UK (Nomis, 2015b). This cross tabulation (replicated in Table 3.1) allows the proportion of internal migrants to be calculated separately for those reporting either 'no', 'a little' or 'a lot' of limitation of their day to day activities due to

health problems or disabilities. There is an association between health and internal migration, as the percentage who migrated is lower among those whose daily activities are limited by health problems, relative to those with no day to day impairments. The tabulation may be broken down by Middle layer Super Output Areas in England (MSOA, medium sized administrative areas with populations between 5 and 15,000), and Intermediate Zones in Scotland (areas with populations between 2,500 and 6,000) to explore whether this association is consistent across GB.

Table 3.1 Cross tabulation of limiting long term illness and internal migration (UK)

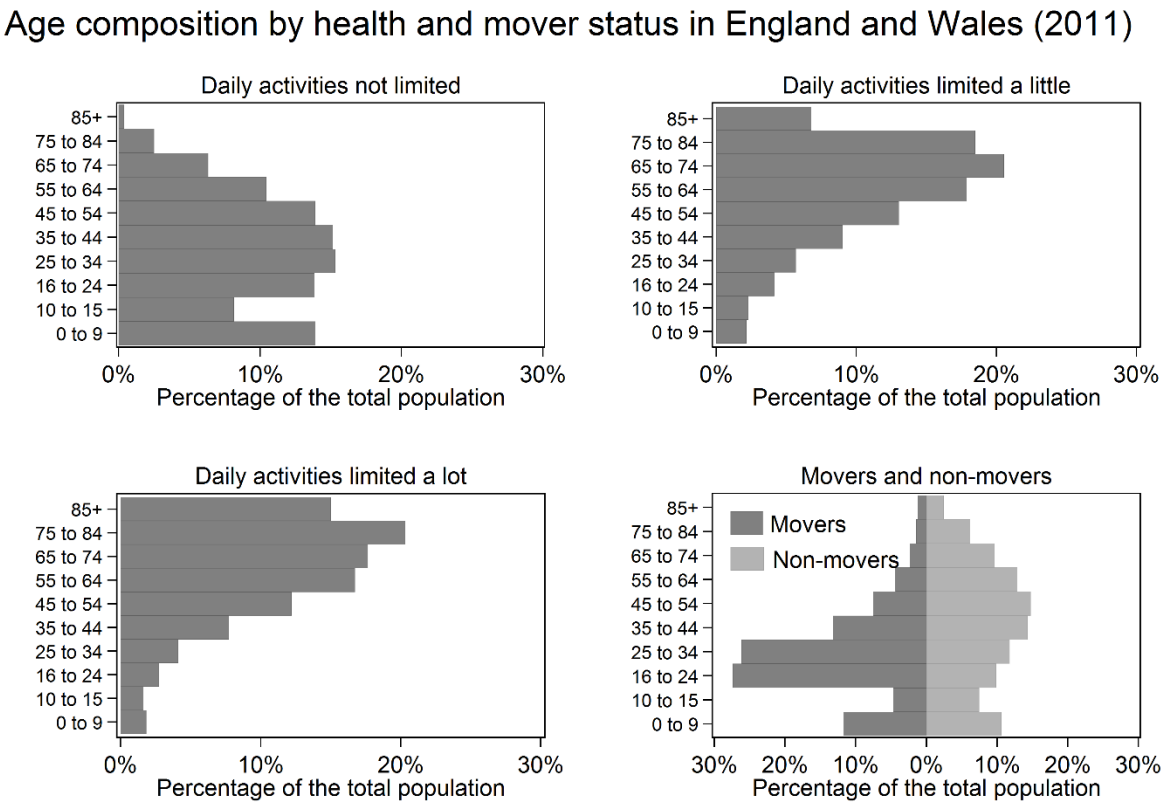
| LLTI | Lived at same address one year ago | Lived elsewhere one year ago | Percentage who migrated |
|---|---|---|---|
| **Day-to-day activities limited a lot** | 5,109,215 | 371,192 | 6.77% |
| **Day-to-day activities limited a little** | 5,566,866 | 386,645 | 6.49% |
| **Day-to-day activities not limited** | 44,913,299 | 6,143,710 | 12.03% |
| **Total** | 55,589,380 | 6,901,547 | 11.04% |

**Source: England and Wales, Scotland and Northern Ireland 2011 Censuses** (Nomis, 2015b)

Whilst tabular data can be used to unpick the relationships between migration and health, the lack of ability to distinguish between population subgroups makes inference difficult. It is important to bear in mind that there is considerable heterogeneity in the socio-demographic composition of the populations in good and poor health. It is well established that low relative income (Wilkinson & Pickett, 2009), manual employment, unemployment (Chandola *et al.*, 2003) and Pakistani or Bangladeshi ethnicity (Darlington *et al.*, 2015a) are associated with poor health in the UK, as well as migration behaviour (Champion, 2005; Simpson & Finney, 2009). This heterogeneity should be controlled for, as health-differences in migration behaviour may be the result of socioeconomic composition, rather than a 'health effect' per se. For example, producing bar charts of population composition separately by LLTI from microdata drawn from the England and Wales 2011 Census shows that those with an LLTI are relatively older than those without an LLTI (see Figure 3.3). Repeating the process for movers and non-movers shows that the population who move are relatively younger than the population who do not move. Thus, there is a bivariate relationship between health and mover status that does not necessarily imply that health is a driver of migration, as those who move are relatively young, and those

who are unhealthy are relatively old. If the tabulation could be broken down by broad age group this would allow analysts to control for this confounding factor, to see if the relationship between health and migration differs by age group. This limitation means that tabular data are not a suitable source for answering the questions underlying this thesis. In addition, whilst this tabulation may be broken down by area, it is not possible to identify where these migrants moved from. Understanding where individuals with varying degrees of healthiness are moving from is important to establish whether health has an influence on migration, independent of place of residence. In order to obtain such origin and destination flow data from the Censuses, other releases are required.

Figure 3.3 Age composition by health and mover status




Source: 2011 Census Individual Safeguarded Sample, author's own calculations

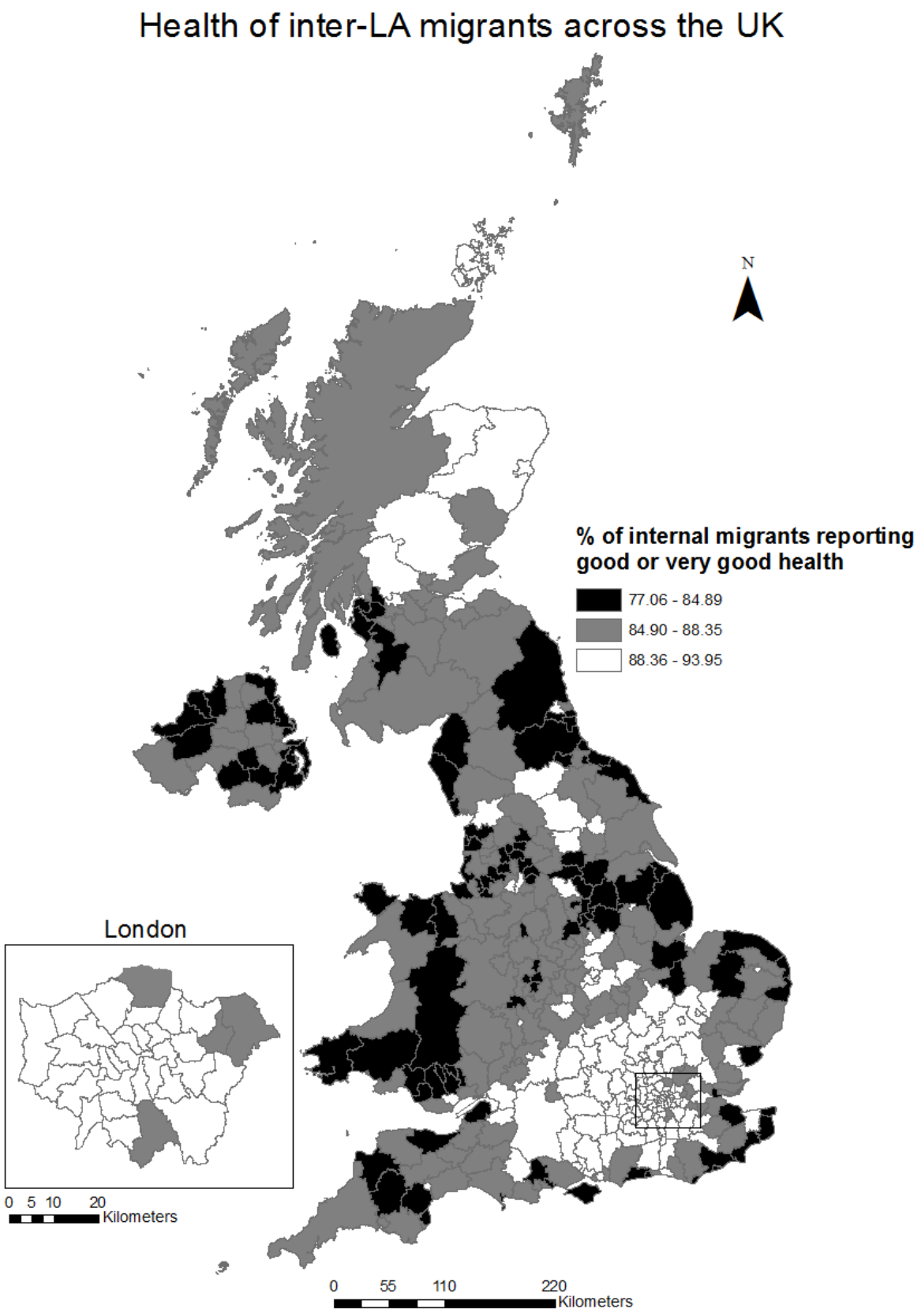
### 3.2.2 Census flow data – Special Migration Statistics

Aggregate flows between areas are released after each round of the Censuses. This dataset is known as the Special Migration Statistics (SMS; Rees & Duke-Williams, 1995). The SMS was introduced after the 1981 Censuses. The SMS dataset contains flow information for all internal migrants, based on the address an individual lived in one year prior and their address at the time of the Census,

and whether they reported moving. The dataset contains the counts of movers for multiple attribute tables, within an origin and destination matrix. The granularity of origin and destination areas data depends on the risk of disclosure from the attribute table (Rees & Duke-Williams, 1995). An up to date list of releases of the SMS is kept at the WICID UK Data Service webpage (UK Data Service Census Support, 2016). Aggregate flows are available for Output Areas (small statistical areas with an average population of 309). Electoral Ward (medium-sized administrative areas with an average population of 6,543) flows can be broken down by age and sex groups, and all other flows are available at the LA level. As the SMS contains information only for internal migrants, the data must be combined with appropriate population denominators to calculate the rates in-migration, out-migration and within-area migration (Stillwell & Hussain, 2010).

Clearly the SMS are a rich source for analysing migration patterns at the sub-national level, however, a review of the SMS literature bears no evidence of analyses examining the relationship between health and internal migration. Two measures of health status which are common between the UK Censuses are available: the five-point general health question (SMS Table MU03UK) and the question for LLTI (SMS Table MU07UK) are both available as attribute tables for LA flows. Different releases are available depending on whether all residents are included or whether those born outside of the UK are excluded. After shaping the latter dataset into an origin and destination format, the relationship between health at the time of the Census and migration transitions in the year preceding the Census can be examined in several ways. To illustrate this, the five-point general health question is combined into two categories: those who report good or very good health, and those who report average, poor or very poor health. Limiting the cells to those which contain counts for inter-LA migration flows (off-diagonal cells), the percentage of internal inter-LA in-migrants reporting good or very good health can be calculated for all UK LAs. On average, 86.9% of inter-LA in-migrants report good or very good health, but this percentage varies across the UK. Figure 3.4 shows that inter-LA in-migrants are healthy relative to the average in the area west and north of London, North-East Scotland and London itself, whilst the opposite is true in Northern Ireland, Wales and the idlands.

Figure 3.4 Health of inter-LA in-migrants by destination in the UK 2010/11



Whilst the SMS are a rich source for analysing migration patterns, the lack of usage by those interested in health differentials in migration patterns may reflect underlying shortcomings in the structure and definitions used in the SMS for health mobility research. The lack of ability to subset the SMS by several factors, in common with Census tabular data, is a particular problem for research. There are compositional differences between the populations in good and poor health, which makes isolating the effect of health difficult without data on confounders. In addition, there are underlying problems with the disclosure control methods applied to LA-LA migration flows in the SMS, wherein small cells are adjusted. The exact methodology is undisclosed, however analysis of the 2001 Census suggests that if cell counts for origin and destination flows take values of 1 or 2 then the ONS applies a 'Small Cell Adjustment Methodology', whereby these values are adjusted to a value of 0 or 3 (Duke-Williams, 2010), and a similar procedure was conducted for 2011 data (Office for National Statistics, 2007). When flows are stratified by small subgroups then the proportion of cells which have been adjusted will rise and the accuracy of the underlying data will be reduced, for example 92% of the cells for LA-LA flows for the group who report very bad health contain counts of 0, some of which are genuine and some of which will be the result of an adjustment procedure. It is possible to calculate the expected distance of LA-LA flows by comparing the distance between LA centroids at origin and destination, although this method presents no estimate for intra-LA moves, and experiments find that short distance migration is underestimated with this method (Stillwell & Thomas, 2016). Due to these shortcomings, individual level Census data are considered instead.

### 3.2.3 Census microdata

Thus far the recurring theme has been that aggregate data are inadequate for the purposes of this thesis, due to the inability to control for compositional differences in the populations with good and poor health. Census microdata, as opposed to the SMS and tabular data, contains individual level information. In the interest of accessing data with sufficient sample sizes for health-stratified and multilevel analysis, only census products derived from the England and Wales Census are considered, although similar products exist in Scotland. Currently there are 5 different versions of Census microdata for the England and Wales 2011 Census, varying by the number and specificity of variables and sample size (see Table 3.), with similar versions for Scottish data. Each release of Census microdata contains a transition measurement of internal migration, derived from

question 23 of the England and Wales Census questionnaire (see Figure 3.2). Given that the focus of this thesis is on individual migration, and that migration behaviour is known to be sensitive to local-area characteristics (Lee, 1966), only the LA safeguarded and secure micro-datasets are considered. The safeguarded and secure files contain over 100 variables measuring a variety of socioeconomic characteristics. This allows differences in composition to be controlled for whilst investigating the relationship between health and internal migration, unlike aggregate data. Both the safeguarded and secure versions contain a measure of the distance of move, and thus are suitable for answering the second research question on distances moved by health status. The straight-line distance between an individual's current residence and their residence one year ago is calculated by the ONS. In the safeguarded dataset this is released in bands of distance (e.g. 0-2km, 3-6km), and in the secure sample it is released in a continuous format, in 100 metre increments. The safeguarded file provides the LA an individual lives in at the time of the Census, allowing differences across migration destinations to be explored. In this dataset LAs with populations below 120,000 persons are grouped, such that there are 265 combined LAs in this dataset out of a total of 324 LAs in England and Wales (Office for National Statistics, 2016). This is problematic as these groupings are not made on the basis of homogeneity (i.e. dissimilar LAs may be grouped together), so contextual LA-specific data are missed when combining these areas together. This grouping effect may mask underlying influences on migration behaviour at the LA level.

Table 3.2 Geographies, sample sizes and availability of England and Wales Census microdata

| Census microdata file | Lowest level of geography | Sample size | Availability |
|---|---|---|---|
| OGL teaching file | Government Office Region | 1% | Open Government Licence |
| Individual Safeguarded Sample (CISaS) | Government Office Region | 5% | Special licence [a] |
| Individual Safeguarded Sample | LA | 5% | Special licence [a] |
| Individual Secure Sample (CISeS) | LA | 10% | Secure environment only [b] |
| Household Secure Sample | LA | 10% [c] | Secure environment only [b] |

[a] Data may be accessed through any device conditional on data management protocols [b] Data may only be accessed at an ONS secure environment [c] Sample size refers to a sample of all households rather than individuals.

The secure sample contains an individual's LA at the time of the Census (destination) and their LA one year ago (origin), and these LAs are not grouped, enhancing the level of detail possible in potential analyses. The inclusion of origin and destination data permits an analysis of push and pull effects on migration behaviour, however health status is measured only at the time of the Census (when individuals lived within destination LAs), and not one year prior (when individuals lived within origin LAs).

England and Wales Census microdata offer large numbers of individuals, with three measures of health status, migration and distance of migration, and differences between LAs can also be explored. For these reasons the secure sample are utilised in this thesis to answer the first (is physical health associated with internal migration, controlling for place of residence) and second (is physical health associated with long-distance migration, and does the definition of long-distance affect this association) research questions. The third research question (is the relationship between mental health and future internal migration explained by ability to meet mobility preferences, independent of place effects?) relies on longitudinal data, where health is measured at a point (or points) in time and compared to migration at a later date, such a study design cannot be conducted on the secure sample. For the remainder of this chapter longitudinal sources of data from the Census, administrative sources and surveys are considered, for the purposes of answering the third research question.

### 3.2.4 Census longitudinal studies

In addition to the standard releases of Census microdata mentioned above, there is a separate dataset which follows a subset of individuals between Censuses. For England and Wales, the ONS Longitudinal Study (LS) contains records from the 1971 Census onwards for individuals born on any one of the four days in the calendar year chosen by the ONS, for a total of 1% of the population (Smallwood & Lynch, 2010). Individuals may enter the sample through birth or immigration, and exit the sample through mortality or emigration from England or Wales. After entering the LS, individuals' Census returns for subsequent Censuses are linked, to enable researchers to study individual behaviour over the 1971-2011 period. For health measures, the LLTI question was asked from the 1991 Census onwards and the SRH question from 2001 onwards, but the LS enhances the available data by linking to mortality records and the cancer registry. The time nature of the LS allows more causal associations to be drawn from the data, however there is a

ten-year gap between exposure (health) and outcome (migration), thus events and changes within the interim period may conflate such causal associations.

The Scottish equivalent is known as the Scottish Longitudinal Study (SLS), which dates back to 1991 for any individuals born on 20 birthdates, for a total of 5.5% of the Scottish population (Hattersley & Boyle, 2007). The SLS contains more detailed information drawn from inpatient (1981-present) care, outpatient care (1997-present), interactions with substance abuse agencies (1996-present) and prescription data (1993-present) for all SLS members which could be linked to these datasets (Administrative Data Liason Service, 2013). The SLS also contains more detailed information on place of residence; the postcode of mother's usual residence at birth is provided, as well as postcodes in 1990, 1991, 2000, 2001, 2010 and 2011, which can then be aggregated into larger areas for contextual analysis (Feng, 2013). Contextual data are also readily available, including deprivation indices (Carstairs, Townsend, SIMD), urbanicity, air pollution (in 1km grids), weather records (in 5km grids), green space and smoking rates (Feng, 2013).

There are problems in using the LS and SLS to track migration and health behaviour for individuals over time, as the definition of these concepts in the Censuses has changed over time. The question used to derive internal migration has varied over the 1991, 2001 and 2011 Censuses, these changes are illustrated using the England and Wales Census, as shown in Figure 3.2. In 1991, the England and Wales Census offered three tickboxes for individual's usual address one year ago: 1) the same as their current usual address 2) different (from their usual address) or 3) a child aged under one. In 2001 the 'child under one' box was removed and a 'no usual address one year ago' box was introduced. The latter category was intended for those aged less than one and the small proportion who were homeless one year ago. The proportion of individuals aged one or older who were reported as having no usual address one year ago was much higher than expected, implying that the 2001 routing order was misunderstood (Office for National Statistics, 2012b). In addition, those living at a term time address in 1991 may not have indicated that they had moved, as the 1991 question specifies whether an individual's usual address has changed, and this would have led to an unknown undercount of students moving from term time addresses to another address. In 2001 the migration question included specific instructions for those who lived at term time addresses to indicate that they lived elsewhere one year ago, likely leading to more accurate estimates of

such moves. This means that estimates of the proportion moving in 1991 and 2001 cannot be directly compared without accounting for the relative overestimation in 2001 and underestimation of term time to other address movers in 1991. The 'no usual address one year ago' box was removed for the 2011 Census, and a separate tickbox was added for those who lived at a term time or boarding address one year ago. Analysis conducted by the ONS (2012a) found that the use of the word 'elsewhere' in 2001 may have led to very short distance movers (i.e. within the same neighbourhood or city) not reporting that they had lived elsewhere one year ago, as the wording implies that the two areas are distinct in some manner. The ONS' assessment is that figures from 2001 and 2011 are broadly comparable, but that the counts for each individual tick box are not directly comparable, with the bias tending towards a higher proportion of movers using the 2011 rather than the 2001 question. In addition to inconsistencies in the wording of the questions used to measure internal migration, the way in which Census returns are recoded has also changed. For the 1991 England and Wales Census, movers of distances less than 500 metres were recoded to be non-movers, whilst in the 2001 and 2011 Censuses any change of address is considered to be a move, regardless of the distance between addresses (Champion & Shuttleworth, 2015).

The questions used to measure health status have also changed over the period. The most drastic changes are found in the general health question (13). This question was not included in the 1991 England and Wales Census. In 2001 this was a three-point question, where respondents could rate their health as 'good', 'fairly good' or 'not good' over the last twelve months. Compare this to 2011, where respondents were asked to rate their health in general (with no time component explicitly defined) on a five-point scale, including 'very good', 'good', 'fair', 'bad' and 'very bad'. A simulation study of the switch from a three- to a five-point scale finds that the overall trend is towards individuals reporting better health on the five-point scale, 52% of individuals who reported 'not good' health were projected to report 'fair' or better health (Smith & White, 2009). The LLTI question (23) underwent a less drastic change. In the 1991 England and Wales Census, the wording was "do you have any long-term illness, health problem or handicap which limits your daily activities or the work you can do?", and included tickboxes for yes and no. The 2001 question replaced the word 'handicap' with 'disability', whilst the 2011 question introduced that qualifier that the problem "has lasted, or is expected to last, at least 12 months" and separate tickboxes for 'yes, limited a lot' and 'yes, limited a little'. The move from a yes/no dichotomy to

a three-point scale may have encouraged those with low-impact health problems to indicate that they are limited a little, whereas they may have answered no in the yes/no dichotomy, although no research has explicitly tested the impact of this change.

In summary, the LS would allow a research design that measures health at 1991 or 2001 and estimate the association with migration behaviour at 2001 or 2011 respectively for the third research question, however the long period between 'exposure' (health status) and the outcome (migration) makes isolating the health effect difficult. For instance, an individual reporting good health in 2001 may have fallen ill in the year preceding the 2011 census and as a result required a move to another residence close to specialist healthcare facilities, such a health transition cannot be captured by the LS. The SLS would allow exposure to change in the intercensal years, utilising hospital or prescription data, but this dataset has a small sample size and is geographically limited relative to the LS. For this reason alternative longitudinal administrative and survey data are considered in the remainder of this chapter.

### 3.2.5 Limitations of Census data

Census data are a useful tool for exploring the relationship between health and migration, however the findings of such analyses must be placed in the context of the Censuses themselves. The GB Censuses are decennial; the LS does not capture changes in intercensal years and the SLS captures changes in health but not migration. The common migration question of each Census can only be used to define movers as those whose address at time of the Census differs to their address one year prior. This definition does not capture several migration patterns: i) return migration - those who moved to a new address in the interim, but returned to the same address before the day of the Census are not captured and are considered to be non-movers ii) multiple movers - the Census does not measure how many moves were performed in the interim period iii) recent movers - the Census does not distinguish between moves which occurred one day prior or moves which occurred three-hundred days prior.

The common measures of health captured by the Censuses: SRH, disability and LLTI, are open to scrutiny. Self-reported measures of health are widely used as a proxy for 'healthiness' in social science research (Quesnel-Vallée, 2007), as individuals who report poor health have higher future mortality rates (DeSalvo *et al.*, 2006). Critiques of the validity of self-report measures of health were covered

in section 2.3.3. More recent investigations show significant positive associations between self-rated health and mental wellbeing (Lachytova *et al.*, 2015), but it remains unclear how distinct these two concepts are. As England and Wales Census microdata (which do not measure mental health) are used for the first two research questions, it is important for the third analysis to investigate the relationship between mental health and migration, to assess if the physical and mental-health selection processes are similar.

There is evidence of an underlying bias in the proportion of individuals who report moving. Shortly after the 2011 England and Wales Census, the ONS ran a face-to-face interview on a small sample of respondents (called the Census quality survey). Previous studies show that interviews lead to more accurate responses, as interviewers can prompt respondents and ensure that the question is correctly understood (Office for National Statistics, 2014c). The results of the survey find that Census respondents incorrectly report moving as they misunderstood the time-frame of moves to be considered, as a result the Census overcounts the proportion of movers, and this is particularly prominent for Census returns filed via the internet.

Although the Censuses provide the largest sample sizes of the data described in this chapter, every census represents an undercount of the population. The ONS estimate that 93% of all persons resident in England and Wales on March 27th 2011 responded to the Census (Office for National Statistics, 2012c). Undercoverage is not an inherent problem, but can lead to inaccurate inference if non-respondents differ from respondents (Groves, 2004). Such differences are evident across place, as coverage rates are particularly low in inner-London (87%), and relatively high in the East of England (95%) and the South West (95%), although this may be due to differences in socioeconomic composition rather than place per se. In addition, there are differences in response rates among various socioeconomic groups, which have been identified during quality control checks for census returns (Office for National Statistics, 2012c). Groups who have low coverage rates include those who are in a same-sex civil partnership (88%), self-identify as Arabian (72%), full-time students (85%) and immigrants intending to stay less than 6 months (73%). Conversely groups with high coverage rates include the married (97%), retired (97%) and those aged 40 and over (97%).

## 3.3 Administrative data

As mentioned in the beginning of this chapter, GB lacks a single and unified population register, although numerous administrative datasets exist. The term 'administrative data' refers to a dataset which is created and maintained to support the administration of government services, which may be used for research purposes. For the purpose of addressing the research questions outlined in Chapter 2, administrative datasets are considered if they contain record-level information for individuals, some measure of place of residence, and one or several measures of health status.

Within GB there is a wealth of administrative data (Simon, 2014), however linkage between these datasets is made difficult by a lack of common unique identifiers and a cultural reluctance to share administrative data for research purposes from government departments (Administrative Data Taskforce, 2012). Individual records collected through routine healthcare administration use a unique identifier known as the 'NHS number' (Office for National Statistics, 2012d), records related to benefit and earnings data use the 'National Insurance number' (Office for National Statistics, 2013c), and electoral roll data contain no unique identifiers (Office for National Statistics, 2013d). This situation is likely to improve with the passing of the Digital Economy Act (2017), which grants powers for greater data sharing for research purposes. Currently, most administrative datasets can only be considered independent of one another, e.g. electoral data cannot be used to validate address data from hospital records without some form of 'probabilistic linkage', which will introduce error.

### 3.3.1 HES/MHMDS

GB's publicly funded healthcare service (the NHS) operates as a two-tiered system, where there is a distinction between primary (frontline) care and secondary (specialist) care. General Practitioners operate as primary healthcare professionals, providing care and advice for patients, and procuring secondary (speciality, outpatient and hospital) care on behalf of patients (Greenfield *et al.*, 2016) if deemed necessary. Patient-record data for secondary care are available on a monthly basis as a dataset known as the Hospital Episode Statistics (HES). Every month secondary care providers submit details of procedures and routine care carried out for each patient to the Secondary Uses Service, in order to claim funds from the NHS (NHS Digital, 2016b). These data are released to NHS Digital

who apply quality control measures and anonymise the data to be used for research purposes as the HES. A fee must be paid to access HES microdata, which is dependent on the number of required fields, geographical extent and frequency of extracts (NHS Digital, 2014). Each record contains the date and length of treatment, clinical information and geographical identifiers (Health and Social Care Information Centre, 2015). Each patient may have several such observations within a given extract. Individuals may be linked between annual extracts as persistent anonymised patient identifiers are derived by NHS Digital.

HES records contain information on the primary diagnosis (i.e. primary reason for using services) and secondary diagnoses (co-morbidities and historical health problems), cancer registry membership and can be linked to mortality data through the ONS. The diagnosis codes are based on the 10th edition of the International Classification of Diseases (ICD-10). Each individual record contains a number of geographical identifiers derived from an individual's postcode. Within an annual extract, geographical codes may be compared between observations, if the two differ then a measure of migration may be derived. For mental health care, a separate dataset containing inpatient, outpatient and community treatment episodes is also available, known as the Mental Health Minimum Data Set (MHMDS; NHS Digital, 2016). This release is important for exploring the breadth of mental health care, as GB moved towards a care in the community model in the 1990s, where individuals seeking treatment for mental health conditions are preferably treated outside of the hospital (Moon, 2000).

Annual extracts of the HES or MHMDS may be linked to explore the migration propensities of individuals receiving treatment for different conditions, to test whether the 'healthy migrant effect' varies across health conditions. In studies based in the US and Canada, individuals who received treatment for schizophrenia and were more likely to move than those with depression, and those with inflammatory bowel disease, for example (Lix *et al.*, 2006; McCarthy *et al.*, 2007). The detailed level of geography allows contextual information for individuals' local area of residence to be attached to individual records from external sources, which would allow tests of whether the relationship between the local environment and migration differs across health conditions.

At the time of writing this review, there is no evidence of published work which has explored migration patterns using HES or MHSDS, despite the richness of the sources detailed by the respective data dictionaries. A systematic review of studies using HES data published between 1989 and 2011 (Sinha *et al.*, 2013)

finds that of 148 published studies, the largest proportions explore inequalities in outcomes (27%) and time-trends in outcomes (22%) and a small number explore the epidemiology of specific diseases (12%). Given the evidence that migration patterns have an impact on regional inequalities in mortality (Brimblecombe *et al*., 1999), it is puzzling that HES/MHSDS data have not been used to explore the origins and destinations of migrants with specific health conditions.

### 3.3.2 Limitations of administrative data

There are two major disincentives related to accessing HES or MHMDS data. These two issues: public perception of secondary uses of healthcare data and NHS Digital's application process are inherently intertwined, as explained in this section.

At the time of writing, there is widespread concern and lack of trust regarding secondary use of patient data. Patient data became a major public issue in 2014 with the advent of the 'care.data' initiative. The care.data initiative aimed to create a central electronic database for patient data, drawn from primary and secondary care records as well as historical information about allergies and vaccinations. This dataset would have been much larger in scope than the HES/MHMDS, and the dataset would be available for research purposes, for projects deemed to promote or be beneficial to healthcare (Sterckx *et al*., 2016). The initiative was scrapped after it was uncovered that the NHS had sold extracts of HES to the Institute and Faculty of Actuaries in 2013, who used the data to validate insurance premium pricing, an analysis which led to increased premiums for those aged under 50 (Donnelly, 2014). Controversy also arose over ethical issues. Under the Data Protection Act (1998), sensitive data (including measures of health) may be used for research purposes if due diligence is paid to disclosure protection, and patients are informed of the purposes of research. However NHS Digital is exempt from this stipulation as they have a legal authority to collate such data and do not directly create patient data (Grace & Taylor, 2013). Concern about data rights arose among the public and led to campaigns for the public to 'opt-out' from having their data shared by NHS Digital (this opt-out includes HES and MHMDS releases), with 2.3% of patients choosing to opt-out as of March 2017 (NHS Digital, 2017b).

This lack of public trust led to a review of data releases by NHS Digital (then HSCIC), known as the Partridge review (Partridge, 2014). The review found that

93% of HES data released between April 2009 and 2012 complied with NHS Digital's governance protocols, however nine projects were receiving supplementary mortality data from the ONS without proper approval. As a result of this review, NHS Digital redeveloped management procedures and access agreements for data releases. It is plausible that the care.data saga and the findings of the Partridge review led to HES and MHMDS data becoming harder to access. NHS Digital require applications for HES data to submitted and approved by the Data Access Advisory Group. Data access is relatively likely to be granted if it reaches the advisory group; 75% of the 47 requests received from academic institutions were approved between October 2015 and March 2016 (Bell, 2016). The time required to access HES or MHMDS data can be lengthy, as NHS Digital have a target for data delivery to take no more than 60 working days once applications are ready to be heard by the DAAG, pending approval. Given that an application needs to be prepared before this stage, it is reasonable to expect the process to take longer than 90 working days (just over a third of a year).

### 3.3.3 An account of barriers to accessing administrative data

Despite the ethical and time considerations in using MHMDS data, an application for six years of MHMDS data (2006-2012) was prepared in late 2014 for this thesis. As identified in this chapter, in order to explore the effect of mental health on migration one has took look beyond the Censuses; as the England and Wales Census contains no measure of mental health, whereas the Scottish Censuses does, but the longitudinal counterpart (SLS) has considerable lag between measures of migration. It was decided that the MHMDS should be used instead of survey data due to the temporality, sample size and geographical detail offered by this dataset. What follows is an overview of the application, and an account of the difficulties encountered which led to the decision to pursue survey data instead.

The original aim of this was to explore the relationship between mental health and migration within England using MHMDS data. The project was granted funding by the Economic and Social Research Council Southampton Doctoral Training Centre and the Administrative Data Research Centre for England. Ethical approval for the study was granted by the University of Southampton's ethics board in October 2014. The application included aggregating each individual's place of residence at each year between 2006 and 2012 into Lower layer Super Output Areas (LSOA; small statistical geographies with between 1,000 and 3,000)

to minimize the risk of disclosure. LSOA codes were planned to be linked to green space, deprivation and Census in- and out-migration data to explore potential interactions between mental health, place and migration over time. The data was to be hosted at the Administrative Data Research Centre for England's (ADRC-E) secure environment at the University of Southampton, in order to reduce the risk of inappropriate access to sensitive data on individual health and residential trajectories. The centre's governing body is the Administrative Data Research Network (ADRN). The ADRN have their own project approval board, and the ADRN applies for data on behalf of researchers for approved projects. A project proposal was submitted to the ADRN board in December 2014 and a revised proposal was later resubmitted in January 2015, and approved in April 2015. The ADRN began liaising with HSCIC (now known as NHS Digital) in June 2015.

The first barrier to access was related to the storage of the final linked dataset. As the dataset would contain detailed information on the area of residence for mental health service users over a six year period, as well as information on the characteristics of these areas, there is a possibility that individuals could be identified by those accessing the final dataset. One could use look up tables to link combinations of area characteristics, and then identify the areas individuals lived in at a given time, even if area identifiers were pseudonymized. The ADRN minimizes this risk by hosting the data in an accredited 'secure environment', which has no internet access, and where data cannot be exported without being vetted by members of staff for disclosure risk (Lowthian & Ritchie, 2017). The ADRN were informed that NHS Digital have their own form of accreditation, and that the Administrative Data Research Centre for England's secure environment at the University of Southampton did not hold this accreditation. As a result another institution would need to host the dataset. It was indicated on the application form that that the secure environment at the ONS's office in Titchfield (known as the Virtual Microdata Laboratory), or the secure environment at the University College London were potential hosts for the dataset, neither of which were accredited by NHS Digital at the time when this application was processed.

Even without identifying a site to host these data, another barrier emerged, related to timescales. The project was approved by the ADRN in April 2015, and formal discussions between the ADRN (as applicants) and NHS Digital (as data holders) began in May 2015. A protracted series of discussions (described in Table 3.) were held with the ADRN and NHS Digital, which did not proceed at a rate where data would arrive within a timeframe suitable for this thesis.

Table 3.3 Timeline of author's application for MHMDS data

| Date | Progress in applying for MHMDS data |
|---|---|
| 25/09/2014 | PhD studentship begins |
| 23/10/2014 | Project approved by the University of Southampton's ethics board |
| 09/12/2014 | Project submitted to the ADRN |
| 22/01/2015 | Project application revised and sent to the ADRN |
| 20/02/2015 | Received notice that the project was not heard at the latest ADRN Approvals Panel |
| 24/04/2015 | Project approved by the ADRN Approvals Panel |
| 15/05/2015 | ADRN begin to discuss draft application with HSCIC (now NHS Digital) |
| 18/08/2015 | Phone call held with the ADRN – ADRN, NHS Digital & ONS liaising on data linkage and storage |
| 10/09/2015 | Phone call with NHS Digital – agreed the details of a bespoke abstract of the MHMDS, project to be heard by the NHS Digital approval board in the near future |
| 25/11/2015 | Informed by ADRN that the Administrative Data Research Centre for England's secure environment is not accredited to the standard required for this dataset and a suitable host needed to be found before data release |
| 18/12/2015 | ADRN submit an application for data with the Data Access Request Service at NHS Digital. The author of this thesis was only informed of this on 21/01/2016 |
| 11/01/2016 | Informally told by a member of the ADRN that the data may be hosted at the ONS |
| 21/01/2016 | Informed by ADRN that the project will be discussed at the next approvals panel – if approved the data are expected to arrive within 30 working days |
| 27/01/2016 | Informed by NHS Digital that the project is 'complex', has not been heard by the approvals panel and that the intent of the application is 'unclear', if approved the data are expected to arrive within 60 working days |
| 24/09/2017 | Intended submission data for this thesis |

This account of applying for administrative data is not intended as a criticism of any of the bodies mentioned, but rather an explanation of why using administrative data was not a viable option for this thesis. By the time NHS Digital stated that the application would have to be rewritten, cross-sectional analysis was already underway using the 2011 England and Wales CISeS. At this point, nearly half of the PhD studentship had passed and, as it was still unclear when or if the MHMDS dataset would arrive, a decision to use survey data for longitudinal analysis was made.

The following section presents a review of the suitability of survey datasets for the third research question: is the relationship between mental health and future internal migration explained by ability to meet mobility preferences, independent of place effects? Surveys were considered if they met the following criteria: the dataset contains an indicator of health status, migration and place of residence, and these indicators are captured over several instances.

## 3.4 Survey data

Thus far sources of census and administrative data (HES/MHMDS) have been discussed, and the need for survey data has been established in light of temporal issues in the LS/SLS, and data access barriers for administrative data. The requirements are twofold; first a data source that measures health and migration at several points in time is required, to control for reverse causality (i.e. migration is affecting health, rather than health influencing migration). Second, data which can be readily accessed are required, as the account of applying for administrative data demonstrates that delivery of administrative data is uncertain in the GB context. The extent to which longitudinal survey datasets are suited to answering the questions posed in this thesis is then explored. The basic premise of survey data is to ask a series of questions of a small sample of individuals, in order to make inference on the prevalence of unknown characteristics of interest among the general population (Curtice, 2007). Longitudinal surveys expand this approach by attempting to follow the same population over several iterations of a survey, the content of which may change over time. In section 3.4.1, a justification for cross-sectional surveys not being considered for the analyses contained in this thesis is provided. Different forms of longitudinal surveys and their suitability are then assessed, under the following categories: panel surveys (where a population are sampled and the followed over time), cohort studies (where a population of a similar age, or with a shared characteristic are sampled and followed) and birth cohort studies (where a population are sampled at birth and followed).

### 3.4.1 A note on cross-sectional surveys

Surveys where all questions are asked at one point in time are known as ‘cross-sectional’ surveys. Information about current health and migration history are collected in numerous cross sectional surveys in GB. Information is usually collected on whether an individual or household have moved recently, or the

length of time spent at their current address (Bell *et al.*, 2015). In the context of the questions posed in this thesis, cross-sectional surveys do not hold a sufficient advantage over Census microdata described in section 3.2.3. Some cross-sectional surveys contain finer geographical detail on previous and current place of residence (such as Axciom's Research Opinion Poll) in comparison to Census microdata (Thomas *et al.*, 2013). This benefit is weighed against the limitation set by smaller sample sizes and lower population coverage in most cross-sectional surveys relative to the GB Censuses. As the questions posed in this thesis are framed through a multilevel perspective, large sample sizes are required to ensure that there is adequate variation in migration and health status within each geographical area present in the data (Centre for Multilevel Modelling, 2017). In addition, many cross-sectional surveys which contain measures of migration do not also have measures of health status. If measures of health are collected, then by definition they measure post-move health, so it is not possible to investigate the third research question with such data. In light of the relative limitations of cross-sectional survey data in comparison to Census microdata, only longitudinal surveys are considered for the third research question in this thesis ('is the relationship between mental health and future internal migration explained by ability to meet mobility preferences, independent of place effects').

### 3.4.2 Panel surveys

Although GB has a large number of panel surveys (UK Data Service, 2017b), only the Labour Force Survey (LFS) and the BHPS/ USoc collect health and migration data for individuals over several waves. The LFS is a quarterly survey which dates back to 1992, and is still running at the time of writing. Although the LFS is primarily designed to capture employment-related trends, the survey contains questions on how individuals rate their health, as well as health-related absences from work. The LFS has a rotating panel design, where households participate in five waves, allowing change to over time to be examined (Office for National Statistics, 2015d). Despite this design, the LFS does not follow households who move, so movers are excluded from future waves. Individuals are asked to provide their length of residence at their current address only in the first wave, however information on previous health is not collected. The LFS has a smaller sample size and lower population coverage in comparison to Census microdata discussed in section 3.2.3. As the data on health and migration are similar in both Census microdata and the LFS, the LFS is not considered as an alternative to Census microdata in this thesis.

Data landscape

The BHPS began in 1991, with a sample of approximately 10,000 individuals followed up over a total of eighteen waves (Brice *et al*., 2010). There are two ways in which migration is measured in the BHPS. There is a derived variable measuring whether an individual or household has moved since the previous survey wave. Second, there is also a question asking how long an individual has lived at their current address. These two measures may be compared to identify cases where individual responses differ from survey measures and vice versa. There are numerous measures of health status and behaviours captured by the survey, however the questionnaire content changes over time. An index of which health questions are captured in each wave may be found on the user support page (Institute for Social and Economic Research, n.d.). Health measures which were collected in all survey waves include: in-patient stays, GP visits, the number (and type) of health problems, general health (except wave 9), cigarette smoking and the 12 item General Health Questionnaire (GHQ), an instrument measuring the risk of common mental disorders (Goldberg, 1978). The BHPS was discontinued in 2008, a new survey began in 2009 (USoc) which is similar in design and content to the BHPS. After the inception of USoc, it was decided that BHPS sample members would then be included in USoc, and those who were successfully followed-up and wished to do so then began to participate in wave two of USoc (2010/11). The BHPS sample continue to participate in USoc, and maintain their unique identifiers from the BHPS, allowing their responses to be linked over the two surveys. All of the health measures mentioned in this paragraph are also captured within USoc, allowing the effective BHPS panel to extend past 2008.

Whilst the content and structure of the BHPS and USoc are appropriate for studying the relationship between health and future migration behaviour, one issue which needs to be overcome is the lack of an indicator of individual migration in USoc. The migration indicator presented in the USoc dataset is measured at the household level, with the same value being given to all household members if the survey is carried out at a different address than in the previous wave (Understanding Society User Support, 2016). As a result, individuals who enter the survey for the first time or drop out and return later may be incorrectly labelled as a mover, and it is unclear what value is given if one household member moves away whilst others remain. In comparison, the BHPS contains a derived measure of individual migration based on interview address and household composition change, and is therefore unaffected by such issues. Work which intends to take advantage of the potential linkage between the two surveys will have to develop a measure of individual migration which is consistent

between the two surveys, potentially through comparing geographical unit of residence or grid reference (longitude and latitude) data at each survey wave.

### 3.4.3 Cohort studies

An inherent shortcoming of panel surveys is that less information is known about the history of participants before they began participating in the panel. Often questions on health and migration histories are asked in longitudinal surveys, but as the time between the current survey and events of interest increases, the likelihood of remembering the event decreases (Raphael, 1987). This is particularly problematic when inference is made in panel studies if there are differences in the accuracy of the recall of events across social or economic groups, a phenomenon known as the 'recall bias' (Basso *et al.*, 1997). Recall bias has been established in the reporting of childhood health across levels of education (van de Mheen *et al.*, 1998), for example. A particular form of longitudinal survey where participants of a similar age are followed up are known as cohort surveys. Some cohort surveys sample individuals during their teenage or adult years, often asking these individuals to recollect past events and moves and then tracking changes over time, and these may be termed 'adult cohort surveys'. Other cohort surveys sample individuals at birth or during childhood, and these may be termed 'birth cohort surveys'. Birth cohort surveys (arguably) have the benefit of reducing the effect of recall bias, as baseline information is provided by parents during childhood and then updated at intervals during adulthood, instead of adults being asked to recall their event history at adulthood.

There are several cohort surveys which have been considered as datasets to address the third research question in this thesis: is the relationship between mental health and future internal migration explained by ability to meet mobility preferences, independent of place effects? The Longitudinal Survey of Young People in England (LSYPE) sampled children aged 13 attending secondary schools in 2004, and followed-up these individuals annually until 2010 (Department for Education, 2011). At each wave, the LA the young person lived in is recorded, and several questions measuring health are collected in waves 2-4 and 6-7, including questions about general feelings of healthiness, anxiety and depression. Migration is not included as a measure in the dataset, but a measure may be constructed by comparing the LA of residence between two waves, however this approach will exclude moves within LAs. The short length of this cohort survey

means that it is therefore not considered suitable for the third research question of this thesis. Cohort members are aged 20 in the final wave of the survey, so there is only a short frame of time where members may move out of their parental home, and these moves are likely to be primarily for education reasons rather than driven by health per se (Smith & Jons, 2015). The second cohort survey which was considered is the English Longitudinal Study of Ageing (ELSA). ELSA began in 2002 and has 7 waves of data, the latest collected between May 2012 and June 2013 at the time of writing (NatCen Social Research, 2016). ELSA members are aged 50 or over when they are sampled. Several measures of health are collected (many of which are age-related e.g. Parkinson's disease), and the LA of residence is collected at each wave, which can be used to construct a measure of migration. This dataset is therefore not considered suitable for the third research question of this thesis as the drivers of migration for this age group are substantially different from those of working age (Thomas, Stillwell, & Gould, 2016). Historic health and migration data are collected at the third wave of ELSA, and this data has successfully been used to explore migration trajectories across the lifecourse (Falkingham *et al.*, 2016), however there has not been any examination of the accuracy of these histories. Two similar studies are ongoing in Scotland (known as the Lothian Birth Cohorts), where aptitude tests took place in 1921 and 1947 and the samples were followed up at ages 79 and 70 respectively (Deary *et al.*, 2012), and these cohorts are not considered for similar reasons to ELSA.

There are several birth cohort studies based in GB. The oldest birth cohort is the 1946 National Survey of Health and Development (NSHD). The cohort included interviews of 13,000 mothers who had given birth during one week of March 1946, and the sample are re-interviewed intermittently (Watts, 2011). At each re-interview several measures of physical and mental wellbeing are collected, as well as sociodemographic characteristics (Kuh *et al.*, 2011). The cohort profile on the Medical Research Council lists 'housing' as one of the characteristics collected during survey sweeps, but it is unclear if a migration indicator is measured or may be derived (Medical Research Council, 2015), and for this reason this dataset is not considered for this thesis. Shortly after the NSHD was underway, the 1958 National Child Development Study (NCDS) birth cohort began. Data were collected on the families of just over 17,000 babies born in GB during one week in March 1958, and the research team has followed these individuals over nine surveys, most recently in 2013 when the cohort were aged 55 (Brown & Hancock, 2015). Over the period numerous measures of health have been collected at different

ages, participants who died in-between follow-ups are recorded as such in a separate file which may be linked to the individual's responses in previous waves. There are two ways in which a measure of migration may be derived from the study. The region and LA are recorded at baseline and each survey wave. Although there is some inconsistency in the administrative boundaries of these areas over time (Johnson & Hancock, 2015), an indicator of migration from place of birth may be derived if the current LA differs from the LA of birth, and an indicator of between-wave migration if the current LA differs from that reported in the previous wave. At each wave respondents are asked to provide the year at which they moved into their current address, this can be used to calculate between-year migration rates and between-wave migration rates. The NCDS is not considered suitable for this thesis due to the relatively low sample size of the survey. For example, the latest wave has 9,137 respondents, and this is inadequate for capturing health and migration behaviour at the LA level. There are 378 LAs in GB, so there will be an average of 24 individuals per area (if they are evenly sampled), and likely very low numbers of those in poor health and/or movers. These small numbers will limit the variety of models which will converge.

The British Cohort Study began in 1970 and is similar in content and structure to the National Child Development Study. Data were collected for just over 17,000 babies born in the UK during one week in April 1970, with the cohort being followed up eight times, most recently in 2012 when the cohort were aged 42 (Brown & Hancock, 2014). This cohort study contains a similar number of health measures as the NCDS, including a mortality register. During each survey wave, respondents are asked whether they live at the same address as the previous survey wave (Centre for Longitudinal Studies, 2016) and if they have moved, how long have they lived at their current address, so the between-year and between-wave migration rates may be calculated. The lowest level of geography available is region (the entire UK split into 12 areas), and therefore this dataset is not considered applicable for this thesis, as migration is sensitive to local area factors, which must be controlled for to make inference on the effect of health on migration (Lee, 1966).

The Avon Longitudinal Study of Parents and Children (ALSPAC) is a birth cohort survey which follows the children of 13,761 mothers who lived in the Avon area in South West England with an expected date of delivery in 1991 (Fraser *et al.*, 2013). These mothers and their children are followed up at irregular intervals, when they are asked to fill in a questionnaire on behalf of themselves and their

children and answer several health-related questions in a rotating design. A biobank contains genome, serum and plasma data for participants taken at various points over the period. The dataset does not contain a measure of migration (University of Bristol, 2017), but the address at which each survey was conducted is aggregated to a range of geographical identifiers including grid reference (presumably derived from participants' postcode), which may be used to construct such a measure. Although this dataset meets the requirements for this thesis, a decision was made to seek alternative sources for reasons of representativeness. First, as the survey was designed to explore the relationship between mothers and their children, there is not a comparative sample of non-mothers or men. This limits what can be inferred from an analysis on the relationship between health and migration, as any associations may be moderated or mediated by motherhood, and there is no suitable comparative group to control for this effect. This sample bias could be worked around by using offspring data, but at the time of writing this cohort is aged 19 years old at the latest survey sweep, too young to gather large numbers of moves independent of their parents. Second, participants were selected from one defined geographical area in England, relationships between health and migration behaviour observed among this cohort may not be replicated in other areas of GB, thus a survey with a wider sampling frame is required.

There are two recent cohort studies which are not considered to be appropriate for this thesis, as the cohorts have only reached teenagehood or younger. The Millennium Cohort Study began in 2001/02, when cohort members were aged 11 months old (Hansen *et al.*, 2014). The Born in Bradford cohort study sampled pregnant mothers between 2007 and 2010 in a city in the North of England and follows these mothers, their partners and their children over time. Currently there are 5 waves of follow-up data (the latest at 3 years old), where mothers provide information on their health as well as their child's health, as well as address data (Born in Bradford, 2017). The Born in Bradford study is geographically limited, the factors influencing migration in this cohort may be subject to region-specific factors and may not apply to GB in general. Both of these datasets have the required data for this thesis, however only for the cohorts' parents. This limits the amount of inference possible from these datasets, as non-parents are not sampled, and the recruitment rate for fathers is much lower than that for mothers, for example there are 3.7 times as many mothers as fathers in the Born in Bradford study.

### 3.4.4 Limitations of survey data

Several issues inherent to longitudinal survey and cohort data must be considered when working with such data. Panel conditioning, for example, is a phenomenon wherein participants change their reporting of behaviours or attitudes in future surveys as a result of being asked questions within prior surveys. Several mechanisms for panel conditioning have been offered, for example: repeated questioning may reinforce the acceptability of stigmatised behaviours or attitudes, participants develop a more trusting bond with the survey team over time or participants may learn that certain responses lead to shorter survey routes (Warren & Halpern-Manners, 2012). Pertinent to health, panel conditioning effects have been found to increase rates of unhealthy and healthy behaviours or outcomes in later survey waves. Respondents are more likely to report illicit drug use, regular exercise (Williams *et al*., 2006) and are less likely report feeling happy or energetic (Warren & Halpern-Manners, 2012), but less likely to report feelings of depression or anxiety (Sharpe & Gilbert, 1998), relative to those who had not been asked questions on these behaviours previously. Given that the combined BHPS and UKHLS cohort are observed over a total of 23 survey waves, and the birth cohorts over 7 waves, there may be substantial conditioning effects on the health measures covered in these surveys. The expected direction (and upward or downward reporting bias) is not entirely clear from the literature and appears to be outcome-dependent, so there is no consensus on how to adjust for conditioning. Any analysis based on such data would have to take the conditioning effect into account, or at least consider the impact this may have on the results.

Aside from issues of conditioning, non-response also needs to be accounted for. In the longitudinal context there is a distinction between unit non-response (never taking part in the survey), wave non-response (not taking part in a certain wave, but later returning), item non-response (not answering a specific question) and attrition (not taking part in any future waves of the survey past a certain point). With survey data, inference is made from a sample to the population. Unit non-response can affect whether the sample at the start of the survey represent the overall population, and attrition can affect whether sample who partake in every survey represent the overall population. These forms of non-response are problematic if non-respondents differ from respondents, that is to say that there are selection processes associated with non-response and/or attrition (Mostafa & Wiggins, 2015). Analysis of response probabilities in the BHPS finds that survey

non-response is related to region, tenure, household size, marital status, employment status, age and sex (Taylor *et al.*, 2010). Survey non-response may be controlled for using weights for the probability of response, however these weights cannot be applied in all statistical packages, for example MLwiN has not incorporated weights for MCMC estimation (Centre for Multilevel Modelling, 2011). Survey non-response is negligible in the birth cohort surveys, for example 1.2% of eligible births were not covered in the first sweep of the NCDS (Hawkes & Plewis, 2006). For attrition, evidence from the BHPS and cohort surveys suggest that attrition is also not random. Attrition is found to be related to household amenities, household size, parental social class and the number of family moves in the NCDS (Hawkes & Plewis, 2006), whilst attrition is related to physical impediments, time spent at home and migration (Uhrig, 2008) in the BHPS. Attrition can be controlled for using longitudinal weights, or research designs which utilise multiple patterns of wave response (i.e. statistical models which can be used where subjects are not measured at the same number of timepoints), such as multilevel modelling (Hedeker & Gibbons, 1997).

## 3.5 Synthesis of available data

To conclude, the purpose of this chapter was to evaluate existing datasets for answering the questions posed in this thesis. Three research questions were established in the literature review chapter for working-age adults within Great Britain, based on gaps in the literature:

1) Is physical health associated with internal migration, controlling for place of residence?

2) Is physical health associated with long-distance migration, and does the definition of long-distance affect this association?

3) Is the relationship between mental health and future internal migration explained by ability to meet mobility preferences, independent of place effects?

These research questions are addressed within three distinct research papers, which together will develop the understanding of the relationship between health and migration within GB. It is important to note that questions 1 and 2 are focused on associative effects between health and migration, so cross-sectional sources were considered, whilst question 3 focuses on predictive effects, so

longitudinal sources were considered. What follows is a summary of which datasets could be used to answer each question.

The England and Wales Census has the greatest population coverage of available cross-sectional datasets, contains three measures of health, has a properly defined migration measure and the distance of residential moves are calculated. Turning to the different releases of Census data, tabular and flow data are not appropriate for the questions posed in this thesis, as these data are not able to control for (multiple) socioeconomic confounders. This is important because, as established earlier, there are several socioeconomic characteristics which are associated with migration (Champion *et al.*, 1998), as there are with the likelihood of poor health (Andres, 2004), and these characteristics need to be controlled for to 'isolate' the effect of health itself. Census microdata provide a large sample size, which can be broken down by LA, and contains two externally validated measure of health status. Given that the focus of this thesis is on individual migration, the 2011 England and Wales CISeS (a 10% sample of individual Census returns) are used to answer the first and second research questions. A consequence of this decision is that, as the England and Wales Census only collects data on disability, SRH and LLTI, findings of these questions will relate primarily to physical health, as opposed to mental health (Wright *et al.*, 2016). To ensure that the relationship between health and migration is not specific to these measures of health covered in the Census, measures of mental health are prioritised when addressing the third research question.

For the third research question the suitability of census, administrative and survey data are assessed. The LS has a ten-year period between exposure (health status) and outcome (migration), and no proxy measure for mental health. The SLS does contain a measure of mental health, but this is only measured in 2011. As such, any statistical association between health and migration is confounded through events and changes in health which occur in the interim period which are not observed. Multiple moves may have occurred over the 10 year period, and the health selection process between singular and multiple moves appears to differ, as revealed by analyses of administrative data (Lix *et al.*, 2007), so these datasets are not appropriate for the third research question. Turning to administrative data derived from secondary healthcare provision, the MHMDS permits an exploration of the migration patterns of individuals receiving treatment for a variety of mental health conditions, which could be contrasted with each other, although it would be hard to isolate the 'health' effect without a control group to

compare to. A detailed account is presented of the author's experience of applying for this dataset, and why this application was cancelled in the interest of analysing data within the timescale of this thesis.

Longitudinal survey data are then considered as an alternative to census and administrative data. Although GB has a wealth of surveys there are relatively few which cover both health and migration. The BHPS and USoc surveys enable an analysis of health and its influence on future migration behaviour over two decades, but a measure of migration which is consistent between the two surveys must be developed. The number of adult cohort surveys in the GB suffer from issues of limited time points of observation (and thus fewer exposure – outcome pairs to model) and there is a lack of assessment on how accurate migration histories collected in the ELSA study are. The birth cohort studies cover large periods of time, however these surveys have small sample sizes for multilevel analysis, which would make explorations at the sub-regional (e.g. LA) level difficult. An alternative is to use parental data from more recent birth cohort surveys such as ALSPAC and Born in Bradford, however these surveys are drawn from specific geographic areas which impairs the ability to make inference at the population level. On balance, combining data from the BHPS and USoc will provide a sizable longitudinal dataset to assess the relationship between mental health and future migration, and has the advantage of a larger (total) sample size, greater geographical detail and GB-wide inference. A decision was made to use this combined BHPS/USoc panel for the third research question, in light of this review.

# Chapter 4 Overview of analytical work

In response to the research questions identified in Chapter 2 and the potential datasets in Chapter 3, three analytical papers are developed in this thesis. The author of the present thesis, Sam Wilding, was responsible for all aspects of data management, analysis and manuscript writing, whilst David Martin and Graham Moon provided feedback on study design, methods and manuscripts. In each research question, the inference is centred on working-age adults, to control for age-specific variations in the health and internal migration relationship.

Chapter 5 addresses the research question: *is physical health associated with internal migration, controlling for place of residence*? The 2011 England and Wales CISeS sample is stratified into those who report a LLTI and those who do not to assess whether the drivers and overall odds of migration differ between the two groups. Internal migration is defined by an individual's address differing from their address one year ago, where both addresses are within England and Wales. Multilevel models are used, such that the odds of having moved vary by LA at the time of the Census, to control for differential probabilities of migration by destinations. LA-specific residuals greater than 1 standard deviation from the mean are then plotted to investigate LAs where individuals with an LLTI were more likely to have moved. Access to the CISeS was granted by the ONS, and data were accessed at the ONS' Virtual Microdata Laboratory in Titchfield, England. This paper was published in August 2016 as Wilding, S., Martin, D., & Moon, G. (2016). The impact of limiting long term illness on internal migration in England and Wales: new evidence from census microdata. *Social Science & Medicine*, 167, 107–115.

Having established the relationship between physical health and the probability of internal migration, Chapter 6 addresses the research question: *is physical health associated with long-distance migration, and does the definition of long-distance affect this association*? All internal migrants (as defined above) are drawn from the 2011 England and Wales CISeS, and the association between LLTI and long-distance migration is tested. The distance of internal migration is derived from the Euclidean distance from the previous and current residential address. Due to the lack of a consistent definition of 'long-distance' in the GB context, three definitions of long-distance are employed: i) moves ≥10km; ii) moves ≥20km & iii) moves ≥50km. Multilevel models with random slopes are employed to test

whether individual LLTI has an effect on the odds of long-distance migration, controlling for the likelihood that populations with and without an LLTI are likely to have moved to different LAs. Age interaction terms are included, as health selection appears to be positive for young adults, but negative for near-retirement adults. Spatial patterns in the health-specific odds of moving long-distance are then explored. Access to the Census microdata was granted by the ONS, and data were accessed at the ONS' Virtual Microdata Laboratory in Titchfield, UK. This paper was published in August 2017 as Wilding, S., Martin, D., & Moon, G. (2017). How far is a long distance? An assessment of the issue of scale in the relationship between limiting long-term illness and long-distance migration in England and Wales. *Population, Space and Place*, e2090. DOI: 10.1002/psp.2090.

Chapter 7 addresses this question of temporality by addressing the research question: *is the relationship between mental health and internal migration explained by ability to meet mobility preferences, independent of place effects*? Using data from BHPS (1991-2008), and following-up this sample in USoc (2010-2015), the relationship between mental health at each survey wave and the likelihood of moving by the following survey wave is tested. Mental health is measured using the 12-item GHQ. A method for constructing a migration indicator is developed, as migration was inconsistently defined between the two surveys. As this paper utilises longitudinal data, a cross-classified model is employed, which controls for drivers of migration on the likelihood of moving by area (origin), and the likelihood of having moved by area (destination). The model tests whether individual mental health has an effect independent of these factors. To ensure that there are adequate sample sizes within each LA as an origin and destination, the sample is expanded to include those of retirement age (65 and over). The differential association between mental health and internal migration in this age group is controlled for by controlling for age within the models, with the inference still focused on the working age population. Additionally, this analysis tests whether the relationship between mental health and internal migration is mediated by migration preference, as the literature suggests that those with high GHQ scores are more likely to want to move, but less likely to realise desired moves (Woodhead *et al*., 2015). Access to data was granted by the UK Data Service after attendance at an approved researcher training course, and the data were accessed through the UK Data Service's remote access facility. The manuscript of this paper is being prepared for submission to *Health and Place*.

# Chapter 5 The impact of limiting long term illness on internal migration in England and Wales: New evidence from census microdata

## 5.1 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 England and Wales CISeS. 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. 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. It is concluded that migration is health-selective and implications for understanding area level concentrations of poor health in England and Wales are proposed.

## 5.2 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 (Wiggins *et al*, 1998) and among older women in Turkey (Ergin & 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 & Boyle, 2014). In the UK, these

understandings are based on results that are over a decade old. In this paper, the latest available census microdata for England are used 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, general theories of migration decision processes are detailed, in addition to the role of health as a mediating factor in those processes. From this, key aims of this study are elucidated. Census microdata and its relevance to the research questions, measures of health provided, how migration is defined and the analytical approach of this paper are then outlined. The findings and policy implications are then presented.

## 5.3 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 & 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 & Huang, 2003), or desirable schools are found (Smith & 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 transfers. According to the same list, having health problems is another common trigger for moving.

### 5.3.1 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 & 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 & 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 & 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 & Boyle, 2014). Thus there is a need for further investigation of the relationships between health and migration.

### 5.3.2 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*, 2014a).

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 & 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.

Overview of analytical work

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 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 & 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) 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, a reassessment of the

role that health plays in migration patterns is required. In this analysis, the association between health and migration is tested. From previous research, it is expected that i) healthy individuals have a higher propensity to migrate and that ii) healthy migrants and unhealthy migrants move within or to different areas.

## 5.4 Methods

### 5.4.1 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 LAs 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 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, 2015b).

Children (aged <16 years old) and adults aged 65 years old and over are excluded from the sample, as the 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 & Longino, 1987).

### 5.4.2 Access

The CISeS 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.

### 5.4.3 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 & Shen, 1997).

The exposure variable was LLTI. It is hypothesised 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 & 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 & Manderbacka, 1996) and other

research has shown a lack of differences in reporting patterns among socioeconomic (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).

Ten covariates are included in this analysis, which are anticipated to be related to migration propensity, to control for factors confounding the association between mover/stayer status and LLTI (Table 5.1).

Table 5.1 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 characteristics and migration | | |

### 5.4.4 Analytical approach

Multilevel modelling is used in this analysis (Goldstein, 2011). Multilevel models allow for processes at the individual level to be modelled within 'contexts' (Duncan *et al*, 1998), in this 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). It is expected 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, 2015f). The analysis proceeds with individuals (level one) nested within destination LAs (level two).

In this section, the associations between individual level factors and migration are explored. Migration is measured as a binary variable, so binary logistic multilevel models (Guo & Zhao, 2000) are used to predict the odds of migration during the year preceding the census. Both inter and intra-LA movers are included in the interest of capturing the continuum of migration behaviour, as the majority of migration occurs within LAs (Boyle & Shen, 1997). The effect of LLTI on migration propensity is assessed by stratifying the sample into those with an LLTI and those without, and the overall odds of migration are contrasted. 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.

This 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 in this analysis the factors underpinning migration in the healthy and unhealthy groups are expected to vary. The following hypothesis in this section: 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 ($\sigma_u^2$), so that the proportion of individuals who migrated can vary across LAs (Goldstein, 2011). Models are estimated 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 this analysis area level patterns are investigated through residual analysis. LA residuals are mapped using ArcMap 10.2.2 (ESRI, 2014) separately for the samples with and without an LLTI. LA residuals are then linked to the 2011 Area Classifications for LAs (Office for National Statistics, 2015g), an LA-based geodemographic classification scheme which classifies LAs in eight Supergroups (clusters). It is tested whether there is a relationship between

*migration propensity* (residuals), *health* (LLTI stratified models) and *area typology* (using the 2011 Area Classification for LAs) as fixed effects for residuals associated with the healthy and unhealthy samples using seemingly unrelated regressions (Zellner, 1962). Seemingly unrelated regressions are appropriate when the errors in two (or more) models are expected to be correlated (*ibid*), and are estimated using the *sureg* command in STATA 12.1 (Statacorp LP, 2013). In this section it is tested whether the underlying propensity to migrate by LA Supergroup differs between those with and without an LLTI. The equations are as follows, where $\alpha_n$ refers to dummy variables indicating supergroup membership.

Equation 5.1 Calculation of destination-LA residuals by LLTI

$$No\ LLTI\ residual = \beta_0 + \beta_n \alpha_n$$

$$LLTI\ residual = \gamma_0 + \gamma_n \alpha_n$$

## 5.5 Results

In this section the relationship between health status and migration propensity is examined. Table 5.2 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 = .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 .99 level.

Table 5.2 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 | |

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

To establish whether there is geographical variation in migration behaviour, Table 5.3 shows the results of a null model for the sample nested within LAs with migration as the outcome.

Table 5.3 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: CISeS (ONS, 2011b), author's own calculations.** | | |

The 1-year probability of migration is calculated using the following formula:

Equation 5.2 Calculation of one-year migration probabilities

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

where $\beta_0$ is the constant and $\beta_n X_n$ is a vector of covariates which are set to zero for the base respondent. The inclusion of sociodemographic variables (results not shown) improve the fit of the model (log likelihood= -1,035,526; difference=240,486 30 d.f, p=<.01), those with an LLTI were less likely to move; this relationship was significant at the .99 level.

### 5.5.1 Stratified models

With sufficient evidence that LLTI is a significant predictor of migration behaviour health stratified models are estimated (Equation 5.3). Model 2 includes only the sample in good health, whilst model 3 includes only those in poor health, the results are displayed in Table 5.4.

Equation 5.3 Model structure predicting the log odds of moving by destination-LA, stratified by LLTI

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

Table 5.4 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 |

Overview of analytical work

| **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] | 1.00 |
| **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** | 1.60 | [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] | 1.10 | [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** | 0.20 | [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] | 1.20 | [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] | 0.80 | [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] | 0.70 | [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 | | |

**Source: CISeS (ONS, 2011b), author's own calculations. n.s = not significant at the .99 level. ORs = odds ratios, CI = 95% confidence interval Relative Odds Ratios = 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.**

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 = .64). Comparatively the OR of 0.83 is closer to 1 than the effect estimated in the unadjusted odds ratio (0.6, see Table 5.2), 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 negative, 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 the 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.

### 5.5.2 Analysis of residuals

Residuals for 2011 LA at destination are calculated from models 2 and 3; the geographical distribution of these residuals is shown in Figures 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. Figure 5.1(a) shows that there are many coastal areas in South England and Western Wales where the odds of migrating either within or to these areas are higher than expected for the healthy sample. Figure 5.1(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.

Figure 5.1 Odds of migrating by area (residuals +1SD)


It is tested whether the area typology fixed effects vary between the LA destinations for LLTI and non-LLTI samples, the results are shown in Table 5.5.

Table 5.5 Seemingly unrelated regressions predicting level two residuals in the healthy and LLTI samples

| | **Healthy residuals** | | | **LLTI residuals** | | | |
|---|---|---|---|---|---|---|---|
| **Sample size** | 346 | | | 346 | | | |
| | Coef. | LB | UB | Coef. | LB | UB | $X^2$ value[a] |
| **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] |
| **$R^2$** | 0.55 | | | 0.35 | | | |

**Source: CISeS (ONS, 2011b), author's own calculations. n.s = not significant at the .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.**

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=.02 and p=<.01 respectively).

Using the seemingly unrelated regression coefficients in Table 5.5 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 5.5 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, 'Mining Heritage and Manufacturing' and 'Suburban Traits' areas are associated with higher migration propensity in the LLTI sample, this difference is significant at the .99 level.

## 5.6 Discussion and Conclusions

This paper is the first to assess the relationship between health and migration in England using newly available 2011 census data. Previous studies are extended by using a health-stratified analysis that better reflects the complex relationship between migration propensity and health status across geographical regions. 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 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.

These 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 contrary to previous research (Finney and Simpson, 2008). These 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 identified. The results 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 & Finney, 2015). However, weaknesses in car access as a proxy for income may explain the disparity between these findings and those 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 the results herein do not control for rurality, this effect may reflect urban-rural differentials in migration propensity.

This analysis extends Cox *et al*'s (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*'s (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 & Jones, 1996; Shouls *et al*, 1996) may be artefacts caused by the flows of healthy migrants into the South West and flows of unhealthy migrants into the Midlands. Norman and Boyle's (2014) argument for health selective migration distorting the spatial patterning of regional inequalities is extended. It is demonstrated 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.

There are, however, limitations to this analysis research. The sample selection design excludes individuals living in communal residences and recent immigrants, who may be concentrated in urban centres, particularly London. Thus the design may overemphasise the strength of counter-urbanisation. This 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*., 2016), and the implicit assumption that influences are constant across working age adults is unlikely to hold. A key shortfall of this analysis is that the Census is a cross-sectional data source; thus multiple moves or return migration within the year preceding the census are not captured. Furthermore, key interactions which presumably have large effects on migration propensity (age and LLTI, ethnicity and tenure) were not feasible to model; 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, the findings suggest that long-term health service planning should consider health-selective migration. In line with other research (Brimblecombe *et al*, 1999; Norman & Boyle, 2014) it is demonstrated that concentrations of poor health in regions of England are influenced by the relative mobility of healthy individuals. Specifically, in this case there were greater flows of healthy migrants into and within the South West in 2010/11 than expected.

# Chapter 6 How far is a long distance? An assessment of the issue of scale in the relationship between limiting long term illness and long distance migration in England and Wales

## 6.1 Abstract

Research consistently shows that those in poor health are less likely to migrate over long distances, but analyses rarely consider what constitutes a long distance in this context. Additionally, the migration literature often fails to account for place of residence effects on migration behaviour. This paper addresses these issues through analysis on the distance of residential moves by working age adults in the year preceding the 2011 Census. Multilevel logistic regression models predict the odds of having moved long distance relative to short distance, for different definitions of long distance: 10km+, 20km+ and 50km+. It is tested whether those reporting an LLTI are less likely to move long distance in all models, controlling for LA at the time of the 2011 Census. There is no evidence for health-selectivity in long distance migration in the 10 and 20km models, but selection is evident in the 50km model. By age, the odds of having moved long distance do not vary for middle-working age adults (25-54) by LLTI, whilst those with an LLTI in the pre-retirement age group (55-64) are less likely to move long distance in all models. Clusters of LAs where those with an LLTI are more likely to have moved long distance are uncovered in the 10km and 20km models, but in the 50km model only two of these areas remain significantly positive. It is concluded that health selection in distances moved occurs above a cut-off somewhere between 20km and 50km.

## 6.2 Introduction

A large body of research is dedicated to establishing whether variations in health behaviours and outcomes are the result of 'places' affecting health, or a reflection of varying population characteristics across areas (Kearns & Moon, 2002; Smyth, 2008). The role of internal migration is often overlooked as a driver of these

spatial variations in health (Norman *et al*., 2005). In the UK, healthy people tend to move to less deprived areas, whilst those in poor health tend to move to more deprived areas; these migration patterns widen regional health inequalities as some areas of the UK have a positive net migration for unhealthy migrants, whilst others have a negative net migration (Boyle *et al*., 2009; Brimblecombe *et al*., 1999; Norman & Boyle, 2014). The size of this effect is small, as the majority of migrants move between areas with similar mortality patterns (Green *et al*., 2015), but migration patterns do have a significant effect on geographies of health. This phenomenon is not particular to the UK, as similar patterns have been found for rates of smoking in New Zealand (Pearce & Dorling, 2010) and poor self-rated health in the Netherlands (Dijkstra *et al*., 2015).

Migration leads to a change in an individual's environment, thus migration is selective for characteristics which are related to adaptability (Lu, 2008). In this framework, distance is as an intervening obstacle for migrants (Thomas *et al*., 2015), increasing distances are associated with loss of social networks (Brown, 2002) and greater financial costs due to searches and moves (Flowerdew, 1976). Thus there are characteristics which are not only selective for the propensity to move, but also selective of the distances moved among migrants. Long distance migrants are younger, have higher levels of educational attainment (Thomas *et al*., 2015) and are more likely to be in the higher social classes (Boyle & Shen, 1997) than the general population, for example. Migration over long distances is relatively uncommon, an estimated 9.3% of the population living in England and Wales at 2001 moved to an address 50km or further away by 2011, compared to 27.5% moving less than 10km (Champion & Shuttleworth, 2015). The literature suggests that these long distance moves are driven primarily by employment, housing, amenities and education (Champion *et al*., 1998).

The healthy migrant hypothesis posits that good health is one of the characteristics which relates to adaptability (Fennelly, 2007). Individuals in good health are more able to move over long distances, as they are free of constraints on physical mobility and reliance on long-term healthcare. Conversely, the onset of poor health can lead to long distance migration. Individuals may move back to their area of origin due to place-based ties and the family being seen as factors aiding recovery from ailments, a phenomenon known as the 'salmon bias' (Abraído-Lanza *et al*., 1999). Analysis of the British Household Panel Survey shows that individuals who died during the survey tended to have recently moved back to their area of birth (Brimblecombe *et al*., 1999). Evidence for the salmon bias is

mixed, as no evidence of such flows are found when moves between England and Scotland are considered (Wallace & Kulu, 2014). The lack of accessible rural healthcare in the UK (Jordan *et al*., 2004) may also drive long distance migration for those in poor health. Administrative records from New York and Western Australia show that the onset of mental disorder leads to rural residents moving towards urban areas surrounding hospitals (Breslow *et al*., 1998; Moorin *et al*., 2006), a similar effect may exist for physical health conditions.

The healthy migrant hypothesis for long distance migration has largely been supported by research based in the UK since the 1980s. Long distance migrants are healthier than those who do not migrate (Boyle *et al*., 2002; Strachan *et al*., 1995) and are healthier than those who migrate over short distances (Boyle *et al*., 2001; Fox *et al*., 1982). In addition, the association between health and long distance migration varies by age: sickness rates decrease with increasing distances moved for those aged 21-44, but converge for short and long distance migrants at ages 45+ (Bentham, 1988). Outside of the UK however, several measures of poor health are found to be associated with long distance migration. For example, mental health disorders (except schizophrenia) in the US (McCarthy *et al*., 2007), chronic diseases in the US (Findley, 1988) and health specialist usage in Australia (Larson *et al*., 2004) are associated with long distance moves. It is plausible that there is an opposing 'unhealthy migrant effect': the onset of health conditions which require long-term health care leads to moves from rural to urban areas, where there is a greater degree of health service provision. Evidence from outside of the UK supports this explanation (Breslow *et al*., 1998; Moorin *et al*., 2006), whereas this idea has not been tested explicitly within the UK. This paper aims to assess the healthy migrant theory for distances moved. First, definitions of long distance within the UK context are drawn from the literature.

### 6.2.1 The issue of scale – how long is long distance?

The association between good health and long distance migration is established in several UK studies (Bentham, 1988; Boyle *et al*., 2001, 2002; Fox *et al*., 1982; Strachan *et al*., 1995). It is common in the internal migration literature for the Euclidean distance moved between residences to be calculated, and those who migrate over distances greater than a certain value (cut-off) are then considered to be long distance migrants. Alternatively, moves between administrative areas may be referred to as long distance moves, whilst moves within such areas are

referred to as short distance moves. There is disagreement in the literature over which cut-off is considered to be indicative of long distance migration (Table 6.1).

Table 6.1 Definitions of long distance in selected studies investigating the association between health and long distance migration

| Study | Country | Measure of health | Distance cut-off | Sample | Finding |
|---|---|---|---|---|---|
| (Boyle *et al.*, 2001) | England and Wales | LLTI | 50km | 1991 England and Wales Census microdata | Long distance migrants are less likely to report an LLTI (OR .86) than short distance and non-movers. |
| (Strachan *et al.*, 1995) | England and Wales | Stroke | Regional | 1991 ONS LS for England and Wales | Migrants into Greater London have lower rates of stroke-related mortality than non-movers. |
| (Boyle *et al.*, 2002) | Scotland | LLTI | 10km | 1991 Scotland Census microdata | Long distance migrants have lower rates of LLTI than short distance migrants. |
| (Bentham, 1988) | UK | Self-report permanent and temporary 'sickness' | Within district vs between district vs between region | 1981 Census | Between district and region migrants have lower rates of permanent sickness than within district migrants. Between region migrants have |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | lower rates of temporary sickness than between and within district migrants. |
| (Larson *et al.*, 2004) | Australia | Numerous self-reported measures | Within postcode mover vs stayer, between postcodes mover vs stayer | Australian Longitudinal Study on Women's Health 1996 & 1998 (NB study included data on women aged 45-50 in 1996) | Those who expect their health to deteriorate and experience several symptoms are more likely to move over short distances, those with several visits to health specialists are more likely to move long distance. Chronic diseases and smoking are associated with short and long distance moves. |
| (McCarthy *et al.*, 2007) | US | Disability, substance abuse, Schizophrenia, dipolar disorder, depression | Linear distance | US Veterans' Association data | Disability, substance abuse, bipolar disorder and depression are associated with moves over longer distances, whilst |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | schizophrenia is associated with moves over shorter distances. |
| (Findley, 1988) | US | Onset of chronic disease | 500 miles | National Health Interview Survey 1979 & 1980 | Those who are diagnosed with a chronic disease are more likely to move long distance, this effect is strengthened for those who had a pre-existing condition |

All of the studies within the UK find evidence for the healthy migrant effect regardless of the way in which poor health is measured, whilst studies from outside the UK find evidence for an 'unhealthy migrant effect'. The issue of scale is problematic for the understanding of the health and migration relationship, as it is unclear at which distances health selection occurs. For example, two studies authored by Boyle and colleagues (2001; 2002) find that long distance migrants are healthier than short distance migrants, using the 50km and 10km cut-offs respectively. The 2001 study uses microdata from the Scottish Census whilst the 2002 study uses microdata from the England and Wales Census, so it is not apparent whether the association persists at and above the 10km cut-off in England and Wales, nor at and above the 50km cut-off in Scotland. Recent work on internal migration in the UK which does not include health in their analysis has also defined long distance migration using 5 mile (8km) (Cho & Whitehead, 2013) and 20km cut-offs (Sapiro, 2016). These definitions have not been explored in the health literature. Several studies define moves across administrative regions as long distance, this is also problematic as individuals living near boundaries can move relatively short distances to cross such boundaries and be considered a long distance migrant. There is a distinct lack of justification for the use of cut-off points, and little evidence of reflection on the implications this may have for

findings. Of the aforementioned studies, only Sapiro (2016:16) justifies the usage of a cut-off, stating that "only one person in eight commut[es] further than [20km]". There is little theoretical justification in defining long distance migration using one cut-off over another, this paper will test whether there is evidence for the healthy migrant effect using the 10km, 20km and 50km cut-offs previously used to define long distance migration in the UK context.

In addition to inconsistent definitions of long distance, research on migration and health in the UK often fails to account for multilevel structures in migration behaviour (Thomas *et al*., 2015). Individual (micro) behaviours are shaped by the environments in which individuals operate (macro), and controlling for these macro influences is necessary when inferences are made on the behaviours of individuals (Goldstein, 2011). Recent advances in methodology show regional variation in distances moved by destinations, with movers to coastal and rural areas in the north of England tending to move further than average, whilst movers to metropolitan cores tend to move shorter distances (Thomas *et al*., 2015). This regional variation in distances moved has not been linked to health. The population in poor health are expected to be reliant on healthcare provision, and therefore less likely to move over long distances into rural areas relative to the population in good health, as healthcare provision is less accessible in rural areas of the UK. This has implications for previous studies which show that poor health is associated with short distance migration; selection may play a role, as those in poor health are concentrated in urban and deprived areas (Dorling, 2013) where short distance moves are more common (Champion, 2005; Kearns & Parkes, 2003), thus exaggerating the role of health in determining short distance moves.

There are three aims of this study, drawn from the above review of the literature. In models accounting for the areas individuals live in at the time of the 2011 Census, it is tested whether there is an association between health and long distance migration using different definitions of long distance found in the literature. Second, it is tested whether the association between health and long distance migration varies by age. Third, the extent of spatial variation in the likelihood of long distance migration by health status is assessed.

## 6.3 Methods

### 6.3.1 Data

This analysis uses data on internal migrants living within England and Wales in 2011, drawn from the 2011 CISeS. The England and Wales Census is a mandatory decennial questionnaire for residents (Office for National Statistics, 2011a). Ten percent of individuals within each Output Area are randomly selected for inclusion in the CISeS by the Office for National Statistics (ONS) to ensure that the sample represents the usually resident population of England and Wales (Office for National Statistics, 2011b). The lowest available level of geography in the CISeS is LA. There are 348 LAs in England and Wales each containing an average of 120,000 individuals. Due to small LA sizes, the Isles of Scilly with are combined with Cornwall, and those living in the City of London are excluded. LAs are used as an analytical level to reflect regional variations in pull factors (employment rates, access to healthcare, tenure composition) which are known determinants of long distance moves (Boyle & Shen, 1997; Breslow *et al*., 1998; Thomas *et al*., 2015). The LA an individual lived within one year before the Census (origin) and the LA they live within at the time of the Census (destination) are provided in the CISeS. Although there is evidence of variation in distances moved both at the origin and destination (Thomas *et al*., 2015), the measure of health used in this analysis only captures health at the time of the Census (when individuals lived within their destination LA), not one year prior (when individuals lived within their origin LA). If origins were to include origins as an analytical level, an unknown quantity of individuals with an LLTI would not have reported an LLTI one year prior when they lived within origin LAs and vice versa. As a result, only destination LAs are included in the analytical models.

CISeS microdata may only be accessed at the ONS Virtual Microdata Laboratory. Access is granted for approved research projects conditional on disclosure control training. Due to the risk of disclosure from sensitive individual level microdata, all analytical outputs are vetted by the ONS before release.

### 6.3.2 Inclusion criteria

This study is limited to working age adults (aged 16-64) at the time of the census in line with previous studies on internal migration using census microdata (Bailey and Livingston, 2005; Wilding *et al*., 2016), as recent research shows that the

drivers of migration among the very young and very old differ from the working age population (Thomas *et al*., 2016). Migration is measured using the question "one year ago, what was your usual address" (Office for National Statistics, 2011a), respondents may answer "the address on the front of this questionnaire" (non-movers), write in a different address within the UK (movers), or write in the country where they lived one year ago (recent immigrants). Non-movers and those who lived outside of England and Wales 12 months prior to the Census are excluded, as distances are calculated by the ONS only for those who moved within England and Wales. Students who move from a term-time address to another address are also excluded, as distances are not calculated for this group by the ONS. Those who report living rent free are also excluded from the sample, this is likely a very heterogeneous group who experience very different drivers of migration than those in other living arrangements. Excluding participants with missing data for family status (902), whether they are part of a wholly moving household (257) or report living rent free (5,821), the final sample contains 442,340 working-age adult internal migrants.

### 6.3.3 Outcome

The outcome measures in this analysis derive from a variable containing the straight line distance (in kilometres) between an individual's address at the time of the 2011 Census and their address 12 months prior. The Euclidean (straight line) distance between the two residences are calculated from household to household by the ONS (Office for National Statistics, 2014d), and provided as a continuous measure. To explore the issue of scale, three definitions of long distance migration are used, where moves are considered long distance if an individual moved: 1) 10km or further 2) 20km or further 3) 50km or further; herein referred to as the 10km model, 20km model and 50km model respectively. These outcomes are used to test whether there is an association between health and long distance migration across these definitions of long distance, drawn from the literature (Table 6.1).

### 6.3.4 Exposure variable

There are two measures of health captured by the Census, a measure of self-rated health ("how is your health in general") and a measure of LLTI. The exposure variable used in this analysis is LLTI. LLTI is 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) in line with other studies exploring the relationship between health and migration (e.g. Norman *et al*., 2005). Those with an LLTI are expected to be less likely to move long distance (Bentham, 1988; Boyle *et al*., 2001; Fox *et al*., 1982). No significant differences are found if self-rated health is used instead of LLTI in fully adjusted models. LLTI is used as the exposure variable in this analysis, as LLTI has been used in previous studies based on Census microdata (Boyle *et al*., 2004, 2002; Norman *et al*., 2005; Norman & Boyle, 2014).

Self-reported measures of health are often used as proxies for morbidity in social science research (Curtis *et al*., 2009). Although LLTI is a subjective valuation of health, those reporting an LLTI have higher rates of mortality, hospitalisation and serious conditions than those who do not report an LLTI (Manor, 2001; Payne and Saul, 2000) and are more likely to access health services in the future (Jordan, 2003). Comparisons of different dimensions of health show that LLTI is closely aligned with physical limitations, and less associated with mental and social wellbeing (Cohen *et al*., 1995), whilst area rates of LLTI correlate with the number of cases of chronic heart disease and hypertension (Martin & Wright, 2009). It is important to note that LLTI is measured at the time of the Census, and migration in the year preceding the Census, so it is not possible to ascertain whether there is a difference in pre and post move health status.

### 6.3.5 Covariates

Twelve covariates are included in this analysis, to control for factors confounding the association between distance moved and LLTI, shown in Table 6.2.

Table 6.2 Covariates included in the analysis and their relationship to distances moved

| Variables | Groupings | Which group(s) are more likely to move long distance |
|---|---|---|
| Age | 0=16-24 1=25-34 2=35-44 3= 45-54 & 4=55-64 | Those aged 30 and over (Boyle & Shen, 1997; Thomas *et al*., 2015). |
| Sex | 0= male & 1= female | Men (Boyle & Shen, 1997; Thomas *et al*., 2015). |

| | | |
|---|---|---|
| Ethnicity | 0= White, 1= Indian, Pakistani or Bangladeshi, 2= Chinese or other Asian, 3= African, Caribbean or Black, 4= Other or Mixed | One study finds that all minority ethnic groups move shorter distances (Finney & Simpson, 2008) whilst others report that only the Asian group to move shorter distances than other ethnic groups (Cho & Whitehead, 2013; Thomas *et al.*, 2015). |
| Marital status | 0= single, 1=married or civil partners, 2=divorced, separated or widowed | One study finds that the divorced and separated move shorter distances, with no difference between single and married (Thomas *et al.*, 2015) whilst another finds that the divorced and separated move longer distances (Cho and Whitehead, 2013). |
| Family status | 0= no family or household, 1= in a couple or married family, 2= in a lone parent family | Those living without children (Boyle & Shen, 1997). |
| Country of birth | 0= UK born 1=born outside of the UK | Non-UK born (Finney & Simpson, 2008). |
| Educational qualifications | 0= none, 1= GCSE or apprenticeship, 2= A level, 3=Degree or higher | Higher educated (Boyle & Shen, 1997; Fielding, 2012; Thomas *et al.*, 2015; van Ham *et al.*, 2001). |
| Tenure | 0= private renter, 1= LA or Housing Association renter, 2= owner | Those in LA housing to move shorter distances (Cho & Whitehead, 2013; Thomas *et al.*, 2015) and private renters to move further (Boyle & Shen, 1997; Cho & Whitehead, 2013) |

| | | |
|---|---|---|
| Car access | 0= none, 1= one car, 2= two or more cars | Those with access to a car, as a proxy for wealth (Boyle & Shen, 1997) |
| Employment status | 0= employed, 1= unemployed, 2= economically inactive | Economically inactive move further than the employed, whilst the unemployed move the furthest (Boyle & Shen, 1997; Thomas *et al.*, 2015). |
| Wholly moving households | 0= partially moving household 1= wholly moving household | Partial movers (Cho & Whitehead, 2013). |
| Interactions | Age and gender interactions<br>Age and LLTI interactions | Younger women to be more likely to move long distance (Finney, 2011).<br>Young adults without an LLTI to be more likely to move long distance (Bentham, 1988). |

### 6.3.6 Modelling strategy

All models are estimated using multilevel logistic regression with individuals nested within LA at destination, as the average distance moved is expected to vary by destination (Thomas *et al.*, 2015). The effect of LLTI is allowed to vary randomly across destination LAs, to test whether those with an LLTI are less likely to have moved long distance in all LAs.

The log odds of having moved long distance (P = 1|X) are modelled relative to the odds of having moved short distance (P = 0|X) for migrant i living in LA j as follows (van Ham *et al.*, 2001):

Equation 6.1 Predicting the log odds of moving long-distance by LLTI and destination LA

$$\log(odds)_{ij} = \beta_0 + \beta_n X_n + LLTI_i + \mu_{0j} + \mu_{1j} + e_i \quad (1)$$

Where $\beta_0$ is a fixed constant, $\beta_n X_n$ is the matrix of fixed covariates defined in Table 6.2, $LLTI_i$ is the fixed coefficient for individuals with an LLTI, $\mu_{0j}$ is the random intercept associated with LA j, $\mu_{1j}$ is the random slope for individuals with

an LLTI in LA j, an additional effect for the population with an LLTI and $e_i$ an error term for individual i. The random effects approach is used, such that $\mu_{0j}$ and $\mu_{1j}$ have a mean of 0 and a standard deviation equal to $\sigma^2_{u_{0j}}$ and $\sigma^2_{u_{1j}}$ respectively. Utilising random intercepts $U_{oj}$ and slopes $U_{1j}$ health-differences in the log-odds of having moved long distance vary across LAs and definitions of long distance are investigated. The average log-odds of having moved long distance for an individual without an LLTI is given by the parameter $\beta_0$, the average log-odds of having moved long distance for an individual without an LLTI in LA *j* is given by the parameters $\beta_0 + U_{0j}$ and the average log-odds of having moved long distance for an individual with an LLTI in LA j is given by the parameters $\beta_0 + LLTI_i + U_{0j} + U_{1j}$.

The odds are then converted into a percentage using the following transformation:

Equation 6.2 Transforming log-odds into predicted percentages

$$\%\, moved\ long\ distance_{ij} = \frac{\exp(\log(odds_{ij}))}{(1+\exp(\log(odds_{ij}))} * 100 \quad (2)$$

Models are estimated 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 effect coefficients and log-likelihood values are estimated using Laplacian approximation (adaptive quadrature), the distribution of which is assumed to be Gaussian (Statacorp LP, 2015).

Interaction terms between age and LLTI are used to test whether the relationship between health and long distance migration differs across age groups. In order to calculate confidence intervals for the log odds for each age group by LLTI, the STATA lincom command is used. As the 16-24 age group are used as a reference category, the log odds for an individual without an LLTI are given by the parameter $\beta_0$ and for those with an LLTI by the parameters $\beta_0 + LLTI_i$. Thus the difference in log odds for the 16-24 age group shows the overall effect of LLTI on long distance migration. For all other age groups, the log odds for an individual without an LLTI are given by the parameters $\beta_0 + AGE_i$ and for those with an LLTI by the parameters $\beta_0 + LLTI_i + AGE_i + LLTI * AGE_i$.

## 6.4 Results

In this section the relationship between health status and long distance migration is examined. In the sample, 404,004 movers (91.3%) do not report an LLTI whilst the remaining 38,336 (8.7%) report an LLTI. Individuals without an LLTI have a higher mean and median for distances moved, as well as greater variation as indicated by the standard deviation. These differences in continuous distance moved are statistically significant at the 99% level (Table 6.3). Turning to the distance cut-offs, the percentages suggest increasing health-selectivity over greater distances, as the ratio of probabilities shifts further from one.

Table 6.3 Cross-tabulation of long distance migration and LLTI

| | Overall | No LLTI (a) | LLTI (b) | Ratio (b/a) |
|---|---|---|---|---|
| **Mean (km)** | 30.1 | 30.4 | 25.7 | 0.84 |
| **SD (km)** | 66.3 | 66.5 | 61.8 | |
| **Median (km)** | 4.1 | 4.1 | 3.7 | 0.90 |
| **T-test (b=a)** | | 4.8, p<.01 | | |
| **10km+ (%)** | 32.3 | 32.9 | 28.9 | 0.88 |
| **20km+ (%)** | 22.8 | 23.3 | 19.4 | 0.83 |
| **50km+ (%)** | 15.2 | 15.6 | 12.5 | 0.80 |
| **N** | 442,340 | 404,004 | 38,336 | |

**Source: CISeS** (Office for National Statistics, 2011b)**, authors' own calculations.**

Having established that LLTI is associated with lower odds of long distance migration, it is considered whether there are variations in the relationship between health and definitions of long distance, after controlling for demographic characteristics. Table 6.4 shows the results of multilevel logistic regressions for the 10km, 20km and 50km models. All coefficients are shown as additive effects on the log odds of having moved long distance (see Equation 6.1). Coefficients greater than zero indicate that this characteristic is associated with greater odds of having moved long distance in each model, whilst the inverse is true of coefficients lower than zero. The estimate and confidence intervals for the standard deviation of the random intercept ($\mu_{0j}$) and slope ($\mu_{1j}$) are also shown.

Table 6.4 Multilevel logistic regressions predicting the log-odds of having moved long distance relative to short distance

| | 10km | | | 20km | | | 50km | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Logit** | **LB** | **UB** | **Logit** | **LB** | **UB** | **Logit** | **LB** | **UB** |
| **Constant** | -0.81** | -0.87 | -0.75 | -1.37** | -1.43 | -1.31 | -1.94** | -2.01 | -1.88 |
| **Age (ref 16-24)** | | | | | | | | | |

| | 10km | | | 20km | | | 50km | | |
|---|---|---|---|---|---|---|---|---|---|
| | Logit | LB | UB | Logit | LB | UB | Logit | LB | UB |
| **25-34** | -0.18** | -0.20 | -0.15 | -0.32** | -0.35 | -0.30 | -0.50** | -0.53 | -0.46 |
| **35-44** | -0.12** | -0.15 | -0.09 | -0.23** | -0.27 | -0.20 | -0.42** | -0.46 | -0.37 |
| **45-54** | -0.05* | -0.09 | -0.01 | -0.15** | -0.19 | -0.10 | -0.28** | -0.33 | -0.23 |
| **55-64** | 0.22** | 0.17 | 0.27 | 0.15** | 0.10 | 0.20 | 0.11** | 0.05 | 0.16 |
| **LLTI (ref None)** | 0.03 | -0.03 | 0.09 | -0.10** | -0.17 | -0.04 | -0.24** | -0.32 | -0.16 |
| **LLTI and age interactions** | | | | | | | | | |
| **LLTI & 25-34** | 0.06 | -0.02 | 0.14 | 0.16** | 0.08 | 0.25 | 0.28** | 0.17 | 0.38 |
| **LLTI & 35-44** | 0.03 | -0.05 | 0.11 | 0.14** | 0.05 | 0.23 | 0.30** | 0.19 | 0.40 |
| **LLTI & 45-54** | -0.05 | -0.13 | 0.04 | 0.01 | -0.09 | 0.10 | 0.10 | -0.01 | 0.21 |
| **LLTI & 55-64** | -0.23** | -0.32 | -0.15 | -0.14* | -0.23 | -0.04 | -0.01 | -0.12 | 0.10 |
| **Sex (ref Male)** | -0.13** | -0.15 | -0.10 | -0.15** | -0.18 | -0.13 | -0.17** | -0.20 | -0.14 |
| **Sex and age interactions** | | | | | | | | | |
| **Female & 25-34** | 0.10** | 0.06 | 0.13 | 0.10** | 0.06 | 0.13 | 0.09** | 0.05 | 0.14 |
| **Female & 35-44** | -0.01 | -0.05 | 0.03 | 0.01 | -0.03 | 0.06 | 0.06* | 0.00 | 0.11 |
| **Female & 45-54** | 0.03 | -0.01 | 0.08 | 0.07* | 0.01 | 0.12 | 0.11** | 0.05 | 0.17 |
| **Female & 55-64** | 0.11** | 0.05 | 0.17 | 0.14** | 0.08 | 0.21 | 0.20** | 0.13 | 0.27 |
| **Ethnicity (ref White)** | | | | | | | | | |
| **Indian, Pakistani or Bangladeshi** | 0.13** | 0.10 | 0.17 | 0.26** | 0.23 | 0.30 | 0.30** | 0.25 | 0.34 |
| **Chinese or other Asian** | 0.18** | 0.14 | 0.22 | 0.19** | 0.15 | 0.24 | 0.20** | 0.15 | 0.25 |
| **African, Caribbean or Black** | 0.21** | 0.17 | 0.25 | 0.24** | 0.19 | 0.28 | 0.25** | 0.20 | 0.30 |
| **Other or Mixed** | 0.20** | 0.16 | 0.23 | 0.21** | 0.17 | 0.25 | 0.21** | 0.17 | 0.26 |
| **Marital status (ref Single)** | | | | | | | | | |
| **Married or Civil Partners** | 0.06** | 0.04 | 0.08 | 0.15** | 0.12 | 0.17 | 0.22** | 0.20 | 0.25 |
| **Separated or Widowed** | 0.00 | -0.02 | 0.03 | -0.07** | -0.10 | -0.04 | -0.16** | -0.20 | -0.13 |
| **Family status (ref None)** | | | | | | | | | |
| **In a couple or married family** | -0.14** | -0.17 | -0.11 | -0.10** | -0.13 | -0.07 | -0.03 | -0.06 | 0.01 |
| **In a lone parent family** | 0.13** | 0.12 | 0.15 | 0.19** | 0.17 | 0.21 | 0.21** | 0.19 | 0.24 |
| **Nativity (ref UK born)** | -0.24** | -0.26 | -0.22 | -0.26** | -0.28 | -0.24 | -0.27** | -0.30 | -0.24 |
| **Education (ref None)** | | | | | | | | | |
| **GCSE or apprenticeship** | 0.14** | 0.11 | 0.17 | 0.16** | 0.13 | 0.19 | 0.18** | 0.14 | 0.22 |
| **A Level** | 0.30** | 0.27 | 0.33 | 0.39** | 0.35 | 0.42 | 0.47** | 0.43 | 0.51 |
| **Degree** | 0.84** | 0.82 | 0.87 | 1.01** | 0.98 | 1.04 | 1.14** | 1.10 | 1.18 |

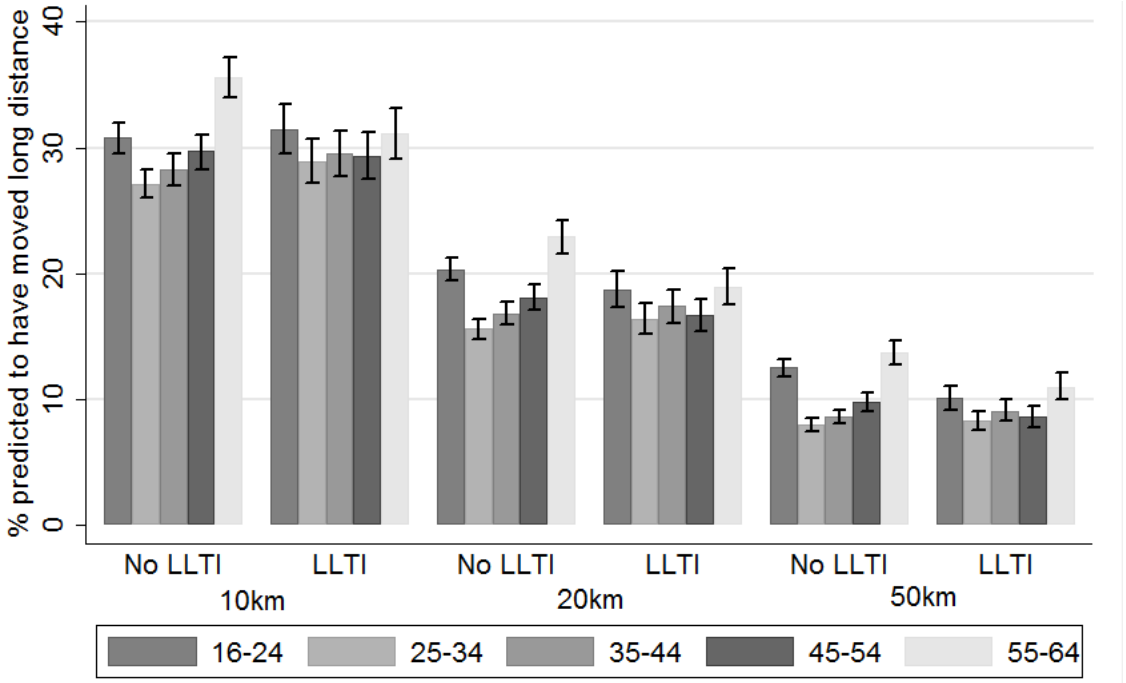
| | 10km | | | 20km | | | 50km | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Logit** | **LB** | **UB** | **Logit** | **LB** | **UB** | **Logit** | **LB** | **UB** |
| **Tenure (ref Private renter)** | | | | | | | | | |
| **LA or charity renter** | -0.31** | -0.33 | -0.29 | -0.42** | -0.45 | -0.39 | -0.51** | -0.55 | -0.48 |
| **Owns** | 0.08** | 0.07 | 0.10 | 0.07** | 0.05 | 0.09 | 0.06** | 0.03 | 0.08 |
| **Car access (ref None)** | | | | | | | | | |
| **One** | 0.12** | 0.10 | 0.14 | 0.11** | 0.09 | 0.13 | 0.08** | 0.06 | 0.10 |
| **Two or more** | 0.16** | 0.14 | 0.18 | 0.08** | 0.06 | 0.10 | 0.02 | 0.00 | 0.05 |
| **Employment status (ref employed)** | | | | | | | | | |
| **Unemployed** | 0.42** | 0.39 | 0.45 | 0.56** | 0.53 | 0.60 | 0.67** | 0.64 | 0.71 |
| **Economically inactive** | 0.32** | 0.30 | 0.35 | 0.47** | 0.44 | 0.50 | 0.55** | 0.51 | 0.58 |
| **Student** | 0.05** | 0.02 | 0.07 | 0.16** | 0.13 | 0.18 | 0.18** | 0.16 | 0.21 |
| **Whole household moved (ref nol)** | -0.58** | -0.59 | -0.56 | -0.64** | -0.65 | -0.62 | -0.65** | -0.67 | -0.63 |
| **Random effects** | | | | | | | | | |
| $\sigma^2_{u0j}$ | 0.19 | 0.16 | 0.22 | 0.18 | 0.15 | 0.21 | 0.17 | 0.15 | 0.20 |
| $\sigma^2_{u1j}$ | 0.03 | 0.02 | 0.04 | 0.01 | 0.00 | 0.03 | 0.02 | 0.00 | 0.03 |
| **Covariance** $\sigma^2_{u0j}$, $\sigma^2_{u1j}$ | 0.05 | 0.03 | 0.06 | 0.04 | 0.03 | 0.05 | 0.03 | 0.01 | 0.05 |
| **VPC** | 0.06 | | | 0.05 | | | 0.05 | | |
| **Log likelihood** | -259862 | | | -220140 | | | -173869 | | |
| **N** | 442340 | | | 442340 | | | 442340 | | |

****,* = significant at the .99 and .95 levels respectively. LB = 95% confidence interval lower bound; UB = 95% confidence interval upper bound; VPC = Variance Partition Coefficient. Source: CISeS (Office for National Statistics, 2011b), authors' own calculations.**

Comparing coefficients across the three models, the direction of effects is consistent in the majority of cases and conforms to expectations (Table 6.2), thus many of the characteristics are scale invariant. Figure 6.1 presents the estimates by health and age across the three models, transformed into percentages predicted to move long distance (Equation 6.1), and their associated 95% confidence intervals. Comparing the difference in probabilities by health for the 16-24 age group, LLTI is associated with a lower likelihood of having moved long distance only in the 50km model, as the odds for those with and without an LLTI overlap in the 10 and 20km models, despite a p value <.01 in the latter model. After taking the uncertainty in the estimate of the constant into account (Wolfe and Hanley, 2002), health selection occurs above a cut-off somewhere between 20 and 50kms, as the confidence intervals for those with and without an LLTI overlap in the 20km model, but do not in the 50km model. Looking at the differences for other age groups, the only significant difference is found in the

55-64 age group, where having an LLTI is associated with a lower likelihood of having moved long distance in all models. This suggests that the healthy migrant effect for long distance migration is specific to the youngest and oldest working age groups.

Figure 6.1 Percentage predicted to have moved long distance by model, age and LLTI status



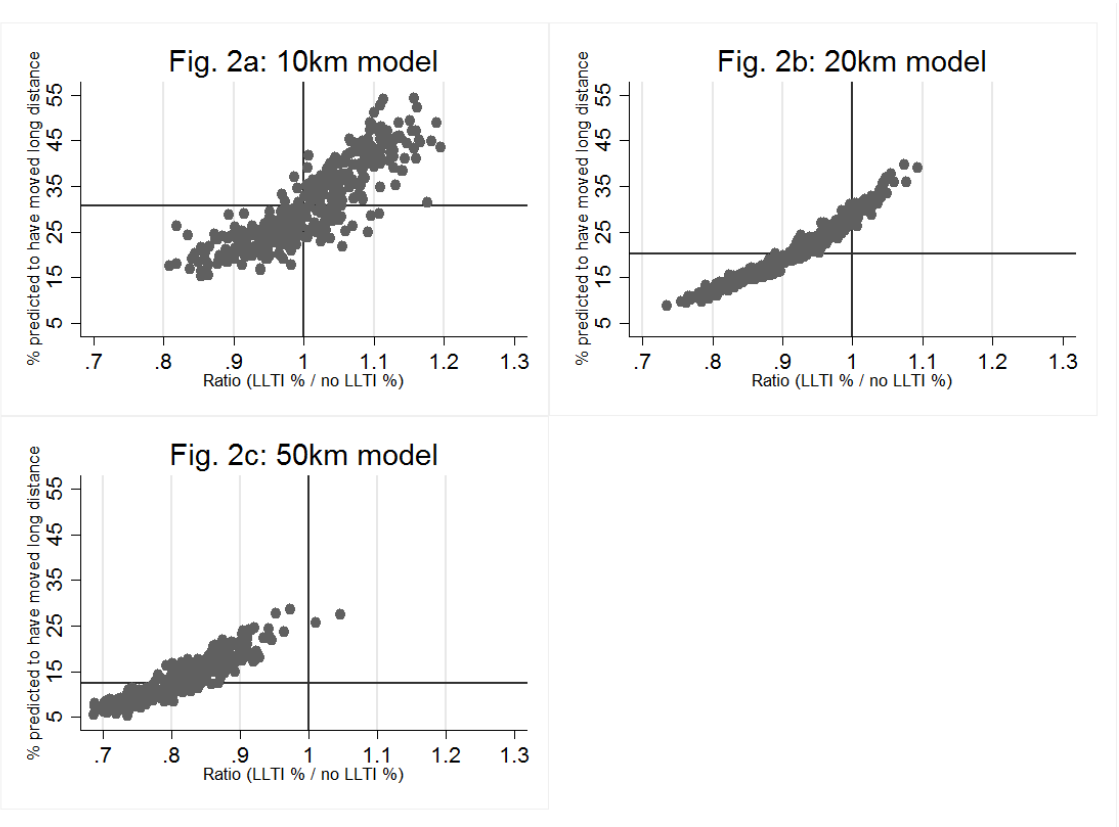

Comparing probabilities across age and model, for the population with and without an LLTI, it is observed that the relationship between age and long distance migration is u-shaped. Adults in the youngest and oldest age groups (16-24 and 55-64) and more likely to move long distance relative to those in the 25-34, 35-44 and 45-54 age groups. For the population without an LLTI, the predicted percentages are significantly higher for the 16-24 and 55-64 age groups relative to all other age groups in the 10, 20 and 50km models; except adults aged 45-54 are not significantly less likely to move long distance in the 10km model. For the population with an LLTI the u-shaped distribution is less pronounced, those aged 25-34 are less likely to move long distance than those aged 16-24 or 55-64 in the 50km model, whereas all other age differences overlap. The Variance Partition Coefficient (Browne *et al.*, 2005) shows that a relatively small proportion of the variance in long distance migration is explained at the destination LA level (6% in the 10km model and 5% in the 20 and 50km models), with the remainder explained at the individual level.

### 6.4.1 Random intercepts and slopes

Having explored effects at the individual level, effects at the destination LA level are assessed. Figure 6.2 (a-c) illustrates these transformed parameters. The percentage predicted to have moved long distance for each LA is represented on the y axis, and the ratio of predicted percentages for those with an LLTI relative to those without an LLTI on the x axis. If the ratio is greater than one, this indicates that those with an LLTI are more likely to move long distance in this LA, whilst the inverse is true if the ratio is less than one. Reference lines illustrate the global mean for the percentage predicted to move long distance (30.8%, 20.3% and 12.5%) in the 10, 20 and 50km models respectively.

In the 10km model it is observed that the population with an LLTI are more likely to have moved long distance than those without an LLTI in destinations with higher than average rates of long distance migration (top-right quadrant). In the 20km model the same trend is found, however the distribution of ratios shifts to the left, such that there are fewer areas where the population with an LLTI are more likely to have moved long distance. Finally, in the 50km model the distribution of ratios shifts further to the left, the population with an LLTI are more likely to have moved long distance only in two LAs (of a total of 346). Thus there is no evidence of health selection in the 10km model, but the effect is present in the 20km model and strongest in the 50km model.

Figure 6.2 Ratio of health differences in long distance migration by LA and model

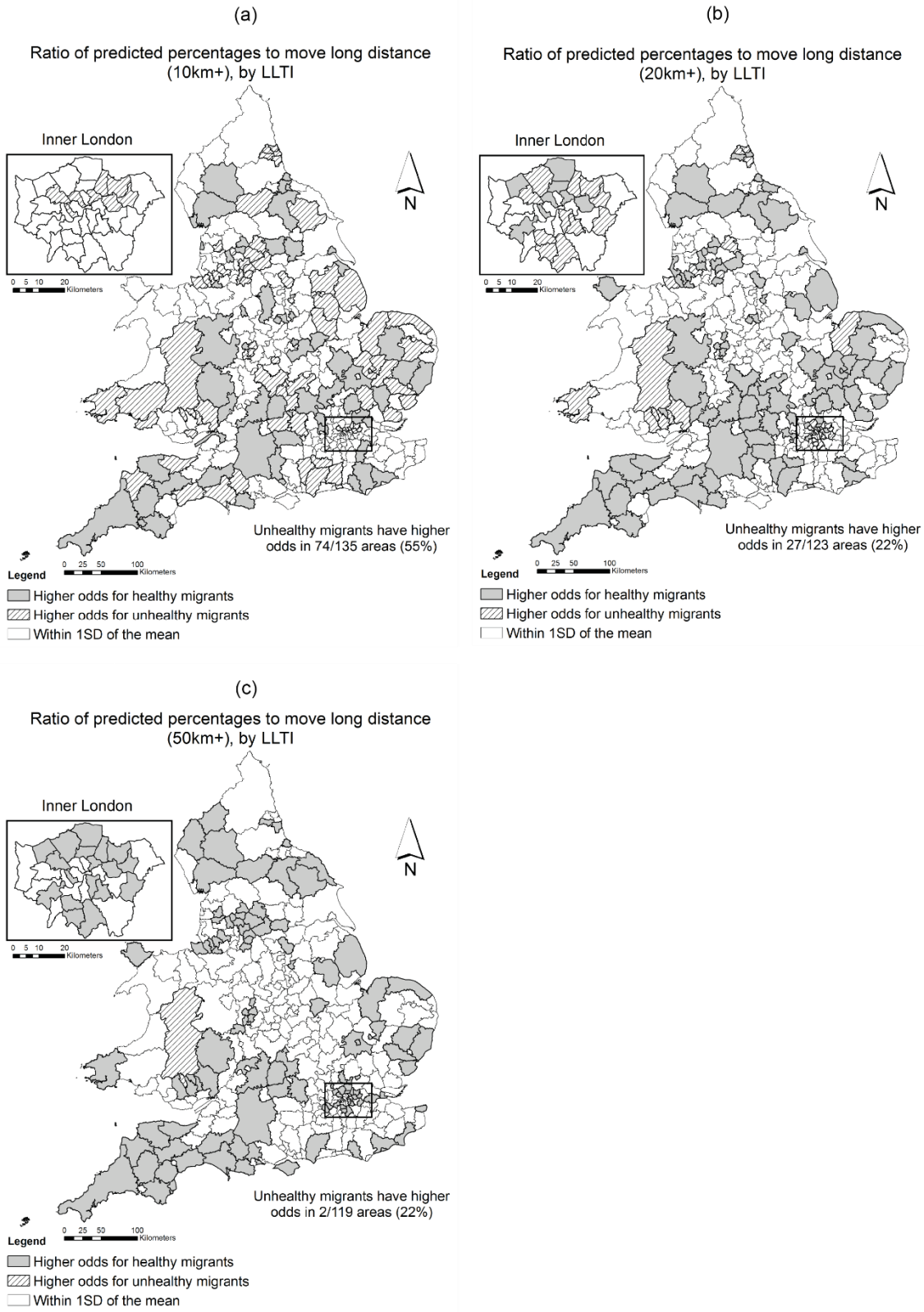



To explore the spatial pattern of these residuals for destination areas, the values for LAs are plotted using ArcMap 10.4.1 (ESRI, 2014). The ratio of predicted percentages from Figure 6.2 are shown for the 10km, 20km and 50km models in Figure 6.3 a, b and c respectively. Destinations where those with an LLTI are more likely to have moved long distance are hatched, whilst destinations where those without an LLTI are more likely to have moved long distance are shaded in grey. Areas with a random intercept ($U_{0j}$) within 1SD from the mean are unshaded, to investigate the relationship between health and destination specific probabilities in the more extreme ends of the distribution.

Figure 6.3a shows that there are a greater number of areas where those with an LLTI have higher odds to have moved long distance (55%) in the 10km model, clustered in London, South Wales and East England. Areas with higher odds for those without an LLTI are clustered in the South of England, south east from London and north from London. Figure 6.3b shows that there is a clearer spatial pattern in the 20km model. Areas where those with an LLTI have higher odds are fewer in number (22%), and these are now clustered in London and South Wales, whilst areas with higher odds for those without an LLTI are spread across the South, North and East of England. Figure 6.3c shows that in the 50km model

there are only two areas (2%) where those with an LLTI have higher odds, Powys and Methyr Tydfil in South Wales.

Figure 6.3 Ratio of predicted odds to have moved long-distance by model and LLTI



## 6.5 Discussion

The work here must be placed in context of its shortfalls. The measure of health in this analysis (LLTI) is a self-reported measure, whilst the healthy migrant theory is mainly drawn from research on mortality (Abraído-Lanza *et al*., 1999), which find that individuals who move have lower future mortality rates than those who do not move. It is plausible that conditions which are conducive to mortality in working age adults are barriers to long distance migration, whilst LLTI does not have enough specificity to distinguish forms of poor health which drive long distance moves. The focus on working age adults is in contrast with the fact that rates of LLTI are much higher at post-retirement ages, the relationships between health and long distance migration may differ in this older age group. Additional cut-off points are found in the wider migration literature, but are beyond the scope of the present paper. The issue of scale in the health and long distance migration relationship may be unique to the data source used here, or to England and Wales, thus further work is needed from other countries to assess the robustness of the association.

The first aim of this analysis is to test whether there is an association between health and long distance migration across a range of definitions of 'long distance'. Adjusting for mediators and taking into account the uncertainty present in the models, evidence of health selection on the propensity to have moved long distance is found only when the definition of 50km or more is used. This finding contradicts research from Scotland (Boyle *et al*., 2002) and GB (Bentham, 1988) which find evidence of health selection at the 10km and inter-district cut-offs respectively, but confirms research on England and Wales using 1991 data (Boyle *et al*., 2001). It is concluded that for migration within England and Wales, the healthy migrant effect occurs above a cut-off somewhere between the 20 and 50km cut-offs.

There are several plausible explanations for the lack of healthy migrant effect at the 10 and 20km cut-offs. First, covariates in the models which are not present in previous research (nativity and whether the individual moved as part of a wholly moving household) may explain the heterogeneity in migration behaviour of those in good and poor health. Second, the healthy migrant effect may not be present at the 10 and 20km cut-offs specifically in England and Wales, with studies showing contrary results being drawn from GB and Scotland data. Third, the inclusion of multilevel modelling may also influence the direction of the

relationship, as the error of the health effect is partitioned into the individual and destination LA levels, and the variance explained by individual health may be too small at the 10 and 20km cut-offs to remain significant. Finally, this is an analysis of individuals and their migration behaviour, whilst the characteristics of one's family also influence migration behaviour. For instance, if an individual's partner is unwell then they may be particularly reluctant to move over long distances, despite being coded as 'healthy' in this analysis. It is not possible to control for this in the CISeS as not all household relationships are preserved, although an analysis of 'unhealthy households' and their migration behaviour could be conducted using the household counterpart of the dataset.

The second aim is to test whether the association between health and long distance migration varies by age across definitions of long distance. The findings contradict past research showing that poor health is associated with moves over shorter distances in all working age groups (Bentham, 1988), as this analysis finds evidence for the healthy migrant effect only in the youngest (16-24) and oldest (55-64) working age groups. A scale dimension in the health and long distance migration relationship is identified, LLTI is associated with reduced odds of having moved long distance for the 16-24 age group at the 50km cut-off, whilst this difference is not significant at the 10 and 20km cut-offs. There is one effect which is consistent across all models, among the oldest age group (55-64) those without an LLTI are more likely to move long distance. Evidence suggests that the healthy migrant effect is scale-invariant at pre-retirement ages (55-64), observable only over great distances for the youngest age group (16-24), and is not present for adults of mid working-age (25-54). This reinforces recent calls for age differences in the health and migration relationship to be accounted for (Norman and Boyle, 2014).

The third aim is to assess whether there is spatial variation in long distance migration by health status. It is identified that those with an LLTI who moved to London, South Wales and eastern England are more likely to have moved long distance, relative to those without an LLTI in the 10km model. Over greater distances however, long distance migration becomes increasingly health selective, and for the furthest moves those with an LLTI are more likely to move long distance to only two LAs in South Wales. These findings show that those with and without an LLTI are attracted to different areas over distances less than 20km, but those with an LLTI are not more likely to move further than 20km to most areas relative to those without an LLTI. In conclusion, the healthy migrant

effect is apparent in destination LAs for residential moves of 20km or further, and the effect is even stronger when only moves of 50km or further are considered to be long distance.

In terms of policy, health differences in the spatial pattern of long distance migration are found. The youngest (16-24) and oldest (55-64) working age adults with an LLTI are less likely to move over very long distances (50km+), health services can adequately plan long term provision for those with an LLTI in these age groups with the knowledge that when these populations change residence, these moves are likely to be of distances less than 50km. The population without an LLTI appear to be drawn over long distances to rural areas of England and to Inner London: this reflects wider trends of counter-urbanisation in the UK (Stockdale, 2015) and the migration of healthy young people to London (Norman & Boyle, 2014). The relative lack of very long distance migration into rural areas by the population with an LLTI may be the result of poor rural healthcare provision failing to 'pull' this population towards these areas, whilst this factor is considered less important for the population in good health. Given that the incumbent Government is pushing for the devolution of healthcare planning and provision to LAs with the 2016 Cities and Devolution Act (Sandford, 2016), rural LAs will need to account for the needs of incoming long distance migrants, who may require health services in future as they age.

# Chapter 7 Place and preference effects on the association between mental health and internal migration within Great Britain

## 7.1 Abstract

Working age adults with mental health needs are more likely to migrate than the general population, but the effects of migration preference and place of residence on this association 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.

## 7.2 Introduction

Poor physical health has been shown to be associated with low likelihoods of internal (within-country, over any distance) migration among working age adults 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, working age internal migrants are more likely to self-report mental health problems than non-migrants (Larson *et al.*, 2004). 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 among all adults (Tunstall et al., 2015, 2014). Although the mental health of internal migrants is well studied, it is unclear whether mental health is associated with the likelihood of internal migration. 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 (migration preference) may explain the relatively high rates of internal migration among the working age population with mental health needs, and GB 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 higher rates of internal migration, but are also associated with belonging to both undesired staying and moving groups in GB (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). In the context of rising house prices and rental rates in GB over the 1990s and 2000s (Dorling, 2015), 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. 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, as migration decisions are affected by local area characteristics (such as deprivation, employment, transport links, housing composition). Place of residence has differential effects on the probability of moving for individuals who do and do not report physical health limitations (Wilding *et al.*, 2016), but this has not been tested in the mental health context. There are indications that those with mental health needs respond differently (in terms of migration patterns) to area characteristics in comparison to the general population. 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). The social selection or drift hypothesis has been proposed to explain these shifts from rural and affluent areas towards urban and deprived areas, where the onset of mental health

problems leads to reductions in earning capacity or unemployment, and then a reduced ability to remain in affluent neighbourhoods (Lowe *et al.*, 2014).

Understanding how place affects the relationship between mental health and migration is further obfuscated by evidence that place characteristics also affect self-evaluation and subsequent reporting of mental wellbeing (Gong *et al.*, 2016). It follows that the association between mental health and internal migration is affected by place of residence, but studies estimating the association between mental health and internal migration often do not control for such moderation effects. 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).

In summary, poor mental health is associated with internal migrantion (over any distance) in the working age population, but this is affected by migration preference, as those with poor mental health are more likely to move, but less likely to meet their migration preferences. The extant evidence fails to adequately account for the potential moderation of place effects on migration behaviour, and there are theoretical reasons for expecting the relationship between mental health and migration to vary by area. The remainder 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.

## 7.3 Methods

### 7.3.1 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) is 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. The booster samples from Northern Ireland (added in 2001) and the European Community Household Panel (added in 1997) are excluded, as no individuals were surveyed in Northern Ireland before 2001 and the latter sample were followed for four years only. Data collection for USoc started in 2009, and BHPS sample members were included in USoc from 2010 onwards.

As the question posed in this analysis is whether mental health is predictive of future migration among the working age population, 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) 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*. All predictors, including mental health, are lagged by one survey wave (i.e. measured at time t-1). For example, for all individuals who participated in the 1992 and 1991 waves of the BHPS, migration and destination LA is measured in the 1992 wave of the BHPS, and all predictors of migration and the origin LA are measured in 1991.

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). As this analysis uses 1-wave lagged measures, an individual has a maximum of 23 potential appearances in the person-year dataset. 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. In addition, observations for retirement age adults (65 and over) are included to ensure that there are adequate sample sizes within each LA as an origin and destination. The differential association between mental health and internal migration in this age group is controlled for by controlling for age within the models, with the inference still focused on the working age population.

### 7.3.2 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. If any member of the current household had moved in since the previous wave, or if any household members present in the previous wave have moved out, then all household members are considered to be 'movers' (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). Between annual releases of BHPS and USoc, a postcode's centroid may change as homes are demolished or new homes are built. Reliable statistics on the distribution of centroid shifts due to these developments are unavailable. As a result, 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.

### 7.3.3 Mental health

The 12-item 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 (Appendix A). 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). Critics of the GHQ point to evidence that it may have two- or three underlying dimensions (Hankins, 2008). In the interest of parsimony, the GHQ is considered as a one-dimensional construct in this analysis. 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).

### 7.3.4 Contextual measures

Local (or neighbourhood) characteristics such as deprivation and population density are known predictors of migration behaviour, and therefore must be controlled for in order to make inference on the relationship between mental health and internal migration. The comparability of population statistics reported for small areas is limited over time, as the size and shape of geographical units used for reporting purposes change over time (Norman, 2010). 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 ONS for England and Wales, and NRS for 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. 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. Individuals in more deprived quintiles typically have higher migration rates (Connolly *et al.*, 2007). PPH is included as a proxy of rural/urban status, as the ONS measure of urban/rural only dates back to 2001 (Office for National Statistics, 2017). Individuals in more urban areas tend to be more likely to move (Champion, 2005).

Individuals are linked to their LA at time *t* and *t-1* in the model hierarchy as destination and origin respectively, at each occasion. No contextual data are used at the LA level as these are relatively coarse units with heterogeneous populations. Two individuals residing in the same LA may experience differing degrees of deprivation and density, as these are defined at the neighbourhood (MSOA/IZ) level in this analysis, areas which are smaller in scale than LAs. The likelihood of moving to LAs in England and Wales varies by self-rated health status (Chapter 5), justifying the inclusion of LA as an analytical level. There are 378 LAs in GB. Observations from 11 LAs which contain fewer than 10 observations are excluded from the sample.

### 7.3.5 Definition of independent variables

Potential confounders of migration behaviour are controlled for at time *t-1* (Table 7.1). 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. Interaction terms between mental health status and migration preference are included to test whether the association between mental health and migration is explained through the ability to realise migration preferences. From extant research, it is hypothesised that individuals with poor mental health are more likely to move between survey waves, and that this association is affected by migration preference and place of residence.

Table 7.1 Covariates and their relationship to internal migration

| 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:<br>High GHQ and wants to move (mental health = 1 & migration preference = 1) and<br>High GHQ, doesn't know migration preference ( mental health = 1 & migration preference = 2) | Yes | High GHQ more likely to be undesired stayers and movers (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) |

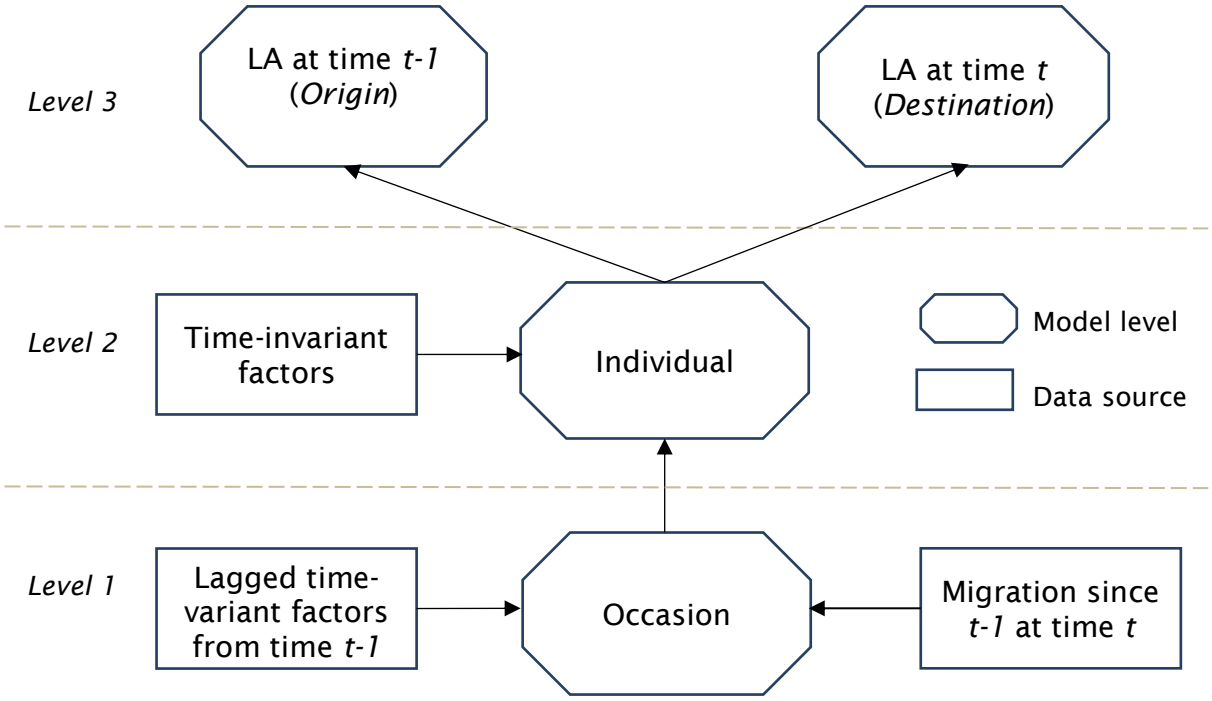
| | | | |
|---|---|---|---|
| Tenure | 0 = owner; 1 = private renter; 2 = social renter | Yes | Private renters (Rabe & Taylor, 2010; Thomas *et al.*, 2016) |
| Marital status | 0 = married; 1 = widowed; 2 = divorced/separated; 3 = never married | Yes | All relative to married (Cooke *et al.*, 2016; 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*) | 0 = lowest quartile - 3 = highest quartile | Yes | Lowest quartile (Thomas *et al.*, 2016) |
| Car access | 0 = none; 1 = yes | Yes | No car access (Wilding *et al.*, 2016) |
| Nativity | 0 = UK-born; 1 = non-UK born | No | Non-UK born (Sapiro, 2016) |

## 7.4 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 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, where individuals with poor mental health may be drawn away from and to different areas than the general population. Figure 7.1 is an illustration of the CCM used in this paper, measuring 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 7.1 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* are estimated (Equation 7.1):

Equation 7.1 Model structure

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

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. $\beta_0$ is a fixed constant, $\beta_n X_n$ is the vector of covariates outlined in Table 7.1 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 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 ($\sigma$) are assumed to be normally distributed, have a mean of zero and a constant variance. The variance of each parameter ($\sigma^2$) 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 7.2, where $\theta$ indicates the probability of the value of $y^*$ according to the normal cumulative distribution function.

Equation 7.2 Calculating the probability of migration, expressed as a percentage

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

As multilevel models estimate the variance between origins, destinations, individuals and occasions, it is desirable to quantify the proportion of the variance explained at each of these levels. This is achieved through the Variance Partition Coefficient (VPC), the interpretation of which is the proportion of variance in migration behaviour explained between units at a given level of the hierarchy. The VPC is calculated at the origin, destination, individual and occasion levels as follows (Jones & Subramanian, 2014):

Equation 7.3 Variance Partition Coefficients for a three-level cross-classified model

$$VPC_{origins} = (\boldsymbol{\sigma^2_{l0} + 2cov_{\sigma_{0l},\sigma_{1l}} + \sigma^2_{l1}})/(\boldsymbol{\sigma^2_{l0} + 2cov_{\sigma_{0l},\sigma_{1l}} + \sigma^2_{l1} + \sigma^2_{k0} + 2cov_{\sigma_{0k},\sigma_{1k}} + \sigma^2_{k1} + \sigma^2_{j0}} + 1)$$

$$VPC_{destinations} = (\boldsymbol{\sigma^2_{k0}} + \boldsymbol{2cov_{\sigma_{0k},\sigma_{1k}}} + \boldsymbol{\sigma^2_{k1}})/(\boldsymbol{\sigma^2_{l0}} + \boldsymbol{2cov_{\sigma_{0l},\sigma_{1l}}} + \boldsymbol{\sigma^2_{l1}} + \boldsymbol{\sigma^2_{k0+2cov_{\sigma_{0k},\sigma_{1k}}}} + \boldsymbol{\sigma^2_{k1}} + \boldsymbol{\sigma^2_{j0}} + 1)$$

$$VPC_{individuals} = (\boldsymbol{\sigma^2_{j0}})/(\boldsymbol{\sigma^2_{l0}} + \boldsymbol{2cov_{\sigma_{0l},\sigma_{1l}}} + \boldsymbol{\sigma^2_{l1}} + \boldsymbol{\sigma^2_{k0}} + \boldsymbol{2cov_{\sigma_{0k},\sigma_{1k}}} + \boldsymbol{\sigma^2_{k1}} + \boldsymbol{\sigma^2_{j0}} + 1)$$

$$VPC_{occasions} = (1)/(\boldsymbol{\sigma^2_{l0}} + \boldsymbol{2cov_{\sigma_{0l},\sigma_{1l}}} + \boldsymbol{\sigma^2_{l1}} + \boldsymbol{\sigma^2_{k0}} + \boldsymbol{2cov_{\sigma_{0k},\sigma_{1k}}} + \boldsymbol{\sigma^2_{k1}} + \boldsymbol{\sigma^2_{j0}} + 1)$$

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).

## 7.5 Results and discussion

To establish whether there is an association between mental health and migration a cross tabulation is conducted (Table 7.2). The overall between-wave migration percentage is 9.2%, the percentage for the population with good mental health is lower than this average and it is higher than average among the population with poor mental health. The association is significant according to the chi-square statistic ($X^2$ = 330.9 df = 1, p<.01).

Table 7.2 Tabulation of mental health and migration status

| | **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. Author's own calculations.**

Table 7.3 shows the results for a CCM including all contextual and independent 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.

Table 7.3 Cross-classified probit model predicting the probability of moving between survey waves

| | Coefficient | | CI (2.5%) | CI (97.5%) |
|---|---|---|---|---|
| **Constant** | -1.350 | | -1.447 | -1.260 |
| **Poor mental health** | 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)** | | | | |
| 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 |

| | Coefficient | | CI (2.5%) | CI (97.5%) |
|---|---|---|---|---|
| **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 ($\boldsymbol{\sigma^2_{0l}}$) | 0.201 | | 0.159 | 0.252 |
| Covariance ($\boldsymbol{\sigma^2_{0l}}$,$\boldsymbol{\sigma^2_{1l}}$) | -0.006 | | -0.022 | 0.011 |
| Slope ($\boldsymbol{\sigma^2_{1l}}$) | 0.003 | | 0.001 | 0.008 |
| **Destination** | | | | |
| Constant ($\boldsymbol{\sigma^2_{0k}}$) | 0.348 | | 0.285 | 0.421 |
| Covariance ($\boldsymbol{\sigma^2_{0k}}$,$\boldsymbol{\sigma^2_{1k}}$) | -0.013 | | -0.039 | 0.010 |
| Slope ($\boldsymbol{\sigma^2_{1k}}$) | 0.005 | | 0.001 | 0.012 |
| **Individuals** | | | | |
| Constant ($\boldsymbol{\sigma^2_{0j}}$) | 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 | | | |

| | Coefficient | CI (2.5%) | CI (97.5%) |
|---|---|---|---|

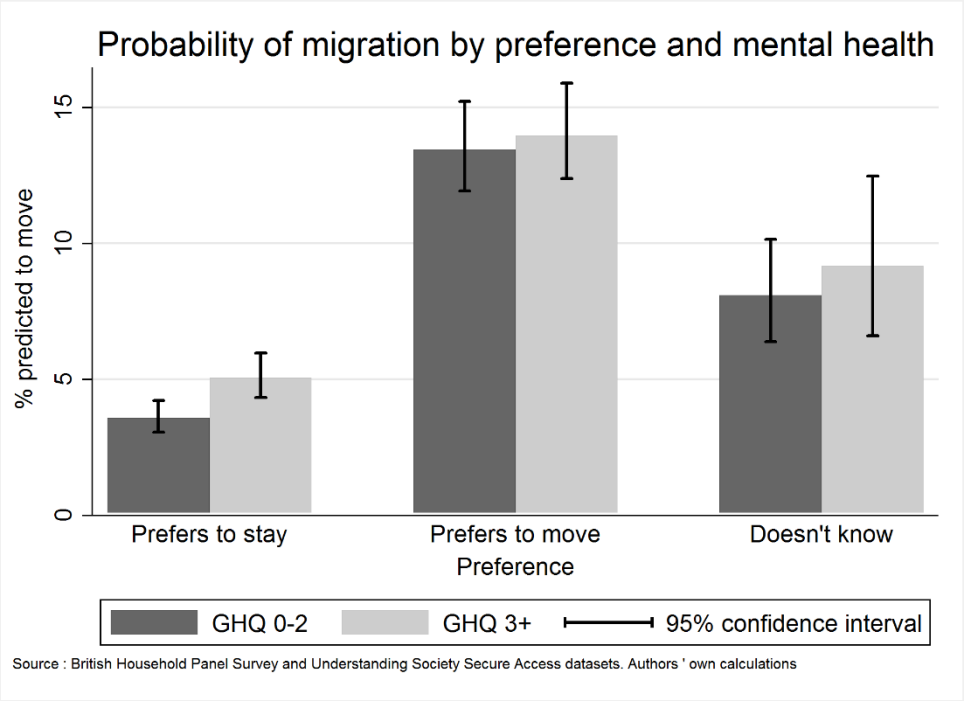
CI = credible interval, DIC = deviance information criterion, PPH = Persons Per Hectare (centred on its mean, 24.366), IPB = Indian, Pakistani or Bangladeshi, * = credible interval does not contain zero. Source: British Household Panel Survey and Understanding Society Secure Access datasets. Author's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

### 7.5.1 Fixed effects

The probability of migration between survey waves is 8.85% (Equation 7.2), and most of the effects are as expected (Table 7.3). Characteristics associated with migration include poor mental health (Tunstall *et al,* 2014), preferring to move (Kearns & Parkes, 2003), being a young adult (Champion, 2005), higher education qualifications (Duke-Williams, 2009), unemployment (Cho & Whitehead, 2013), private renting (*ibid*) high income (Parkes *et al*, 2002) and car ownership (Findlay *et al*, 2003).

To test whether mental health is associated with migration and if this is explained by migration preference, predicted probabilities are plotted by mental health and migration preference (Figure 7.2). 95% confidence intervals, controlling for other covariates, are calculated in MLwiN's prediction window. The population with poor mental health at time *t-1* are more likely to move by time *t* in comparison to the population with good mental health at time *t-1* in all migration preference groups. The confidence intervals suggest that this difference is only significant among those who prefer to stay, providing evidence of differential health selection across migration preference groups.

Figure 7.2 Probability of migration by mental health and migration preference




In terms of local area effects, the Townsend deprivation quintile appears to have limited associations with migration behaviour, as there is a lower probability of migration by time *t* in the middle quintile relative to the most affluent quintile, whereas the probabilities overlap in other deprivation quintiles. In terms of density, individuals in MSOAs/IZs with higher PPH at time *t-1* are more likely to move by time *t*. These area effects could plausibly explain the relationship between mental health and internal migration, as rates of first episode psychosis are higher in deprived and population-dense areas of GB (Kirkbride *et al.*, 2013). In this analysis there is evidence for an effect of mental health independent of place of residence, as the predictions in Figure 7.2 control for deprivation and density of individuals' MSOA/IZ at time *t-1*, as well as LA at origin and destination.

### 7.5.2 Origin and destination effects

Table 7.4 displays the VPCs for each analytical level in the sample (see Equation 7.3). The VPC represents the proportion of the variance in the outcome (in this case migration) explained at the corresponding level in a multilevel model. The VPCs show that both the between-origin and between-destination parameters explain a greater proportion of the variance than between-individual parameters, with the largest proportion of the variance explained between-occasions. It is well documented that migration behaviour is sensitive to

macroeconomic conditions (Champion *et al.*, 1998). Given that GB experienced two economic recessions in over the study period, it is unsurprising that the between-occasion variance is relatively large, as these effects will reflect period fluctuations in migration behaviour.

Table 7.4 Variance Partition Coefficients by level

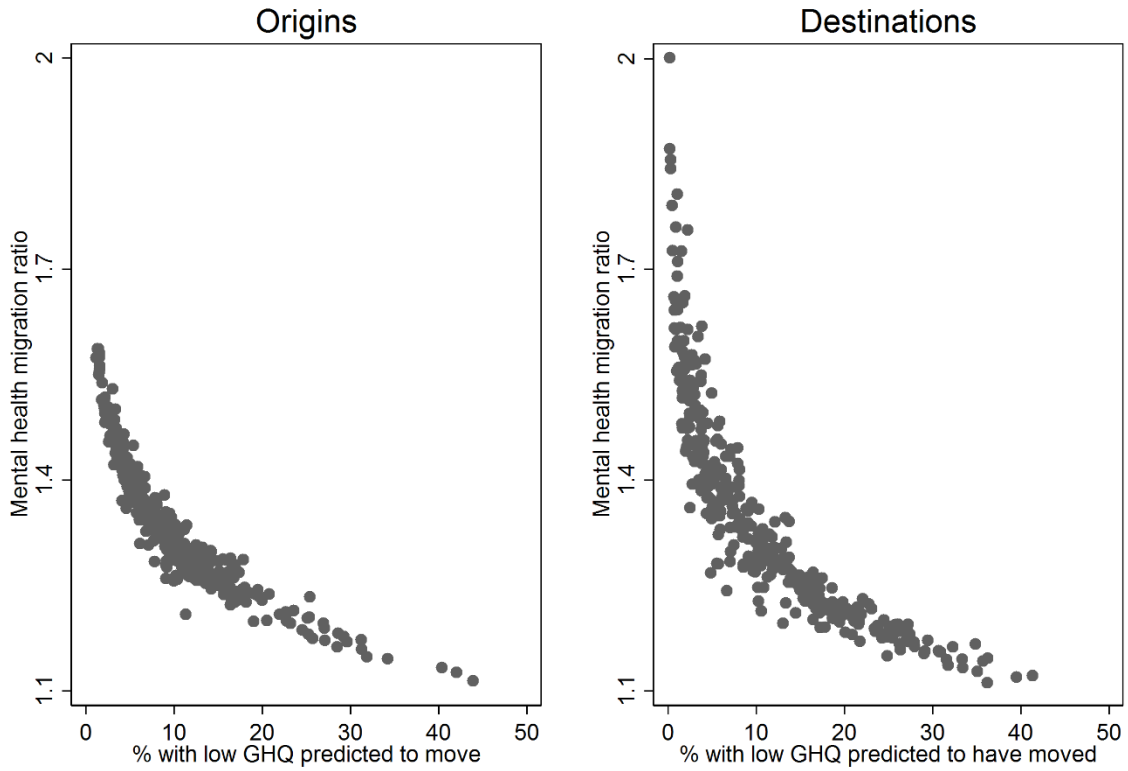
| Level | Percentage |
|---|---|
| **Origin** | 11.56 |
| **Destination** | 19.69 |
| **Individual** | 8.55 |
| **Occasion** | 60.20 |

The structure of the CCM allows the probability of moving from and to each LA to be calculated where BHPS sample members are enumerated, to explore whether the relationship between mental health and migration is similar across all LAs. 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 $(cons + \sigma_{0k} + \sigma_{1k})$**.** For illustration, the mental health migration ratio is plotted on the y axis and the migration rate for those with good mental health on the x axis in Figure 7.3. 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 than the population in good mental health in this 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. There is no evidence that these LA effects explain the relationship between mental health and migration, as the predicted probabilities in Figure 7.2 control for place of

residence at times *t* and *t-1*, instead place of residence moderates the relative likelihood of migration for those with poor mental health.

Figure 7.3 Ratio of predicted probabilities for migration by health status for each LA




Source: British Household Panel Survey and Understanding Society Secure Access datasets. Authors' own calculation

### 7.5.3 Non-response analysis

Non-response (not participating in a survey wave) and attrition (permanent non-response) have the potential to affect the generalisability of findings from panel survey data, if population subgroups are particularly likely to not respond (Mostafa & Wiggins, 2015). Analysis of the US Panel Study of Income Dynamics finds that self-rated health is a strong predictor of attrition, to the extent that the underlying (negative) relationship between health and internal migration is likely underestimated as a result of such attrition (Halliday & Kimmitt, 2008). In the BHPS and USoc, however, there is no evidence that GHQ scores are associated with non-response, although internal migration and preferring to move are predictors of non-response (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. To assess whether attrition is

affected by a combination of mental health and migration preference, between-wave non-response rates in each wave are displayed by one-year lagged migration preference and GHQ for each pair of waves in the BHPS and USoc, controlling for the clustering of standard errors by individual. The average between-wave response rate is 89.5% (95% CI 89.4%-89.6%). Those who prefer to stay and have a low GHQ score are particularly likely to respond in the following survey wave (95% CI 91.5%-91.8%), whilst those who prefer to move and have a high GHQ score are less likely to respond in the following wave (95% CI 87.6%-89.6%). In addition, among those with a preference to stay, and those who prefer to move, high GHQ scores are associated with a greater likelihood of between-wave non-response. 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.

Table 7.5 Lagged migration preference, GHQ score and wave-specific non-response in the BHPS & USoc

| Migration preference & GHQ | Person-years | % Responding in next wave | 95% CI LB | 95% CI UB |
|---|---|---|---|---|
| Prefers to stay & low GHQ | 114,179 | 91.6 | 91.5 | 91.8 |
| Prefers to stay & high GHQ | 34,046 | 89.7 | 89.4 | 90.0 |
| Prefers to move & low GHQ | 50,766 | 89.3 | 89.0 | 89.6 |
| Prefers to move & high GHQ | 22,880 | 88.1 | 87.6 | 88.6 |
| Doesn't know & low GHQ | 1,760 | 89.0 | 87.5 | 90.4 |
| Doesn't know & high GHQ | 727 | 88.3 | 85.8 | 90.4 |
| **Total** | 224,358 | 89.5 | 89.4 | 89.6 |

**Author's own calculations. Migration preference and GHQ are lagged by one survey wave. High GHQ is defined as a sum of 3 or higher over the 12 items. Confidence intervals adjusted for individuals contributing several person-years.**

## 7.6 Conclusion

This analysis set out to test whether poor mental health is associated with a greater likelihood of moving, using a novel extension of the methodology of Thomas *et al* (2015). The effect of poor mental health on future moves is estimated whilst controlling for place of residence and migration preference, effects often overlooked in the literature. Evidence is found for a relationship between mental health and migration; however this effect is affected by migration preference and is moderated by place of residence. Mental health is associated with a greater likelihood of migration only among those who prefer not to move (see Figure 7.2). This finding contributes to understanding the mechanisms

driving the higher levels of migration amongst the population with mental health needs (Tunstall *et al*, 2014), as this differential is explained by differences in undesired migration, contrary to past research (Woodhead *et al*, 2015).

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 desirable housing and neighbourhoods towards areas with greater access to healthcare (Moorin *et al*, 2006), or communities which provide greater anonymity 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 is required to assess the challenges related to retaining residence faced by those with mental health needs in order to further understand the elevated rates of undesired migration among this group.

At the macro level, the difference in predicted probabilities of migration for the populations in good and poor mental health is not consistent across LAs in GB. Relatively high rates of internal migration among those with poor mental health are moderated but not explained by place of residence effects, as these high rates are found in all LAs covered in the BHPS sample. A curvilinear trend is present in this ratio over migration rates, as the population in poor mental health are particularly likely to move from and to LAs with low migration rates. It is important to note that these effects are independent of local area deprivation and population density, despite past studies finding that individuals in poor mental health are more likely to move towards more deprived (Tunstall *et al*, 2014) and urban areas (Lewis *et al*, 1992). Controlling for these effects, differentials in migration probabilities by mental health are present at the macro level.

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 in order 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. Finally, no distinction is made between intra and inter-LA migration in this analysis. 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.

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.

# Chapter 8 Conclusion and priorities for future research

The objective of this thesis is to test whether the association between health and internal migration within GB persists, once place of residence effects are accounted for. The literature review (Chapter 2) finds that place of residence effects are rarely included in a realistic manner, extant literature lacks a common definition of 'long-distance' in terms of health-selection, and that the distinction between physical and mental health is underdeveloped in migration research. The review of datasets (Chapter 3) for health and internal migration research finds that Census microdata, the BHPS and USoc are the only datasets with sufficient sample sizes and temporality. Each of the analytical papers presented here contributes to the understanding of the health and internal migration relationship.

## 8.1 Assessment of research questions

Three research questions were posed in Chapter 2. These questions address key research gaps and will contribute to understanding of the interlinkages between health and internal migration. In summarising the analytical works written in response to these research gaps, it is important to identify the original contributions that have been made by this thesis. In this section, these questions are restated, and the evidence gathered across these original empirical works is summarised.

The first research question was: "*is physical health associated with internal migration, controlling for place of residence*?". This question was explored in chapter 5. Previous analyses do not control for place of residence and there was reason to suspect that place of residence affects the relationship between health and internal migration. The relationship between self-reported LLTI and migration in the past year is explored using microdata from the 2011 England and Wales Census. Incorporating place of residence at the time of the Census as an additional analytical level, individuals who report an LLTI were less likely to have moved in the past year. It is established that the association between physical health and internal migration is moderated by place of residence, with those reporting a LLTI being more likely to have moved in mining areas of England and Wales, relative to those not reporting an LLTI. Although not directly related to this

research aim, evidence is found through stratification that the drivers of internal migration appear to be different among those with and without physical health limitations. Separation or widowhood, further and higher education, household ownership and economic inactivity have less effect on the probability of moving for those with a LLTI, relative to those without. Conversely, age, lone parenthood, being born outside of the UK, living in social housing and car ownership had greater associations with migration among those with an LLTI. Factors which were important for those without a LLTI, such as ethnicity and economic inactivity, had no association with migration among those with an LLTI. This analysis contributes to migration and health literature by restating that health is associated with internal migration, and establishing that this association is not an artefact of area characteristics experienced by those with and without physical health limitations.

The second research question is assessed in Chapter 6, and was: *"Is physical health associated with long-distance migration, and does the definition of long-distance affect this association*?" Previous work in this area does not control for place of residence effects and there is no consistent definition of long-distance. Microdata from the 2011 England and Wales Census are used to test the effect of LLTI on the odds of moving long distance, using competing definitions of long distance found in the literature, whilst also accounting for place of residence effects. LLTI was associated with lower odds of moving 50km or further, but there is no evidence for an association when long distance is defined as 10km or further, nor 20km or further. Further, health-selection in distances moved is evident only among the youngest (16-24) and eldest (55-64) working age adults. By area, there is evidence of health selection in destinations at the 20km or further definition, and this evidence is stronger among moves of 50km or further. This analysis contributes to the literature by identifying that health-selection in long distance migration is evident only at the 50km or further cut-off, once place of residence is accounted for, and that this health selection is evident only among youngest and oldest working-age adults.

The third research question is assessed in Chapter 7, and was "*Is the relationship between mental health and internal migration explained by ability to meet mobility preferences, independent of place effects*?". The methodology presented in Chapter 5 is extended. Migration is measured between pairs of survey waves from 1991 to 2015, by mental health status, accounting for place of origin and destination, using data from the BHPS and USoc. High rates of internal migration are found among those with poor mental health, and this is explained primarily

by undesired migration. The degree of difference in overall migration rates between those in good and poor mental health is higher in areas where low percentages of the total population are moving, but this difference is consistently positive across GB. This analysis contributes to the literature by making strides towards determining the mechanisms driving the relatively high rates of migration among those with mental health problems in GB.

## 8.2 Contributions to the literature

In Chapter 2 it was stated that the direction of the relationship between health and internal migration is unclear, as the majority of research compares the health of movers and non-movers, without examining whether health also affects the likelihood of moving. The empirical analyses in this thesis provide evidence that an individual's health is associated with their likelihood of moving and how far they move, and that this finding is moderated, but not explained, by place of residence. This has implications for future research, as differences in the health of movers and non-movers are not explained wholly by the effects of moving, they also reflect health selection in who moves, and accounting for this duality is recommended to make inference on the relationship between health and migration.

The original evidence presented in this thesis makes a clear case that the interlinkages between health and internal migration occur within spatial structures, which have their own influence on migration behaviour, and thus there is a continuing need for a geographical perspective in this body of literature. Multilevel models are used throughout as a means to make inference on individual behaviours which are modified by area of residence, and at the time of writing multilevel models have been underutilised in migration research. In each analysis, place of residence explained a significant proportion of the variance in migration behaviour. In Chapter 5 place of residence at the time of the Census (destination) explains 4% of the variance in migration behaviour for individuals without an LLTI, and 5% for those with an LLTI. In Chapter 6 destination effects explain between 5 and 6% of the variance in the probability of having moved long-distance, and in Chapter 7 origin effects explain 12% and destination effects 20%. Ignoring spatial clustering will bias the standard errors of individual factors that impact migration (Goldstein, 2011).

In Chapter 7, previous work modelling cross-classified structures in migration modelling is extended to include a time component, in addition to being utilised for modelling whether individuals move or not. Significant variance is found at the area of origin and destination levels. This framework is explained in detail so that it can be used for future research. Future assessments of the relationship between health and internal migration must account for these area influences in order to adequately reflect complexity behind the decision to move and where to move to.

A clear argument is made for the need to reflect on how 'long-distance' is conceptualised and operationalized, especially as the association between health and long-distance migration is dependent on the definition used. Currently within the literature, long-distance is inconsistently defined between studies and there is a lack of justification for these definitions a priori. Based on empirical work contained in Chapter 6, health selection is evident when long-distance is defined as 50km or further, and this definition should become a baseline for future research in this area.

## 8.3 Reflections and limitations

The limitations of each analytical paper are discussed within their respective chapters. However, there are several cross-cutting themes which extend through all of the original analyses presented herein. All of the papers utilise self-reported measures of health status, and there is substantial debate about the veracity of such measures. There is a suggestion that more educated individuals may be better equipped to recognize the symptoms of poor health, and thus provide better self-reported valuations of their healthiness (Sen, 2002). Although the supporting evidence for such an argument is limited (Subramanian *et al*., 2009) and self-reported measures of health are strong predictors of mortality and morbidity (Cohen *et al*., 1995; Jordan, 2003), it is likely that there is individual heterogeneity in reporting behaviour.

In terms of mental health, several public health campaigns have focused on reducing the stigma around discussing mental health in GB, such as Time to Change (2007 – present), and the royal family launching the 'Heads Together' campaign (2017). It is plausible then, that the admission of mental health needs may have become more acceptable over time, so there is time-variant heterogeneity in the likelihood of reporting mental health difficulties to consider

also. As discussed in Chapter 3, this limitation derives from the lack of appropriate datasets which contain migration and objective health data, which has led to a reliance on self-reported measures in the wider literature, and this thesis.

All three papers utilise one-year transition definitions of internal migration (i.e. is person *a*'s address different to their address one year prior). There is an argument to be made that multiple moves are particularly detrimental to health, and are indicative of negative life events such as divorce and bereavement, and that the health-selective process is likely different for single and multiple moves as a result. Multiple moves provide less time for adjustment to the new home, its surrounding area, social networks and commuting routes, and mental health may be one of the mechanisms which drives this process. Beyond the frequency of moves, the specific lag of one-year utilised in all three analyses may exaggerate the degree of health selection. For example, one study finds that movers to less green areas have significantly lower GHQ scores in the year prior to moving, relative to two years prior to moving (Alcock *et al.*, 2014), so the degree of health selection in migration is not consistent over lag periods. In the case of Chapter 5 and Chapter 6, the use of one-year lags is due to data constraints, as Census microdata only capture one-year migration transitions, but the datasets used in Chapter 7 could be reshaped to capture migration transitions over longer intervals. It was decided that one-year transitions be used in order to maximize the effective sample size for analysis, as the fit of the cross-classified model improves as the number of individuals in each LA increases. 11 LAs had to be excluded due to low sample sizes in this analysis using one-year transitions, greater lags would have led to smaller sample sizes and likely exclusion of further LAs, which would reduce the representativeness of the analysis.

Another limitation of the work presented is that life-course events and household influences are not measured. Since Rossi's (1955) seminal work, migration has largely been understood as a response to changes in the family life cycle. For example, a family are likely to move in anticipation or as a response to a new child, while young adults are likely to move upon entering higher education. Comparing the migration behaviour of those who do and not experience such life events is the basis of the life-course event approach. In the analytical models herein, those who are married are contrasted to those who are single, for example, without exploring whether it is the transition from one state to another (e.g. becoming married) which drives migration behaviour, rather than 'being

married' itself. Past analyses have shown that partnership formation, dissolution, transitions into-, between- and out of employment and the arrival of a baby are all important correlates of internal migration (Cooke *et al.*, 2016; Coulter & Scott, 2014). The consideration of lag components may also be important, as those who are retired are more likely to have moved in the past year, but *becoming* retired is not associated with migration (Coulter & Scott, 2014), so not all migration correlates are captured through the life-course event approach. The Census microdata applied in Chapter 5 and Chapter 6 are cross-sectional, and do not measure such transitions, whilst the data used in Chapter 7 are longitudinal, and such life-course events could have been controlled for or explored. Given that the primary concern of this thesis was to make inferences about the influence of an individual's health on their probability of internal migration, it was decided that a more focused approach be taken to the measurement of socioeconomic characteristics in the interest of parsimony, but there is scope to develop the interactions between health, life-course events and internal migration.

## 8.4 Future research and policy implications

In the context of increasing life expectancy, rising rates of non-communicable diseases and awareness of mental health, detailed data on the health needs of local populations are required. Complex models can effectively predict the incidence of health problems at small area levels (e.g. Kirkbride *et al.*, 2013) but, in order to plan services effectively, information on how likely individuals are to move, and where they are likely to move to is also needed. In this thesis, evidence is presented that an individual's self-rated physical and mental health affects their likelihood of moving, and that individuals in poor physical health are particularly likely to have moved to or within 'mining heritage and manufacturing' areas. These findings suggest that migration patterns of groups with differing health needs may affect regional patterns of health care need, similar to how migration patterns affect rural/urban differentials in mortality (Riva *et al.*, 2011). Healthcare providers and local government must take these patterns of migration behaviour into account in planning future services, and further research is needed on the patterns of patients with specific conditions to create targeted programmes and interventions, to increase the efficiency of health service planning and provision.

A large body of literature is dedicated to investigating the associations between place and health (Dunham & Faris, 1939; Poortinga *et al.*, 2007; Truong & Ma, 2006). The finding that health affects migration behaviour has implications for

the identification of such neighbourhood effects. Place and health research largely correlates an individual's current or recent health status with area-characteristics (e.g. deprivation, household composition), or estimates the area-deviation from a population average rate of 'poor health' through multilevel modelling (Diez Roux, 2001). Evidence presented in this thesis contributes to recent calls for the neighbourhood effects literature to take migration into account (Green *et al.*, 2017). It is suggested here that those in poor physical health are less mobile than the general population, whereas those in poor mental health are more mobile than both groups. These movements may lead to the 'residualisation' of unhealthy populations in certain areas, exaggerating the extent to which places affect health. Individuals moving between the most and least deprived neighbourhoods exhibit different rates of morbidity from the residual populations in both areas, and therefore the overall prevalence of morbidity is affected at both the origin and destination (Norman *et al.*, 2005). If neighbourhood effects are to be observed, then a life-course approach is needed which accounts for individual exposure (through migration between areas, and areas changing over time) over an individual's life (Spallek *et al.*, 2011), in light of evident health-selective migration.

As indicated in Chapter 3, there are few datasets which are longitudinal, contain measures of health status and migration, and cover large parts of GB. Administrative data are identified in that chapter as an alternative data source which would allow the migration patterns of individuals receiving treatments for varying conditions to be contrasted, in order to build a more nuanced model of health, beyond a healthy/unhealthy dichotomy. A detailed account of barriers to accessing these data are also described, but further and more persistent interest from researchers, as well as enthusiasm from data-holders is required to develop analyses based on such data in GB.

Passing reference is made to healthcare access in all of the empirical works presented in this thesis, but no effort is made to measure the degree of access experienced by individuals. In the case of Census microdata, this is difficult as the lowest geography (LAs) is coarse, risking the ecological fallacy as the degree of access will vary largely within LAs. The construction of an access measure is possible with longitudinal survey and birth cohort data, which have finer levels of geographical detail, and this would enable the relationship between health, healthcare access and migration to be modelled more realistically. An additional layer of complexity occurs when considering these longitudinal data sources, as

changes in providers need to be accounted for, and changes in the speciality of healthcare delivered. Using NHS Digital data, it is possible to geo-reference all providers of secondary mental healthcare within England using quarterly statistics on cases processed by provider, and this is another further avenue for research.

In terms of modelling, there are several methodologies which would further expand knowledge of the relationship between health and migration. There is great compositional difference between the population who move and do not move, and those in 'good' and 'poor' health. Matching methods may be more appropriate for contrasting the health of movers and non-movers. These methods select persons who are 'most similar' between control (non-movers) and case (movers) groups. One study explored this methodology for three years of BHPS data, finding that (in contrast to established literature), individuals with poor self-rated health are more likely to become internal migrants (Green *et al*., 2017). Further research is also required on alternative indicators of health status (particularly mental health), to identify if health-selection differs across different forms of health. Event history analysis, modelling the time until migration occurs, is a commonly used approach in the migration literature, but is used less often in terms of health and migration (Westphal, 2016). This approach has not yet been used to assess whether a change in health status (e.g. the onset of a mental health condition) has an effect on the time between migrations, with the majority of the literature (and the analytical works in this thesis) focusing on one-year migration probabilities. Such an analysis would begin to unpick the timescales over which health-selection occurs in migration behaviour. Finally, the analyses conducted in this thesis account for area influences on migration behaviour, but only a limited number of characteristics of these areas are compared. Structural equation modelling, and other factor analysis derivative methods could be used to compare the relative importance of individual health, socioeconomic characteristics and specific area-level characteristics (e.g. access to healthcare, green space, employment) to determine the relative importance of health for migration behaviour, among competing drivers of migration.

In terms of policy, it is clear from the account of attempting to access administrative data provided in section 3.3.3 that extra work is needed to provide clear frameworks and incentives for government departments to share data between departments, and with researchers for research purposes. Perhaps the new legislative arrangements for data sharing set out by the Digital Economy Act (2017) will smooth this process in future, although a clearer legal framework will

not change the nature of access unless government departments become more enthusiastic and open towards research. Data access may even become more difficult when the European-wide General Data Protection Regulation is effected in March 2018 (Information Commissioner's Office, 2017). This regulation introduces new rights to data subjects, but also aims to promote the free movement of personal data, and it is unclear what impact this regulation will have for science and social science research (Chassang, 2017). Given that academia is tending towards a focus on 'impact', there could be benefits to the Government for sharing such data. For example, a thorough analysis of individual migration trajectories for patients receiving treatment for specific conditions might inform health care providers on the likely destinations of individuals who become lost to services, and therefore lead to cost reductions in tracing such persons.

Maintaining access to individual microdata is key for future research on health and internal migration. Upon reviewing the data landscape in Chapter 3, England and Wales Census microdata was identified as the most suitable source for physical health and internal migration research due to the large population coverage and sample size offered. The 2021 England and Wales Census will primarily be administered online, with a view towards moving to a continuously updated statistical population database thereafter, making extensive use of administrative data(Office for National Statistics, 2015h). It is currently unclear whether a similar microdata product will be available for research purposes. The ONS have developed a dataset (the Statistical Population Dataset) which currently contains data on location, age and sex, of individuals identified from administrative data, for the purpose of estimating local population estimates (Office for National Statistics, n.d.). This dataset could, in principle, link to health service usage collected by NHS Digital through probabilistic matching, but there are no current plans to release these data for research purposes. Without census or administrative microdata, data from surveys will likely remain important, however these data suffer from selective participation in surveys which affects the representativeness of the covered sample, a feature less prominent in census and administrative data.

Attention must be paid towards supporting the needs of the population with poor self-rated mental health, as Chapter 7 finds that they are particularly likely to make undesired moves, given that being an 'undesired mover' is associated with worsening mental health (Woodhead *et al.*, 2015). Provision of long-term and secure housing for this vulnerable population is vital to foster an environment in

which improvements in mental wellbeing and overall stability can be achieved , and more can be done by central and local government to ensure that this need is met (Mental Health Foundation, 2016). Housing conditions have been linked to a wide range of physical and mental health outcomes (Kreindler & Coodin, 2010) and, as a result, perhaps housing needs to become a more central aspect of public health policy, which has seen quality housing as a commodity rather than a fundamental need in the neo-liberal era (Stewart, 2005).

## 8.5 Final thoughts

This thesis has modelled the influence of health on internal migration using secondary data. It was largely motivated and informed by the lack of consideration of place effects and efforts to understand the mechanisms underpinning the bivariate relationship between health and internal migration. Throughout, multilevel models demonstrate that place of residence affects migration behaviour, and capture and explain the influence of health on migration. Hopefully this thesis will lead to the further development of multilevel modelling in health mobility research.

# Appendix A The 12-item General Health Questionnaire

| GHQ question | Possible responses (1 indicates the lowest amount of psychological distress, 4 the most) | | | |
|---|---|---|---|---|
| Have you recently… | 1 | 2 | 3 | 4 |
| Been able to concentrate on whatever you're doing? | Better than usual | Same as usual | Less than usual | Much less than usual |
| Lost much sleep over worry? | Not at all | No more than usual | Rather more than usual | Much more than usual |
| Felt that you were playing a useful part in things? | More than usual | Same as usual | Less so than usual | Much less than usual |
| Felt capable of making decisions about things? | More so than usual | Same as usual | Less so than usual | Much less capable |
| Felt constantly under strain? | Not at all | No more than usual | Rather more than usual | Much more than usual |
| Felt you couldn't overcome your difficulties? | Not at all | No more than usual | Rather more than usual | Much more than usual |
| Been able to enjoy your normal day-to-day activities? | More so than usual | Same as usual | Less so than usual | Much less than usual |
| Been able to face up to problems? | More so than usual | Same as usual | Less able than usual | Much less able |
| Been feeling unhappy or depressed? | Not at all | No more than usual | Rather more than usual | Much more than usual |

| | | | | |
|---|---|---|---|---|
| Been losing confidence in yourself? | Not at all | No more than usual | Rather more than usual | Much more than usual |
| Been thinking of yourself as a worthless person? | Not at all | No more than usual | Rather more than usual | Much more than usual |
| Been feeling reasonably happy, all things considered? | More so than usual | Same as usual | Less so than usual | Much less than usual |

Note: responses 1 and 2 are recoded as 0, and responses 3 and 4 as 1 for each question. The total is then calculated for all twelve items, with totals of 0-2 indicating a lack of psychological distress, and 3-12 indicating psychological distress ('GHQ method'; Hankins, 2008).

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