Social capital, employment, and health: Examining area factors in England

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Abstract

This dissertation explores area-level and individual factors (deprivation and social capital) related to health inequalities among adults in England, using the UK Household Longitudinal Study (UKHLS). Chapter 2 examines the relationships between employment states and transitions and physical health, with area deprivation as a potential moderator, using 9 years (2009-2020) of UKHLS data (Waves 1-10). Fixed effects model show improved physical health was associated to unemployment transitions in the second least employment-deprived areas. Retirement transition was associated with deteriorating physical health, though the association was less severe in the second least income-deprived areas than in the least income-deprived areas.

Chapter 3 investigates the associations between area deprivation and physical health and examined the potential mediating role of area social capital. Employing three-level analyses with 9-year data (2011-2019, Waves 3, 6, and 9), the findings indicate that area deprivation and area civic engagement were associated with physical health. The mediating role of area civic engagement in the main associations were not definitive.

Chapter 4 investigates the associations between social capital and mental health at individual and area-level, applying autoregressive cross-lagged models. The analytic sample was mainly drawn from Waves 3, 6, 9, and 12 (2011-2022), except for the trust and cooperative norms model, which used Waves 3 and 6 (2011-2014). Area characteristics and individual traits, including mental health, civic engagement, friendship network homogeneity, and trust and cooperative norms, were correlated. Furthermore, a reciprocal, though not consistently significant, relationship between friendship network homogeneity and mental health. The reciprocal relationships between trust and cooperative norms and mental health were found.

Policymakers may consider employment support for retirees in the least income-deprived areas and could collaborate with bodies to improve civic engagement in LADs. Interventions, such as extending infrastructure (e.g., parks), to strengthen local social capital are suggested as they may increase social capital.

Chapter 1. Social Capital, employment, and health: examining area factors in England

Introduction

This dissertation explores the relationship between deprivation and social capital, both at individual and area levels, and health outcomes. Specifically, Chapter 2 examines the association between employment states and transitions and health across deprived and less deprived areas. Apart from social causation, this project examines the health selection hypothesis, questioning whether health selects individuals' employment states or transitions in deprived and less deprived areas. Chapter 3 investigates the relationship between area deprivation and health, considering various forms of area social capital as potential mediators. Chapter 4 tests the association between area characteristics and personal characteristics, such as social capital, and the reciprocal relationship between social capital and mental health. Chapter 5 discusses implications of these findings and provides an overall discussion.

This chapter is structured as follows. In the next section, I discuss the perspectives of social causation and health selection, providing the theoretical foundation for Chapters 2 and 4. I bring in the perspectives of retirement kink, health selective migration, contextual explanations, and unemployment rates while discussing social causation. Before ending the section, I discuss the methodology of testing social causation and health selection. For the theoretical foundation of Chapter 3, I then discuss compositional and collective explanations under the section titled "Places, People, and Health." Next, I explore the social-interactive mechanisms for the theoretical foundation of Chapter 4. Additionally, I highlight the importance of examining both local authority districts (LADs) and counties of England and define key concepts such as deprivation, health, social capital, and compositional, contextual, and collective explanations. The definitions of compositional, contextual, and collective explanations are aligned with Macintyre, Ellaway, and Cummins (2002). I then discuss the secondary data used and the characteristics of the sample. Finally, I outline my studies and discuss the methodology in detail.

social causation and health selection

Social causation

This project, especially Chapters 2 and 4, utilises the social causation and health selection perspectives. These perspectives offer different viewpoints on the relationships between individual deprivation (i.e., employment states and transitions) and health, as well as the associations between social capital and health. Social causation maintains that low socioeconomic position of individuals, such as lower employment grade, social class, unemployment, and household income, is relevant to their health. Researchers also use this perspective to investigate the association between social capital and health outcomes. These studies are well-documented (Marmot *et al.*, 1991; Ecob and Davey Smith, 1999; Chandola and Jenkinson, 2000; Bartley, Sacker and Clarke, 2004; Yu *et al.*, 2015; Hughes *et al.*, 2017; Akanni, Lenhart and Morton, 2022). For example, using a random-effects meta-analysis and samples from the Health Survey for England (HSE), the Scottish Health Survey (SheS), the National Child Development Study (NCDS), and Understanding Society, Hughes *et al.* (2017) found that unemployed individuals are more likely to have elevated levels of C-reactive protein (CRP) and fibrinogen, two markers of systemic inflammation. Yu *et al.* (2015) also found that social participation was associated with better mental health, adjusting for gender, age, employment status, educational attainment, marital status, household wealth, and region.

Social causation: Retirement kink

Most studies from European countries show that retirement is associated with poor health (Behncke, 2012; Xue, Head and McMunn, 2020). However, there are not many studies examining the association between retirement state and transition and health across deprived and less deprived areas. Several perspectives could explain the association. Specifically, Marshall and Norman (2013) indicate that the increase in illness rates with age either slows or declines at retirement age. The study suggests potential health benefits after retirement—a phenomenon they refer to as the "retirement kink." This kink is observable in coalfield and former industrial districts but is negligible in less deprived areas in the South East of England. Marshall and Norman (2013) argue that hidden unemployment and health selective migration explain the retirement kink. Unemployed individuals, particularly those reside in coalfield and former industrial and mining areas, may have reported poorer health or more limiting long-term illness (LLTI) because they were claiming Incapacity Benefit instead of Jobseeker's Allowance. This situation represents a form of hidden unemployment, as these individuals were effectively out of the workforce but not classified as unemployed. Upon reaching the state pension age, these individuals report more accurate health statuses; and they can claim the Basic State Pension, regardless of their health. While the amount of Incapacity Benefit is higher than Jobseeker's Allowance, the Basic State Pension exceeds the Incapacity Benefit. These individuals were not malingering; rather, their illnesses may have impeded their ability to work in physically demanding jobs in coalfield and former industrial and mining areas. Reaching the state pension age allows them to provide a more accurate account of their health status. Additionally, healthy individuals may move to certain areas when they retire. If an area experiences a high level of out-migration of healthy individuals, it leads to a rapid increase in the prevalence of LLTI among the remaining retirement-age population.

Social causation: Health selective migration and contextual explanations

Another perspective is that retirees in less deprived areas have better health than retirees in deprived areas. Knies and Kumari (2022) show that areas with both low income and high unemployment rates are associated with multimorbidity. They explain that it may be due to health selective migration wherein retirees and unemployed individuals who are sick tend to reside in these deprived areas (Knies and Kumari, 2022). Therefore, unemployed individuals and retirees in deprived areas are more prone to poor health than retirees in less deprived areas. Additionally, physical environment in low- or high-income areas may also explain the association. For instances, left-behind neighbourhoods in England lack places to meet and have fewer leisure and sports facilities (Local Trust, 2020). Residents in the left behind neighbourhoods have the worst health in England (APPG, 2022). The lack of infrastructure in deprived areas may affect the lives of retires and it, in turn, relate to their health.

Social causation: unemployment rates

Two studies explored the association between employment status and health across areas with high and low unemployment rates. Studies consistently show that being unemployed is associated with poor physical health in deprived areas than in less deprived areas. Specifically, Hughes *et al.* (2017) show that jobseekers are more likely to have CRP levels indicative of high cardiovascular risk in the UK, even after controlling for age, gender, education, long-term illness, smoking, and body mass index. The associations are more pronounced in Scotland and Wales compared to England. The reasons for this discrepancy are unclear, but researchers suspect that it may be related to differing unemployment rates in these countries. In the years of data collection, England had a lower unemployment rate than Scotland and Wales. Another similar study using a sample from the "Americans' Changing Lives" (ACL) study, which collected data in 1986 from non-institutionalized adults aged 25 and older across the continental US, showed similar results. In areas with high unemployment rates, those who are unemployed are estimated to exhibit depression levels that exceed those of their employed counterparts by more than a standard deviation, with even more pronounced disparities in physical health (Turner, 1995), while in areas with low unemployment rates, the associations between unemployment and physical and mental health are not statistically significant (Turner, 1995). The results suggest that the anticipation of prolonged unemployment may be detrimental to health.

Health selection in deprived and less deprived areas

On the other hand, health selection or social drift perspectives maintain that health affects individuals in attaining or maintaining socioeconomic positions (type I health selection) (Warren, 2009; Ki *et al.*, 2011). This perspective has also been applied to explain health selection in social inequalities, such as social capital (type II health selection) (Ki *et al.*, 2011). Studies have examined the social causation and health selection hypotheses for decades (Bartley and Plewis, 1997; Chandola *et al.*, 2003; Ki *et al.*, 2011; Kröger, Pakpahan and Hoffmann, 2015; Yu *et al.*, 2015). Ki *et al.* (2011) show that subjective health predicts transition out of and into employment in British Household Panel Survey (BHPS), while the association is minimal for transition between classes, using a multilevel multinomial approach. Additionally, there is evidence indicating that mental health is correlated with social capital (Downward, Rasciute and Kumar, 2020), which is an example of type II health selection.

Individuals are not randomly selected into certain employment states; rather, the mechanisms by which they transition out of unemployment may vary across different socio-economic contexts (Turner, 1995). Research indicates that poor health increases the likelihood of unemployment (Jusot *et al.*, 2008). Turner (1995) argued that the possibility of health selection is higher in areas with low unemployment rates, whereas in regions with high unemployment rates, the chances of individuals becoming unemployed are more often due to poor socio-economic conditions. However, it may be the case that health selects people into unemployment in deprived areas. Deprived areas are characterised by a scarcity of jobs and job insecurity (Public Health England, 2015). Individuals with poor health may be more likely to transition into unemployment because they may struggle to cope with poor working environments, which are characteristic of workplace in deprived areas, such as environments with low autonomy, compared to individuals who are healthier (Jusot *et al.*, 2008). This perspective highlights the complex relationship between health and socio-economic factors in determining employment states and transitions.

There is a notable lack of research exploring the relationship between health and retirement status, as well as the transition to retirement, across deprived and less deprived areas in England. In the US, research shows the correlation between poor health and retirement state (Dwyer and Mitchell, 1999). I argue that residents in low-income areas, where a significant proportion of the population has limited financial resources, may face a higher likelihood of transitioning into retirement due to health issues. Individuals living in high-poverty areas who are sick may be more prone to exiting the labour market because of low wages and poor quality of available jobs in their local areas. In contrast, individuals residing in less deprived areas who are also sick may be less likely to retire, as their jobs are of better quality and more likely to accommodate their health needs (Public Health England, 2015).

Social causation and health selection: social capital and health

Apart from examining social causation and health selection in the relationship between individual deprivation and health, prior studies have also explored the association between social capital and health. Reverse causality is one aspect of endogeneity when examining the relationship between social capital and health. For example, studies have shown that individuals with high levels of civic engagement, trust, and cooperative norms tend to be mentally healthier (Berry and Welsh, 2010; Ehsan and Silva, 2015). However, it is also possible that individuals with better mental health are more likely to participate in civic activities and exhibit greater trust in others (Ding, Berry and O’Brien, 2015; Downward, Rasciute and Kumar, 2020; Roychowdhury, 2021).

Social causation and health selection: Methodology

Empirical evidence for social causation and health selection is mixed, varying by the specific SES indicators, health outcomes, and methodologies applied in the studies (Warren, 2009). Kröger, Pakpahan and Hoffmann (2015) suggest addressing five key problems. Firstly, studies should address random measurement errors in social factors and health. Secondly, missing values should be accounted for, as excluding them relies on the assumption that they are randomly distributed. Thirdly, the coefficients should be comparable between health selection and social causation models. Fourthly, it is essential to control for third variables using control variables and adjust for unobserved variables with methods such as the fixed effects model. Finally, it is recommended to include both social causation and health selection in simultaneous equations.

Places, people, and health

There is a long tradition of research in Britain into the association between living in certain types of areas and health outcomes (Macintyre, Maciver and Sooman, 1993). Most studies in this field can be grouped into two traditions (Macintyre, Maciver and Sooman, 1993). The first tradition focuses on examining the association between the physical environment and health, aiming to understand the aetiology of disease through environmental factors. Studies explore variables such as air pollution, climate, water hardness, and other environmental factors (West and Lowe, 1976; Pocock *et al.*, 1980; Chinn *et al.*, 1981; Macintyre, Maciver and Sooman, 1993). The second tradition examines the relationship between area deprivation and health, focusing on morbidity and mortality in the late 19th and early 20th centuries, and explores how areas shape people's health. In recent years, researchers have attempted to integrate these two traditions (Chaparro *et al.*, 2018). The study examines the association between area deprivation and biomarkers, treating physical environment, such as the levels of air pollutants (e.g., sulphur dioxide, particulate matter, and others), green space, and proximity to waste and industrial facilities as potential mediators. Although this project focuses on the second tradition, the discussion touches the physical environment in both deprived and less deprived areas.

Before the micro-level analyses of the late 20th century, studies of health and living areas primarily utilised census data to conduct macro-level research (Macintyre, Maciver and Sooman, 1993; Townsend, Phillimore and Beattie, 2023). From this period, researchers in Britain began investigating the associations between area and individual deprivation and personal health, utilising secondary data (Crombie *et al.*, 1989; Hart, Ecob and Smith, 1997). A handful of studies show that deprived areas are associated with poor health (Smith *et al.*, 1998; Shohaimi *et al.*, 2004; Knies and Kumari, 2022). For example, using data from the towns of Renfrew and Paisley in the west of Scotland, Smith *et al.* (1998) found that poorer postcode sector deprivation categories, measured by the Carstairs Deprivation Index, are associated with more detrimental health outcomes, such as in lung function (FEV1), bronchitis, and angina, controlling for age and social class.

Research investigated how area differences in various health outcomes are attributable to the both the compositional characteristics of the residents and the features of the places (Macintyre, Ellaway and Cummins, 2002). The features of places can be categorized into contextual and collective elements which may affect health. The findings have been mixed. Some studies conclude that there is no effect of the area of residence on health when adjusting for individual predictors (Macintyre, Ellaway and Cummins, 2002). This suggests that health differences in these areas are not because of place features but because of the socioeconomic characteristics of people who live in these areas (Macintyre, Ellaway and

Cummins, 2002). However, research also found remaining excess health after including compositional predictors. For example, using a multilevel approach, Hart, Ecob and Smith (1997) show differences in diastolic blood pressure, cholesterol, and alcohol consumption across 22 local government districts, even after controlling for socioeconomic and other individual-level variables. This study demonstrated that both place features and compositional factors might explain coronary heart disease risk. Nonetheless, the majority of the variance is observed at the individual level (Hart, Ecob and Smith, 1997). While studies caution that the findings of excess health may be due to unobserved individual variables, most researchers are inclined to conclude that places are relevant to health (Macintyre, Ellaway and Cummins, 2002).

In Chapter 3, I examine the associations between area deprivation and health, considering various forms of area social capital as potential mediators while controlling for individual-level social capita and deprivation, which represents the compositional element. There is a notable absence of studies examining the association between area deprivation, area social capital, and health. Several studies in the UK have considered area social capital as a potential mediator in the relationship between neighbourhood disorder and various outcomes, such as burglary (Markowitz *et al.*, 2001) and psychological distress (Steptoe and Feldman, 2001).

Since the 1990s, a handful of studies have examined area social capital in relation to health (Kawachi *et al.*, 1997; Kawachi, Kennedy and Glass, 1999; Macintyre, Ellaway and Cummins, 2002). Lisa F. Berkman and Ichiro Kawachi (2015) classified research on social capital and health into three generations. The first generation (1996–2000) primarily employed ecological designs. For example, Kawachi *et al.* (1997) investigated the associations between income inequality, area-level social capital, and mortality. The second generation (2000–present) incorporated both individual-level and multilevel analyses. The third generation (since approximately 2007) has adopted causal inference approaches, such as instrumental variable methods, to clarify these associations. This body of research seeks to address the challenge of endogeneity in the relationship between social capital and health, recognising that unobserved variables may influence both factors.

Area social trust is found to benefit our health, but the association between civic engagement and health outcomes is mixed. For example, Kawachi, Kennedy and Glass (1999) found that state social trust is associated with better health among individuals residing in 39 states in the US, after adjusting for individual-level variables such as income, education, and smoking, using the SUDAAN logistic regression procedure. In the UK, Snelgrove, Pikhart and Stafford (2009) found that area social trust in postcode sectors was associated with better self-rated health, controlling for individual characteristics, baseline self-rated health, and individual trust, using multilevel analyses. In the UK, no evidence was found of a relationship between area civic participation and self-rated health in postcode sectors (Snelgrove, Pikhart and Stafford, 2009), while research shows positive association in local authority districts (LADs) (Pattie, Seyd and Whiteley, 2004).

Social-interactive mechanisms

Apart from testing the association between various forms of social capital and health, Chapter 4 also examines the association between area characteristics and personal attributes. For example, it investigates whether residing in areas with high social capital is related to an individual's personal social capital. Additionally, it explores whether living in areas with high depression is associated with increased levels of depression in individuals. Notably, the social contagion of physical health appears to be less prevalent than that of mental health. Previous studies have predominantly focused on mental health, loneliness, happiness, and health behaviours within the realm of social contagion, underscoring its importance (VanderWeele, 2011). The literature scarcely documents the social contagion of physical health, with obesity through physical activities being the primary exception (Huang *et al.*, 2016). Therefore, Chapter 4 justifiably prioritises mental health over physical health.

Social-interactive mechanisms, such as social contagion and collective socialization may explain the associations of my study (Galster, 2012). Specifically, social contagion refers to the spread of behaviours through people in the neighbourhoods, potentially leading to widespread changes akin to epidemics when a critical threshold is reached, while collective socialization emphasises the conformity to social norms in neighbourhoods, which are conveyed by role models (Galster, 2012). The threshold notion in both social contagion and collective socialization mechanisms can be identified through regression models that allow for non-linear associations between individual outcomes and the percentage of neighbourhood characteristics (Galster, 2012). For example, the association between neighbourhood poverty rates and outcomes like crime or school leaving appears to be negligible until neighbourhood poverty exceeds about 20% (Galster, 2012).

Previous research has not investigated how the characteristics of living areas are associated with personal traits in the context of the relationship between social capital and health. For instance, characteristics of an area, such as high civic engagement, might shape individual traits, including personal civic engagement, due to social contagion. Personal social capital, such as civic engagement, is associated with mental health (Berry and Welsh, 2010). Living in areas with high social capital suggests a high proportion of individuals with significant social capital. Interacting with individuals in their areas who actively participate in civic engagement could encourage those less involved in community and organisational activities to increase their participation, again due to social contagion (Galster, 2012). This increased participation, in turn, could be associated with better mental health outcomes (Berry and Welsh, 2010).

Counties, Local Authority Districts, and small area units

Counties, Local Authority Districts (LADs), and small area units can be used for statistical purposes. This study used counties and LADs as the geographical units. Small areas, defined as geographic entities below LADs in England and Wales, are categorised into four main groups: Census geography, electoral areas, postal geography, and various ad hoc local areas. Within Census geography, there are Census Output Areas (OAs) and Super Output Areas (SOAs) across England, Wales, Northern Ireland, and Scotland. OAs were introduced in England, Wales, and Northern Ireland in 2021, while SOAs were introduced following the 2001 Census. For England and Wales, the Office for National Statistics (ONS) delineated three levels of SOA: Lower Layer Super Output Areas (LSOAs), Middle Layer Super Output Areas (MSOAs), and Upper Layer Super Output Areas. In England, each OA typically comprised around 40 households and 100 residents in 2001, while LSOAs housed approximately 1,500 residents and MSOAs about 5,000 residents. This classification by ONS aims to establish a stable, permanent geographic framework suitable for publishing a wide range of statistics consistently (Association of Public Health Observatories, 2009).

Additionally, electoral areas or statistical wards encompassing wards, civil parishes, and parliamentary constituencies in England, Wales, and Scotland, primarily serve as constituencies for local elections, with each ward electing one or more councillors to the Local Authority. Beyond their electoral function, these wards are also employed by the ONS as geographical units for data publication. The Census Area Statistics, for instance, are released using slight variations of statistical wards, often merging the smallest wards (Association of Public Health Observatories, 2009). In 2001, Census Area Statistics (CAS) wards each had an average population of approximately 6,000 residents (Association of Public Health Observatories, 2009).

Postal geography is mainly designed for delivering mail. England can be divided into postcode areas. These postcodes help to identify specific location across the country. Postcodes can be aggregated to areas, districts, and sectors. For example, YO10 5DG. Postcodes starting with "YO" refer to the area of York. "10" refers to a smaller district in York. "5" refers to a sector in the district. "DG" refers to the exact group of addresses, like a few streets. However, obtaining reliable population sizes at the postcode level poses challenges (Association of Public Health Observatories, 2009).

Justifications for the use of LADs and counties

LADs

Most studies in social epidemiology employ small area units such as Lower Layer Super Output Areas (LSOAs) and wards (Snelgrove, Pikhart and Stafford, 2009; Knies and Kumari, 2022). In contrast, this study adopts LADs and counties as the geographical units. The choice of LADs and counties is particularly pertinent due to the focus of the National Institute of Health Research (NIHR) Applied Research Collaboration (ARC) East of England (EoE), the sponsoring body of this research, on specific LADs: Great Yarmouth and Waveney, Peterborough and Fenland, Stevenage, and Thurrock. A factor influencing this approach is the absence of secondary data with adequate sample sizes for these LADs in England. Consequently, this dissertation employs LADs and counties within England as the basis for its investigative studies. Due to this, the findings from this project cannot be generalised to populations outside England.

Conducting studies at the LAD level is essential for several reasons. Firstly, since 2013, upper-tier and unitary LADs have been responsible for enhancing the health of their residents and reducing health disparities (Castro *et al.*, 2020). In that year, Public Health

England (PHE) was established to reduce health gaps among different groups by promoting healthier lifestyles, advising the government on social determinants of health, and supporting actions by local government, the NHS, and the public (Bonner, 2020). Figure 1.1 illustrates the role of local authorities in addressing the social determinants of health in local authority districts (LADs) (Local Government Association, 2010; Bonner, 2020). The figure highlights the diverse interventions local governments can implement to make a difference, including fostering social cohesion in communities and improving the local economy to help residents secure employment, which is relevant to this project. Despite the transfer of public health responsibilities back to local authorities in England, local governments have not effectively tackled the social determinants of health in LADs (Bonner, 2020). Researchers have proposed strategies to develop a robust local public health system (Bonner, 2020). Nevertheless, local governments remain responsible for reducing health inequalities in LADs.

Secondly, in addition to using infrastructure within their postcode sectors, residents may utilise facilities in their LADs. Deprived areas often have a limited range of infrastructure. A representative sample of residents living in 225 left-behind areas in England, commissioned by Local Trust (2020), revealed that 57% believe their residential areas lack places to meet, while 55% perceive a shortage of leisure and sports facilities. Engaging with community infrastructure provides residents with opportunities to connect with others in the LADs, thereby fostering social capital (Ziersch, 2011). A lack of meeting places can adversely affect the social capital in deprived areas. Social capital within LADs may be related to health outcomes among residents.

LADs encompass left-behind neighbourhoods (LBNs) characterised by poor infrastructure (Local Trust, 2018). Within the 82 LADs containing LBNs, County Durham includes 16 LBNs, Birmingham has 9, and both Fenland and Great Yarmouth have 3 each (CWFA, 2021). All 225 left-behind neighbourhoods exhibit higher rates of worklessness, lower rates of skilled employment, and lower levels of economic activity compared to the national average (Local Trust, 2023). LBNs exhibit the worst health compared to other deprived areas in England (APPG, 2022). Similarly, deprived LADs may also lack sufficient infrastructure. A lack of infrastructure may affect social capital in these LADs, which, in turn, could relate to health outcomes.

Thirdly, unemployment rates in LADs are more likely to reflect the local unemployment conditions. People compare themselves with individuals they interact with daily, not just those within their postcode sectors. Therefore, it is meaningful to compare the association between employment transitions and states and health across different unemployment rates in LADs. Fourthly, the findings may differ when the associations are tested at different geographical scales (Jivraj *et al.*, 2020). Consequently, findings derived from smaller areal units may not be directly generalisable to the more diverse populations in LADs.

Counties

Counties were used as the geographical unit in only Chapter 3 to construct area characteristic variables. Firstly, the use of LADs was deemed impractical due to the small sample sizes in some LADs, which meant the values could not adequately represent these areas. Secondly, several LADs belong to the same local government, which made counties a more suitable unit for analysis, particularly when the sample sizes of LADs were small. For example, LADs, including Breckland, Broadland, Great Yarmouth, King’s Lynn and West Norfolk, North Norfolk, Norwich, and South North belong to Norfolk County Council.

Figure 1.1 The role of local authorities in Social Determinant of Health

Source: Local Government Association (2010)

Definitions

Health

In social epidemiology, research incorporates both subjective and objective health outcomes, using measures such as the Center for Epidemiological Studies-Depression (CES-D), the General Health Questionnaire (GHQ), the Short Form Health Survey (SF-12), and allostatic load to evaluate health statuses (Turner, 1995; Chandola *et al.*, 2003; Prior, Manley and Jones, 2018). For this project, we are using the SF-12 to measure subjective health. The SF-12 is a scale for assessing the health status of both general and specific populations (Ware, Kosinski and Keller, 1995). It includes a subset of items from the SF-36 (Ware, Kosinski and Keller, 1995). SF-12 is used to measure respondents' quality of life in terms of mental and physical health, encompassing eight dimensions: physical functioning (2 items), role limitations due to physical problems (2 items), bodily pain (1 item), general health (1 item), vitality (1 item), social functioning (1 item), role limitations due to emotional problems (2 items), and mental health (2 items). It is crucial to note that Mental Component Summary (MCS) and Physical Component Summary (PCS) are measured by the same domains. However, MCS gives greater weight to aspects such as vitality, social functioning, role-emotional, and mental health, whereas the PCS focuses more on physical functioning, role physical, bodily pain, and general health. Both PCS and MCS have high test-retest reliability in the US and in the UK (Ware, Kosinski and Keller, 1995). The test -retest reliability for PCS was 0.89 in the US, while it was 0.86 in the UK (Ware, Kosinski and Keller, 1995). The test-retest reliability for MCS was 0.76 in the US and 0.77 in the UK (Ware, Kosinski and Keller, 1995).

Studies discuss the validity of SF12 in a range of observations, including clinical and general samples (Jenkinson and Layte, 1997; Jenkinson *et al.*, 2001), and compare SF-12 to

SF-36 (Gandek *et al.*, 1998; Sanderson and Andrews, 2002) . My focus is on the general sample when discussing validity. Studies from the UK and Australia consistently show the construct validity of SF12, including MCS and PCS, is robust (Jenkinson *et al.*, 2001; Gill *et al.*, 2007). Specifically, using data from the National Survey of NHS Patients, Jenkinson *et al.* (2001) aim to test the construct validity of the SF-12 across different ethnic groups in the UK. The validity of the SF-12 is examined by correlating the Mental Component Summary (MCS) and Physical Component Summary (PCS) with overall self-assessed health and limiting longstanding illness. The study demonstrated consistent relationships between self-assessed health or limiting longstanding illness and MCS and PCS scores across different ethnic groups. However, significant differences are found among Indians, Pakistanis, and Bangladeshis who understood English fluently and those who do not. The UKHLS developed instruments using independent translators, checkers, and adjudicators. The translated instruments are implemented in Computer-Assisted Personal Interviewing (CAPI) software. Bilingual interviewers can switch to the language of choice while using the software, whereas non-bilingual interviewers can work with a translator. The UKHLS translates instruments into Welsh, Urdu, Punjabi, Gujarati, Bengali, Cantonese, Somali, and Arabic. Among an Australian sample drawn from the Australian National Survey of Mental Health and Wellbeing, the MCS-12 outperformed the GHQ-12 in reflecting depression and anxiety. Additionally, research shows that SF-12 can be used as a substitute for the SF-36. SF-12 explains at least 90% of the variance in both MCS and PCS of SF-12, using data from the Australian National Health Survey (Sanderson and Andrews, 2002).

The following are the details of these eight domains (Table 1.1). *Physical Functioning* evaluates limitations in everyday activities due to physical health issues through two items: moderate activities (such as moving a table, using a vacuum cleaner, bowling, or playing golf) and climbing several flights of stairs (Ware, Kosinski and Keller, 1995).

Responses are categorised on a three-level continuum: “yes, limited a lot”, “yes, limited a little”, or “no, not limited at all” (Ware, Kosinski and Keller, 1995). *Role-Physical* assesses limitations in typical role activities over the past four weeks due to health problems, using two items with binary response options: “yes” or “no” (Ware, Kosinski and Keller, 1995). *Bodily Pain* is gauged based on the extent to which pain hinders work, with response options ranging from “not at all” to “extremely” (Ware, Kosinski and Keller, 1995). *General Health* is measured through self-reported health, with a range from “excellent” to “poor” (Ware, Kosinski and Keller, 1995). *Vitality* is measured by a single item assessing energy levels and fatigue, with options spanning from “all of the time” to “none of the time” (Ware, Kosinski and Keller, 1995). *Social Functioning* examines limitations in social activities, such as visiting friends or relatives, due to physical or psychological issues (Ware, Kosinski and Keller, 1995). Options range from “All of the time” to “None of the time”. Role-Emotional measures limitations in usual role activities due to emotional problems with two items, specifically whether tasks are accomplished less than wanted and whether activities are performed as carefully as usual, with binary responses of "yes" or "no"(Ware, Kosinski and Keller, 1995). Lastly, *mental Health* evaluates psychological distress over the past four weeks with two items, including feelings of calmness, peaceful, and depression, with responses ranging from “All of the time” to “None of the time” (Ware, Kosinski and Keller, 1995).

Table 1.1 Domains, descriptions, items, and response options of SF-12

Dimensions	Description	Items	Response Options
Physical Functioning	Evaluates limitations in everyday activities due to physical health issues	1.Moderate activities 2. Climbing several flights of stairs	“Yes, limited a lot”, “Yes, limited a little”, “No, not limited at all”

Role-Physical	Assesses role activity limitations over the past four weeks due to physical health	1.Accomplish less than you would like; 2.Limited in the kind of activities	“Yes”, “No”
Bodily Pain	Gauges the extent to which pain hinders work	Pain interferes with normal work	“Not at all”, “a little bit”, “moderately”, “quite a bit”, or “Extremely”
General Health	Measures health through self-reported status	In general, would you say is	“Excellent”, “Very good”, “good”, “fair”, or “Poor”
Vitality	Assesses energy levels and fatigue	Have a lot of energy	“All of the time”, “Most of the time”, “A good bit of the time”, “Some of the time” A little of the time”, or “None of the time”
Social Functioning	Examines limitations in social activities due to physical or	Health interferes with social activities	“All of the time”, “Most of the time”, “A good bit of the time”, “Some of the time”

	psychological issues		A little of the time", or "None of the time"
Role-Emotional	Quantifies limitations in usual role activities due to emotional problems	1.Accomplish less than you would like 2.Didn't do activities as carefully as usual	"Yes", "No"
Mental Health	Evaluates psychological distress over the past four weeks	1.felt calm and peaceful 2.felt downhearted and blue	"All of the time", "Most of the time", "A good bit of the time", "Some of the time" A little of the time", or "None of the time"

This project utilises repeated measures of health. People's health status changes over time. Repeated observations of health can help address health selection issues from previous waves. Furthermore, using repeated measures can account for changes within individuals and differences among individuals (MacKinnon, 2008a).

Deprivation

Deprivation refers to a state of observable and demonstrable disadvantage compared to the local community, broader society, and nation to which an individual, family, or group belongs (Townsend, 1987). The concept takes many forms. Individuals are considered deprived if they lack access to typically customary diet, clothing, housing, household facilities, fuel, and environmental, educational, working, and social conditions in the societies they belong to (Townsend, 1987). Socioeconomic position (SEP) is a measure used to evaluate deprivation (Krieger, Williams and Moss, 1997). SEP refers to social and economic factors that influence the positions individuals hold in society.

Socioeconomic position: Unemployment

This project uses unemployment and the English Indices of Multiple Deprivation (IMD) as SEP indicators. Unemployment reflects the state where individuals want to work but do not have jobs and captures those outside the workforce. This project focuses on employment rather than other individual deprivation indicators (e.g., social class, income) when examining health outcomes across deprived and less deprived areas. Comparing the associations between employment transitions and status and health outcomes across different areas in England is more relevant than comparing the associations between social class and health in these areas. Although some studies show that health is associated with both intergenerational and intragenerational social class mobility, health is more strongly associated with employment transitions than to social class transitions (Ki *et al.*, 2011; Anderson, 2021). This suggests that health plays a role in the transition in and out of employment but is unlikely to play a role in upward social mobility. Furthermore, while income is a key indicator of individual deprivation and material living standards, it is often considered sensitive information, and some individuals may be hesitant to disclose it (Galobardes, 2006). The details of the coding are provided in Chapter 2, in the methods section.

Socioeconomic position: Index of Multiple Deprivation

The Index of Multiple Deprivation (IMD) captures various dimensions of deprivation (Noble *et al.*, 2006). This project opts not to use the Townsend Deprivation Index because it lacks measures for deprivation specific to rural UK, such as access to services. The

Townsend Deprivation Index includes car ownership as an item; however, in rural UK, owning a car is not a valid indicator of SEP, as even the poorest households often own cars (Galobardes, 2006). Car ownership is widespread in rural areas due to inadequate public transport and the necessity of covering long distances (Jordan, Roderick and Martin, 2004).

Following Townsend, IMD includes only deprivation types resulting from low income, using income as a significant proxy for material deprivation, which represents socially perceived necessities (Department for Communities and Local Government, 2015). The IMD is operationalised by evaluating deprivation across several distinct domains (Department for Communities and Local Government, 2015):

1. **Income Deprivation**: This is measured by the percentage of people living in poverty due to low income, including those who are unemployed and those who have low earnings.
2. **Employment Deprivation**: Assesses the proportion of working-age adults who are out of the labour market due to reasons such as job loss, illness, disability, or caregiving responsibilities.
3. **Education/Skills/Training Deprivation**: Evaluates levels of educational achievement and skills development.
4. **Health Deprivation and Disability**: Measures risks of premature mortality and impacts on quality of life-related to physical and mental health conditions.
5. **Crime**: Gauges the likelihood of becoming a victim of crime.
6. **Barriers to Housing and Services**: Evaluates both the physical and financial accessibility of housing and local services, which includes geographical barriers that affect physical proximity to services, and wider barriers that relate to housing affordability and homelessness.

7. **Living Environment Deprivation**: Assesses the quality of the local environment, including housing quality, air quality, and the incidence of road traffic accidents.

IMD reflects the cumulative impact of various disadvantages, representing relative deprivation. The IMD is designed to acknowledge the cumulative impact of multiple deprivation factors without one domain negating the effects of another (Noble *et al.*, 2006; Department for Communities and Local Government, 2015). This is achieved with weighted cumulative models, which ensure that each domain contributes to the overall deprivation score. For instance, if an area demonstrates high levels of income deprivation but low levels of educational deprivation, the low educational deprivation does not mitigate the high-income deprivation. IMD is also designed as a relative measure that enables comparisons of deprivation levels across LADs (Noble *et al.*, 2006; Department for Communities and Local Government, 2015). For instance, if a LAD exhibits a higher proportion of unemployed people compared to another LAD, this indicates that it is relatively more deprived in terms of employment deprivation.

Employment deprivation

This project examines employment deprivation as a potential moderator in the relationship between unemployment and health, and income deprivation as a potential moderator in the relationship between retirement and health. Employment deprivation assesses the proportion of the working-age population involuntarily excluded from the labour market. Indicators of employment deprivation include the claimants of Jobseeker's Allowance (JSA), Employment and Support Allowance (ESA), Incapacity Benefit (IB), Severe Disablement Allowance (SDA), and Carer's Allowance (CA) (Department for Communities and Local Government, 2015). JSA is provided to individuals actively seeking employment but currently out of work. ESA supports individuals unable to work due to illness or disability, while CA is available to adults providing unpaid care, thereby excluding them from the workforce.

Income deprivation

Income deprivation assesses the proportion of the population in LAD due to low income. This category includes both unemployed individuals and those employed but earning low wages. Indicators of income deprivation encompass various forms of financial assistance: families receiving Income Support, income-based Jobseeker's Allowance, and income-based Employment and Support Allowance; individuals receiving Pension Credit; and families qualifying for Working Tax Credit[1] and Child Tax Credit[2] with incomes below a specified threshold. Additionally, asylum seekers receiving subsistence and accommodation support are included (Department for Communities and Local Government, 2015). Pension Credit is available to individuals over the State Pension age with low income, assisting them with living costs. Recipients of Pension Credit are eligible for further assistance, such as Housing Benefits, Cost of Living Payments, and Support for Mortgage Interest, a free of TV licence if the elderly are 75 or over, help with NHS-related cost.

Average scores and average ranks

I used the average score of certain domains of IMD (i.e., employment and income) and the average rank of IMD, both from 2015, as key variables of area deprivation. The average scores and the average ranks are grouped into 5 quintiles. Specifically, the average score summarizes the average deprivation scores across lower-layer super output areas after these

[1] Working Tax Credit supports low-income individuals and families who work a certain number of hours per week but earn low wages.

[2] Child Tax Credit is payable to families with children, regardless of the parent's employment status, to help with the costs of raising children.

scores have been population-weighted (Department for Communities and Local Government, 2015). For example, consider a Local Authority District (LAD) containing five LSOAs with populations of 1,200, 1,800, 1,400, 1,500, and 1,700 residents. These LSOAs have IMD scores of 45.90, 26.51, 65.67, 59.14, and 13.64, respectively (Department for Communities and Local Government, 2015). The average score of a LAD is calculated as follows:

$$The\ average\ Score\ of\ LAD = (45.90\ \times 1{,}200 + 26.51 \times 1{,}800 + 65.67\ \times 14{,}00 + 59.14 \times 1{,}500 + 13.64 \times 1{,}700)\ \div 7600\ = 40.35$$

Source: Department for Communities and Local Government (2015)

The average rank summarises the average deprivation ranks across LSOAs after these ranks have been population-weighted (Department for Communities and Local Government, 2015). For example, consider a LAD containing five LSOAs, with populations of 1,200, 1,800, 1,400, 1,500, and 1,700 residents, respectively, totalling 7,600 residents. The IMD ranks of these districts are 3,000, 10,000, 5,00, 1,000, and 20,000 respectively. These ranks are multiplied by the population in each district. These values are summed and divided by the total populations in the LADs to create the average rank for the LAD (Department for Communities and Local Government, 2015). The calculation also uses a reversed ranking, where 32844 corresponds to the most deprived areas, to achieve the goal of giving deprived areas a higher average rank (Department for Communities and Local Government, 2015). The average rank of a LAD is calculated as follows:

$$\begin{aligned} The\ average\ rank\ of\ a\ LAD \\ &= 32845 \\ &- \ (3{,}000\ \times 1{,}200 + 10{,}000\ \times 1800 + 500\ \times 14{,}000 + 1{,}000 \times 1{,}500 \\ &+ 20{,}000\ \times 1{,}700) \div 7600\ = 24411 \end{aligned}$$

Source: Department for Communities and Local Government (2015)

The main difference between the average rank and average score is that the average rank is less sensitive to polarisation between LSOAs, while the average score reflects the actual severity of the deprivation (Department for Communities and Local Government, 2015). If a LAD has a mix of both extremely deprived and less deprived LSOAs, the ranks will average out (Department for Communities and Local Government, 2015). This suggests that if some LSOAs are very deprived, the presence of less deprived LSOAs will lower the overall rank. However, LADs with high scores indicate that these LADs have more highly deprived areas.

In this project, the average scores of employment and income, as well as the average rank of IMD, are categorised into five quintiles. Higher quintiles represent areas with greater levels of deprivation. Higher scores and ranks indicate worse deprivation. Therefore, the means of the higher quintiles in the average scores of employment and income, and the average rank of IMD, are higher than those of the lower quintiles.

Social capital

This project adopts a cohesion-based perspective on social capital. In social epidemiology, studies typically employ either a network-based (Bourdieu) or a social cohesion-based (Putnam) perspective when examining social capital, with the latter being more common (Berkman and Kawachi, 2015). Bourdieu (1986) treats social capital as an individual resource, while Putnam treats it as a collective resource (Snelgrove, Pikhart and Stafford, 2009). According to Bourdieu (1986), social capital refers to actual and potential resources available to group members, which they can rely on in the absence of or in conjunction with their economic capital through their durable social groups, such as in a neighbourhood (Carpiano, 2007). It is not just only about who you know but how you maintain these networks through mutual exchange (Bourdieu, 1986).

The network-based approach to social capital is often measured using the position generator and the resource generator (Berkman and Kawachi, 2015), while Carpiano (2007) presents a framework that applies Bourdieu’s concept through multiple social dimensions. The position generator assesses whether individuals have connections to people in prestigious occupations, such as lawyers or doctors, while the resource generator evaluates access to specific skills and support, such as emergency childcare (Berkman and Kawachi, 2015). Additonally, Carpiano (2007) operationalises social capital through four key dimensions: social support, social leverage, informal social control, and neighbourhood organisation participation. Social support refers to the social capital that residents can rely on to address daily problems. Social leverage refers to social capital that helps individuals access information, such as job referrals. Informal social control refers to residents’ ability to maintain social order. Neighbourhood organisation participation refers to participation in activities aimed at dealing with issues within the neighbourhood. However, the UKHLS does not include either of these network-based measures. Additionally, a limitation of the position generator is that it considers only prestigious occupations, overlooking roles such as homemakers. This exclusion may underestimate the contributions of individuals in non-prestigious occupations, who can also provide network-mediated resources, such as emotional support.

Putnam defines social capital as the features of social organisation, such as networks, norms, and social trust, that lead to cooperation for mutual benefits (Ziersch, 2011). He views social capital as a product of social structure that enhances cooperation for shared benefits in the communities (Ziersch, 2011). The resource benefits members of the communities (Ziersch, 2011). Dimensions of social capital relevant to this approach include civic engagement, trust and support, a sense of community, and social cohesion within communities (Ziersch, 2011). Cohesion-based perspective measure social capital elements in two domains: cognitive social capital and structural social capital. Specifically, cognitive social capital measures individual attitude, perceptions, and cognitions about the groups they belong to, while structural social capital measures actual behaviours, such as if they participate in organisations or interact with their social networks. Both social capitals can be measured in individual and group levels. Area social capital can be aggregated from personal social capital (Berkman and Kawachi, 2015) (refer to Methods in Chapter3).

Social capital can also be categorised into bonding and bridging social capital. Bonding social capital represents resources accessible within networks sharing similar characteristics with the subjects, such as shared ethnicities and similar age groups (Moore and Kawachi, 2017). It can be measured by homogenous friendship networks (Jonsson *et al.*, 2020). In contrast, bridging social capital pertains to resources obtainable through networks that have different characteristics from subjects (Moore and Kawachi, 2017). It can be measured by civic engagement and trust and cooperative norms (Jonsson *et al.*, 2020). Additionally, social capital's dimensions include cognitive elements, such as perceptions of trust and mutual norms; structural elements, including institutional memberships and contacts with family and friends (Stafford *et al.*, 2008).

Moderators and Mediators

This project examines potential moderators in the associations between employment states/transitions and physical health across both disadvantaged and advantaged areas. Additionally, it investigates potential mediators in the associations between area deprivation and physical health. Moderators are third variables that modify the strength of the association between the independent variable and the dependent variable (MacKinnon, 2008b). Mediators, on the other hand, are variables through which an independent variable relates to (or causes) an intervening variable, which in turn leads to the dependent variable

(MacKinnon *et al*., 2002). In Chapter 2, the moderator is area deprivation. Specifically, the strength of the association between employment states/transitions and physical health may vary according to the socioeconomic context of the areas. In Chapter 3, the mediator is the various forms of area social capital. Area deprivation may predict various forms of area social capital, and area social capital, in turn, predicts physical health outcomes.

Compositional, contextual, and collective explanations

There are three types of explanations for variations in health across different areas: compositional, contextual, and collective (Macintyre, Ellaway and Cummins, 2002). The compositional explanation pertains to the characteristics of individuals within a place, attributing differences in health to the attributes of the people living in these areas, such as the distribution of socioeconomic status in communities. The contextual explanation highlights the impact of the social and physical environment, including factors such as infrastructure quality and community safety. The collective explanation focuses on the shared norms, values, and interests of the communities, considering the socio-cultural and historical features of the communities. For instance, the area social capital in a place. In summary, the compositional explanation addresses the characteristics of people in different places, the contextual explanation focuses on the environmental aspects of these places, and the collective explanation emphasizes the socio-cultural and historical aspects of the communities.

However, Macintyre, Ellaway and Cummins (2002) argued that it is no longer sensible to distinguish between contextual and compositional explanations, nor between collective and contextual explanations. For instance, the mechanism of the association between low- or high-income areas and health can be explained by both compositional and contextual explanations. Retirees and unemployed people who are sick tend to live in deprived areas, establishing an association between area deprivation in terms of IMD and health. Meanwhile, the contextual explanation suggests that this association may be due to differences in the physical environment in deprived and less deprived areas. Areas with concentrated low- and high-income populations may develop better infrastructure. For example, left-behind neighbourhoods often lack places to meet and sports facilities (Local Trust, 2020). Another example is the Index of Multiple Deprivation (IMD), an indicator that consists of compositional elements (income, education, employment) and contextual elements (accessibility of housing and local services).

Data

Study design and participant selection

The research conducted in this thesis primarily utilises data from Understanding Society: the UK Household Longitudinal Study (UKHLS) (University of Essex, Institute for Social and Economic, NatCen Social Research, and Kantar Public) and Department of Communities and Local Government (2015), particularly Index of Multiple Deprivation (IMD) (Refer to Definitions in this chapter for the details of IMD). This section focuses on UKHLS. UKHLS is a representative household panel study covering all four countries in the UK (i.e., Wales, Scotland, England, and Northern Ireland).The design of UKHLS enables analysis of the smaller countries within the UK, acknowledging that some policies differ between these countries (Platt *et al.*, 2020). The UKHLS employs clustering and stratification to ensure coverage of different types of areas, such as deprived and less deprived areas. Understanding Society is designed to have a large sample size to ensure sufficient statistical power for regional and other subgroup comparisons. The sample size for each LAD distribution ranges from 27 adults to 350 adults, averaging 212 adults, with a standard deviation of 107 adults. These LADs are grouped into five quintiles according to their deprivation levels. Thus, the sample sizes are not considered an issue in this situation.

Table 1.2 shows the waves and samples in UKHLS. The first wave of UKHLS was collected between 2009-2011, interviewing adults in approximately 40,000 households in the UK. UKHLS's first wave comprised a general population sample (GPS) and an ethnic minority boost sample (EMBS). The GPS included 24,000 households across Great Britain during 2009-2010, utilising a clustered, stratified, and probability sampling method. Additionally, 2,000 households in Northern Ireland were selected through a simple random sample. The EMBS, comprising about 4,000 households, was drawn from areas with high ethnic minority populations during 2009-2010, where at least one household member belongs to an ethnic minority. Additionally, respondents from the British Household Panel Survey (BHPS), the study's predecessor, were integrated into UKHLS in its second wave (2010-2012). Around 8,000 households from the BHPS were incorporated in Wave 2 of the study. The Immigrant and Ethnic Minority Boost Sample (IEMBS), initiated in 2015 at Wave 6, included approximately 2,900 households from areas with moderate to high ethnic minority or immigrant population density, with at least one member either born outside the UK or from an ethnic minority. This survey, annually repeated, collects data from household members aged 10 and above, encompassing approximately 10,000 people from each birth cohort decade since the 1940s. Households are interviewed once a year, but the fieldwork for each wave is completed within 2 years. Only adults aged 16 and over residing in England are included in this project. The samples used comprised the GPS, the BHPS, the EMBS, and the IEMBS, excluding the Northern Ireland sample.

Table 1.2 UKHLS waves and samples: general population sample (GPS), Northern Ireland sample, ethnic minority boost sample (EMBS), and Immigrant and Ethnic Minority Boost Sample (IEMBS)

Waves	Samples
Wave 1 (2009-2011)	GPS (24,000 households) & EMBS (4,000 households) & Northern Ireland (2,000 households)
Wave 2 (2010-2012)	BHPS (8,000 households)
Wave 6 (2014-2016)	IEMBS (2,900 households)

Notes: Northern Ireland sample were excluded from this project

Methods of data collection

UKHLS collects data using mixed modes. Initially, the UKHLS conducted face-to-face interviews. From Wave 3 onwards, a subset of respondents was interviewed via telephone. Starting with Wave 7, web interviewing was introduced for adults who did not participate in Wave 6, with the expectation that they complete the survey online. In Wave 8, adults who had completed the Wave 7 survey were also invited to participate online. Over time, the proportion of online responses increased to 80%. Participants who did not respond within the first 5 weeks of the online invitation were subsequently contacted for in-person interviews. Non-respondents eligible for online and Computer Assisted Personal Interviewing (CAPI) were also given the option to participate via telephone.

Response rates

Table 1.3 presents the response rates of the UK Household Longitudinal Study (UKHLS) from Waves 1 to 12, focusing on adults aged 16 and above residing in England. In the first wave, 49,928 adults were targeted, with a response rate of 80.23%. Consequently, 40,058 adults responded to the survey. In the second wave, the response rate increased to 90.73%. The response rates remained above ninety percent at the Waves of 3, 4, and 5. At wave 6, the response rates decreased to 88.59%, which the Understanding Society team believes may related to a change in fieldwork agency (Benzeval *et al.*, 2020). At Wave 7, the response rate was 88.86%. The response rates began to decrease from Waves 8 to 12. There was a yearly decrease in the number of targeted adults, except at Wave 6. The reduction in sample size over the waves can be attributed to attrition (Benzeval *et al.*, 2020).

Table 1.3 Response rates by wave: The UK Household Longitudinal Study (Waves 1-12)

Waves	Response rates (%)	Respondents (N)	Samples (N)
1	86.04	42,960	49,928
2	90.73	41,587	45,837
3	90.56	37,902	41,852
4	92.10	36,163	39,267
5	93.09	34,760	37,340
6	88.59	35,942	40,571
7	88.86	33,349	37,531
8	87.06	31,023	35,632
9	84.88	28,394	33,453
10	84.53	27,066	32,018
11	83.08	25,233	30,373
12	81.30	23,068	28,374

Survey weighting

Weighting serves three main functions: correcting for unequal selection probabilities, adjusting for non-response, and aligning with the population distribution (Peter Lynn and Olena Kaminska, 2010; Understanding Society, 2022). In UKHLS, weights are constructed using design weights and non-response weights (Understanding Society, 2022). Design weights adjust for unequal selection probabilities among different groups, such as in the Ethnic Minority Boost (EMB) and Immigrant and Ethnic Minority Boost (IEMB) samples (Understanding Society, 2022). Non-response weights correct for differential non-response and attrition at different levels, including the household level, the individual level within a household, and whether adults completed a self-completion questionnaire (Understanding Society, 2022). Non-response occurs when certain individuals or households are more likely to respond than others (Understanding Society, 2022). Differential response occurs when the likelihood of responding is related to a particular variable of interest. After applying design weights and non-response weights, post-stratification may be used to align the survey sample with population characteristics (Peter Lynn and Olena Kaminska, 2010).

Available Measures

UKHLS focuses on three specific areas: race, ethnicity, and migration; individuals in socio-spatial contexts; and biosocial processes (Platt et al., 2020). Table 1.4 shows the survey timeline and key variables of this project. UKHLS includes the current labour force status in each wave. In Chapter 2, I use the employment variable from Waves 1 to 10 to construct and measure individual deprivation (i.e., employment states) and Waves 2 to 10 to construct transitions into deprivation (i.e., employment transitions). Wave one lacks of a preceding wave, so it cannot be used to construct transitions. Although Waves 11 and 12 exist now, they are not available when the study is conducted, so they are excluded. UKHLS also includes various forms of social capital measures at the individual level, such as civic engagement (Waves 3, 6, and 9), homogenous friendship networks (Waves 3, 6, and 8), and trust and cooperative norms (Waves 3, 6, and 12). Trust and cooperative norms at Wave 12 are excluded from this project because they are measured at the household level. UKHLS has a variety of health outcome variables. This project used SF-12 PCS and MCS as measures for physical and mental health, respectively. SF-12 is available in every wave.

Strengths of using UKHLS

The use of the UKHLS presents several advantages for research in area factors, personal characteristics, and health inequalities. Firstly, it enables the acquisition of area-specific characteristics, thereby enhancing our understanding of area factors relevant to health inequalities in both deprived and less deprived areas. In this study, geographical data from UKHLS, specifically local authority districts, are linked to the IMD for each area. Additionally, personal characteristics, such as social capital, are aggregated to the level of LADs. Secondly, the longitudinal nature of UKHLS data is particularly beneficial, as it allows for the observation of changes in individuals over time. For instance, this study examines whether social capital at both the area and individual levels could explain variations in health outcomes across different waves of the survey. Thirdly, the longitudinal dataset provides an opportunity to control for unobserved heterogeneity. Time-invariant individual differences, such as ethnicity and gender, can be accounted for in the analyses.

Table 1.4 Survey timeline and key variables: UK Household Longitudinal Study (UKHLS) and Department of Communities and Local Government

Key variables	Wave 1 2009-2011	Wave 2 2010-2012	Wave 3 2011-2013	Wave 4 2012-2014	Wave 5 2013-2015	Wave 6 2014-2016	Wave 7 2015-2017	Wave 8 2016-2018	Wave 9 2017-2019	Wave 10 2018-2020	Wave 11 2019-2021	Wave 12 2020-2022
Deprivation												
Employment states	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓[a]	✓[a]
Index of multiple deprivation -Average score of employment (2015)	Obtain from Department of Communities and Local Government											

Key variables	Wave 1 2009-2011	Wave 2 2010-2012	Wave 3 2011-2013	Wave 4 2012-2014	Wave 5 2013-2015	Wave 6 2014-2016	Wave 7 2015-2017	Wave 8 2016-2018	Wave 9 2017-2019	Wave 10 2018-2020	Wave 11 2019-2021	Wave 12 2020-2022
-Average Score of income deprivation (2015) -Average rank of IMD (2015)												
Social capital												
Civic engagement			✓			✓			✓			✓
homogenous friendship networks			✓			✓			✓			

Key variables	Wave 1 2009-2011	Wave 2 2010-2012	Wave 3 2011-2013	Wave 4 2012-2014	Wave 5 2013-2015	Wave 6 2014-2016	Wave 7 2015-2017	Wave 8 2016-2018	Wave 9 2017-2019	Wave 10 2018-2020	Wave 11 2019-2021	Wave 12 2020-2022
Trust and cooperative norms			✓			✓						✓[b]
Health												
physical health (SF-12 PCS)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mental health (SF-12 MCS)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

[a] Employment states at Waves 11 and 12 were exclude from this project because the data did not exist when the study was conducted.
[b] Trust and cooperative norms at Wave 12 were excluded from this study because the data was collected at the household level, not the individual level.

Sample Characteristics

Table 1.5 presents the unweighted descriptive analysis of key variables, including employment status and the Index of Multiple Deprivation (IMD), alongside health outcomes and social characteristics from Wave 1 of the UK Household Longitudinal Study (UKHLS). Although various forms of social capital are also key variables in this study, they are not available in Wave 1. Only respondents from Wave 1 of the UKHLS who reside in England are included in this analysis. The IMD, which comprises average scores of unemployment rates, income deprivation, and average ranks of IMD, was merged into Wave 1 of the UKHLS. The descriptive analysis was performed in Stata 18.

Table 1.5 indicates that the mental health of adults at Wave 1 was slightly better than physical health. The mean scores for physical and mental health were 49.62 and 50.42, respectively. There are two indicators of deprivation: employment status and IMD. Employment status shows that the majority (53.61%) are employed, with only 6.77% unemployed. Additionally, 19.54% are retired. Other categories include 8.34% on maternity leave or family care, 7.78% full-time students, 3.72% sick or disabled, and 0.23% in government training schemes, unpaid work, family business, or apprenticeships.

As expected, the average scores of employment and income and the average ranks of IMD were higher in deprived areas compared to less deprived areas. The average scores for employment deprivation increased from 0.068 in the least deprived quintile to 0.178 in the most deprived quintile. These results suggest that employment issues are more severe in deprived LADs than in less deprived LADs. Furthermore, the average score of income deprivation increased from around 0.079 in the least deprived areas to 0.231 in the most deprived quintile. Moreover, in the average rank of IMD, higher ranks indicate worse deprivation. Ranks increased from 9,058.10 in the least deprived quintile to 24,596.75 in the most deprived quintile. The standard deviation decreased as deprivation increased, suggesting that LSOAs within more deprived quintiles are more homogeneously deprived, while less deprived areas have a broader range of deprivation levels.

The average age of the population is 45, with a standard deviation of 18. Women constitute a slightly larger proportion of the sample at 54.13%, compared to 45.87% of men. In terms of education, 22.18% hold a degree, 29.25% have A Level or another higher qualification, 31.35% have GCSEs or equivalent, and 17.22% have no educational attainment. Most participants are married or in a partnership, with 8.43 % divorced or separated, 5.64% widowed, and 23.68% never married. Regarding occupational skill level, 41.71 % are in high-skilled jobs, 40.52% in middle-skilled, and 17.77% in low-skilled positions. Additionally, 27.62% of adults own their homes, while 37.84% are paying off a mortgage. A total of 18.53% are social renters, whereas 16.01% rent privately. The demographic statistics reveal that 76.66% are White and 23.34% are minorities (i.e., Asian, Black, Mixed, and other backgrounds).

Table 1.5 Sample characteristics at Wave 1

	Percentage or mean	**Standard Deviation**	**N**
Health outcomes			
Physical health (SF-12 PCS)	49.62	11.34	39,770
Mental health (SF-12 MCS)	50.42	10.06	39,770
Deprivation			
Employment status			
Employment (%)	53.61		22,870
Unemployment (%)	6.77		2,889
Retirement (%)	19.54		8,337
On maternity leave/Family care (%)	8.34		3,557
Full-time student (%)	7.78		3,317
LT sick or disabled (%)	3.72		1,589
Govt training scheme/Unpaid, family business/On apprenticeship (%)	0.23		99
Total	100		42,658
IMD			
Average score of employment (2015)			
0%-20% (least deprived)	.068	.009	
20%-40%	.094	.007	
40%-60%	.121	.007	
60%-80%	.142	.008	
80%-100%	178	.015	
Total			42,221
Average score of income deprivation (2015)			
0%-20% (least deprived)	.079	.011	
20%-40%	.115	.010	
40%-60%	.152	.010	
60%-80%	.185	.011	

80%-100%	.231	.018	
Total			42221
Average rank of IMD (2015)			
0-20% (least deprived)	9058.10	1829.25	8644
20%-40%	13734.15	1208.44	8318
40%-60%	17918.59	974.85	8497
60%-80%	20688.52	829.93	8683
80%-100%	24596.75	1164.27	8079
Total	17127.7	5529.43	42221
Social demographic variables			
Age	45	18.14	42,960
Gender			
Men (%)	45.87		19,705
Women (%)	54.13		23,254
Total	100.00		42,959
Educational attainment			
Degree (%)	22.18		9,508
A level and other higher degree (%)	29.25		12,540
GCSE and other qualification (%)	31.35		13,441
No qualification (%)	17.22		7,384
Total	100.00		42,873
Household income	7.86	1.12	42,938
Marital Status			
Married/coupled (%)	62.26		26,734
Divorced/separated (%)	8.43		3,618
Widowed (%)	5.64		2,420
Never married (%)	23.68		10,170
Total	100.00		42,942
Social Class			
High skilled (%)	41.71		9,891

Middle skilled (%)	40.52		9,607
Low skilled (%)	17.77		4,214
Total	100.00		23,712
Housing tenure			
Owned outright (%)	27.62		11,782
Owned with mortgage (%)	37.84		16,141
Social renting (%)	18.53		7,907
Private renting (%)	16.01		6,831
Total	100.00		42,661
Race and Ethnicity			
White (%)	76.66		31,701
Minorities (%)	23.34		9,652
Total	100.00		41,353

Notes: Social capital, encompassing homogenous friendship networks, civic engagement, trust, and cooperative norms at both individual and area levels, are key variables of this project. However, these variables are not included in Wave 1 of the UKHLS.

Study design: Thesis plan and methodological outline

In Chapter 2, I examine the associations between various employment states (e.g., being employed, retired), employment transitions, and physical health. Additionally, this chapter investigates whether area deprivation moderates these relationships. For the unemployment state and transition models, I use five quintiles based on the average employment score in 2015 to indicate area deprivation. Similarly, for the retirement state and transition models, I categorize area deprivation into five quintiles, using income score in 2015.

The hypotheses are tested using autoregressive cross-lagged models and fixed-effects regression models. Autoregressive cross-lagged panel models are chosen to simultaneously clarify both health selection and social causation. Unlike Turner (1995), who used a cross-sectional approach due to the limitations of cross-sectional data when testing the association between unemployment and health across different socioeconomic status groups in areas with high and low unemployment rates, this study employs autoregressive cross-lagged panel models. These models allow for the consideration of both social causation and health selection within a single equation, as recommended by Kröger, Pakpahan and Hoffmann (2015).

In Chapter 3, the study integrates both area-level deprivation and social capital. The quintiles of average ranks of the IMD in 2015 are used to operationalise area-level deprivation, while various forms of area social capital are operationalised by area civic engagement (bridging social capital), area homogenous friendship networks (bonding social capital), and area trust and cooperative norms (bridging social capital). The details of the operationalisation of the area-level variables are discussed in the definitions section of this chapter. Chapter 3 examines the association between area social deprivation and physical health outcomes. Additionally, it explores how various forms of area social capital may mediate this main association. These relationships are analysed using a multilevel approach (Jonsson *et al.*, 2020). Multilevel models are employed for several reasons (Flint *et al.*, 2013). Residents living in the same areas may exhibit clustering, where their scores in health outcomes are related. Furthermore, repeated observations on the same individual over multiple waves are likely to be correlated. Multilevel models provide correct standard errors for clustered data and appropriate statistical power (MacKinnon, 2008c).

Chapter 4 tests the associations between various aspects of social capital and mental health, focusing on both area-level social capital and mental health. It posits that an individual's social capital might relate to the social capital within the LADs they inhabit, potentially due to social-interactive mechanisms. Similarly, a relationship may exist between an individual's mental health and the collective mental health conditions within these LADs, a phenomenon I term as the social contagion effect in mental health. Autoregressive cross-lagged models are used in Chapter 4 to untangle the reciprocal relationships between individual social capital and mental health, similar to the approach employed by Yu *et al.* (2015).

This project examines statistical significance using p-values and confidence intervals and assesses model fit in autoregressive cross-lagged models through several key indicators. Specifically, $p < 0.05$ and 95% confidence intervals are used to identify statistical significance (Andrade, 2019). To evaluate model fit, the Root Mean Square Error of Approximation (RMSEA), the Comparative Fit Index (CFI), and the Tucker-Lewis Index (TLI) are employed (Hu and Bentler, 1999; Lim, Kim and Choi, 2023). RMSEA values approximating 0.06 are indicative of a good fit, while for CFI and TLI, values nearing 0.95 denote a good fit (Hu and Bentler, 1999). To improve models' fit, paths were integrated following recommendations from modification indices.

In summary, individual and area deprivation such as employment states, areas with high unemployment rates and low income, alongside social capital at individual and area levels, may play roles in shaping health outcomes. The details of the three studies conducted will be elaborated upon in the following chapters.

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Chapter 2. Employment states and transitions and physical health across disadvantaged and less disadvantaged areas in England

Abstract

Background: Employment transitions and states are associated with health. However, the factor of living in deprived areas has received less attention when examining these associations. Disentangling the associations between employment states or transitions and physical health is challenging due to potential selection bias.

Methods: This study utilised data from *Understanding Society:* the UK Household Longitudinal Study (UKHLS), categorising areas based on employment deprivation and income deprivation, domains of the English Indices of Deprivation (IMD). The analytic samples were drawn from Waves 1 to 10 (2009-2020). Both fixed-effect models and autoregressive cross-lagged panel models were utilised. When physical health was the dependent variable, the autoregressive cross-lagged panel models were analysed using linear regression, whereas probit regression was used when the dependent variable was employment transitions.

Results: First, neither social causation nor health selection mechanisms were identified in the associations between transitions into unemployment and changes in physical health. However, improved physical health were associated with unemployment transition in the second least employment-deprived areas (20%-40%) compared to the least employment-deprived areas (odds ratio = 1.028, $p < 0.05$, 95 CI% = 1.003, 1.054). Second, both social causation and health selection mechanisms explained the associations between retirement transitions and changes in physical health. Specifically, transitioning into retirement was associated with a decline in physical health (Estimate = -1.153, $p < 0.001$, 95% CI = -1.704, -0.601). However, in the second least income-deprived areas, the negative changes in physical health related to retirement transitions were less pronounced compared to those observed in the least income-deprived areas (Estimate = 0.893, $p < 0.05$, 95% CI = 0.164, 1.623). In the second least deprived areas, the decline in physical health was reduced to -0.260 (calculated

as -1.153 + 0.893) when transitioning into retirement. Poor changes in physical health was associated with retirement transition (odd ratio = 0.966, $p < 0.001$, 95% CI = .945, .987). Third, when considering health selection, retirement or unemployment was associated with both subsequent positive and negative outcomes in physical health. Additionally, good physical health was associated with both an increased and decreased likelihood of later being retired or unemployed.

Conclusion: Implementing a healthcare system that systematically records social determinants of health, such as employment states, would enable healthcare practitioners to more effectively identify and support at-risk groups, such as retirees.

Introduction

Health is an important contributor to inequality, as health-relevant resources are distributed unevenly, such as in deprived and less deprived areas (Stafford and Marmot, 2003). Studies have demonstrated that the places where people live are associated with their health (Diez Roux *et al.*, 2001; Pickett and Pearl, 2001; Stafford and Marmot, 2003). National Statistics (2021) reported that in England from 2017 to 2019, the duration of life spent in good versus poor health was correlated to area deprivation: men in the most deprived areas spent 21.8 years in poor health, while men in the least deprived areas only spent 12.8 years in poor health. Similarly, women in the most deprived areas lived merely 51.4 years in good health, whereas women in the least deprived areas lived 71.2 years in good health. Employment also plays a pivotal role in inequality as it allows individuals to access both economic and social resources and is relevant to health (Stauder, 2019). The perspectives of social causation and health selection explain how employment transitions and states and health are associated with each other. Previous studies show unemployment is one factor related to poor physical health (Eshak Ehab S. *et al.*, 2017; Hughes *et al.*, 2017), while poor self-rated health may increase the chance of being unemployed (Jusot et al., 2008). This study seeks to integrate these two research lines – social causation and health selection – to advance our understanding of the relationship between employment transitions and states and physical health in deprived areas and less deprived in England.

Employment states contributes to the development of poor health, especially in disadvantaged areas (Hughes *et al.*, 2017). A cross-sectional study from the US by Turner (1995) found that unemployment is associated with increased physical illness in areas with high unemployment rates, while there are no differences between unemployed and stably employed in terms of physical illness in places that have a low level of unemployment. Furthermore, a meta-analysis shows that jobseekers are more likely to have CRP levels matched to high cardiovascular risk, and the results are stronger in Scotland and Wales than in England (Hughes *et al.*, 2017). However, the findings may not be generalisable to individuals living in disadvantaged and less disadvantaged areas in England.

Beyond unemployment, I argue that retirement state and the transition into retirement are associated with poor physical health in deprived areas compared to less deprived areas. Most of the literature from European countries indicates that retirement is detrimental to physical health (Behncke, 2012a; Xue, Head and McMunn, 2020). Living in deprived areas is associated with poor physical health (Smith *et al.*, 1998; Shohaimi *et al.*, 2004; Knies and Kumari, 2022). Therefore, the health of retirees in deprived areas is poorer than retirees in less deprived areas.

Employment states, such as unemployment and retirement, and transitions can be interpreted as both causes and consequences of health outcomes (Kasl and Jones, 2000; Barban *et al.*, 2017; Stauder, 2019). However, cross-sectional studies, such as Turner (1995), face limitations in addressing potential selection bias in the associations between employment states and physical illness across deprived areas and less deprived areas. Jusot et al. (2008) found that individuals with poor self-rated health are more likely to be unemployed, suggesting a potential selection bias, similar to the association between health and retirement (Dwyer and Mitchell, 1999). Additionally, the variations in health between employed and unemployed or retired individuals may not stem from unemployment status or retirement per se but rather from unobserved characteristics of these groups (Myllyntausta and Stenholm, 2018). Consequently, these studies provide limited evidence on causal linkages between employment states and transitions and health outcomes.

This study has two specific aims. The first aim is to explore how employment states and transitions relate to physical health across both deprived and less deprived areas (social causation). The second aim is to explore how physical health relate to employment states and transitions across deprived and less deprived areas (health selection). To achieve these aims, I use fixed effects regression models to test the association between employment transitions and changes in physical health across these areas. Each fixed effect model is responsible for analysing either social causation or health selection. Additionally, I employ autoregressive cross-lagged models to examine the association between employment states and physical health in these areas. Two groups of hypotheses: employment and retirement. Employment hypotheses:

H1a. There is an association between unemployment and decreased physical health, compared to employed individuals. The association is more pronounced in deprived areas, compared to less deprived areas.

H1b. Adults with poor physical health may be more likely to be unemployed, compared to those with better physical health. The association could be more pronounced in deprived areas, compared to less deprived areas.

H1c. A transition into unemployment is associated with a decrease in physical health, compared to those who remain employed. The association could be stronger in deprived areas, compared to less deprived areas.

H1d. The adverse change in physical health increases the likelihood of transition into unemployment. The association could be stronger in deprived areas, compared to less deprived areas when they have similar physical health.

Retirement hypotheses:

H2a: Retirement is associated with a decline in physical health, compared to employment. The association are more pronounced in deprived areas than in less deprived areas.

H2b: Adults with poor physical health are more likely to retire, compared to adults with better health. The association is stronger in deprived areas than in less deprived areas.

H2c: Transition into retirement is correlated with a greater reduction in physical health compared to maintaining employment. This correlation is more substantial in deprived areas than in less deprived areas.

H2d: Deterioration in physical health is associated with an increased likelihood of transition into retirement. This likelihood is elevated in deprived areas compared to less deprived areas, given comparable levels of physical health.

Background

Employment states and transitions and physical health: ecological effects

Unemployment and the transition into unemployment

Unemployment and transition into it may be associated with poor mental and physical health (Thomas, Benzeval and Stansfeld, 2005; Eshak Ehab S. *et al.*, 2017; Hughes *et al.*, 2017; Herber *et al.*, 2019). However, Gebel and Voßemer (2014) found no significant causal effect of the transition into unemployment on physical health using a difference-in-differences propensity score matching approach. The yearly transition from being employed (t) to unemployed (t+1) may not be detrimental to physical health, potentially due to the short duration of the transition. Unemployment can cause stress through the loss of financial and non-financial benefits (Young, 2012; Hughes *et al.*, 2017). For example, unemployment is often perceived as a repercussion of personal shortcomings, such as a shortage of talent and laziness (Young, 2012). Consequently, unemployment may be correlated to systemic inflammation due to psychosocial stress (Hughes *et al.*, 2017). Systemic inflammation is associated with cardiovascular disease (Yudkin *et al.*, 2000) and depression (Dowlati *et al.*, 2010). A meta-analysis by Hughes et al. (2017) found that C-reactive protein (CRP) and fibrinogen levels are higher among job seekers than employed. On the other hand, previous studies have suggested that both employment transitions and states can be associated with health behaviours, which may benefit or be detrimental to health (Montgomery *et al.*, 1998; Sjösten *et al.*, 2012; Xue, Head and McMunn, 2020). Stressors faced by individuals undergoing employment transitions may lead to differential changes in these behaviours.

To date, less attention has been paid to the association between unemployment state and transition and physical health by area differences. Prior studies focus on individual factors, such as gender and socioeconomic status (Mein *et al.*, 2003; Eshak Ehab S. *et al.*, 2017) in examining the associations between employment states and transitions and physical health. I argue that the state of unemployment and the transition into unemployment detrimentally affects physical health, especially in disadvantaged areas. Hughes *et al.*, (2017) found that the markers of systemic inflammation are higher among unemployed individuals compared to employed individuals. Job seekers are more likely to have CRP levels relevant to cardiovascular risk. The associations are stronger in Wales and Scotland compared to England, possibly due to differences in unemployment rates in these countries.

Turner (1995) demonstrated that unemployed individuals residing in areas with high unemployment rates are associated with poorer physical illness than individuals with stable jobs. However, among individuals living in areas with low unemployment rates, there is no significant difference in physical illness between those who are stably employed and those who are unemployed. Turner (1995) explains that unemployed people living in areas with low unemployment rates are confident of regaining their jobs, while unemployed people living in areas with high unemployment rates may anticipate a prolonged waiting time to obtain jobs. These expectations affect their stress levels and health. Additionally, due to the job characteristics in deprived areas, unemployed individuals who previously worked in poor-quality jobs may also have poorer physical health compared to their counterparts in less deprived areas. These low-quality 'low-commitment' jobs are typically characterised by Taylorist work organisation, which features low task discretion, limited skill requirements, low pay, minimal training, scant job security, and restricted working time flexibility (Holman, 2013). In contrast, high-quality 'high-commitment' jobs offer an empowered work organisation with high task discretion, greater skill variety, higher pay, extensive training, increased working time flexibility, and stronger job security (Holman, 2013). These job factors which are the indicative of high- or poor-quality jobs are relevant to individual health (Holman, 2013).

It is worth noting that area deprivation may mediate the relationship between employment status and health. Alternatively, the association between high unemployment, low-income areas, and poor health outcomes could be due to reverse causation, where individuals with poor health who are unemployed or retired tend to live in deprived areas, referred to as health-selective migration. Low socioeconomic areas, characterised by high unemployment rates and low income, may appear to be associated with poor health (Knies and Kumari, 2022). Thus, in deprived areas with high unemployment rates, the state of unemployment and the transition of unemployment tend to correlate with poor health or negative changes in health.

Individuals with poor health may be more likely to transition into unemployment and being unemployed among population of Great Britain and France (Jusot *et al.*, 2008; Don J. Webber *et al.*, 2015). However, these studies did not examine variations across different areas. I argue that individuals with poor health residing in deprived areas are at a high risk of unemployment or transition into it, compared to people in less deprived areas. The area where people live influences their life chances for economic activities (Atkinson and Kintrea, 2004). As I discussed above, employment in deprived areas in England is often characterised by positions requiring low skill levels and offering low remuneration (Public Health England, 2015). Such disadvantages not only contribute to health inequalities but also perpetuate a higher unemployment rate among residents with poor health in these areas, compared to those in less deprived areas.

Retirement and the transition into retirement

The relationship between retirement and health outcomes has been extensively studied, yielding mixed findings. Research in this area has identified positive, negative, or no significant associations with retirement itself (Mein *et al.*, 2003; Coe and Zamarro, 2011; Behncke, 2012b; Eibich, 2015; Xue, Head and McMunn, 2020). However, when it comes to the specific transition into retirement, Lee and Kim (2017) show that transition into retirement is associated with positive health outcomes. This improvement could stem from a reduction in role strain, as retirees may experience relief from work-related stress, leading to increased sleep duration and exercise (Eibich, 2015).

Conversely, the role enhancement perspective suggests that engaging in multiple roles fosters social integration and provides access to power, prestige, resources, and emotional gratification (Reid and Hardy, 1999). These benefits include social recognition and a strengthened sense of identity (Reid and Hardy, 1999). From this perspective, retirement could have detrimental health effects. Behncke (2012) discovered that retirement increases the risk of chronic conditions such as cardiovascular disease and cancer compared to those who are employed, and this finding was based on an instrumental approach using data from the first three waves of the English Longitudinal Study of Ageing (ELSA). Predominantly, evidence from the UK suggests that retirement is associated with poorer physical health (Behncke, 2012b; Xue, Head and McMunn, 2020). However, Mein et al. (2003), analysing a sample of civil servants in London, found no significant association between retirement and physical health. A meta-analysis revealed that most longitudinal studies in the US reported no significant impact of retirement on cardiovascular disease (CVD), whereas European studies consistently showed negative effects of retirement on CVD (Xue, Head and McMunn, 2020).

The negative health implications of retirement might be more serious in deprived areas in England. Although Marshall and Norman (2013) found health improvements associated with retirement in deprived areas, referred to as the "retirement kink," their study focused on state pension age and industrial and mining areas. This study focuses on self-reported retirement rather than retirement at the state pension age and income deprivation. There are several reasons why retirement in deprived areas is more closely relevant to poor health. Firstly, according to Kauppi et al. (2021), the transition into retirement reduces social connections within the outer circle, which could adversely affect health. This association is likely to be more pronounced in deprived areas. Social networks in these areas tend to be homogeneous, often comprising local extended family and a smaller circle of local friends (Cattell, 2001; Atkinson and Kintrea, 2004). These networks provide support and understanding but may offer limited health benefits (Cattell, 2001).

Secondly, according to the contextual explanation, less disadvantaged areas have greater access to social and physical environment beneficial for health, such as private and public services (Macintyre, Ellaway and Cummins, 2002). Retirees in less deprived areas can spend their time using private and public services, such as libraries and sports centres, which may benefit their health. According to health-related selective migration, retired people who are sick may tend to live in deprived areas such as low-income areas (Marshall and Norman, 2013; Knies and Kumari, 2022), the concentration of residents with high or low income in certain areas may relate with the characteristics of these areas. For example, left-behind neighbourhoods often lack of leisure and sports facilities (Local Trust, 2020). Areas with higher income may tend to have better private services, while those with lower income may have poorer private services. Therefore, the contextual explanation can also account for the association between retirement states or transitions and health across areas of varying deprivation, such as high and low-income areas.

Poor physical health and its adverse changes may be associated with the state of retirement and the transition into retirement, respectively, with a more pronounced association observed in deprived areas. Barban *et al.*(2017) identified that in Sweden, early retirement among individuals born between 1935 and 1946 correlates with adverse health outcomes, notably increased hospitalization rates and reduced survival rates. This research implies that such retirees likely experienced poor health prior to retirement. Furthermore, the relationship between area deprivation and health outcomes deserves careful consideration.

Parker et al. (2020) observed that individuals living in the least deprived areas of England tend to have a longer expectancy of a healthy working life, by an average of 3.73 years, compared to those in the most deprived areas. In deprived areas, The quality of employment in deprived areas tends to be poor, often involving more physically demanding roles (Public Health England, 2015). In Denmark, individuals engaged in physically demanding jobs are found to be more inclined towards early retirement due to health problems than those in less demanding roles (Pedersen *et al.*, 2020). This suggests that both poor health and job quality in disadvantaged areas act as precursors to retirement.

Methodology

Data

This study drew data from Wave 1 to Wave 10 of UKHLS (Institute for Social and Economic Research, NatCen Social Research, and Kantar Public, 2020). This study included samples from the general population sample (GPS), an ethnic minority boost sample (EMBS), respondents from the British Household Panel Survey (BHPS), and the Immigrant and Ethnic Minority Boost Sample (IEMBS) (Refer to Data of Chapter 1 for details). Additionally, only households based in England, whose local authority districts were covered in the list of IMD 2015 (Department for Communities and Local Government, 2015), were included in this study. Geographical identifier which is local authority district on linked data in UKHLS will be used to draw the households in England across waves and link IMD 2015[3].

This study used the Index of Multiple Deprivation (IMD) from 2015 for the analysis, rather than IMD 2019 or both IMD 2015 and 2019. The constructs of income deprivation and employment deprivation, which are key variables of this study, are different between IMD 2015 and IMD 2019 (Ministry of Housing, Communities & Local Government, 2019). Income deprivation and employment deprivation from two versions cannot be compared.

[3] Do the local authority districts in IMD 2015 align with those in the UKHLS? They may not be aligned due to their reliance on different geographical data sources. However, the differences may not be substantial. These datasets derive their geographical data from different sources. According to the Department for Communities and Local Government (2015), the IMD 2015 employs 2011 Lower Super Output Areas (LSOAs) from the 2011 Census. Conversely, the UKHLS's geographical data is derived from the ONS Postcode Directory (ONSPD), as noted in the Understanding Society documentation. The ONSPD updates their postcode directory quarterly in February, May, August, and November each year. Understanding Society derives its data from the ONSPD's May release for each wave. For instance, the geographical data of UKHLS Wave 1 is derived from data released in May of 2011; Wave 2 is from data released in May 2012; and so on. This divergence in data sources might impact the direct comparability of geographical information (e.g., local authority districts) between the two datasets.

Additionally, the four 'populations-in-focus' [4]of National Institute for Health Research (NIHR) Applied Research Collaboration (ARC) East of England (EoE) included Great Yarmouth and Waveney, Peterborough and Fenland, Stevenage, and Thurrock. Because English indices of deprivation 2019 did not cover Waveney, IMD 2015 were used. Index of multiple deprivation (IMD) 2015 used the 2013 version of local authorities, while IMD 2019 used the version of 2019 (Ministry of Housing, Communities & Local Government, 2019). On 1st of April 2019, Waveney were abolished as a local government area.

Nearly two-thirds of Lower Layer Super Output Areas (LSOAs) remained in the same decile when comparing IMD 2019 and IMD 2015, indicating minimal movement between the two indices. Similarly, there was little movement in the ranking of Local Authority Districts (LADs) among the most deprived areas between IMD 2019 and IMD 2015. It is worth noting that IMD is not designed for direct comparison with previous versions (Ministry of Housing, Communities & Local Government, 2019). However, due to the consistency of methodology between different versions of IMD, they can be compared in terms of relative rankings (Ministry of Housing, Communities & Local Government, 2019). The high degree of similarity between the relative positions of LADs between IMD 2019 and IMD 2015 does not indicate that the deprivation level remained the same between 2015 and 2019. The absolute deprivation of these LADs can improve at the same rates, which maintains their relative positions despite changes in overall deprivation levels. When ranks improve between years, it does not necessarily mean that the areas have become more deprived compared to previous

[4] Populations-in-focus (PIFs) are communities experiencing considerable income and health inequalities. When the ARC EoE applying funding from NIHR, these PIFs were selected for research and activities. Due to PIFs being meaningless outside of ARC, they also suggest using "place-based." There have been few opportunities for these communities to participate in and benefit from health research. While the PIFs were intended to be the focus, NIHR ARC EoE's engagements with the public extend beyond these areas, across the county and nationally(Porter and Wills, 2023).

years. The improvement in ranks suggests that the areas have become more deprived in relation to other areas. Briefly, only relative rankings can be compared in these versions of IMD.

Measures

Dependent variable: This study adopted the 12-item Short Form (SF-12) Physical Component Summary (PCS) as the dependent variable to measure physical health (Refer to Data of Chapter 1 for details). Townsend argues that health should be conceptualised not merely as the absence of illness, but as encompassing active participation in life, including engagement in social activities and roles (Townsend, Phillimore and Beattie, 2023). The SF-12 scale aligns with this understanding by including domains that assess limitations in social activities and roles due to health issues, in addition to measuring general health. In contrast, scales like CES-D and GHQ predominantly adopt an individual perspective, with items such as "I felt lonely," which do not capture the social perspective emphasised by the SF-12. In this study, the SF-12 PCS was quantified as a continuous score, ranging from 0 to 100, where lower scores indicate lower physical health functioning.

Independent variables: This study identified five independent variables, including unemployment state, retirement state, transition into unemployment, transition into retirement, and physical health. These independent variables were grouped into three groups:

1. **Employment States**: This group included the unemployment state and retirement state. The UKHLS measures employment states through the question, “Which of these best describes your current employment situation?”, offering options include self-employed, paid employment (full or part-time), unemployment, retirement, and others. Self-employed and paid employment categories were combined under “employed”.

2. **Employment Transitions**: This group encompassed transitions from employment into unemployment and retirement. Transitions were operationalised as the difference in current and lagged values, where t represents the current employment state and t-1 represents the lagged values of transition.
3. **Physical Health**: This variable is used as an independent variable in health selection models. It is measured by the SF-12 Physical Component Summary (PCS), the same instrument used for assessing the dependent variable in this study.

Moderators: Two domains from the English indices of deprivation were used as potential moderators of this study: income deprivation and employment deprivation (refer to Data of Chapter 1 for details). Specifically, income deprivation, indicating the proportion of the population experiencing income-related deprivation (Department for Communities and Local Government, 2015), was used as a potential moderator in the association between retirement state or transition and physical health. Knies and Kumari (2022) show that low-income areas are associated with multimorbidity. They explain that individuals who are both sick and retired or unemployed may be more likely to reside in low-income areas. Using this indicator as a potential moderator could shed light on the physical health of retirees living in low-income areas.

In contrast, employment deprivation, reflecting the proportion of individuals desiring employment but are unemployed due to various reasons like job loss, disability, health issues or caregiving responsibilities (Department for Communities and Local Government, 2015), was applied as a potential moderator to the association between employment and physical health. Hughes *et al.* (2017) found that the association between being a job seeker and systemic inflammation is stronger in Scotland and Wales than in England. They suspect that unemployment rates in these countries may explain the association. Additionally, Turner

(1995) elaborates that the expectation of prolonged duration of job seeking in areas with high unemployment rates explain the association between unemployment and physical and mental health in the US.

In this study, both income and employment deprivation were time-invariant variables. They were constructed by deriving average scores for income and employment from the respective domains of the Index of Multiple Deprivation 2015 at the LAD level. These average scores were then linked to the LAD where respondents resided at Wave 1. Respondents who relocated during subsequent waves (Waves 2-10) were excluded from the analytic sample. Both income deprivation and employment deprivation were grouped into 5 quintiles as Prior, Manley and Jones (2018): 0%-20% (least deprived), 20%-40%, 40-60%, 60%-80%, and 80%-100% (most deprived).

Covariates /control variables: To mitigate potential confounding in the relationships between employment states, employment transitions, and physical health, this study controlled for several covariates : age, educational qualifications, marital status, ethnicity, gender, housing tenure, and gross household income, which may correlate with key variables (Chandola and Zhang, 2018). In addition to these covariates, physical health at baseline wave was included as a covariate in the social causation models within autoregressive cross-lagged models, while employment state at baseline was included as a covariate in health selection models within autoregressive cross-lagged models. Educational qualifications, ethnicity, and gender were omitted the fixed-effects regressive models because they were treated as time-invariant variables. We are aware that some covariates, not measured at baseline, may mediate the main associations within fixed-effects regression models. Therefore, if a covariate mediated the main associations, it was excluded from models. In autoregressive cross-lagged models, covariates were derived from the first wave of the UKHLS, serving as baseline measures to examine associations between employment status, area deprivation, and physical health.

Age was treated as a continuous variable, with ages above 89 were coded as 90. Educational qualifications were categorised into 4 groups: Degree (reference), A-Level, GCSE, and no qualification. Individuals who reported being students within employment status categories were excluded from the analysis. In the unemployment transition sample, 1,557 adults (See Appendix Figure 1) reported an educational transition, while 1,473 adults (See Appendix Figure 2) did so in the retirement transition sample. Excluding individuals with educational transitions helps avoid extreme values in the fixed effects regression models, which could arise due to small sample sizes within each educational level.

Marital status was categorised into three groups: married or coupled; separated, divorced, or widowed; and never married. Due to the small number of individuals who experienced widowhood, this category was combined with divorced and separated. In the fixed effects regression models, the never married group served as the reference category, whereas in the autoregressive cross-lagged models, the married or coupled group was used as the reference category. By selecting never-married as a reference group, the model allows estimating the associations between changes in marital statuses and outcome variables.

Ethnicity was categorised into 2 groups: White (British / English / Scottish / Welsh / Northern Irish) and non-White, with White as the reference group. Housing tenure was grouped into 4 categories: owned outright (reference), owned with mortgage, social renting (i.e., local authority rent and housing association rented), and private renting (i.e., rented private unfurnished, rented private furnished, and rented from employer). The other option in housing tenure was excluded from analyses because of small sample size and the category is not appropriate to combine with other option.

Household income was adjusted for households’ size and composition, using Modified OECD equivalence scale. In Stata, Ihstrans package was used to apply the inverse hyperbolic sine (IHS) transformation to household income. The IHS transformation can handle zero and negative values (Aihounton and Henningsen, 2021). While the natural logarithm transformation is applied to address skewed distributions, it cannot be defined when the value is zero or negative (Norton, 2022).

Analysis

I applied both autoregressive cross-lagged panel models (Segel-Karpas, Ayalon and Lachman, 2018; Awan *et al.*, 2020) and fixed-effect models to test the hypotheses. The significance levels and goodness-of-fit were documented in Chapter 1 (Study Design). Autoregressive cross-lagged panel models were adept at examining bidirectional relationships between employment states and physical health simultaneously. The Autoregressive Cross-Lagged model rests on three key assumptions: measurement invariance, model specification, and measurement reliability (Selig and Little, 2012). Specifically, measurement invariance ensures that the construct being measured remains consistent across different waves, with all indicators changing in the same direction and to the same extent; any deviation in an indicator's change indicates non-invariance. Proper model specification is crucial, as it involves including all relevant associations and predictors to avoid biased coefficients. Furthermore, disturbances at one wave should be uncorrelated with those at another wave and with all variables measured in previous waves (Lucas, 2023). Lastly, measurement reliability assumes that variables are measured without error. On the other hand, Fixed-effect models were employed to assess the associations between employment transitions and physical health in both deprived and less deprived areas. The fixed effects approach focusses on within-individual differences, controlling for unobserved, time-invariant heterogeneity. In this study, transitions were computed between t and t-1 across Waves 1-10.

To test the potential moderating effect, the association between employment transitions and changes in physical health across deprived and less deprived areas was analyzed in Stata, while the association between employment states and physical health across deprived and less deprived areas was examined in Mplus. In Stata, interaction terms were specified using the ## operator, such as for the interaction between unemployment transition and employment deprivation. This operator includes both the main effects of the independent variables (i.e., employment transition) and the moderator (i.e., employment and income deprivation), as well as their interaction, in the regression model. However, in this study, due to the time-invariant nature of employment and income deprivation, the results do not display the main effects of these variables on physical health. Additionally, the models account for the clustering of individuals by fitting social causation models using the -xtreg- command with fixed effects and -vce (clusterpidp)- in Stata. For the health selection models, the -xtlogit- command was used to construct the model.

Mplus is one of a statistical softwares well-suited for autoregressive cross-lagged panel models (Zyphur *et al.*, 2020). In Mplus, I initially aimed to test the differences in the associations between employment states (specifically unemployment and retirement) and physical health across various deprivation levels, and the models did not converge. Upon recent review, I attribute this issue to the small sample sizes of certain variables within each deprivation level. For example, at Wave 2, there were only 10 (14.71%), 9 (13.24%), 13 (19.12%), 15 (22.06%), and 21 (30.88%) unemployed individuals in the least deprived, second least deprived, medium, second most deprived, and most deprived areas, respectively (the proportions are shown in Table 2.2).

Only the results of main associations were showed. The analyses were conducted using the settings: TYPE = COMPLEX, ESTIMATOR=WLSMV, and PARAMETERIZATION =THETA (Linda K. Muthén and Bengt O. Muthén, 2017). The TYPE = COMPLEX option in Mplus is specifically designed for data from complex survey design. When this option is used, the analysis is also including the default model type, TYPE = GENERAL, which accounts for relationships among observed variables, as is relevant to this study. The observed outcomes variables can be continuous, binary, or of other types. The COMPLEX option computes standard errors and chi-square tests of model fit by considering stratification, non-independence of observation, and unequal probability of selection, which is essential given the UKHLS data's clustered, stratified, and probability sampling method. When at least one dependent variable is binary, it is appropriate to use ESTIMATOR=WLSMV. By switching to Theta parameterization, PARAMETERIZATION =THETA, weighed least square estimation is employed in the analyses. Moreover, to account for repeated measures within the same individual acorss waves, cluster-robust standard errors were included (Mansournia *et al.*, 2021). In the ESTIMATOR=WLSMV approach, continuous dependent variables (e.g., physical health) were analysed using linear regression, while binary variables were analysed using probit models.

Complete cases: Models for employment transition and employment states

Complete cases were used for data analysis. This study includes four distinct samples: two in wide data format and two in long data format. The wide data includes only unique individuals present across all 10 waves with key variables and covariates of this study. It was constructed using the -merge- command, which combine datasets based on unique identifier (pidp). Table 1 in Appendix outlines the exclusions and total observations in the study on the associations between unemployment state and physical health. Initially, there were 85,436 unique individuals across waves 1 to 10. However, after applying the criteria specific to Table 1 in Appendix, the sample was reduced to 2589 unique individuals across waves 1 to 10. The analytic sample in Table 1 includes respondents who met the following criteria: (1) based in England and aged 16 and above; (2) who are unemployment or employment. Respondents who were retired, on maternity leave, family care or home, full-time student, long-term sick or disabled, government training scheme, in unpaid family business, or doing something else were excluded; (3) provide complete data on physical health and elements in covariates (i.e., physical health, gender, ethnicity, educational attainment, marital status, Gross household income, Modified OECD equivalence scale at baseline wave); (3) do not move across waves 2 to 10.

Table 2 in Appendix shows the exclusion and total observations for the study examining the association between retirement state and physical health. Similar to Table 1 in Appendix, there were 85,436 unique individuals based in England with information of area deprivation across waves 1 to 10. After applying the specific criteria, the unique individuals reduced to 4288. The criteria for Table 2 are largely similar to those in Table 1, with primary differences being: (1) the inclusion of unique individuals who were either retired or employed, while excluding those who were unemployed and in other states; and (2) the focus on income deprivation rather than employment deprivation.

The long data set was constructed using the -append- command, which combines datasets across 10 waves by stacking them on top of each other, thus adding rows from each wave. For some individuals, the first wave is Wave 1, while for others it may be Wave 3 or later. In contrast, the wide data set only includes individuals who have participated in all 10 waves. Figure1 of Appendix indicates the exclusions and total observations in the study on the associations between unemployment transition and changes in physical health. Initially, this data included 86797 unique individuals. However, after applying specific criteria, only

26298 unique individuals remained across Waves 1 to 10. The analytic sample was composed of respondents meeting the following criteria:

1. Respondents in England and aged 16 and above.
2. Respondents based in the same LAD across Waves 2-10.
3. Have complete information in key variables (SF12-PCS and unemployment status), covariates (household income & modified OECD equivalence scale, age, gender, marital status, educational attainment, housing tenure, and ethnicity).

In the modal of health selection, the analytic sample remained 2,604unique individuals. To examine unemployment transition, Stata automatically drop unique individual who continuously being unemployed or being employed. This process is fundamental in preparing and analysing panel data where the changes within individuals across waves is of interest.

Figure 2 in Appendix illustrates the exclusion and the total number of observations included in the study examining the association between retirement transition and changes in physical health in deprived and less deprived areas. The initial data included 86797 unique individuals. After applying specific criteria, the sample was reduced to 32390 unique individuals remained. In the health selection models, the analytic sample consisted of 2,461 unique individuals, as Stata excluded individuals who were continuously retired or continuously employed throughout the waves. The differences of criteria between figures 1 and 2 are minimal, with only two notable distinctions. First, the study depicted in Figure 2 focuses on individuals transitioning from employment to retirement, whereas the study in Figure 1 centres on individuals transitioning from employment to unemployment. Second, Figure 2 employs income deprivation as the indicator of area deprivation, while Figure 1 uses employment deprivation as the indicator.

Results

Descriptive Statistics by Area Deprivation

Table 2.1 presents the distribution of dependent variables, independent variables, and covariates, segmented by the level of employment and income deprivation, with both mean values and percentages outlined. This section discusses the descriptive analysis of two analytic samples comprising 26,298 and 32390 unique individuals, respectively. The first sample is the sample of unemployment transition, while the second sample is the sample of retirement transition. The sample of 26,298 individuals was segmented by employment deprivation, while the sample of 32390 individuals was segmented by income deprivation. Both samples were categorized into the least deprived, second least deprived, medium, second most deprived, and most deprived areas, corresponding to deprivation levels of 0%-20%, 20%-40%, 40%-60%, 60%-80%, and 80%-100%, respectively.

Analytic sample (n=26,298):

The following presents a descriptive analysis of SF-12 PCS scores and unemployment, two key variables in this study. Individuals living in more deprived areas exhibited lower SF-12 PCS scores, indicating poorer physical health. For instance, adults residing in the most deprived areas had the lowest SF-12 PCS score (51.87), compared to 53.12 in the least employment-deprived areas (0-20%). The proportion of unemployed individuals was higher in more deprived areas. Unemployment was most prevalent in the most deprived areas (28.26%) compared to the least deprived (10.14%). Similarly, unemployment proportions in the second least deprived (14.49%), medium (21.10%), and second most deprived areas (26.01%) were also higher than in the least deprived areas (10.14%).

Below is a descriptive analysis of covariates: age, education, homeownership, marital status, ethnicity, gender, and gross household income. Adults in less deprived areas tended to be older than those in more deprived areas. The average age was 42 years in the least deprived areas, 40 years in medium deprived areas, and 39 years in the most deprived areas. Educational attainment was lower in more deprived areas. For example, 22.58% of adults in the least deprived areas had a degree, compared to only 15.08% in the most deprived areas. Conversely, 28.19% of adults in the most deprived areas had no educational qualifications, compared to only 12.57% in the least deprived areas.

Homeownership was more common in less deprived areas. For instance, 21.68% of adults in the least deprived areas owned their homes, compared to 19.79%, 19.64%, and 16.95% in the second least deprived, medium, and second most deprived areas, respectively. However, the proportion of owning their homes in the most deprived areas were close to the proportion in the least deprived areas (21.94%). Social renting was more prevalent in deprived areas. In the least deprived areas, 13.07% of adults were social renters, compared to 14.30%, 22.57%, 27.14%, and 22.92% in the second least deprived, medium, second most deprived, and most deprived areas, respectively.

Marital or coupled status varied across deprivation levels. Only 20.35%, 20.11%, 18.18%, and 20.24% of adults in the second least deprived, medium, second most deprived, and most deprived areas, respectively, were married or coupled, compared to 21.13% in the least deprived areas. The proportion of adults who were never married was higher in more deprived areas. Only 16.75% of adults in the least deprived areas had never married. However, the proportion rose to 17.39%, 21.55%, 23.11%, and 21.20% in the second least deprived areas, medium, second most deprived areas, and the most deprived areas, respectively.

Ethnic minorities were more like reside in deprived areas. Only 8.47% of individuals in the least deprived areas were from ethnic minority, compared to 16.18%, 23.06%, 31.44%, and 20.85% in the second least deprived, medium, second most deprived, and most deprived areas, respectively. The proportions of women varied across different areas. In the least deprived areas, 20.03% were women, compared to 19.06% in the second least deprived areas. In medium deprived areas, 21% were women, while in the second most deprived areas, the proportion was 18.87%. In the most deprived areas, 21.03% were women, a proportion similar to that in the least deprived areas. Gross household income was higher in least deprived areas than in more deprived areas.

Analytic sample (n=32390):

The descriptive analysis of physical health and retirement is presented below. Compared to the previous analytic sample (n=26,298), SF-12 PCS scores in this sample were lower. However, the trends were consistent with the previous sample, showing that individuals residing in more deprived areas had lower scores on average compared to those in less deprived areas. Individuals in less deprived areas were more likely to be retired. For instance, 20.52% of adults in the least deprived areas were retired, compared to 19.57%, 19.73%, and 18.90% in the medium, second most deprived, and most deprived areas, respectively. However, there were 21.28% of individuals in the second least deprived areas were retired.

The descriptive analysis of covariates (i.e., age, educational attainment, housing tenure, marital status, ethnicity, gender, and gross household income) is presented below. People in this sample were older. The average age in the least deprived, second least deprived, medium, second most deprived, and most deprived areas was 51, 50, 48, 48, and 46 years, respectively.

The proportion of individuals with Degree and A-Level qualifications varied across deprived areas. In some instances, deprived areas had a higher percentage of individuals with these qualifications, while in others, the proportion was lower. Conversely, the proportion of individuals with GCSE qualifications or no formal qualifications was higher in more deprived areas. Specifically, 20.33% of people in the least deprived areas held a Degree, compared to 20.46% and 22.60% in the medium and most deprived areas, respectively. Regarding A-Level qualifications, 20.07% of individuals in the least deprived areas had achieved this level of education, while the percentages were 20.40%, 20.12%, and 20.12% in the second least deprived, medium, and most deprived areas, respectively. Furthermore, only 14.90% of people in the least deprived areas had no qualifications, compared to 17.84%, 19.47%, 21.97%, and 25.81% in the second least deprived, medium, second most deprived, and most deprived areas, respectively.

People in more deprived areas were generally less likely to own their homes, either outright or with a mortgage. For example, 21.57% of adults owned their homes outright in the least deprived areas, compared to only 19.95%, 18.39%, and 17.31% in the medium, second most deprived, and most deprived areas, respectively. Additionally, only 19.85% and 19.23% of adults in the second most deprived areas and the most deprived areas owning their houses with mortgage, while there were 19.93, higher proportion of people in the least deprived areas owing their houses with mortgage. However, 22.77% of adults in the second least deprived areas owned their homes outright, a proportion higher than in the least deprived areas (21.57%). There were 20.13% and 20.86% of people in the second least deprived areas and medium areas owning their houses with mortgage, proportions higher than in the least deprived areas (19.93%). Social renting was more prevalent in most deprived areas. In the least deprived areas, only 12.91% of adults were social renters, compared to 19.17%, 21.87%, and 33.63% in the medium, second most deprived, and most deprived areas, respectively.

People are more likely to get married in less deprived areas, compared to deprived areas. In the least deprived areas, 20.34% of adults were married, compared to 20.26%, 20.61%, 19.15%, and 19.64% in the second least deprived, medium, second most deprived, and most deprived areas, respectively. There were more ethnic minorities in deprived areas than in less deprived areas. For example, there were only 5.61% in the least deprived areas, while there were 46.61 in the most deprived areas. The proportion of women was higher in more deprived areas. In the least deprived areas, 19.46% of the population were women, compared to 19.58%, 20.28%, 19.67%, and 21.01% in the second least deprived, medium, second most deprived, and most deprived areas, respectively. The gross household income was higher in less deprived areas than in deprived areas.

Table 2.1 Unweighted descriptive statistics by area deprivation at baseline: UK Household Longitudinal Survey, Wave 2-Wave 10

	Analytic sample of unemployment transition n= 26,298					Analytic sample of retirement transition n=32390				
	Employment deprivation (0-20%) % / Mean (SD) n = 5145	Employment deprivation (20%-40%) % / Mean (SD) n = 5031	Employment deprivation (40%-60%) % / Mean (SD) n = 5458	Employment deprivation (60%-80%) % / Mean (SD) n = 5182	Employment deprivation (80%-100%) % / Mean (SD) n = 5482	Income deprivation (0-20%) % / Mean (SD) n =6158	Income deprivation (20%-40%) % / Mean (SD) n = 6244	Income deprivation (40%-60%) % / Mean (SD) n =6554	Income deprivation (60-80%) % / Mean (SD) n = 6413	Income deprivation (80-100%) % / Mean (SD) n = 7021
Key variables										
Physical health (SF-12 PCS) (0 -100)	53.12***	52.54	52.56	52.19	51.87	50.46***	50.08	49.86	49.55	49.40
Employment states										
Employment (%)	21.12***	19.90	20.70	18.66	19.62	18.46***	18.55	20.48	19.82	22.69
Unemployment (%)	10.14****	14.49	21.10	26.01	28.26					
Retirement (%)						20.52***	21.28	19.57	19.73	18.90
Covariates										
Age	42***	42	40	39	39	50.68	50.31	48.38	48.00	45.62

	Analytic sample of unemployment transition n= 26,298					Analytic sample of retirement transition n=32390				
	Employment deprivation (0-20%) % / Mean (SD) n = 5145	Employment deprivation (20%-40%) % / Mean (SD) n = 5031	Employment deprivation (40%-60%) % / Mean (SD) n = 5458	Employment deprivation (60%-80%) % / Mean (SD) n = 5182	Employment deprivation (80%-100%) % / Mean (SD) n = 5482	Income deprivation (0-20%) % / Mean (SD) n =6158	Income deprivation (20%-40%) % / Mean (SD) n = 6244	Income deprivation (40%-60%) % / Mean (SD) n =6554	Income deprivation (60-80%) % / Mean (SD) n = 6413	Income deprivation (80-100%) % / Mean (SD) n = 7021
Educational qualification										
Degree (%)	22.58***	19.32	22.26	20.76	15.08	20.33***	18.13	20.46	18.47	22.60
A level (%)	20.15***	19.79	20.60	18.16	21.30	20.07***	20.40	20.12	19.28	20.12
GCSE (%)	17.67***	19.01	19.88	19.05	24.38	18.77***	19.93	20.53	20.47	20.30
No qualification	12.57***	16.15	18.81	24.27	28.19	14.90***	17.84	19.47	21.97	25.81
Housing tenure										
Owned outright (%)	21.68***	19.79	19.64	16.95	21.94	21.57***	22.77	19.95	18.39	17.31
Owned with mortgage (%)	21.88***	20.75	19.83	16.88	20.66	19.93***	20.13	20.86	19.85	19.23
Social renting (%)	13.07***	14.30	22.57	27.14	22.92	12.91***	12.42	19.17	21.87	33.63

	Analytic sample of unemployment transition n= 26,298					Analytic sample of retirement transition n=32390				
	Employment deprivation (0-20%) % / Mean (SD) n = 5145	Employment deprivation (20%-40%) % / Mean (SD) n = 5031	Employment deprivation (40%-60%) % / Mean (SD) n = 5458	Employment deprivation (60%-80%) % / Mean (SD) n = 5182	Employment deprivation (80%-100%) % / Mean (SD) n = 5482	Income deprivation (0-20%) % / Mean (SD) n =6158	Income deprivation (20%-40%) % / Mean (SD) n = 6244	Income deprivation (40%-60%) % / Mean (SD) n =6554	Income deprivation (60-80%) % / Mean (SD) n = 6413	Income deprivation (80-100%) % / Mean (SD) n = 7021
Private renting (%)	17.14***	18.52	22.67	23.25	18.42	16.96***	16.12	20.22	20.65	26.05
Marital status										
Married (%)	21.13***	20.35	20.11	18.18	20.24	20.34***	20.26	20.61	19.15	19.64
Widowed/divorced/ separated (%)	19.86***	17.23	21.50	20.21	21.20	19.07***	18.65	19.88	20.71	21.69
Never married (%)	15.33***	16.68	22.16	23.52	22.31	14.18***	16.27	19.20	21.37	28.99
Ethnicity										
White (%)	23.17***	20.09	20.01	15.90	20.84	22.24***	22.31	19.98	19.80	15.66
Ethnic minorities (%)	8.47***	16.18	23.06	31.44	20.85	5.61***	6.69	21.28	19.82	46.61
Gender										

	Analytic sample of unemployment transition n= 26,298					Analytic sample of retirement transition n=32390				
	Employment deprivation (0-20%) % / Mean (SD) n = 5145	Employment deprivation (20%-40%) % / Mean (SD) n = 5031	Employment deprivation (40%-60%) % / Mean (SD) n = 5458	Employment deprivation (60%-80%) % / Mean (SD) n = 5182	Employment deprivation (80%-100%) % / Mean (SD) n = 5482	Income deprivation (0-20%) % / Mean (SD) n =6158	Income deprivation (20%-40%) % / Mean (SD) n = 6244	Income deprivation (40%-60%) % / Mean (SD) n =6554	Income deprivation (60-80%) % / Mean (SD) n = 6413	Income deprivation (80-100%) % / Mean (SD) n = 7021
Men (%)	19.05**	19.21	20.48	20.62	20.64	18.50**	18.93	20.18	19.94	22.44
Women (%)	20.03**	19.06	21.00	18.87	21.03	19.46**	19.58	20.28	19.67	21.01
Gross household income	8.30***	8.16	8.10	7.96	7.90	8.18***	8.08	8.06	8.00	7.91

Note: Employment deprivation ranging from 0-20% indicates the least deprived areas, while 80%-100% signifies the most deprived areas. SD denotes standard deviation. ***$p < 0.001$

Descriptive Statistics by Employment Deprivation

Table 2.2 delineates the descriptive statistics for the key variables and covariates, categorised by employment deprivation levels. Mean or proportion was applied to describe the distributions. Individuals in more employment-deprived areas exhibited poorer physical health compared to those in less-deprived areas across Waves 2, 3, 4, and 5. For instance, the SF-12 PCS score at Wave 2 was 54.57 for residents in the least employment-deprived areas, declining to 53.17 in the most employment-deprived areas. Notably, the percentage of employed and unemployed individuals did not differ statistically between less and more employment-deprived areas across waves. The vast majority of adults were employed, with proportion ranging from 97.07% to 98.73% across the waves, while unemployment remained low, ranging from 1.31% to 2.63% across the waves.

Statistically significant differences between deprived and less-deprived areas were observed for age, Degree, GCSE, social renting, ethnicity, and gross household income. Specifically, adults in more deprived areas tended to be younger, with the average age decreasing from 43 years in the least deprived areas to 40 years in the most deprived areas. Adults in less deprived areas were more likely to have Degree. The proportions of having Degree among people in the second least deprived, medium, the second most deprived, and the most deprived were 23.68%, 20.04%, 18.94%, 21.92%, and 15.42%. People in deprived areas are more likely to have GCSE. There was 18.52% of adults having GCSE, while the proportion of having GCSE in the medium and the most deprived areas were 20.30% and 23.59%., respectively. Social renting was more prevalent in deprived areas, with only 18.80% of residents in the least deprived areas being social renters, compared to 24.86% in the most deprived areas. There were more ethnic minorities in deprived areas, compared to less deprived areas: 13.15% in the lowest employment deprivation, 17.53% in second lowest employment deprivation, 19.12% in the middling employment deprivation, 29.48% in the second highest employment deprivation and 20.72% in the highest employment deprivation. Finally, gross household income was highest in the least deprived areas and lowest in the most deprived areas.

Table 2.2 Unweighted descriptive analysis by employment deprivation levels: UK Household Longitudinal Survey, Waves 1-10 (n= 2,589)

	Total % / mean (SD) n = 2589	Employment deprivation (0-20%) % / mean (SD) n = 549	Employment deprivation (20-40%) % / mean (SD) n = 491	Employment deprivation (40-60%) % / mean (SD) n = 524	Employment deprivation (60-80%) % / mean (SD) n = 510	Employment deprivation (80-100%) % / mean (SD) n = 515
Key variables						
Physical health (0 -100)						
W2	54.07 (6.91)	54.57 (6.59) ***	54.54 (6.25)	54.51 (6.53)	53.54 (7.63)	53.17 (7.36)
W3	53.61 (7.53)	54.59 (6.66) ***	53.51 (7.55)	53.82 (7.06)	53.44 (8.18)	52.60 (8.03)
W4	53.53 (7.43)	53.94 (7.18) *	54.06 (6.90)	53.53 (7.60)	53.48 (7.57)	52.66 (7.80)
W5	53.21 (7.58)	53.92 (7.18) **	53.60 (7.06)	53.13 (7.55)	53.06 (7.91)	52.31 (8.06)
W6	53.17 (7.79)	53.61 (7.18)	53.18 (7.85)	53.07 (7.60)	53.01 (8.01)	52.92 (8.34)
W7	52.68 (7.84)	53.09 (7.89)	53.07 (7.51)	52.61 (7.71)	52.42 (7.89)	52.20 (8.15)
W8	52.83 (7.64)	53.46 (6.95)	52.89 (7.65)	52.66 (7.69)	52.47 (7.78)	52.62(8.10)
W9	52.32 (7.87)	52.52 (7.95)	52.24 (7.99)	52.41 (7.68)	52.35 (7.60)	52.07 (8.13)
W10	51.85 (7.94)	52.11 (7.81)	51.79 (7.74)	51.70 (8.40)	51.78(7.85)	51.86 (7.89)
Employment states						

	Total % / mean (SD) n = 2589	Employment deprivation (0-20%) % / mean (SD) n = 549	Employment deprivation (20-40%) % / mean (SD) n = 491	Employment deprivation (40-60%) % / mean (SD) n = 524	Employment deprivation (60-80%) % / mean (SD) n = 510	Employment deprivation (80-100%) % / mean (SD) n = 515
Employment (%)						
W2	97.37	21.38	19.12	20.27	19.64	19.60
W3	97.45	21.24	19.26	20.06	19.58	19.86
W4	98.07	21.31	19.02	20.13	19.69	19.85
W5	97.99	21.13	18.96	20.34	19.75	19.83
W6	98.73	21.21	19.01	20.27	19.68	19.84
W7	98.38	21.20	19.08	20.22	19.75	19.75
W8	98.53	21.17	19.01	20.34	19.68	19.80
W9	98.69	21.29	19.10	20.23	19.65	19.73
W10	98.34	21.09	19.13	20.15	19.80	19.84
Unemployment (%)						
W2	2.63	14.71	13.24	19.12	22.06	30.88
W3	2.55	19.70	7.58	27.27	24.24	21.21
W4	1.93	16.00	16.00	26.00	20.00	22.00
W5	2.01	25.00	19.23	15.38	17.31	23.08

	Total % / mean (SD) n = 2589	Employment deprivation (0-20%) % / mean (SD) n = 549	Employment deprivation (20-40%) % / mean (SD) n = 491	Employment deprivation (40-60%) % / mean (SD) n = 524	Employment deprivation (60-80%) % / mean (SD) n = 510	Employment deprivation (80-100%) % / mean (SD) n = 515
W6	1.27	21.21	15.15	18.18	21.21	24.24
W7	1.62	21.43	11.90	21.43	16.67	28.57
W8	1.47	23.68	15.79	13.16	21.05	26.32
W9	1.31	14.71	8.82	20.59	23.53	32.35
W10	1.66	27.91	9.30	25.58	13.95	23.26
Covariates						
Physical health (0 -100)						
W1	53.59 (6.99)	54.05 (6.78) +	53.56 (6.65)	53.41 (7.00)	53.94 (6.88)	52.95 (7.55)
Employment (%)						
W1	96.25	21.35	19.14	20.22	19.46	19.82
Unemployment (%)						

	Total % / mean (SD) n = 2589	Employment deprivation (0-20%) % / mean (SD) n = 549	Employment deprivation (20-40%) % / mean (SD) n = 491	Employment deprivation (40-60%) % / mean (SD) n = 524	Employment deprivation (60-80%) % / mean (SD) n = 510	Employment deprivation (80-100%) % / mean (SD) n = 515
W1	3.75	17.53	14.43	20.62	25.77	21.65
Age	42	43***	42	42	42	40
Educational qualification						
Degree (%)	35.07	23.68***	20.04	18.94	21.92	15.42
A level (%)	33.33	21.21	18.77	20.63	18.42	20.97
GCSE (%)	71.84	18.52*	18.79	20.30	18.79	23.59
No qualification (%)	3.44	17.98+	11.24	29.21	16.85	24.72
Housing tenure						
Owned outright (%)	16.07	21.15	17.07	19.23	19.95	22.60
Owned with mortgage (%)	68.40	22.25+	19.76	19.99	19.20	18.80
Social renting (%)	6.99	18.80**	12.71	24.31	24.31	24.86
Private renting (%)	8.54	19.00	21.27	20.81	19.46	19.46
Marital status						
Married (%)	73.23	21.99+	19.67	20.09	19.57	18.67

	Total % / mean (SD) n = 2589	Employment deprivation (0-20%) % / mean (SD) n = 549	Employment deprivation (20-40%) % / mean (SD) n = 491	Employment deprivation (40-60%) % / mean (SD) n = 524	Employment deprivation (60-80%) % / mean (SD) n = 510	Employment deprivation (80-100%) % / mean (SD) n = 515
Widowed/ divorced/separated (%)	11.05	20.28	16.78	21.33	20.63	20.98
Never married (%)	15.72	18.18+	17.20	20.15	19.66	24.82
Ethnicity						
White (%)	90.31	22.07***	19.12	20.36	18.65	19.80
Ethnic minorities (%)	9.69	13.15***	17.53	19.12	29.48	20.72
Gender						
Men (%)	51.60	20.99	18.83	20.35	20.27	19.55
Women (%)	48.40	21.41	19.09	20.13	19.16	20.21
Household income	8.26	8.35**	8.30	8.25	8.23	8.16

+p < 0.10 *p < 0.05 **p < 0.01 ***p < 0.001

Descriptive Statistics by Income Deprivation

Table 2.3 shows the means and proportions of key and control variables, segmented by different levels of income deprivation. Notably, only physical health, assessed in Waves 2 and 4, showed significant differences across these levels. For example, the physical health score at wave 2 in the least deprived areas were 52.18, while the scores in the second least deprived, medium, second most deprived, and most deprived areas were 52.27, 52.33, 51.23, and 51.25, respectively. Employment and retirement statuses over 10 waves also varied across different levels of deprivation, indicating that the proportions of both employment and retirement differ depending on the area's level of deprivation. Specifically, deprived areas exhibited lower retirement rates and higher employment rates, suggesting that individuals in deprived areas are more likely to remain employed.

Residents in deprived areas tend to be older than those in less deprived areas. The average age was 54 in the least deprived areas, compared to 52 in both the second least deprived and medium areas, 51 in the second most deprived areas, and 50 in the most deprived areas. Educational attainment varied with area deprivation as well. The proportion of individuals with a degree was 24.38% in the least deprived areas, while the proportions were 17.50%, 19.45%, 20.19%, and 18.47% in the second least deprived, medium, second most deprived, and most deprived areas, respectively.

Residents in less deprived areas were more likely to own houses. For example, 24.01% of adults in the least deprived areas owned their houses outright. However, only 18.59%, 20.71%, 18.70%, and 17.98% of residents in the second least deprived, medium, the second most deprived, and the most deprived areas owned their houses outright. A similar trend was observed for homeownership with a mortgage. Conversely, social renting was more prevalent in deprived areas. Only 16.12% of adults was social renters in the least deprived areas, while 23.14% and 32.64% of adults in medium and the most deprived areas were social renters. As expected, more people were married in less deprived areas than in more deprived areas. There were 22.19% of adults were married in the least deprived areas, while there were only 18.98%, 20.32%, 19.67%, and 18.83% in the second least deprived, medium, the second most deprived, and the most deprived areas. Many ethnic minorities resided in deprived areas: only 8.63% in the least deprived, compared to 10.20%, 16.86%, 20.78%, and 43.53% in the second least deprived, medium, second most deprived, and most deprived areas, respectively. Lastly, gross household income was higher in less deprived areas, compared to more deprived areas.

Table 2.3 Unweighted descriptive analysis by income deprivation levels: UK Household Longitudinal Survey, Waves 1-10 (n= 4288)

	Total % / mean (SD) n = 4288	Income deprivation (0-20%) % / mean (SD) n = 929	Income deprivation (20-40%) % / mean (SD) n = 789	Income deprivation (40-60%) % / mean (SD) n = 861	Income deprivation (60-80%) % / mean (SD) n= 854	Income deprivation (80-100%) % / mean (SD) n = 855
Key variables						
Physical health (0 -100)						
W2	51.85 (8.92)	52.18 (8.49) **	52.27 (8.33)	52.33 (8.48)	51.23 (9.44)	51.25 (9.70)
W3	51.62 (8.87)	51.89 (8.46)	51.88 (8.66)	51.81 (8.47)	51.54 (9.14)	50.99 (9.59)
W4	51.38 (9.15)	51.55 (8.87) *	51.80 (8.59)	51.74 (8.62)	51.16 (9.50)	50.67 (10.02)
W5	51.01 (9.32)	51.18 (9.17)	51.30 (9.04)	51.31 (8.71)	50.88 (9.72)	50.40 (9.92)
W6	50.70 (9.64)	50.84 (9.50)	50.88 (9.20)	50.91 (9.19)	50.53 (9.86)	50.35(10.37)
W7	50.49 (9.63)	50.58 (9.80) +	51.24 (8.86)	50.35 (9.21)	50.48 (9.61)	49.85 (10.51)
W8	50.05 (9.85)	49.96 (10.09)	50.62 (9.14)	50.00 (9.51)	50.06 (9.68)	49.65 (10.68)
W9	49.69 (9.91)	49.56 (10.27)	49.96 (9.37)	49.89 (9.27)	49.75 (10.05)	49.32 (10.48)
W10	49.14 (9.96)	49.32 (9.80)	49.71 (9.10)	49.11 (9.90)	48.91 (10.26)	48.69 (10.63)
Employment states						
Employment (%)						

	Total % / mean (SD) n = 4288	Income deprivation (0-20%) % / mean (SD) n = 929	Income deprivation (20-40%) % / mean (SD) n = 789	Income deprivation (40-60%) % / mean (SD) n = 861	Income deprivation (60-80%) % / mean (SD) n= 854	Income deprivation (80-100%) % / mean (SD) n = 855
W2	71.22	20.17***	18.73	19.52	20.43	21.15
W3	68.96	20.09***	18.77	19.51	20.39	21.24
W4	66.49	19.75***	18.55	19.64	20.73	21.33
W5	64.93	19.58***	18.39	19.65	20.69	21.70
W6	63.18	19.97***	18.42	19.20	20.71	21.71
W7	61.15	20.06***	18.04	19.53	20.59	21.78
W8	58.77	19.96***	17.98	19.68	20.52	21.87
W9	57.16	19.87***	17.95	19.50	20.60	22.07
W10	55.08	19.60***	17.65	19.69	20.70	22.35
Retirement (%)						
W2	28.78	25.36***	17.59	21.47	18.64	16.94
W3	31.04	25.17***	17.58	21.34	18.86	17.05
W4	33.51	25.47***	18.09	20.95	18.30	17.19
W5	35.07	25.53***	18.42	20.88	18.48	16.69
W6	36.82	24.57***	18.37	21.60	18.56	16.91

	Total % / mean (SD) n = 4288	Income deprivation (0-20%) % / mean (SD) n = 929	Income deprivation (20-40%) % / mean (SD) n = 789	Income deprivation (40-60%) % / mean (SD) n = 861	Income deprivation (60-80%) % / mean (SD) n= 854	Income deprivation (80-100%) % / mean (SD) n = 855
W7	38.85	24.19***	18.97	20.95	18.85	17.05
W8	41.23	24.10***	19.00	20.64	19.06	17.19
W9	42.84	24.06***	19.00	20.85	19.00	17.09
W10	44.92	24.20***	19.31	20.56	18.95	16.98
Covariates						
Physical health (0 -100)						
W1	51.98 (8.44)	52.30 (8.14)	51.87 (8.11)	52.36 (7.94)	51.88 (8.82)	51.45 (9.14)
Employment (%)						
W1	73.09	20.20***	18.35	19.81	20.61	21.03
Retirement (%)						
W1	26.91	25.65***	18.54	20.80	18.02	16.98

	Total % / mean (SD) n = 4288	Income deprivation (0-20%) % / mean (SD) n = 929	Income deprivation (20-40%) % / mean (SD) n = 789	Income deprivation (40-60%) % / mean (SD) n = 861	Income deprivation (60-80%) % / mean (SD) n= 854	Income deprivation (80-100%) % / mean (SD) n = 855
Age	52.00 (13)	54 (13) ***	52 (13)	52 (14)	51 (13)	50 (14)
Educational qualification						
Degree (%)	31.18	24.38*	17.50	19.45	20.19	18.47
A level (%)	31.97	21.44	19.26	19.77	19.99	19.55
GCSE (%)	28.80	19.60+	18.70	21.78	18.79	21.13
No qualification	8.05	19.42	17.39	17.68	22.61	22.90
Housing tenure						
Owned outright (%)	41.77	24.01**	18.59	20.71	18.70	17.98
Owned with mortgage (%)	47.43	20.60*	19.17	19.12	21.48	19.62
Social renting (%)	5.64	16.12***	12.81	23.14	15.29	32.64
Private renting (%)	5.15	18.55	15.84	20.36	20.36	24.89
Marital status						
Married (%)	74.81	22.19*	18.98	20.32	19.67	18.83
Widowed/ divorced/separated (%)	15.25	22.48	16.82	18.35	22.32	20.03

	Total % / mean (SD) n = 4288	Income deprivation (0-20%) % / mean (SD) n = 929	Income deprivation (20-40%) % / mean (SD) n = 789	Income deprivation (40-60%) % / mean (SD) n = 861	Income deprivation (60-80%) % / mean (SD) n= 854	Income deprivation (80-100%) % / mean (SD) n = 855
Never married (%)	9.93	16.43***	16.43	20.89	18.08	28.17
Ethnicity						
White (%)	94.05	22.49***	18.92	20.28	19.86	18.45
Ethnic minorities (%)	5.95	8.63***	10.20	16.86	20.78	43.53
Gender						
Men (%)	46.71	21.12	18.52	20.37	20.32	19.67
Women (%)	53.29	22.14	18.29	19.82	19.56	20.18
Household income	8.19 (0.92)	8.27 (0.96)*	8.16 (1.25)	8.17 (0.86)	8.18 (0.71)	8.15 (0.73)

+p < 0.10 *p < 0.05 **p < 0.01 ***p < 0.001

Does the Transition of Unemployment Matter for Physical Health across Deprived and less Deprived Areas in England?

Table 2.4 presents results from the fixed effects regression model, predicting the associations between transition into unemployment, employment deprivation, and changes in physical health. Models tests for social causation. The main association between the transition into unemployment and changes in physical health were reported in Model 1. In Model 2, control variables were included in addition to the main association. Interaction effects of the transition into unemployment and employment deprivation areas on the changes in physical health were tested in Model 3. Table 2.5 shows the fixed-effects logistic regression on the associations between the changes in physical health on the transition into unemployment across different employment deprivation areas, testing for health selection.

Model 1 indicates that the transition into unemployment showed no significant correlation with changes in physical health. In Model 2, control variables (i.e., gross household income and marital transition) cannot be demonstrated as mediators of the main association, as the main association was not significant, despite some of these controls being significant associated with changes in physical health. Specially, in analysis in Model 2 shows that physical health tends to decline with increasing age (coefficient = -0.210; 95% CI = -0.227, -0.192; $p < 0.001$). Additionally, becoming separated, divorced, and widowed was associated with an improvement in physical health by 0.699 points (95% CI = 0.307, 1.090; $p < 0.001$). The transition of housing tenure was not significantly associated with the changes in physical health in terms of 95% CI. Furthermore, an increase in gross household income was not related to changes in physical health.

In Model 3, the interaction term of unemployment transition and living in more deprived areas was not associated with the changes in physical health. Due to the time-invariant nature of employment deprivation, this variable does not produce an estimate in the fixed effects model. The coefficient of the relationship between age and changes in physical health did not differ from Model 2. Similarly to model 2, becoming separated, divorced, and widowed predicted an improvement in physical health (Estimate = 0.701, $p < 0.001$, 95% CI = 0.310, 1.093). The estimates for these marital status transitions were close to those in Model 2.

Model 1 in Table 2.5 shows that changes in physical health were not directly associated with the transition into unemployment. The main association remained non-significant in Models 1 and 2. Similar to Table 2.4, controls (i.e., marital transition and educational transition) cannot be substantiated as mediators. Model 2 shows that each additional increasing in age was associated with a reduce of odds ratio of becoming unemployed by 10.4% (odds ratio = 0.896, 95% CI = 0.881, 0.911, $p < 0.01$). Among individuals, owning a home with a mortgage was associated with a 41% lower odds ratio of becoming unemployed (odds ratio = 0.589, 95% CI = 0.459–0.756, $p < 0.001$) compared to owning a home outright. Social renting was associated with 32% lower odds ratio of becoming unemployment (odds ratio = 0.680, 95%CI = 0.469, 0.985, $p < 0.05$). Similarly, private renting was associated with a lower odds ratio of becoming unemployed (odds ratio = 0.462, 95% CI = 0.339, 0.630, $p < 0.001$). Increasing in gross household income was associated with a decrease odd ratio of becoming unemployed by 79% (odd ratio = 0.208, 95% CI = 0.187, 0.232, $p <0.001$).

In model 3, most of the interactions between physical health and area deprivation was not associated with unemployment transition, except the interaction terms of physical health and employment deprivation (20%-40%). The result suggests that each one-point increase in physical health was associated with a 2.8% ($p <0.05$, 95% CI = 1.003, 1.054) increase in the odds ratio of becoming unemployment among people in the second least employment deprivation areas (20%-40%), compared to the least deprived areas. Increases in age and gross household income remained associated with unemployment transition, with odds ratios consistent with those in Model 2. Owning a home with a mortgage, social renting, and private renting were all associated with lower odds of becoming unemployed, with odds ratios similar or closely aligned to those reported in Model 2.

Overall, the data indicates that the transition into unemployment was not associated with changes in physical health in either deprived or less deprived areas. Changes in physical health also did not predict unemployment transition in most areas, except in the second least deprived areas. The good changes in physical health were associated with unemployment transition in the second least deprived areas.

Table 2.4 Fixed-effect regression models (social causation): the associations between the transition into unemployment, physical health, and employment deprivation (n=26,298)

	Fixed-effect model (Model 1)		Fixed-effect model (Model 2)		Fixed effect model (Model 3)	
	Coef. (95% CI)	Robust std. Err.	Coef. (95% CI)	Robust std. Err.	Coef. (95% CI)	Robust std. Err.
Unemployment transitions						
Employment to unemployment	.161 (-.149, 0.471)	.158	-.059 (-.371, 0.252)	.159	-.227 (-0.200, .546)	.394
Employment deprivation						
20%-40%			0	(omitted)	0	(omitted)
40%-60%			0	(omitted)	0	(omitted)
60%-80%			0	(omitted)	0	(omitted)
80%-100%			0	(omitted)	0	(omitted)
Retirement transition X Income deprivation						
Employment to unemployment X Employment deprivation (20%-40%)					.730 (-.296, 1.755)	.523
Employment to unemployment					.128 (-.872, 1.128)	.510

X Employment deprivation (40%-60%)						
Employment to unemployment X Employment deprivation (60%-80%)					.176 (-.845, 1.197)	.521
Employment to unemployment X Employment deprivation (80%-100%)					-.161 (-1.182, .860)	.521
Age			**.210*** (-.227, -0.192)**	.009	**-.210*** (-.228, -.192)**	.009
Marital transitions						
Married/Civil partner or Living as couple			-.258+ (-.540, .025)	.144	-.258+ (-.540, .025)	.144
Separated, divorced, and widowed			**.699*** (.307, 1.090)**	0.200	**.701*** (.310, 1.093)**	.200
Housing tenure transitions						
Owed with mortgage			-.040 (-.260, 0.181)	.112	-.040 (-.260, 0.181)	.112

Social renting			-.455+ (-.916, 0.006)	.235	-.457+ (-.918, 0.004)	.235
Private renting			-.064 (-.396, 0.267)	.169	-.063 (-.395, 0.269)	.169
Gross household income			.018 (-.045, 0.081)	.032	.018 (-.046, 0.081)	.032
Constant	**52.368*** (52.345, 52.392)**	**.012**	**61.668*** (60.719, 62.617)**	**.484**	**61.674 *** (60.725, 62.622)**	.483

Note: Employment deprivation is noted as a key variable in the analysis, so it is labelled in the table, despite being omitted by Stata along with educational qualification, sex and ethnicity, as these variables are time-invariant and do not vary within individuals across waves. +p <0.10, ***p <0.001

Table 2.5 Fixed-effect logistic regression models (health selection): the associations between physical health, employment deprivation, and transition into unemployment (n= 2,604)

	Fixed-effect model (Model 1)				Fixed-effect model (Model 2)				Fixed-effect model (Model 3)			
	Coef. (95% CI)	Std. Err.	Odds ratio (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Odds ratio (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Odds ratio (95% CI)	Std. Err.
Changes in Physical health	.004 (-.003, 0.010)	.003	1.004 (.997, 1.010)	.003	-.004 (-.011, 0.003)	.003	.996	.003	-.017+ (-.036, .002)	.009	.983+ (.965, 1.002)	.009
Employment deprivation												
20%-40%									0	(omitted)	1	(omitted)
40%-60%									0	(omitted)	1	(omitted)
60%-80%									0	(omitted)	1	(omitted)
80%-100%									0	(omitted)	1	(omitted)
									0	(omitted)	1	(omitted)
Physical health X Employment deprivation												
Physical health X Employment deprivation (20%-40%)									**.028* (.003, .052)**	.013	**1.028* (1.003, 1.054)**	.013

	Fixed-effect model (Model 1)				Fixed-effect model (Model 2)				Fixed-effect model (Model 3)			
	Coef. (95% CI)	Std. Err.	Odds ratio (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Odds ratio (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Odds ratio (95% CI)	Std. Err.
Physical health X Employment deprivation (40%-60%)									.019 (-.004, .042)	.012	1.019 (.996, 1.044)	.0123
Physical health X Employment deprivation (60%-80%)									.008 (-.016, .031)	.012	1.008 (0.984, 1.031)	.0119
Physical health X Employment deprivation (80%-100%)									.009 (-.014, .032)	.0117	1.009 (0.986, 1.032)	.0118
Age					**-.110*** (-.127, -.093)**	.009	**.896*** (.881, .911)**	.008	**-.110*** (-.127, -.093)**	.009	**.896*** (.881, 0.911)**	.008
Marital transitions												
Married/Civil partner or Living as couple					-.097 (-.340, .147)	.124	.908 (.712, 1.158)	.113	-.101 (-.345, .143)	.124	.904 (.708, 1.153)	.112

	Fixed-effect model (Model 1)				Fixed-effect model (Model 2)				Fixed-effect model (Model 3)			
	Coef. (95% CI)	Std. Err.	Odds ratio (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Odds ratio (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Odds ratio (95% CI)	Std. Err.
Separated, divorced, and widowed					.174 (-.165, .513)	.173	1.190 (.848, 1.671)	.206	.173 (-.166, .513)	.173	1.189 (.846, 1.670)	.206
Housing tenure transitions												
Owed with mortgage					**-.529*** (-.779, -.280)**	.127	**.589*****	.075	**-.529*** (-.779, -.279)**	.127	**.589*** (.458, 0.756)**	.075
Social renting					**-.386* (-.757, -.015)**	.189	**.680* (.469, .985)**	.129	**-.380* (-.752, -.009)**	.190	**.684* (.472, 0.991)**	.130
Private renting					**-.772*** (-1.082, -.462)**	.158	**.462*** (.339, .630)**	.073	**-.769*** (-1.079, -.460)**	158	**.463*** (0.340, 0.632)**	.073
Gross household income					**-1.569*** (-1.676, -1.462)**	.055	**.208*** (.187, .232)**	.011	**-1.570*** (-1.678, -1.463)**	.055	**.208*** (0.187, 0.232)**	.011

Note: Employment deprivation is noted as a key variable in the analysis, so it is labelled in the table, despite being omitted by Stata along with educational qualifications, sex and ethnicity, as these variables are time-invariant and do not vary within individuals across waves. +p < 0.10 *p < 0.05 ***p < 0.001

Does the Transition of Retirement Matter for Physical Health across Deprived and less Deprived Areas in England?

Table 2.6 presents fixed-effects regression models that examine the associations between the transition to retirement and changes in physical health, with a particular focus on income deprivation as a moderating factor. The models were designed to test the social causation hypothesis. Model 1 displays the primary associations, while Model 2 incorporates additional covariates alongside the main associations. Model 3 explores the interaction effects between the transition to retirement and income deprivation. Table 2.7 provides insights from fixed-effects logistic regression models, investigating the correlations between changes in physical health and transition into retirement, moderating by income deprivation. These models primarily address the health selection hypothesis. The results are presented in three parts: Model 1 outlines the main associations between changes in physical health and the transition to retirement; Model 2 includes covariates in addition to the primary associations; and Model 3 examines the interaction effects between physical health and income deprivation.

Table 2.6 indicates that the associations between transitions to retirement and physical health significantly differ across varying levels of area deprivation, although the results were not consistently significant. In Model 1, it was observed that the transition to retirement was correlated with a poor change in physical health (Estimate = -2.101, $p < 0.001$, 95% CI = -2.373, -1.829). In contrast, in Model 2, the strength of this association diminished (Estimate = -0.858, $p < 0.001$, 95% CI = -1.135, -0.581). Covariates such as age and becoming separated, divorced, or widowed were found to be relevant to changes in physical health. Specifically, increasing age was associated with a decline in physical health (estimate = -0.294; $p < 0.001$; 95% CI = -0.310, -0.277), while becoming separated, divorced, or widowed was associated with an improvement in physical health (estimate = 0.381; $p < 0.05$; 95% CI =0.001, 0.761).

Social renting was associated with a reduction in physical health (Estimate = -0.741, $p < 0.01$, 95% CI = -1.192, -0.289), compared to outright homeownership.

In Model 3, retirement transition was again associated with poor changes in physical health (Estimate = -1.153, $p < 0.001$, 95% CI = -1.704, -0.601), compared to when being employed. However, the association between the transition to retirement and changes in physical health did not vary significantly across more deprived and less deprived areas, except in the second least deprived areas (20%–40%). In these areas, transitioning into retirement was associated with an improvement in physical health (Estimate = 0.893, $p < 0.05$, 95% CI = 0.164, 1.623), compared to the least deprived areas. This indicates that, in the second least deprived areas, the overall change in physical health associated with retirement was a reduction of 0.260 points (-1.153 + 0.893 = -0.260). The significant associations between increasing age, changes in marital status (i.e., separation, divorce, or widowhood), and housing tenure transitions (i.e., social renting) with physical health in Model 3 remained significant.

Table 2.7 explores the relationship between changes in physical health and the transition to retirement in deprived and less deprived areas. The associations between a negative change in physical health and the transition to retirement did not differ between the two types of areas. Model 1 indicates that a 1-point increase in physical health was associated with a 5.2% decrease in the odds of transitioning to retirement (odds ratio = 0.948, $p < 0.001$). In Model 2, this association remained significant after adjusting for covariates (odds ratio = 0.983, $p < 0.001$, 95% CI = 0.973–0.993). The study also identifies several covariates correlated with the transition to retirement, including age, changes in housing tenure, and gross household income. Specifically, an increase in age was associated with a 1.401-time increase in the odds of transitioning to retirement (odds ratio = 2.401, $p < 0.001$, 95% CI = 2.325–2.480). Owning a home with a mortgage was associated with a 64% reduction in the odds ratio of transitioning to retirement (95% CI = 0.260–0.507, $p < 0.001$). Furthermore, private renting was associated with a lower odds ratio of transitioning to retirement (odds ratio = 0.294, 95% CI = 0.134–0.642, $p < 0.01$). An increase in gross household income was correlated with a higher odds ratio of transitioning to retirement (odds ratio = 0.223, $p < 0.001$, 95% CI = 0.193–0.257). Finally, in Model 3, a 1-point increase in physical health was associated with a 3.4% decrease in the odds of transitioning to retirement. Model 3 also suggests that the main association between physical health and retirement transition did not significantly differ between deprived and less deprived areas.

In sum, our findings support both social causation and health selection. The transition into retirement was associated with a decrease in physical health. However, individuals in the second least deprived areas experienced a smaller reduction in physical health following retirement transition compared to those in the least deprived areas. Furthermore, poor changes in physical health predict transition into retirement.

Table 2.6 Fixed-effect regression models (social causation): the associations between physical health, income deprivation, and transition into retirement (n= 32,390)

	Fixed-effect model (Model 1)		Fixed-effect model (Model 2)		Fixed effect model (Model 3)	
	Coef. (95% CI)	Robust std. Err.	Coef. (95% CI)	Robust std. Err.	Coef. (95% CI)	Robust std. Err.
Retirement transitions						
Employment to retirement	**-2.101*** (-2.373, -1.829)**	.139	**-.858*** (-1.135, -.581)**	.141	**-1.153*** (-1.704, -.601)**	**.281**
Income deprivation						
20-40%					0	(omitted)
40%-60%					0	(omitted)
60-80%					0	(omitted)
80%-100%					0	(omitted)
					0	(omitted)
Retirement transition X Income deprivation						
Retirement transition X Income deprivation (20%-40%)					**.893* (.164, 1.623)**	.372

	Fixed-effect model (Model 1)		Fixed-effect model (Model 2)		Fixed effect model (Model 3)	
	Coef. (95% CI)	Robust std. Err.	Coef. (95% CI)	Robust std. Err.	Coef. (95% CI)	Robust std. Err.
Retirement transition X Income deprivation (40%-60%)					.478 (-.346, 1.303)	.421
Retirement transition X Income deprivation (60%-80%)					.151 (-.721, 1.023)	.445
Retirement transition X Income deprivation (80%-100%)					-.407 (-1.394, 0.580)	.504
Age			**-.294*** (-.310, -.277)**	.008	**-.294*** (-.310, -0.277)**	.008
Married/Civil partner or Living as couple			-.096 (-.384, 0.192)	.147	-.095 (-.383, 0.193)	.147

	Fixed-effect model (Model 1)		Fixed-effect model (Model 2)		Fixed effect model (Model 3)	
	Coef. (95% CI)	Robust std. Err.	Coef. (95% CI)	Robust std. Err.	Coef. (95% CI)	Robust std. Err.
separated/divorced/widowed			**.381* (.001, .761)**	.194	**.384* (.005, .764)**	.194
Owed with mortgage			-.187+ (-.398, 0.024)	.108	-.188+ (-.399, 0.023)	.108
Social renting			**-.741** (-1.192, -.289)**	.230	**-.744** (-1.195, -0.293)**	.230
Private renting			-.231 (-.560, .098)	.168	-.228 (-.557, 0.101)	.168
Gross household income			-.010 (-.077, 0.057)	.034	-.010 (-.077, 0.057)	.034
Constant	**50.231*** (50.142, 50.319)**	**.045**	65.685*** (64.677, 66.693)	.514	65.694 (64.686, 66.702)	.514

Note: Income deprivation is noted as a key variable in the analysis, so it is labelled in the table, despite being omitted by Stata along with educational qualifications, sex and ethnicity, as these variables are time-invariant and do not vary within individuals across waves. +p < 0.10 **p < 0.01 ***p < 0.001

Table 2.7 Fixed-effect logistic regression models (health selection): the associations between physical health, income deprivation, and transition into retirement (n=2336)

	Fixed-effect model (Model 1)				Fixed-effect model (Model 2)				Fixed-effect model (Model 3)			
	Coef. (95% CI)	Std. Err.	Odds ratio (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Odds ratio (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Odds ratio (95% CI)	Std. Err.
Changes in Physical health	-.053*** (-.059, -.048)	.003	**.948*** **	.003	-.017** (-.027, -.007)	.005	**.983** (.973, .993)**	.005	-.035** (-.056, -.013)	.011	**.966** (.945, .987)**	**.011**
Income deprivation												
20%-40%					0	(omitted)	1	(omitted)	0	(omitted)	1	(omitted)
40%-60%					0	(omitted)	1	(omitted)	0	(omitted)	1	(omitted)
60%-80%					0	(omitted)	1	(omitted)	0	(omitted)	1	(omitted)
80%-100%					0	(omitted)	1	(omitted)	0	(omitted)	1	(omitted)
					0	(omitted)	1	(omitted)	0	(omitted)	1	(omitted)
Physical health X Income deprivation												
Physical health X Income deprivation (20%-40%)									.023 (-.006, .053)	.015	1.024 (.994, 1.054)	.015
Physical health X Income deprivation (40%-60%)									.028+ (-.003, .058)	.016	1.028 (.997, 1.060)	.016
Physical health X Income deprivation (60%-80%)									.0187 (-.013, .050)	.016	1.019 (.987, 1.051)	.0164
Physical health X Income deprivation (80%-100%)									.018 (-.015, .050)	.016	1.018 (.986, 1.051)	.017

	Fixed-effect model (Model 1)				Fixed-effect model (Model 2)				Fixed-effect model (Model 3)			
	Coef. (95% CI)	Std. Err.	Odds ratio (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Odds ratio (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Odds ratio (95% CI)	Std. Err.
Age					.876*** (.844, 0.908)	.017	**2.401*** (2.325, 2.480)**	.040	.876*** (.843, .908)	.017	**2.401*** (2.324, 2.480)**	.040
Married/Civil partner or Living as couple					.218 (-.802, 1.238)	.521	1.244 (.448, 3.450)	.647	.204 (-.816, 1.225)	.521	1.226 (.442, 3.403)	.639
separated/divorced/ widowed					-.406 (-1.392, 0.581)	.504	.667 (.248, 1.788)	.336	-.413 (-1.400, .574)	.504	.662 (.247, 1.775)	.333
Owed with mortgage					-1.013*** (-1.346, -.679)	.170	**.363*** (.260, .507)**	.062	-1.012*** (-1.346, -.678)	.170	**.363*** (.260, .507)**	.062
Social renting					-.793 (-1.805, .220)	.517	**.453** (.164, 1.246)	.234	-.810 (-1.826, .207)	.519	.445 (.161, 1.230)	.231
Private renting					-1.225** (-2.008, -.444)	.399	**.294** (.134, .642)**	.117	-1.216** (-2.000, -.432)	.400	**.296** (.135, .649)**	.119
Gross household income					-1.502*** (-1.646, -1.359)	.073	**.223*** (.193, .257)**	.016	-1.502*** (-1.646, -1.358)	.073	**.223*** (.193, .257)**	.016

Note: Income deprivation is noted as a key variable in the analysis, so it is labelled in the table, despite being omitted by Stata along with sex and ethnicity, as these variables are time-invariant and do not vary within individuals across waves. **p < 0.01 ***p < 0.00

The Reciprocal Associations between Employment and Physical Health

Table 2.8 presents the reciprocal associations between unemployment status and physical health. Model 1 includes results with modification indices, while Model 2 shows results without these indices. Below, I compare the findings from the two models.

Social Causation:

Unemployment shows both positive and negative associations with physical health, as well as the instances of non-significant relationships. Specifically, in Model 1, as expected, physical health at Wave 2 was significantly associated with physical health at Wave 3. However, unemployment at Wave 2 in Model 1 did not show a significant association with physical health at Wave 3. In contrast, Model 2 revealed that unemployment at Wave 2 was associated with poorer physical health at Wave 3 (Estimate = -2.777; 95% CI = -4.364, -1.190; $p < 0.01$).

However, in Model 1, unemployment at Wave 3 was associated with better physical health at Wave 4 (Estimate = 0.835; 95% CI = 0.349, 1.321; $p < 0.01$), and this association was not explained by physical health at Wave 2. Similarly, in Model 2, unemployment at Wave 3 was associated with better physical health at Wave 4 (Estimate = 2.201; 95% CI = 1.792, 2.610; $p < 0.001$). Furthermore, in Model 2, without modification indices, unemployment at Wave 4 was initially associated with increased physical health at Wave 5 (Estimate =2.903; 95% CI = 2.517, 3.289; $p < 0.001$). This association was explained by physical health at Waves 2 and 3.

Unemployment at Wave 5 was initially associated with poorer physical health at Wave 6 (Estimate = -1.447; 95% CI = -2.239, -0.656; $p < 0.001$). The association was explained by physical health at Waves 3 and 4, as well as unemployment at Wave 3. These results suggest that unemployment at Wave 3 is a stronger predictor of physical health at Wave 6 than unemployment at Wave 5.

The initial association between unemployment at Wave 6 and increased physical health at Wave 7 (Estimate =2.865; 95% CI = 2.518, 3.212; $p < 0.001$) was explained by physical health at Waves 2 and 4. The negative lagged effect of unemployment observed at Wave 5 also appeared at Wave 7, where unemployment at Wave 7 was initially associated with poorer physical health at Wave 8 (Estimate = -2.448; 95% CI = -2.959, -1.937; $p < 0.001$). However, the association was explained by earlier physical health at waves 2 and 5.

Additionally, unemployment at Wave 8 was initially associated with a 0.425-point increase in physical health at Wave 9, but this association became non-significant after accounting for physical health at Waves 4 and 6. Finally, unemployment at Wave 9 was significantly associated with poorer physical health (Estimate = -0.285; 95% CI = -0.499, -0.071; $p<0.01$). However, the association became positive (Estimate = 0.345; 95% CI = 0.054, 0.637; $p < 0.05$) after adjusting for physical health at Waves 5 and 7 and unemployment at Wave 3.

In sum, unemployment was associated with both poor and good health. Physical health and unemployment state at previous waves may explain the association between unemployment and health.

Health selection:

Good physical health was associated with both higher and lower chances of unemployment. Specifically, in Model 1, which includes modification indices, good physical health at Wave 2 was associated with lower chances of unemployment at Wave 3 (z-score = -

0.034; 95% CI = -0.054, -0.013; $p < 0.01$). However, the trend reversed in Model 2, without modification indices, where good physical health at Wave 2 was associated with higher chances of unemployment at Wave 3 (z-score = 1.108; 95% CI = 0.696, 1.521; $p < 0.001$).

Additionally, good physical health at Wave 4 was associated with lower chances of unemployment in both models. However, the association in Model 1, with modification indices, was not significant, whereas in Model 2, without modification indices, the association was significant (z-score = -1.138; 95% CI =-0.229, -0.047; $p < 0.01$). These results suggest that previous physical health at Waves 5 and 6, which are the modification indices explain the association.

Table 2.8 Autoregressive Cross-lagged Panel Model of the Reciprocal Relations of unemployment and Physical Health (Wave 1 to Wave 10): Social Causation and Health Selection (n= 2589)

	Modal 1 (With modification indices)				Modal 2 (Without modification indices)			
			95% CI				95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Social causation								
Physical health W3	ON				ON			
Physical health W2	0.493***	0.017	0.460	0.525	0.541***	0.017	0.508	0.575
Unemployment W2	-1.316	0.912	-3.104	0.472	**-2.777****	0.810	**-4.364**	**-1.19**
Health selection								
Unemployment W3	ON				ON			
Physical health W2	**-0.034****	0.011	**-0.054**	**-0.013**	**0.124*****	0.011	**0.103**	**0.145**
Unemployment W2	1.543***	0.251	1.051	2.035	1.108***	0.210	0.696	1.521
Social causation								
Physical health W4	ON				ON			
Physical health W3	0.334***	0.012	0.311	0.357	0.47***	0.013	0.444	0.496
Unemployment W3	**0.835****	0.248	**0.349**	**1.321**	**2.201*****	0.209	**1.792**	**2.61**
Modification Indices								
Physical health W2	0.317***	0.019	0.280	0.353				
Health selection								
Unemployment W4	ON				ON			
Physical health W3	-0.005	0.012	-0.028	0.017	-0.001	0.006	-0.013	0.012
Unemployment W3	1.012***	0.161	0.697	1.327	0.298***	0.046	0.208	0.389
Social causation								

	Modal 1 (With modification indices)				Modal 2 (Without modification indices)			
			95% CI				95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Physical health W5	ON				ON			
Physical health W4	0.337***	0.015	0.308	0.366	0.618***	0.032	0.556	0.68
Unemployment W4	0.055	0.175	-0.288	0.398	**2.903*** **	0.197	**2.517**	**3.289**
Modification indices								
Physical health W3	0.212***	0.014	0.185	0.240				
Physical health W2	0.176***	0.017	0.142	0.210				
Health selection								
Unemployment W5	ON				ON			
Physical health W4	-0.013	0.013	-0.039	0.012	**-0.138** **	0.047	**-0.229**	**-0.047**
Unemployment W4	0.799***	0.152	0.501	1.097	2.102**	0.657	0.815	3.389
Social causation								
Physical health W6	ON				ON			
Physical health W5	0.397***	0.013	0.371	0.423	0.867***	0.035	0.799	0.935
Unemployment W5	0.47+	0.267	-0.054	0.993	**-1.447*** **	0.404	**-2.239**	**-0.656**
Modification indices								
Unemployment W3	-0.927*	0.399	-1.709	-0.146				
Physical health W3	0.185***	0.014	0.157	0.213				
Physical health W4	0.189***	0.017	0.156	0.222				
Health selection								
Unemployment W6	ON				ON			
Physical health W5	-0.008	0.014	-0.035	0.019	-0.016	0.012	-0.039	0.007
Unemployment W5	0.755***	0.171	0.42	1.091	0.222***	0.062	0.1	0.344

	Modal 1 (With modification indices)				Modal 2 (Without modification indices)			
			95% CI				95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Social causation								
Physical health W7	ON				ON			
Physical health W6	0.469***	0.014	0.442	0.496	0.829***	0.039	0.753	0.905
Unemployment W6	-0.051	0.164	-0.372	0.269	**2.865*** **	0.177	**2.518**	**3.212**
Modification indices								
Physical health W4	0.175***	0.014	0.147	0.202				
Physical health W2	0.174***	0.017	0.141	0.207				
Health selection								
Unemployment W7	ON				ON			
Physical health W6	0.018	0.014	-0.01	0.046	0.023	0.018	-0.013	0.058
Unemployment W6	0.683***	0.163	0.363	1.002	1.034***	0.139	0.761	1.307
Social causation								
Physical health W8	ON				ON			
Physical health W7	0.453***	0.012	0.429	0.477	0.878***	0.045	0.789	0.967
Unemployment W7	0.015	0.148	-0.274	0.305	**-2.448*** **	0.261	**-2.959**	**-1.937**
Modification indices								
Physical health W5	0.266***	0.013	0.24	0.292				
Physical health W2	0.1***	0.015	0.07	0.13				
Health selection								
Unemployment W8	ON				ON			
Physical health W7	0.003	0.017	-0.03	0.036	0.018	0.018	-0.018	0.053
Unemployment W7	0.908***	0.151	0.613	1.204	0.6***	0.07	0.462	0.738

	Modal 1 (With modification indices)				Modal 2 (Without modification indices)			
			95% CI				95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Social causation								
Physical health W9	ON				ON			
Physical health W8	**0.425*** **	0.013	**0.4**	**0.45**	**0.815*** **	0.032	**0.752**	**0.878**
Unemployment W8	-0.137	0.145	-0.422	0.148	**1.556*** **	0.212	**1.141**	**1.971**
Modification indices								
Physical health W4	0.175***	0.014	0.147	0.203				
Physical health W6	0.217***	0.014	0.191	0.244				
Health selection								
Unemployment W9	ON				ON			
Physical health W8	-0.015	0.017	-0.049	0.019	-0.012	0.022	-0.054	0.031
Unemployment W8	1.13***	0.214	0.711	1.55	1.267***	0.199	0.877	1.658
Social causation								
Physical health W10	ON				ON			
Physical health W9	0.458***	0.014	0.431	0.484	0.787***	0.019	0.749	0.825
Unemployment W9	**0.345***	0.149	**0.054**	**0.637**	**-0.285*** **	0.109	**-0.499**	**-0.071**
Modification indices								
Unemployment W3	-0.897***	0.229	-1.346	-0.449				
Physical health W7	0.212***	0.014	0.185	0.239				
Physical health W5	0.15***	0.014	0.122	0.177				
Health selection								
Unemployment W10	ON				ON			
Physical health W9	-0.003	0.015	-0.032	0.026	-0.028	0.017	-0.061	0.006
Unemployment W9	0.704***	0.153	0.404	1.004	0.681***	0.131	0.424	0.938

	Modal 1 (With modification indices)				Modal 2 (Without modification indices)			
			95% CI				95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Goodness of fit								
RMSEA	0.024				0.077			
CFI	0.985				0.835			
TLI	0.954				0.541			

Note: Coefficients and 95% CIs are presented in bold if they correspond to the hypothesised associations. When the dependent variable is physical health, the analysis controls for physical health and other variables, including household income, age, gender, marital status, educational qualifications, housing tenure, and ethnicity, based on their respective baseline measurements at Wave 1. Conversely, when the dependent variable is unemployment, the analysis controls for unemployment, household income, age, gender, marital status, educational qualifications, housing tenure, and ethnicity, based on their respective baseline measurements at Wave 1.+p < 0.10 ∗p < 0.05 ∗∗p < 0.01 ∗∗∗p < 0.001

The Reciprocal Associations between Retirement and Physical Health

Table 2.9 indicates the reciprocal associations between retirement and physical health. Model 1 presents results with modification indices, while Model 2 presents results without these indices The discussion will first address the social causation models, followed by an examination of the health selection models.

Social causation:

Retirement was associated with increases, decreases, and in some cases, no significant change in physical health. Specifically, both models 1 and 2 show that retirement at Wave 2 was not associated with physical health at Wave 3. As expected, physical health at Wave 2 was associated with physical health at Wave 1 in both models.

Initially, retirement at Wave 3 was associated with a 0.649 increase in physical health at Wave 4 ($p < 0.001$, 95%CI = 0.312, 0.987). However, in model 1, this association became non-significant after including physical health at Wave 2. The increase in physical health at Wave 2 was associated with a 0.293 increase of physical health at Wave 4 ($p < 0.001$, 95% CI = 0.269, 0.316).

Retirement at Wave 4 was associate with a decrease in physical health at Wave 5 at both model 1 (Estimate = -0.194; $p < 0.05$; 95% CI = -0.373, -0.015) and model 2 (Estimate = -0.502, 95% CI = -0.708, -0.297, $p < 0.001$). Although the modification index of physical health at Wave 3 was included, it did not explain the association.

Retirement at Wave 5 was associated with an increase in physical health at Wave 6 at both models. In model 1, with modification index of physical health at Wave 2 included, retirement at Wave 5 was associated with 0.183 increase in physical health. In model 2, without modification indices, retirement at Wave 5 was associated with a 0.315 increase in physical health.

Retirement at Wave 6 was associated with a decrease of physical health at both models despite the inclusion of the modification index of physical health at Wave 2 in Model 1 (Estimate = 0.207; 95% CI = -0.385, -0.030; $p<0.05$) and in model 2 (Estimate = -0.204; 95%CI = -0.388, -0.020, $p < 0.05$).

Retirement at Wave 7 was not associated with physical health at Wave 8 in either model, even in model 2, which did not include a modification index. A similar pattern was observed for the association between retirement at Wave 8 and physical health at Wave 9.

In sum, certain waves demonstrated a positive association between retirement and increased physical health, other waves showed negative or non-significant associations. The inclusion of previous physical health as a modification index explained the association in some models but not in others.

Health Selection:

Poor physical health was associated with both high and low probabilities of retirement, as well as instances where no significant association was observed. Specifically, physical health at Wave 2 was not associated with retirement at Wave 3 in both models, while poor physical health at Wave 3 was associated with retirement at both model 1 (Estimate = 1.599, 95% CI = 1.288, 1.911, $p < 0.001$) and model 2 (Estimate =1.613, 95% CI = 1.291, 1.936, $p < 0.001$). Similarly, there was no association between physical health at Wave 4 and retirement at Wave 5, nor between physical health at Wave 5 and retirement at Wave 6. For one-point increase in poor physical health at Wave 6, the z-score for retirement at Wave 7 increased by -0.023 (95% CI = -0.044, -0.001, $p < 0.05$). Physical health at Wave 7 did not predict retirement at Wave 8, and a similar lack of association was observed between physical health at Wave 8 and retirement at Wave 9. "Contrary to expectations, poor physical health at Wave 9 predicted a low probability of retirement at Wave 10 (z-score = 0.037, 95% CI = 0.008, 0.065, $p < 0.05$).

In sum, the relationship between physical health and retirement appears to be complex and varies across waves. Although poor physical health at certain waves, such as Wave 3 and Wave 6 was associated with an increased likelihood of retirement, this trend was not consistent across waves. For instance, no significant relationships were found between physical health and retirement at Wave 2 and Wave 3, Wave 4 to Wave 5, Wave 5 to Wave 6, Wave 7 to Wave 8, and Wave 8 to Wave 9. Furthermore, poor physical health at Wave 9 unexpectedly associated with a low probability of retirement at Wave 10.

Table 2.9 Autoregressive Cross-lagged Panel Model of the Reciprocal Relations of Retirement and Physical Health (Wave 1 to Wave 10): Social Causation and Health Selection (n= 4288)

	Model 1(With modification indices)				Model 2 (Without modification indices)			
			95% CI				95% CI	
	Estimate	S.E.	Lower2.5%	Upper2.5%	Estimate	S.E.	Lower2.5%	Upper2.5%
Social causation								
Physical health W3	ON				ON			
Physical health W2	0.520***	0.012	0.496	0.544	0.671***	0.013	0.646	0.697
Retirement W2	-1.038	0.741	-2.49	0.413	-1.562	0.681	-2.897	-0.227
Health selection								
Retirement W3	ON				ON			
Physical health W2	0.004	0.007	-0.009	0.017	0.011	0.007	-0.003	0.024
Retirement W2	2.347***	0.145	2.064	2.630	2.323***	0.144	2.041	2.606
Social causation								
Physical health W4	ON				ON			
Physical health W3	0.388***	0.011	0.368	0.409	0.763***	0.013	0.738	0.788
Retirement W3	-0.006	0.169	-0.338	0.325	**0.649*** **	0.172	**0.312**	**0.987**
Modification indices								
Physical health W2	0.293***	0.012	0.269	0.316				
Health selection								
Retirement W4	ON				ON			
Physical health W3	-0.017+	0.010	-0.037	0.002	**-0.035** **	0.013	**-0.061**	**-0.010**
Retirement W3	1.599***	0.159	1.288	1.911	1.613***	0.165	1.291	1.936
Social causation								
Physical health W5	ON				ON			
Physical health W4	0.474***	0.011	0.452	0.495	0.81***	0.014	0.783	0.838
Retirement W4	**-0.194* **	0.092	**-0.373**	**-0.015**	**-0.502*** **	0.105	**-0.708**	**-0.297**

	Model 1(With modification indices)				Model 2 (Without modification indices)			
			95% CI				95% CI	
	Estimate	S.E.	Lower2.5%	Upper2.5%	Estimate	S.E.	Lower2.5%	Upper2.5%
Modification indices								
Physical health W3	0.264***	0.011	0.242	0.286				
Health selection								
Retirement W5	ON				ON			
Physical health W4	0.014	0.011	-0.007	0.036	0.016	0.014	-0.011	0.043
Retirement W4	1.096***	0.123	0.854	1.338	1.072***	0.122	0.834	1.311
Social causation								
Physical health W6	ON				ON			
Physical health W5	0.744***	0.013	0.719	0.77	0.884***	0.014	0.857	0.912
Retirement W5	**0.183***	0.076	**0.035**	**0.332**	**0.315*****	0.081	**0.157**	**0.473**
Modification indices								
Physical health W2	0.156***	0.012	0.134	0.179				
Health selection								
Retirement W6	ON				ON			
Physical health W5	-0.004	0.010	-0.025	0.016	0.001	0.011	-0.020	0.021
Retirement W5	0.822***	0.087	0.652	0.992	0.821***	0.085	0.655	0.988
Social causation								
Physical health W7	ON				ON			
Physical health W6	0.664***	0.013	0.638	0.689	0.843***	0.013	0.817	0.87
Retirement W6	**-0.207***	0.091	**-0.385**	**-0.030**	**-0.204***	0.094	**-0.388**	**-0.020**
Modification indices								
Physical health W2	0.172***	0.013	0.147	0.197				
Health selection								
Retirement W7	ON				ON			

	Model 1(With modification indices)				Model 2 (Without modification indices)			
			95% CI				95% CI	
	Estimate	S.E.	Lower2.5%	Upper2.5%	Estimate	S.E.	Lower2.5%	Upper2.5%
Physical health W6	**-0.023***	0.011	**-0.044**	**-0.001**	**-0.027***	0.012	**-0.050**	**-0.003**
Retirement W6	1.326***	0.133	1.066	1.587	1.313***	0.127	1.063	1.563
Social causation								
Physical health W8	ON				ON			
Physical health W7	0.457***	0.010	0.437	0.477	0.874***	0.015	0.846	0.903
Retirement W7	0.073	0.054	-0.032	0.178	0.038	0.062	-0.083	0.159
Modification indices								
Physical health W3	0.117***	0.012	0.094	0.14				
Physical health W5	0.342***	0.014	0.315	0.369				
Health selection								
Retirement W8	ON				ON			
Physical health W7	0.014	0.011	-0.007	0.035	0.011	0.011	-0.010	0.032
Retirement W7	1.08***	0.12	0.845	1.315	0.988***	0.097	0.797	1.178
Social causation								
Physical health W9	ON				ON			
Physical health W8	0.831***	0.015	0.802	0.859	0.851***	0.014	0.822	0.879
Retirement W8	-0.039	0.056	-0.148	0.071	-0.030	0.062	-0.151	0.091
Modification indices								
Physical health W2	0.123***	0.012	0.101	0.146				
Health selection								
Retirement W9	ON				ON			
Physical health W8	-0.02	0.013	-0.046	0.006	-0.055	0.054	-0.161	0.051
Retirement W8	1.079***	0.131	0.821	1.336	3.550	2.756	-1.852	8.951
Social causation								

	Model 1(With modification indices)				Model 2 (Without modification indices)			
			95% CI				95% CI	
	Estimate	S.E.	Lower2.5%	Upper2.5%	Estimate	S.E.	Lower2.5%	Upper2.5%
Physical health W10	ON				ON			
Physical health W9	0.823***	0.014	0.795	0.851	0.822***	0.014	0.793	0.85
Retirement W9	0.015	0.049	-0.081	0.111	0.004	0.017	-0.029	0.037
Health selection								
Retirement W10	ON				ON			
Physical health W9	**0.037***	0.015	**0.008**	**0.065**	**0.034***	0.013	**0.008**	**0.06**
Retirement W9	0.944***	0.132	0.686	1.202	0.288	0.226	-0.154	0.73
Goodness of fit								
RMSEA	0.045				0.081			
CFI	0.984				0.947			
TLI	0.955				0.856			

Note: Coefficients and 95% CIs are presented in bold if they correspond to the hypothesised associations. When the dependent variable is physical health, physical health and other variables, including household income, age, gender, marital status, educational qualifications, housing tenure, and ethnicity, were controlled for at their respective baseline measurements at Wave 1. Conversely, when the dependent variable is retirement, retirement, household income, age, gender, marital status, educational qualifications, housing tenure, and ethnicity were controlled for at their respective baseline measurements at Wave 1. +p < 0.10 ∗p < 0.05 ∗∗p < 0.01 ∗∗∗p < 0.001

Discussion

This article contributes to the literature on employment states, employment transitions, physical health and the studies of ecological differences. One of the challenges in this field is to address health selection when examining the associations of employment states or employment transitions on health. Prior studies, such as Turner (1995), did not account for health selection because of the use of cross-sectional data. Additionally, few studies, including those by Hughes et al. (2017) and Turner (1995), have explored area deprivation in relation to employment status and health. However, there is no studies have investigated the employment transition, area deprivation, and health. This study addresses these gaps by testing for health selection and incorporating area deprivation in the analysis of the associations between employment states and transitions and physical health.

Both social causation and health selection were supported in the associations between unemployment, retirement, and physical health. Specifically, being unemployed or retired was related to both detrimental and beneficial outcomes for physical health. Similarly, good physical health was associated with both increased and decreased chances of unemployment or retirement. However, neither social causation nor health selection was evident in the relationship between unemployment transitions and changes in physical health in both deprived and less deprived areas. In the second least deprived areas, improvements in physical health were associated with unemployment transition. Additionally, both social causation and health selection were supported in the relationship between retirement transition and declines in physical health. Notably, those in the second least deprived areas based on income deprivation experienced smaller decreases in physical health during retirement transitions compared to those in the least deprived areas. The following section will discuss the main findings and their implications.

Firstly, previous studies have reported mixed findings regarding the association between unemployment transitions and physical health. For example, Herber *et al.*, (2019) found that transitioning into unemployment is associated with poorer physical health, whereas Gebel and Voßemer (2014) found no significant relationship. Similarly, my study indicates that the transition into unemployment was not significantly associated with changes in physical health, particularly in both employment-deprived and less deprived areas. H1c was not supported. The expectation, proposed by Turner (1995), that prolonged job-seeking in areas with high unemployment would worsen health outcomes, cannot explain the results of this study. In this study, the non-significant findings may be partly due to limited statistical power, as relatively few unemployment transitions were observed between times t and t-1. Specifically, only 1.86% (1,505 out of 80804) of total person-wave observations experienced an unemployment transition. Future studies could employ multiple imputation (MI) to increase the sample size for employment transitions before examining the main associations.

Secondly, evidence indicates an association between the transition into retirement and negative changes in physical health. Notably, individuals in the second least income-deprived areas experienced less pronounced declines in physical health related to retirement transition compared to those in the least deprived areas. Thus, H2c was partly supported. These findings diverge from a similar study in Korea, which demonstrated that retirement transition improved physical health (Lee and Kim, 2017). However, they may complement other studies highlighting that retirement can be associated with deteriorating physical health in the UK (Behncke, 2012b; Xue, Head and McMunn, 2020). The finding that individuals in the second least deprived areas experienced smaller declines in physical health than those in the least deprived areas was unexpected, and we do not fully understand the reasons behind this result. One potential explanation could be drawn from the role enhancement perspective. In more deprived areas, job quality—characterised by factors such as autonomy and physical demands—is often lower (Public Health England, 2015). Jobs with greater autonomy and less routinisation tend to foster stronger commitment, whereas those with less autonomy may feel less attached to their jobs as a source of identity (Schieman, 2002). Consequently, individuals in deprived areas may experience fewer disruptions to their sense of identity during the retirement transition. This reduced disruption may mitigate stress and its associated adverse effects on physical health (Hughes *et al.*, 2017). Thus, retirement transitions in deprived areas may lead to less pronounced changes in physical health outcomes. Future research should further examine the association between retirement transition and changes in physical health across both deprived and less deprived areas using additional UK samples.

Future studies could also explore other potential moderators which reflect the contextual resources (see Chapter one for definitions), such as infrastructures relevant to health (Macintyre, Ellaway and Cummins, 2002). For example, examining the interaction effects of the transition into retirement and housing and services deprivation on physical health. This measure of deprivation includes barriers to housing and services including road distances to general stores or supermarkets and GP surgeries (Department for Communities and Local Government, 2015). Although a systematic review concludes that the associations between increased travel distance to healthcare services and poor health outcomes cannot be ruled out, there is evidence that has demonstrated that those who live closer to healthcare services have higher rates of usage, compared to people who live further away (Kelly *et al.*, 2016). The present study explores the relationship between area deprivation and health outcomes, without specifically addressing the role of physical environment factors and their potential association with health, as discussed in Chapter 1, in the section "Places, People, and Health."

Thirdly, no prior study has directly examined the relationship between changes in physical health and transitions into unemployment or retirement (health selection). This study found that changes in physical health were associated with retirement transitions in both deprived and less deprived areas, partially supporting H2d. Unexpectedly, adverse changes in physical health did not correlate with transitions into unemployment, while improvements in physical health were associated with unemployment transitions in areas with higher unemployment rates (i.e., employment deprivation of 20%-40% compared to employment deprivation of 0%-20%). Two perspectives may help explain this pattern. In areas with high unemployment rates, individuals who transitioned into unemployment exhibited improvements in physical health. Alternatively, individuals in these areas with better physical health may possess greater flexibility to leave jobs in pursuit of better opportunities. Good physical health may enhance the capacity to seek and transition into new employment, as it is less likely to hinder job-seeking activities or adaptation to new work environments. Future studies could categorise health variables into groups, such as optimal and non-optimal health (Jusot *et al.*, 2008). The non-significant results may be due to the dampening effect of large health declines within continuous health variables, as continuous measures assume a linear relationship, where a one-point health change holds equal significance for all individuals. However, this assumption may not hold true, as a minor health decline may be irrelevant to unemployment transitions, whereas a more substantial decline may be associated with such transitions.

Finally, both social causation and health selection were supported in the associations of employment states (i.e., retirement and unemployment) and physical health. H1a, H1b, H2a, and H2b were partly supported: there were reciprocal associations between employment states (i.e., retirement and unemployment) and physical health (Shown in Tables 2.8 and 2.9). However, the presence of significant associations was inconsistent, and the directions of these associations were mixed. The results were consistent with previous findings (Berg *et al.*, 2010; Behncke, 2012b; Hughes *et al.*, 2017) that both being retired and being unemployed are negatively associated with physical health, and good physical health decreased both the possibilities of retirement and unemployment. It is important to mention that although one of my findings show that the transition into unemployment was not associated with the adverse change of physical health, the finding does not disprove the associations between being in the state of unemployment and physical health. The fixed effects analyses focus on the associations of the transition into unemployment on the change of physical health within individuals, while the autoregressive cross-lagged analyses focus on the associations between employment states and physical health in different groups (e.g., unemployed and employed people). Results from this study highlight the importance of considering health selection when examining the association of retirement and health.

Also, this study found that the association between retirement state and physical health were mixed: both unemployment and retirement were associated to both positive and negative physical health; conversely, poor physical health was associated with high and low likelihood of both employment and unemployment. Behncke (2012) used ELSA, sample of individuals who born before 1952 in England, and found that retirement decreases physical health and Mein et al. (2003) examined civil servants, aged 54 to 59 at baseline, in the Whitehall II study and found that retirement was not associated to physical health functioning. Due to mixed findings, future studies should investigate the association between both unemployment or retirement and physical health across diverse samples.

To better address the influence of social determinants on health outcomes, it is crucial for policymakers and health practitioners to advocate for the implementation of a healthcare system that records social determinants, including factors like employment status. Studies have underscored social determinants on health (Link and Phelan, 1995; Marmot, 2020). However, this aspect remains notably absent in the patient record system of the UK’s National Health Service, as highlighted by Moscrop et al. (2020). Currently, health practitioners focus on documenting socially patterned outcomes such as health behaviours (e.g., alcohol consumption and smoking habits) and physical health conditions (Moscrop *et al.*, 2020). In contrast, healthcare teams in Toronto records patients' data by asking questions such as "Do you (ever) have difficulty making ends meet at the end of the month? Similar questions could also include employment status. Clear responses for patients facing socioeconomic challenges must be in place. This data could be used in auditing and addressing health inequalities in local areas.

Table 2.10 Hypotheses and Results

Hypotheses	Results	*Supported/not supported/partly supported*
Unemployment and transition into unemployment		
H1a. There is an association between unemployment and decreased physical health, compared to employed individuals. The association is more pronounced in deprived areas, compared to less deprived areas.	Unemployment was associated with both good and poor health. The interaction effects of being unemployed and employment deprivation areas on physical health cannot be demonstrated.	*H1a was partly supported*
H1b. Adults with poor physical health may be more likely to be unemployed, compared to those with better physical health. The association could be more pronounced in deprived areas, compared to less deprived areas.	Poor physical health was associated with both high and low likelihood of unemployment, although the association was not consistently significant. The interaction effect of poor physical health and employment deprivation areas on physical health cannot be demonstrated.	*H1b was partly supported*
H1c. A transition into unemployment is associated with a decrease in physical health, compared to those who remain employed. The association could be stronger in deprived areas, compared to less deprived areas.	The transition into unemployment was not associated with poor changes in physical health in deprived and less deprived areas.	*H1c was not supported*

H1d. The adverse change in physical health increases the likelihood of transition into unemployment. The association could be stronger in deprived areas, compared to less deprived areas when they have similar physical health.	This study found no evidence associating adverse changes in physical health with becoming unemployed. However, a good changes in physical health was associated with unemployment transition in the second least deprived areas.	*H1d was not supported*
Retirement and transition into retirement		
H2a: Retirement is associated with a decline in physical health, compared to employment. The association are more pronounced in deprived areas than in less deprived areas.	Retirement was associated with both good and poor physical health, although the association was not consistently significant. The interaction effects of being retired and income deprivation areas on physical health cannot be demonstrated.	*H2a was partly supported*
H2b: Adults with poor physical health are more likely to retire, compared to adults with better health. The association is stronger in deprived areas than in less deprived areas.	Poor physical health was associated with both high and low possibilities retirement, although the association was not consistently significant. The interaction effect of poor physical health and income deprivation areas on physical health cannot be demonstrated.	*H2b was partly supported*
H2c: Transition into retirement is correlated with a greater reduction in physical health compared to maintaining employment. This correlation is more substantial in deprived areas than in less deprived areas.	Transitioning into retirement was associated with a decline in physical health. However, in the second least deprived areas, retirement was associated with a smaller decrease in physical health compared to the least deprived areas.	*H2c was partly supported*
H2d: Deterioration in physical health is associated with an increased likelihood of transition into retirement.	The adverse changes in physical health were associated with the transition into retirement.	*H2d was partly supported*

This likelihood is elevated in deprived areas compared to less deprived areas, given comparable levels of physical health.	The interaction effect of physical health and income deprivation areas was not demonstrated.	

This study acknowledges several limitations. Firstly, the reciprocal associations between employment status and physical health should not be interpreted as causal effects. While initial physical health, employment status, and baseline confounders were included, the models did not account for unobserved variables. Secondly, the absence of survey weighting limits the generalisability of the findings. Nonetheless, the employment states and transition models may have avoided certain potential biases. Notably, these models relied exclusively on complete case data, which adjusts for non-response, regardless of whether survey weighting was applied (Daniel *et al.*, 2012). Moreover, the study was restricted to respondents from England, helping to avoid biases that might arise from differences between participants from England, Wales, Scotland, and Northern Ireland (Understanding Society, 2023). Furthermore, the employment status models also excluded the Immigrant and Ethnic Minority Boost Sample (IEMBS), which was introduced at Wave 6, as only respondents with complete data from Waves 1 to 10 were included. Consequently, the findings may reduce potential biases between recent immigrants and long-term residents of England (Understanding Society, 2023). However, the employment transition models may not address biases related to differences between immigrants and long-term residents.

In summary, the perspectives of social causation and health selection were not supported in the associations between employment transition and changes in physical health among adults in England. However, improvement in physical health was associated with unemployment transition in the second least deprived areas. Additionally, both social causation and health selection perspectives were supported in the associations between retirement transitions and changes in physical health. Interestingly, the association between retirement transition and poor changes in physical health were less pronounced in the second least deprived areas than the least deprived areas. Both unemployment and retirement demonstrated bidirectional associations with physical health. Specifically, both unemployment and retirement were associated with both positive and negative physical health, with increases and decreases in physical health observed in relation to both states.

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Appendix

Figure 1. Exclusions and total observations in the study on the associations between unemployment transition and physical health (n=26298)

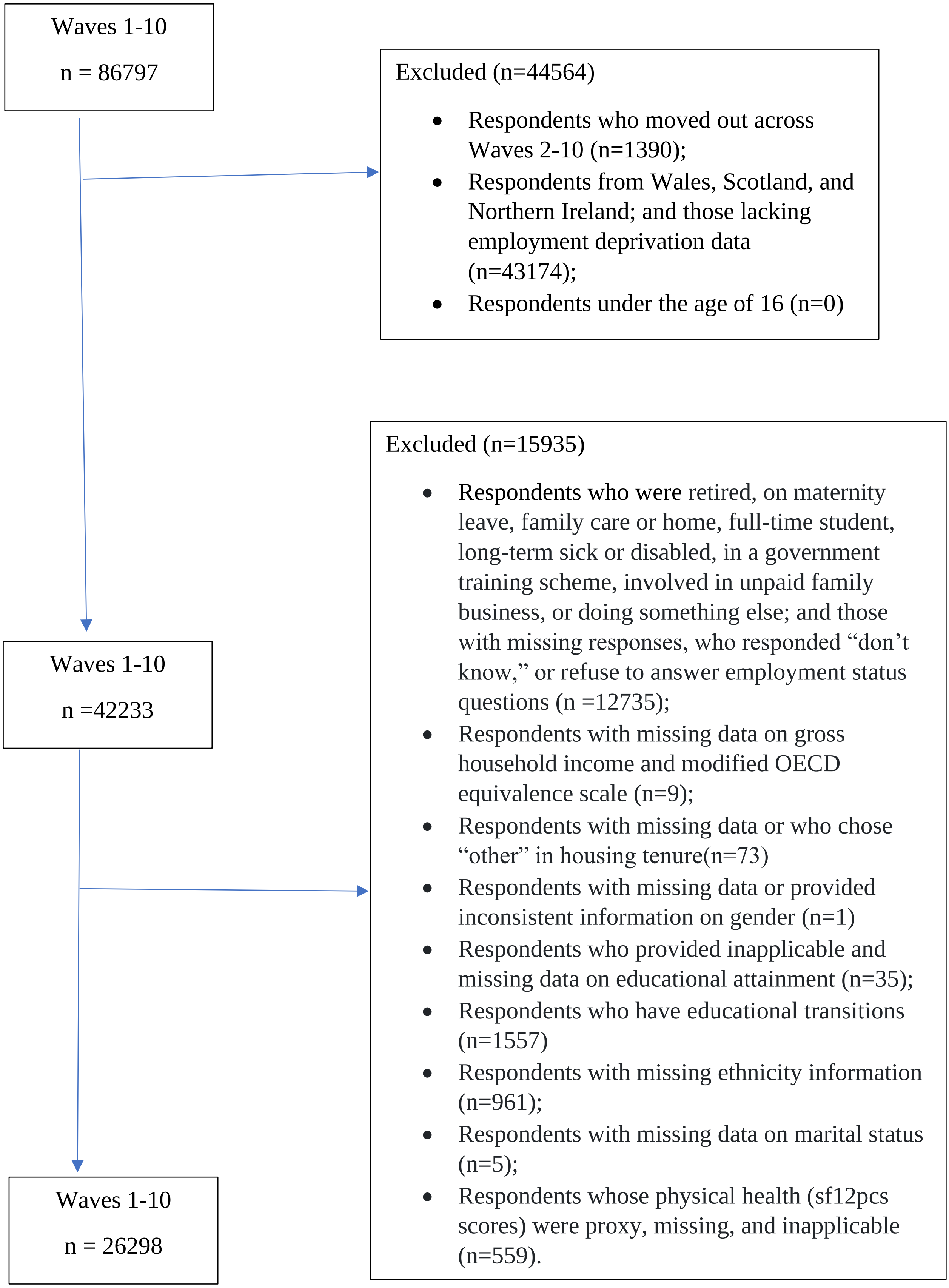

Figure 2. Exclusions and total observations in the Study on the associations between retirement transition and physical health (n=32390)

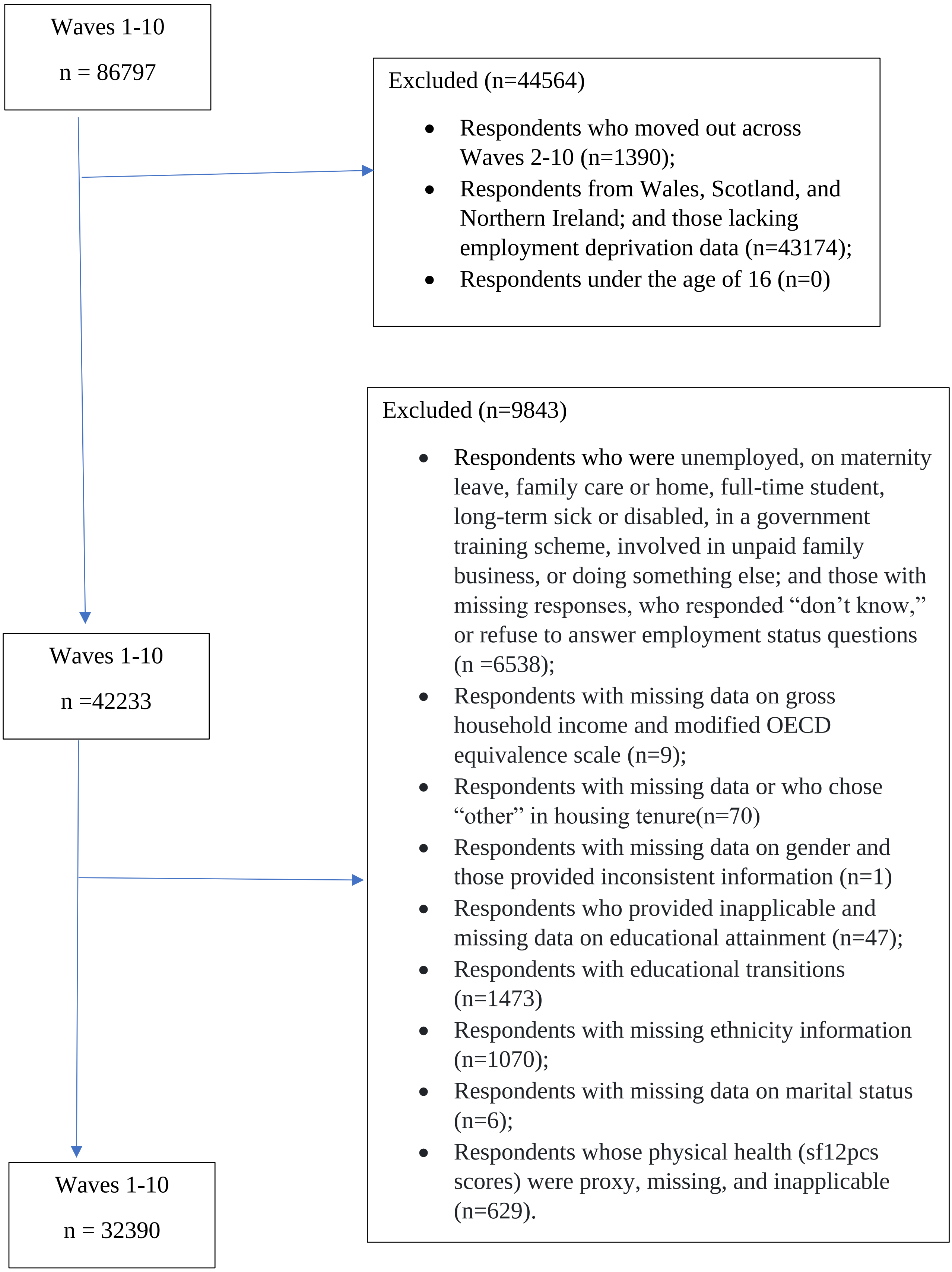

Table 1. Exclusions and total observations in the Study on the associations between unemployment state and physical health (Complete cases Waves 1-10 = 2589)

Waves / Variables	Number of observations excluded	Total observation
Respondents of Waves 1-10 (All respondents based in England with information in employment deprivation)		85,436
Wave 1 (Baseline)		
Age below 16 and missing data	12	85424
Elements of control variables		
Employment states (missing, refusal, don't know, retired, on maternity leave, family care or home, full-time student, LT sick or disabled, Govt training scheme, unpaid family business, doing something else)	55962	29462
Physical health (missing, inappropriate, and proxy)	150	29312
Gender (inconsistent)		
Ethnic minority (missing)	1	29311
Educational attainment (missing)	0	
Marital status (missing and Under 16 years)	1	29310
Gross household income (missing)		
Modified OECD equivalence scale (missing)	1	29309
Housing tenure (missing and other)	8	29301
Wave 2 (B)		
Key variables		
Employment states (missing, refusal, don't know, retired, on maternity leave, family care or home, full-time student, LT sick or disabled, Govt training scheme, unpaid family business, doing something else)	7600	21701
Physical health (missing, inappropriate, and proxy)	553	21148
Other variables		
Move out	469	20679

Wave 3 (c)		
Key variables		
Employment states (missing, refusal, don't know, retired, on maternity leave, family care or home, full-time student, LT sick or disabled, Govt training scheme, unpaid family business, doing something else)	3759	16920
Physical health (missing, inappropriate, and proxy)	186	16734
Other variables		
Move out	652	16082
Wave 4 (D)		
Key variables		
Employment states (missing, refusal, don't know, retired, on maternity leave, family care or home, full-time student, LT sick or disabled, Govt training scheme, unpaid family business, doing something else)	1942	14140
Physical health (missing, inappropriate, and proxy)	94	14046
Other variables		
Move out	655	13391
Wave 5 (E)		
Key variables		
Employment states (missing, refusal, don't know, retired, on maternity leave, family care or home, full-time student, LT sick or disabled, Govt training scheme, unpaid family business, doing something else)	1249	12142
Physical health (missing, inappropriate, and proxy)	64	12078
Other variables		
Move out	985	11093
Wave 6 (F)		
Key variables		
Employment states (missing, refusal, don't know, retired, on maternity leave, family care or home, full-time student, LT sick or	1531	9562

disabled, Govt training scheme, unpaid family business, doing something else)		
Physical health (missing, inappropriate, and proxy)	43	9519
Other variables		
Move out	809	8710
Wave 7 (G)		
Key variables		
Employment states (missing, refusal, don't know, retired, on maternity leave, family care or home, full-time student, LT sick or disabled, Govt training scheme, unpaid family business, doing something else)	1029	7681
Physical health (missing, inappropriate, and proxy)	44	7637
Other variables		
Move out	755	6882
Wave 8 (H)		
Key variables		
Employment states (missing, refusal, don't know, retired, on maternity leave, family care or home, full-time student, LT sick or disabled, Govt training scheme, unpaid family business, doing something else)	757	6125
Physical health (missing, inappropriate, and proxy)	19	6106
Other variables		
Move out	606	5500
Wave 9 (I)		
Key variables		
Employment states (missing, refusal, don't know, retired, on maternity leave, family care or home, full-time student, LT sick or disabled, Govt training scheme, unpaid family business, doing something else)	787	4713
Physical health (missing, inappropriate, and proxy)	42	4671
Other variables		
Move out	743	3928

Wave 10 (J)		
Key variables		
Employment states (missing, refusal, don’t know, retired, on maternity leave, family care or home, full-time student, LT sick or disabled, Govt training scheme, unpaid family business, doing something else)	556	3372
Physical health (missing, inappropriate, and proxy)	41	3331
Other variables		
Move out	742	**2589**

Table 2. Exclusions and total observations in the Study on the associations between retirement state and physical health (Complete cases Waves 1-10 =4288)

Waves / Variables	Number of observations excluded	Total observation
Respondents of Waves 1-10 (All respondents based in England with information in income deprivation)		85,436
Wave 1 (Baseline)		
Age below 16 and missing data	2	85,424
Elements of control variables		
Employment states (missing, refusal, don't know, unemployed, on maternity leave, family care or home, full-time student, LT sick or disabled, Govt training scheme, unpaid family business, doing something else)	50898	34526
Physical health (missing, inappropriate, and proxy)	194	34332
Gender (inconsistent)	0	34332
Ethnic minority (missing)	1	34331
Educational attainment (missing)	0	34331
Marital status (missing and Under 16 years)	1	34330
Gross household income (missing)	0	34330
Modified OECD equivalence scale (missing)	2	34328
Housing tenure (missing and other)	10	34318
Wave 2 (B)		
Key variables		
Employment states (missing, refusal, don't know, retired, on maternity leave, family care or home, full-time student, LT sick or disabled, Govt training scheme, unpaid family business, doing something else)	7999	26319
Physical health (missing, inappropriate, and proxy)	946	25373
Other variables		
Move out	469	24904

Wave 3 (c)		
Key variables		
Employment states (missing, refusal, don't know, unemployed, on maternity leave, family care or home, full-time student, LT sick or disabled, Govt training scheme, unpaid family business, doing something else)	4242	20662
Physical health (missing, inappropriate, and proxy)	381	20281
Other variables		
Move out	652	19629
Wave 4 (D)		
Key variables		
Employment states (missing, refusal, don't know, unemployed, on maternity leave, family care or home, full-time student, LT sick or disabled, Govt training scheme, unpaid family business, doing something else)	2235	17394
Physical health (missing, inappropriate, and proxy)	151	17243
Other variables		
Move out	655	16588
Wave 5 (E)		
Key variables		
Employment states (missing, refusal, don't know, unemployed, on maternity leave, family care or home, full-time student, LT sick or disabled, Govt training scheme, unpaid family business, doing something else)	1475	15113
Physical health (missing, inappropriate, and proxy)	131	14982
Other variables		
Move out	985	13997
Wave 6 (F)		
Key variables		
Employment states (missing, refusal, don't know, unemployed, on maternity leave, family care or home, full-time student, LT sick or disabled, Govt training scheme,	1783	12214

unpaid family business, doing something else)		
Physical health (missing, inappropriate, and proxy)	111	12103
Other variables		
Move out	809	11294
Wave 7 (G)		
Key variables		
Employment states (missing, refusal, don't know, unemployed, on maternity leave, family care or home, full-time student, LT sick or disabled, Govt training scheme, unpaid family business, doing something else)	1248	10046
Physical health (missing, inappropriate, and proxy)	73	9973
Other variables		
Move out	755	9218
Wave 8 (H)		
Key variables		
Employment states (missing, refusal, don't know, unemployed, on maternity leave, family care or home, full-time student, LT sick or disabled, Govt training scheme, unpaid family business, doing something else)	945	8273
Physical health (missing, inappropriate, and proxy)	54	8219
Other variables		
Move out	606	7613
Wave 9 (I)		
Key variables		
Employment states (missing, refusal, don't know, unemployed, on maternity leave, family care or home, full-time student, LT sick or disabled, Govt training scheme, unpaid family business, doing something else)	1012	6601
Physical health (missing, inappropriate, and proxy)	76	6525
Other variables		
Move out	743	5782

Wave 10 (J)		
Key variables		
Employment states (missing, refusal, don't know, unemployed, on maternity leave, family care or home, full-time student, LT sick or disabled, Govt training scheme, unpaid family business, doing something else)	660	5122
Physical health (missing, inappropriate, and proxy)	92	5030
Other variables		
Move out	742	**4288**

Table 3. Autoregressive cross-lagged models: the bi-directional associations between employment state and physical health (n= 2589)

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**
Physical health W3	ON				ON			
Physical health W2	**0.493*** **	0.017	**0.460**	**0.525**	**0.541*** **	0.017	**0.508**	**0.575**
Unemployment W2	-1.316	0.912	-3.104	0.472	**-2.777** **	0.810	**-4.364**	**-1.190**
Physical health W1	**0.220*** **	0.017	**0.187**	**0.253**	**0.22*** **	0.017	**0.187**	**0.253**
Gross household income W1	0.069	0.195	-0.314	0.451	0.068	0.195	-0.315	0.450
Age W1	**-0.045** **	0.015	**-0.074**	**-0.015**	**-0.045** **	0.015	**-0.074**	**-0.015**
Women W1 (Reference: men)	-0.328	0.246	-0.810	0.153	-0.326	0.246	-0.807	0.156
Divorced, widowed, separated W1 (Reference: married/ coupled)	0.089	0.404	-0.704	0.881	0.094	0.404	-0.698	0.887
Never married W1 (Reference: married/ coupled)	0.436	0.386	-0.321	1.194	0.440	0.386	-0.317	1.197
No qualification W1 (Reference: Degree)	-0.239	0.644	-1.501	1.024	-0.247	0.644	-1.509	1.015
GCSE W1 (Reference: Degree)	**-0.691***	0.330	**-1.337**	**-0.045**	**-0.693***	0.330	**-1.34**	**-0.047**
A Level W1 (Reference: Degree)	**-0.649***	0.307	**-1.251**	**-0.047**	**-0.652***	0.307	**-1.254**	**-0.05**
Owned with mortgage W1 (Reference: Owned outright)	0.162	0.337	-0.499	0.824	0.162	0.337	-0.499	0.824
Social renting W1 (Reference: Owned outright)	0.295	0.567	-0.817	1.407	0.294	0.567	-0.819	1.406
Private renting W1 (Reference: Owned outright)	-0.475	0.536	-1.526	0.575	-0.476	0.536	-1.527	0.574
Non-White W1(Reference: White)	**-0.909***	0.408	**-1.709**	**-0.108**	**-0.911***	0.408	**-1.711**	**-0.111**
Unemployment W3	ON				ON			
Physical health W2	**-0.034** **	0.011	**-0.054**	**-0.013**	**0.124*** **	0.011	**0.103**	**0.145**
Unemployment W2	**1.543*** **	0.251	**1.051**	**2.035**	**1.108*** **	0.210	**0.696**	**1.521**
Unemployment W1	**0.854*** **	0.222	**0.419**	**1.289**	**0.494** **	0.178	**0.144**	**0.843**
Gross household income W1	-0.054	0.084	-0.219	0.111	-0.053	0.084	-0.218	0.112
Age W1	-0.001	0.008	-0.018	0.015	-0.001	0.008	-0.018	0.015
Women W1 (Reference: men)	**-0.338***	0.168	**-0.667**	**-0.009**	**-0.339***	0.168	**-0.668**	**-0.009**

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**
Divorced, widowed, separated W1 (Reference: married/ coupled)	-0.132	0.276	-0.672	0.408	-0.134	0.276	-0.674	0.406
Never married W1 (Reference: married/ coupled)	-0.115	0.213	-0.533	0.303	-0.113	0.213	-0.531	0.305
No qualification W1 (Reference: Degree)	0.154	0.342	-0.517	0.825	0.152	0.342	-0.519	0.824
GCSE W1 (Reference: Degree)	-0.003	0.201	-0.397	0.391	-0.004	0.201	-0.398	0.390
A Level W1 (Reference: Degree)	-0.152	0.192	-0.529	0.225	-0.153	0.192	-0.529	0.224
Owned with mortgage W1 (Reference: Owned outright)	-0.104	0.203	-0.502	0.294	-0.104	0.203	-0.502	0.294
Social renting W1 (Reference: Owned outright)	0.325	0.271	-0.206	0.856	0.326	0.271	-0.205	0.857
Private renting W1 (Reference: Owned outright)	0.128	0.288	-0.437	0.693	0.129	0.288	-0.436	0.694
Non-White W1(Reference: White)	0.029	0.234	-0.430	0.488	0.026	0.234	-0.433	0.485
Physical health W4	ON				ON			
Physical health W3	**0.334*****	0.012	**0.311**	**0.357**	**0.470*****	0.013	**0.444**	**0.496**
Unemployment W3	**0.835****	0.248	**0.349**	**1.321**	**2.201*****	0.209	**1.792**	**2.610**
Physical health W1	**0.186*****	0.014	**0.158**	**0.214**	**0.155*****	0.014	**0.127**	**0.184**
Gross household income W1	-0.173	0.151	-0.469	0.123	-0.109	0.227	-0.554	0.336
Age W1	-0.016	0.016	-0.047	0.014	-0.008	0.023	-0.054	0.037
Women W1 (Reference: men)	0.067	0.285	-0.493	0.626	0.575	0.440	-0.287	1.437
Divorced, widowed, separated W1 (Reference: married/ coupled)	-0.773+	0.402	-1.562	0.016	-0.610	0.690	-1.963	0.742
Never married W1 (Reference: married/ coupled)	0.496	0.430	-0.347	1.340	0.583	0.618	-0.627	1.794
No qualification W1 (Reference: Degree)	-1.586*	0.618	**-2.797**	**-0.376**	-1.765+	0.913	-3.554	0.024
GCSE W1 (Reference: Degree)	-0.657*	0.333	**-1.310**	**-0.004**	-0.557	0.528	-1.592	0.477
A Level W1 (Reference: Degree)	-0.368	0.327	-1.008	0.273	-0.068	0.510	-1.067	0.930
Owned with mortgage W1 (Reference: Owned outright)	-0.185	0.384	-0.937	0.568	-0.067	0.565	-1.175	1.040
Social renting W1 (Reference: Owned outright)	-0.426	0.619	-1.639	0.787	-0.898	0.835	-2.534	0.738
Private renting W1 (Reference: Owned outright)	-0.929+	0.543	-1.993	0.135	-1.038	0.807	-2.619	0.544
Non-White W1(Reference: White)	-0.604	0.389	-1.367	0.158	-0.507	0.608	-1.698	0.684

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**
Modification Indices								
Physical health W2	**0.317*****	0.019	**0.280**	**0.353**				
Unemployment W4	ON				ON			
Physical health W3	-0.005	0.012	-0.028	0.017	-0.001	0.006	-0.013	0.012
Unemployment W3	**1.012*****	0.161	**0.697**	**1.327**	**0.298*****	0.046	**0.208**	**0.389**
Unemployment W1	-0.239	0.323	-0.871	0.394	0.090	0.155	-0.214	0.394
Gross household income W1	-0.144	0.096	-0.332	0.044	**-0.131****	0.049	**-0.227**	**-0.034**
Age W1	-0.002	0.014	-0.029	0.025	-0.002	0.009	-0.020	0.016
Women W1 (Reference: men)	-0.082	0.259	-0.589	0.425	-0.206	0.173	-0.545	0.134
Divorced, widowed, separated W1 (Reference: married/ coupled)	0.206	0.441	-0.658	1.071	0.093	0.276	-0.448	0.634
Never married W1 (Reference: married/ coupled)	0.453	0.279	-0.094	1.000	0.278	0.182	-0.078	0.635
No qualification W1 (Reference: Degree)	-0.195	0.586	-1.343	0.952	-0.073	0.398	-0.852	0.706
GCSE W1 (Reference: Degree)	-0.11	0.314	-0.725	0.505	-0.079	0.212	-0.495	0.337
A Level W1 (Reference: Degree)	0.046	0.336	-0.612	0.704	-0.029	0.231	-0.483	0.424
Owned with mortgage W1 (Reference: Owned outright)	0.299	0.352	-0.391	0.989	0.170	0.255	-0.330	0.670
Social renting W1 (Reference: Owned outright)	0.351	0.421	-0.473	1.176	0.405	0.290	-0.164	0.974
Private renting W1 (Reference: Owned outright)	-0.056	0.517	-1.069	0.957	0.020	0.353	-0.671	0.712
Non-White W1(Reference: White)	0.046	0.303	-0.547	0.640	0.047	0.219	-0.383	0.476
Physical health W5	ON				ON			
Physical health W4	**0.337*****	0.015	**0.308**	**0.366**	**0.618*****	0.032	**0.556**	**0.680**
Unemployment W4	0.055	0.175	-0.288	0.398	**2.903*****	0.197	**2.517**	**3.289**
Physical health W1	**0.095*****	0.015	**0.066**	**0.124**	**0.069*****	0.016	**0.037**	**0.101**
Gross household income W1	**0.368*****	0.102	**0.169**	**0.567**	**0.852*****	0.189	**0.481**	**1.224**
Age W1	**-0.049****	0.014	**-0.077**	**-0.021**	-0.043	0.031	-0.103	0.017

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**
Women W1 (Reference: men)	0.041	0.250	-0.449	0.531	0.931	0.581	-0.208	2.069
Divorced, widowed, separated W1 (Reference: married/ coupled)	**-0.777***	0.336	**-1.435**	**-0.12**	-0.665	0.868	-2.366	1.036
Never married W1 (Reference: married/ coupled)	-0.261	0.375	-0.996	0.475	-1.009	0.693	-2.368	0.350
No qualification W1 (Reference: Degree)	-0.488	0.601	-1.666	0.689	-0.025	1.389	-2.747	2.698
GCSE W1 (Reference: Degree)	-0.155	0.308	-0.759	0.450	0.176	0.727	-1.248	1.601
A Level W1 (Reference: Degree)	-0.369	0.290	-0.938	0.199	-0.096	0.756	-1.579	1.387
Owned with mortgage W1 (Reference: Owned outright)	0.122	0.338	-0.539	0.784	-0.174	0.870	-1.880	1.531
Social renting W1 (Reference: Owned outright)	-0.695	0.530	-1.734	0.344	-2.044+	1.059	-4.120	0.032
Private renting W1 (Reference: Owned outright)	-0.128	0.517	-1.142	0.886	-0.133	1.184	-2.454	2.188
Non-White W1(Reference: White)	**-0.964****	0.360	**-1.67**	**-0.257**	-1.067	0.802	-2.639	0.505
Modification indices								
Physical health W3	**0.212*****	0.014	**0.185**	**0.240**				
Physical health W2	**0.176*****	0.017	**0.142**	**0.210**				
Unemployment W5	ON				ON			
Physical health W4	-0.013	0.013	-0.039	0.012	**-0.138****	0.047	**-0.229**	**-0.047**
Unemployment W4	0.799***	0.152	**0.501**	**1.097**	**2.102****	0.657	**0.815**	**3.389**
Unemployment W1	0.490	0.589	-0.665	1.645	0.863	0.530	-0.176	1.903
Gross household income W1	0.266	0.198	-0.121	0.654	0.456	0.334	-0.199	1.110
Age W1	0.023	0.015	-0.006	0.052	0.034	0.026	-0.018	0.086
Women W1 (Reference: men)	-0.227	0.273	-0.761	0.308	-0.302	0.477	-1.237	0.634
Divorced, widowed, separated W1 (Reference: married/ coupled)	0.344	0.415	-0.471	1.158	0.420	0.726	-1.004	1.843
Never married W1 (Reference: married/ coupled)	0.541	0.330	-0.106	1.188	0.853	0.593	-0.309	2.015
No qualification W1 (Reference: Degree)	0.065	0.694	-1.295	1.424	-0.059	1.150	-2.314	2.196
GCSE W1 (Reference: Degree)	0.228	0.378	-0.513	0.969	0.293	0.652	-0.984	1.571
A Level W1 (Reference: Degree)	0.334	0.398	-0.446	1.115	0.487	0.693	-0.872	1.845

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**
Owned with mortgage W1 (Reference: Owned outright)	0.229	0.412	-0.578	1.035	0.298	0.719	-1.110	1.707
Social renting W1 (Reference: Owned outright)	0.523	0.504	-0.465	1.511	0.650	0.860	-1.036	2.335
Private renting W1 (Reference: Owned outright)	0.927	0.575	-0.200	2.053	1.365	1.041	-0.676	3.407
Non-White W1(Reference: White)	-0.668	0.548	-1.742	0.407	-1.211	0.924	-3.022	0.600
Physical health W6	ON				ON			
Physical health W5	0.397***	0.013	**0.371**	**0.423**	0.867***	0.035	**0.799**	**0.935**
Unemployment W5	0.470+	0.267	-0.054	0.993	-1.447***	0.404	**-2.239**	**-0.656**
Physical health W1	0.044**	0.015	**0.014**	**0.074**	-0.027	0.018	-0.062	0.007
Gross household income W1	-0.103	0.168	-0.432	0.225	0.082	0.460	-0.820	0.983
Age W1	**-0.067*** **	0.018	**-0.101**	**-0.032**	0.012	0.035	-0.057	0.081
Women W1 (Reference: men)	0.130	0.306	-0.470	0.729	-1.176+	0.613	-2.378	0.025
Divorced, widowed, separated W1 (Reference: married/ coupled)	-0.051	0.477	-0.985	0.884	1.544+	0.936	-0.291	3.379
Never married W1 (Reference: married/ coupled)	-0.643	0.501	-1.625	0.339	1.873*	0.797	**0.311**	**3.435**
No qualification W1 (Reference: Degree)	0.096	0.758	-1.39	1.581	0.281	1.987	-3.613	4.176
GCSE W1 (Reference: Degree)	-0.664+	0.367	-1.383	0.055	-0.247	0.82	-1.853	1.360
A Level W1 (Reference: Degree)	-0.453	0.381	-1.200	0.294	0.530	0.786	-1.01	2.070
Owned with mortgage W1 (Reference: Owned outright)	0.302	0.425	-0.531	1.134	1.426	0.880	-0.299	3.151
Social renting W1 (Reference: Owned outright)	-0.251	0.615	-1.456	0.955	2.751*	1.278	**0.247**	**5.255**
Private renting W1 (Reference: Owned outright)	-0.598	0.637	-1.846	0.651	2.096	1.225	-0.305	4.497
Non-White W1(Reference: White)	0.850	0.530	-0.189	1.890	-0.527	1.511	-3.490	2.435
Modification indices								
Unemployment W3	**-0.927***	0.399	**-1.709**	**-0.146**				
Physical health W3	**0.185*** **	0.014	**0.157**	**0.213**				
Physical health W4	**0.189*** **	0.017	**0.156**	**0.222**				

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**
Unemployment W6	ON				ON			
Physical health W5	-0.008	0.014	-0.035	0.019	-0.016	0.012	-0.039	0.007
Unemployment W5	**0.755*****	0.171	**0.420**	**1.091**	**0.222*****	0.062	**0.100**	**0.344**
Unemployment W1	-0.394	0.713	-1.792	1.003	0.238	0.237	-0.225	0.702
Gross household income W1	-0.034	0.250	-0.524	0.456	0.001	0.176	-0.344	0.346
Age W1	-0.015	0.014	-0.043	0.013	-0.008	0.010	-0.027	0.012
Women W1 (Reference: men)	0.251	0.333	-0.403	0.904	0.071	0.235	-0.389	0.531
Divorced, widowed, separated W1 (Reference: married/ coupled)	-0.096	0.493	-1.063	0.870	0.003	0.339	-0.661	0.667
Never married W1 (Reference: married/ coupled)	0.396	0.375	-0.338	1.130	0.455	0.262	-0.059	0.968
No qualification W1 (Reference: Degree)	0.676	0.841	-0.972	2.324	0.501	0.623	-0.720	1.722
GCSE W1 (Reference: Degree)	0.394	0.461	-0.510	1.298	0.317	0.329	-0.327	0.961
A Level W1 (Reference: Degree)	0.175	0.513	-0.831	1.180	0.175	0.360	-0.531	0.880
Owned with mortgage W1 (Reference: Owned outright)	0.484	0.634	-0.758	1.727	0.444	0.451	-0.439	1.327
Social renting W1 (Reference: Owned outright)	0.271	0.675	-1.052	1.595	0.406	0.468	-0.511	1.323
Private renting W1 (Reference: Owned outright)	-0.428	0.763	-1.924	1.068	-0.132	0.545	-1.200	0.935
Non-White W1(Reference: White)	0.814	0.554	-0.272	1.900	0.470	0.328	-0.172	1.113
Physical health W7	ON				ON			
Physical health W6	**0.469*****	0.014	**0.442**	**0.496**	0.829***	0.039	0.753	0.905
Unemployment W6	-0.051	0.164	-0.372	0.269	2.865***	0.177	2.518	3.212
Physical health W1	**0.046****	0.016	**0.015**	**0.077**	0.044*	0.017	0.010	0.078
Gross household income W1	0.071	0.166	-0.253	0.396	-0.099	0.540	-1.158	0.959
Age W1	**-0.039****	0.014	**-0.068**	**-0.011**	-0.013	0.034	-0.079	0.053
Women W1 (Reference: men)	-0.195	0.248	-0.682	0.292	0.124	0.725	-1.297	1.545
Divorced, widowed, separated W1 (Reference: married/ coupled)	-0.658+	0.361	-1.367	0.050	-1.174	1.012	-3.158	0.810
Never married W1 (Reference: married/ coupled)	-0.420	0.404	-1.211	0.371	-2.51**	0.856	-4.186	-0.833

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**
No qualification W1 (Reference: Degree)	-0.283	0.782	-1.815	1.249	-1.842	2.192	-6.139	2.454
GCSE W1 (Reference: Degree)	-0.145	0.334	-0.799	0.509	-1.011	1.025	-3.020	0.998
A Level W1 (Reference: Degree)	-0.354	0.297	-0.937	0.228	-1.036	1.047	-3.088	1.017
Owned with mortgage W1 (Reference: Owned outright)	-0.434	0.382	-1.182	0.314	-2.400+	1.343	-5.033	0.233
Social renting W1 (Reference: Owned outright)	-0.833	0.573	-1.956	0.291	**-3.079***	1.465	**-5.95**	**-0.208**
Private renting W1 (Reference: Owned outright)	-0.442	0.537	-1.494	0.611	-1.027	1.697	-4.353	2.299
Non-White W1(Reference: White)	-0.030	0.404	-0.822	0.761	-0.855	0.939	-2.696	0.985
Modification indices								
Physical health W4	**0.175***	0.014	**0.147**	**0.202**				
Physical health W2	**0.174***	0.017	**0.141**	**0.207**				
<u>Unemployment W7</u>	ON				ON			
Physical health W6	0.018	0.014	-0.010	0.046	0.023	0.018	-0.013	0.058
Unemployment W6	0.683***	0.163	**0.363**	**1.002**	**1.034***	0.139	**0.761**	**1.307**
Unemployment W1	0.488	0.618	-0.723	1.700	0.146	0.261	-0.365	0.658
Gross household income W1	0.207	0.251	-0.285	0.699	0.215	0.270	-0.314	0.744
Age W1	0.002	0.018	-0.033	0.036	0.002	0.019	-0.035	0.039
Women W1 (Reference: men)	-0.212	0.292	-0.784	0.360	-0.215	0.317	-0.837	0.406
Divorced, widowed, separated W1 (Reference: married/ coupled)	0.390	0.437	-0.466	1.245	0.407	0.473	-0.519	1.333
Never married W1 (Reference: married/ coupled)	-0.101	0.368	-0.823	0.621	-0.162	0.389	-0.924	0.600
No qualification W1 (Reference: Degree)	0.154	0.830	-1.473	1.782	0.135	0.893	-1.614	1.885
GCSE W1 (Reference: Degree)	0.352	0.424	-0.479	1.184	0.343	0.461	-0.560	1.245
A Level W1 (Reference: Degree)	0.316	0.453	-0.572	1.204	0.315	0.491	-0.648	1.277
Owned with mortgage W1 (Reference: Owned outright)	0.018	0.608	-1.174	1.211	-0.023	0.659	-1.315	1.269
Social renting W1 (Reference: Owned outright)	0.007	0.685	-1.334	1.349	-0.051	0.737	-1.496	1.394
Private renting W1 (Reference: Owned outright)	0.277	0.757	-1.207	1.761	0.286	0.817	-1.315	1.887

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**
Non-White W1(Reference: White)	0.186	0.404	-0.606	0.977	0.182	0.436	-0.673	1.037
Physical health W8	ON				ON			
Physical health W7	**0.453*** **	0.012	**0.429**	**0.477**	**0.878*** **	0.045	**0.789**	**0.967**
Unemployment W7	0.015	0.148	-0.274	0.305	**-2.448*** **	0.261	**-2.959**	**-1.937**
Physical health W1	**0.061*** **	0.016	**0.030**	**0.091**	0.021	0.018	-0.014	0.057
Gross household income W1	0.109	0.107	-0.101	0.319	0.780	0.598	-0.392	1.951
Age W1	**-0.039** **	0.014	**-0.066**	**-0.012**	-0.016	0.047	-0.108	0.075
Women W1 (Reference: men)	-0.085	0.250	-0.575	0.406	-0.874	0.618	-2.084	0.337
Divorced, widowed, separated W1 (Reference: married/ coupled)	-0.283	0.335	-0.940	0.375	1.249	0.924	-0.561	3.060
Never married W1 (Reference: married/ coupled)	-0.076	0.346	-0.754	0.602	1.575+	0.912	-0.212	3.362
No qualification W1 (Reference: Degree)	-0.665	0.659	-1.956	0.626	1.125	2.197	-3.181	5.430
GCSE W1 (Reference: Degree)	-0.010	0.317	-0.632	0.611	**1.941* **	0.950	**0.078**	**3.803**
A Level W1 (Reference: Degree)	-0.262	0.296	-0.842	0.319	1.347	0.963	-0.541	3.235
Owned with mortgage W1 (Reference: Owned outright)	0.063	0.337	-0.597	0.724	1.640	1.151	-0.616	3.896
Social renting W1 (Reference: Owned outright)	0.154	0.483	-0.793	1.101	2.298	1.507	-0.656	5.252
Private renting W1 (Reference: Owned outright)	0.003	0.505	-0.986	0.992	1.526	1.716	-1.838	4.889
Non-White W1(Reference: White)	0.173	0.372	-0.555	0.901	1.075	0.913	-0.715	2.864
Modification indices								
Physical health W5	**0.266*** **	0.013	**0.240**	**0.292**				
Physical health W2	**0.100*** **	0.015	**0.070**	**0.130**				
Unemployment W8	ON				ON			
Physical health W7	0.003	0.017	-0.030	0.036	0.018	0.018	-0.018	0.053
Unemployment W7	**0.908*** **	0.151	**0.613**	**1.204**	**0.600*** **	0.070	**0.462**	**0.738**
Unemployment W1	-0.014	0.566	-1.122	1.095	-0.092	0.310	-0.700	0.516

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**
Gross household income W1	-0.259	0.286	-0.818	0.301	-0.186	0.227	-0.632	0.259
Age W1	0.009	0.025	-0.040	0.058	0.009	0.020	-0.030	0.048
Women W1 (Reference: men)	-0.294	0.309	-0.900	0.312	-0.283	0.247	-0.768	0.201
Divorced, widowed, separated W1 (Reference: married/ coupled)	-0.353	0.623	-1.574	0.869	-0.216	0.508	-1.211	0.780
Never married W1 (Reference: married/ coupled)	0.304	0.355	-0.391	0.999	0.339	0.278	-0.206	0.885
No qualification W1 (Reference: Degree)	-0.144	0.793	-1.697	1.410	-0.004	0.651	-1.280	1.272
GCSE W1 (Reference: Degree)	-0.450	0.464	-1.359	0.460	-0.276	0.375	-1.010	0.459
A Level W1 (Reference: Degree)	-0.062	0.450	-0.944	0.819	0.031	0.355	-0.664	0.726
Owned with mortgage W1 (Reference: Owned outright)	-0.549	0.526	-1.580	0.482	-0.387	0.407	-1.184	0.410
Social renting W1 (Reference: Owned outright)	-0.625	0.723	-2.041	0.791	-0.404	0.573	-1.528	0.719
Private renting W1 (Reference: Owned outright)	-0.131	0.695	-1.494	1.232	-0.037	0.549	-1.113	1.040
Non-White W1(Reference: White)	0.412	0.378	-0.329	1.152	0.406	0.299	-0.180	0.992
Physical health W9	ON				ON			
Physical health W8	**0.425*** **	0.013	**0.400**	**0.450**	**0.815*** **	0.032	**0.752**	**0.878**
Unemployment W8	-0.137	0.145	-0.422	0.148	**1.556*** **	0.212	**1.141**	**1.971**
Physical health W1	**0.036***	0.017	**0.003**	**0.069**	**0.049****	0.019	**0.012**	**0.086**
Gross household income W1	-0.009	0.116	-0.236	0.218	-0.054	0.360	-0.76	0.653
Age W1	-0.029+	0.014	-0.057	-0.001	-0.031	0.034	-0.097	0.035
Women W1 (Reference: men)	0.012	0.261	-0.498	0.523	**0.896***	0.454	**0.007**	**1.785**
Divorced, widowed, separated W1 (Reference: married/ coupled)	**-0.781***	0.337	**-1.443**	**-0.120**	-0.795	0.832	-2.426	0.836
Never married W1 (Reference: married/ coupled)	0.029	0.373	-0.701	0.759	-0.969+	0.576	-2.097	0.160
No qualification W1 (Reference: Degree)	0.056	0.761	-1.436	1.548	-0.532	1.421	-3.317	2.252
GCSE W1 (Reference: Degree)	-0.648	0.306	-1.247	-0.048	-1.064	0.654	-2.347	0.219
A Level W1 (Reference: Degree)	-0.465	0.296	-1.045	0.115	-1.063+	0.600	-2.239	0.112
Owned with mortgage W1 (Reference: Owned outright)	0.086	0.335	-0.570	0.742	0.249	0.634	-0.993	1.492

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**
Social renting W1 (Reference: Owned outright)	-0.034	0.509	-1.031	0.964	0.021	0.976	-1.893	1.934
Private renting W1 (Reference: Owned outright)	0.440	0.544	-0.626	1.506	-0.111	1.045	-2.159	1.937
Non-White W1(Reference: White)	0.238	0.419	-0.582	1.059	-1.006	0.618	-2.218	0.205
Modification indices								
Physical health W4	**0.175*****	0.014	**0.147**	**0.203**				
Physical health W6	**0.217*****	0.014	**0.191**	**0.244**				
Unemployment W9	ON				ON			
Physical health W8	-0.015	0.017	-0.049	0.019	-0.012	0.022	-0.054	0.031
Unemployment W8	**1.130*****	0.214	**0.711**	**1.550**	**1.267*****	0.199	**0.877**	**1.658**
Unemployment W1	-0.162	0.855	-1.838	1.514	0.595	0.825	-1.021	2.212
Gross household income W1	0.205	0.327	-0.436	0.846	0.193	0.313	-0.42	0.806
Age W1	-0.012	0.030	-0.071	0.048	-0.011	0.029	-0.067	0.046
Women W1 (Reference: men)	0.591	0.367	-0.129	1.310	0.548	0.345	-0.128	1.225
Divorced, widowed, separated W1 (Reference: married/ coupled)	-0.375	0.903	-2.145	1.395	-0.358	0.857	-2.038	1.322
Never married W1 (Reference: married/ coupled)	-0.173	0.419	-0.995	0.648	-0.146	0.399	-0.927	0.636
No qualification W1 (Reference: Degree)	0.441	1.064	-1.644	2.526	0.389	1.006	-1.583	2.361
GCSE W1 (Reference: Degree)	-0.019	0.533	-1.063	1.025	-0.010	0.504	-0.999	0.978
A Level W1 (Reference: Degree)	-0.706	0.445	-1.579	0.167	-0.663	0.421	-1.488	0.161
Owned with mortgage W1 (Reference: Owned outright)	0.084	0.502	-0.900	1.068	0.079	0.477	-0.857	1.014
Social renting W1 (Reference: Owned outright)	0.269	0.795	-1.289	1.827	0.258	0.757	-1.225	1.741
Private renting W1 (Reference: Owned outright)	-0.779	0.942	-2.626	1.067	-0.729	0.899	-2.491	1.032
Non-White W1(Reference: White)	0.016	0.459	-0.884	0.916	0.029	0.437	-0.828	0.887
Physical health W10	ON				ON			
Physical health W9	**0.458*****	0.014	**0.431**	**0.484**	**0.787*****	0.019	**0.749**	**0.825**

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**
Unemployment W9	**0.345***	0.149	**0.054**	**0.637**	**-0.285****	0.109	**-0.499**	**-0.071**
Physical health W1	0.021	0.015	-0.008	0.051	0.023	0.016	-0.008	0.055
Gross household income W1	-0.278	0.187	-0.644	0.088	-0.098	0.154	-0.400	0.205
Age W1	-0.023	0.018	-0.059	0.013	-0.019	0.017	-0.052	0.015
Women W1 (Reference: men)	-0.259	0.304	-0.855	0.338	-0.052	0.263	-0.568	0.463
Divorced, widowed, separated W1 (Reference: married/ coupled)	-0.849+	0.463	-1.757	0.060	-0.756+	0.406	-1.553	0.040
Never married W1 (Reference: married/ coupled)	-0.635	0.424	-1.466	0.195	-0.105	0.383	-0.856	0.647
No qualification W1 (Reference: Degree)	-1.391+	0.716	-2.795	0.013	-0.957	0.770	-2.466	0.553
GCSE W1 (Reference: Degree)	-0.474	0.372	-1.204	0.256	-0.201	0.338	-0.863	0.461
A Level W1 (Reference: Degree)	-0.139	0.369	-0.862	0.583	-0.025	0.331	-0.674	0.624
Owned with mortgage W1 (Reference: Owned outright)	-0.492	0.404	-1.283	0.300	-0.477	0.387	-1.235	0.281
Social renting W1 (Reference: Owned outright)	-0.723	0.598	-1.896	0.449	-1.031+	0.597	-2.202	0.139
Private renting W1 (Reference: Owned outright)	-0.321	0.647	-1.590	0.948	-0.923	0.605	-2.108	0.263
Non-White W1(Reference: White)	-0.376	0.520	-1.395	0.643	-0.034	0.471	-0.956	0.889
Modification indices								
Unemployment W3	**-0.897*****	0.229	**-1.346**	**-0.449**				
Physical health W7	**0.212*****	0.014	**0.185**	**0.239**				
Physical health W5	**0.150*****	0.014	**0.122**	**0.177**				
Unemployment W10	ON				ON			
Physical health W9	-0.003	0.015	-0.032	0.026	-0.028	0.017	-0.061	0.006
Unemployment W9	**0.704*****	0.153	**0.404**	**1.004**	**0.681*****	0.131	**0.424**	**0.938**
Unemployment W1	0.577	0.838	-1.066	2.219	0.237	0.794	-1.319	1.793
Gross household income W1	-0.099	0.300	-0.686	0.489	-0.083	0.280	-0.632	0.467
Age W1	0.017	0.020	-0.023	0.056	0.013	0.019	-0.024	0.050
Women W1 (Reference: men)	0.314	0.317	-0.308	0.937	0.294	0.298	-0.289	0.878

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**
Divorced, widowed, separated W1 (Reference: married/ coupled)	-0.384	0.712	-1.780	1.011	-0.392	0.666	-1.698	0.914
Never married W1 (Reference: married/ coupled)	-0.046	0.422	-0.874	0.781	-0.038	0.393	-0.808	0.732
No qualification W1 (Reference: Degree)	-0.396	0.461	-1.299	0.507	-0.382	0.430	-1.225	0.460
GCSE W1 (Reference: Degree)	0.041	0.352	-0.649	0.731	0.012	0.330	-0.636	0.659
A Level W1 (Reference: Degree)	0.069	0.422	-0.758	0.897	0.036	0.395	-0.737	0.810
Owned with mortgage W1 (Reference: Owned outright)	0.042	0.431	-0.803	0.887	0.043	0.404	-0.748	0.834
Social renting W1 (Reference: Owned outright)	-0.178	0.649	-1.449	1.094	-0.175	0.608	-1.367	1.016
Private renting W1 (Reference: Owned outright)	0.532	0.671	-0.782	1.847	0.494	0.624	-0.728	1.717
Non-White W1(Reference: White)	-0.427	0.465	-1.337	0.484	-0.399	0.433	-1.248	0.450
Physical health W10	WITH				WITH			
Unemployment W10	**-1.849****	0.555	**-2.937**	**-0.762**	-0.622	0.442	-1.488	0.244
Intercepts								
Physical health W3	**17.699*****	2.036	**13.709**	**21.690**	**17.596*****	2.036	**13.606**	**21.587**
Physical health W4	**14.337*****	1.615	**11.171**	**17.502**	**11.907*****	1.628	**8.716**	**15.098**
Physical health W5	**9.942*****	1.402	**7.194**	**12.691**	**8.047*****	1.498	**5.110**	**10.983**
Physical health W6	**7.521*****	1.435	**4.708**	**10.334**	0.732	1.653	-2.508	3.972
Physical health W7	**10.037*****	1.835	**6.440**	**13.633**	**8.126*****	1.935	**4.334**	**11.918**
Physical health W8	**8.014*****	1.549	**4.978**	**11.050**	2.143	1.894	-1.569	5.855
Physical health W9	**5.384*****	1.595	**2.257**	**8.511**	**4.076***	1.814	**0.520**	**7.632**
Physical health W10	**7.389*****	1.614	**4.226**	**10.552**	**7.381*****	1.701	**4.046**	**10.715**
Thresholds								
Unemployment W3	1.049	1.033	-0.976	3.074	1.049	1.033	-0.976	3.074
Unemployment W4	-0.334	1.448	-3.171	2.504	-0.191	1.059	-2.267	1.886

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower 2.5%**	**Upper 2.5%**
Unemployment W5	3.969+	2.275	-0.491	8.429	3.999	3.734	-3.320	11.318
Unemployment W6	4.145	2.764	-1.273	9.563	2.502	2.047	-1.51	6.514
Unemployment W7	**5.541***	2.599	**0.447**	**10.636**	**5.335***	2.704	**0.035**	**10.634**
Unemployment W8	2.249	2.937	-3.509	8.006	1.867	2.458	-2.95	6.684
Unemployment W9	3.965	4.131	-4.132	12.061	4.311	3.967	-3.463	12.086
Unemployment W10	2.581	2.848	-3.002	8.164	1.900	2.679	-3.351	7.15
Residual variances								
Physical health W3	**36.437*** **	0.732	**35.001**	**37.872**	**34.694*** **	0.739	**33.245**	**36.143**
Physical health W4	**30.495*** **	0.728	**29.069**	**31.921**	**13.592*** **	1.086	**11.464**	**15.72**
Physical health W5	**31.199*** **	0.674	**29.877**	**32.520**	**11.426*** **	1.139	**9.194**	**13.658**
Physical health W6	**27.777*** **	0.816	**26.177**	**29.376**	**7.988*** **	1.030	**5.969**	**10.007**
Physical health W7	**30.882*** **	0.719	**29.473**	**32.290**	**8.554*** **	1.050	**6.496**	**10.612**
Physical health W8	**27.017*** **	0.629	**25.784**	**28.250**	**6.208*** **	1.252	**3.754**	**8.662**
Physical health W9	**28.519*** **	0.609	**27.325**	**29.713**	**15.462*** **	0.815	**13.865**	**17.060**
Physical health W10	**27.692*** **	0.840	**26.045**	**29.338**	**23.001*** **	0.666	**21.696**	**24.306**
Goodness of fit								
RMSEA	0.024				0.077			
CFI	0.985				0.835			
TLI	0.954				0.541			

Note: The letter "W" denotes wave of longitudinal data. +p < 0.10 ∗p < 0.05 **p < 0.010 ∗∗∗p < 0.001

Table 4. Autoregressive cross-lagged models: the bi-directional associations between retirement state and physical health (n=4288)

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**
Physical health W3	ON				ON			
Physical health W2	**0.520*****	0.012	**0.496**	**0.544**	**0.671*****	0.013	**0.646**	**0.697**
Retirement W2	-1.038	0.741	-2.49	0.413	-1.562	0.681	-2.897	-0.227
Physical health W1	**0.240*****	0.012	**0.216**	**0.264**	**0.24*****	0.012	**0.216**	**0.264**
Gross household income W1	-0.007	0.118	-0.239	0.224	-0.006	0.118	-0.237	0.225
Age W1	**-0.050******	0.011	**-0.072**	**-0.027**	**-0.05*****	0.011	**-0.072**	**-0.027**
Women W1 (Reference: men)	-0.266	0.196	-0.650	0.118	-0.264	0.196	-0.648	0.120
Divorced, widowed, separated W1 (Reference: married/ coupled)	0.004	0.281	-0.547	0.555	0.002	0.281	-0.548	0.553
Never married W1 (Reference: married/ coupled)	-0.113	0.359	-0.816	0.590	-0.114	0.359	-0.817	0.589
No qualification W1 (Reference: Degree)	-0.15	0.399	-0.933	0.632	-0.146	0.399	-0.929	0.637
GCSE W1 (Reference: Degree)	**-0.782****	0.262	**-1.296**	**-0.268**	**-0.779****	0.262	**-1.294**	**-0.265**
A Level W1 (Reference: Degree)	-0.447+	0.254	-0.944	0.050	-0.442+	0.254	-0.939	0.055
Owned with mortgage W1 (Reference: Owned outright)	-0.125	0.253	-0.622	0.372	-0.127	0.253	-0.624	0.370
Social renting W1 (Reference: Owned outright)	**-0.980***	0.410	**-1.783**	**-0.176**	**-0.958***	0.410	**-1.761**	**-0.155**
Private renting W1 (Reference: Owned outright)	-0.644	0.486	-1.596	0.308	-0.649	0.486	-1.601	0.303
Non-White W1(Reference: White)	-0.620	0.405	-1.415	0.174	-0.616	0.405	-1.411	0.178
Retirement W3	ON				ON			
Physical health W2	0.004	0.007	-0.009	0.017	0.011	0.007	-0.003	0.024
Retirement W2	**2.347*****	0.145	**2.064**	**2.630**	**2.323*****	0.144	**2.041**	**2.606**
Retirement W1	**0.697*****	0.135	**0.432**	**0.961**	**0.727*****	0.139	**0.454**	**1.000**

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**
Gross household income W1	-0.051	0.042	-0.134	0.031	-0.052	0.042	-0.134	0.031
Age W1	**0.091*** **	0.010	**0.072**	**0.110**	**0.091*** **	0.010	**0.072**	**0.110**
Women W1 (Reference: men)	0.094	0.098	-0.098	0.287	0.092	0.098	-0.101	0.284
Divorced, widowed, separated W1 (Reference: married/ coupled)	-0.009	0.127	-0.259	0.240	-0.006	0.127	-0.256	0.244
Never married W1 (Reference: married/ coupled)	0.096	0.261	-0.416	0.609	0.095	0.261	-0.417	0.608
No qualification W1 (Reference: Degree)	-0.206	0.205	-0.608	0.196	-0.205	0.205	-0.607	0.197
GCSE W1 (Reference: Degree)	-0.09	0.120	-0.326	0.146	-0.091	0.120	-0.327	0.145
A Level W1 (Reference: Degree)	-0.065	0.115	-0.290	0.16	-0.061	0.115	-0.286	0.163
Owned with mortgage W1 (Reference: Owned outright)	**-0.304** **	0.105	**-0.511**	**-0.098**	**-0.304** **	0.105	**-0.511**	**-0.098**
Social renting W1 (Reference: Owned outright)	-0.328	0.381	-1.075	0.418	-0.309	0.381	-1.056	0.438
Private renting W1 (Reference: Owned outright)	-0.590+	0.345	-1.267	0.087	-0.590+	0.345	-1.267	0.087
Non-White W1(Reference: White)	0.365	0.257	-0.139	0.869	0.368	0.257	-0.136	0.872
Physical health W4	ON				ON			
Physical health W3	**0.388*** **	0.011	**0.368**	**0.409**	**0.763*** **	0.013	**0.738**	**0.788**
Retirement W3	-0.006	0.169	-0.338	0.325	**0.649*** **	0.172	**0.312**	**0.987**
Physical health W1	**0.190*** **	0.012	**0.167**	**0.213**	**0.101*** **	0.014	**0.074**	**0.127**
Gross household income W1	-0.195	0.139	-0.468	0.078	-0.159	0.145	-0.444	0.126
Age W1	-0.031	0.020	-0.070	0.008	**-0.072** **	0.021	**-0.114**	**-0.03**
Women W1 (Reference: men)	-0.339+	0.190	-0.711	0.032	-0.312	0.212	-0.728	0.104
Divorced, widowed, separated W1 (Reference: married/ coupled)	**-0.734** **	0.253	**-1.230**	**-0.238**	**-0.729** **	0.278	**-1.274**	**-0.184**
Never married W1 (Reference: married/ coupled)	0.101	0.375	-0.633	0.835	0.077	0.441	-0.787	0.940

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**
No qualification W1 (Reference: Degree)	**-0.894***	0.351	**-1.582**	**-0.206**	-0.715+	0.396	-1.491	0.061
GCSE W1 (Reference: Degree)	**-0.754****	0.250	**-1.243**	**-0.264**	-0.398	0.281	-0.949	0.154
A Level W1 (Reference: Degree)	-0.171	0.249	-0.658	0.317	0.040	0.274	-0.497	0.578
Owned with mortgage W1 (Reference: Owned outright)	-0.373	0.260	-0.882	0.137	-0.123	0.282	-0.677	0.430
Social renting W1 (Reference: Owned outright)	-0.717+	0.415	-1.531	0.097	-0.168	0.531	-1.208	0.872
Private renting W1 (Reference: Owned outright)	-0.877+	0.468	-1.793	0.040	-0.250	0.569	-1.366	0.865
Non-White W1(Reference: White)	-0.475	0.367	-1.195	0.245	-0.499	0.420	-1.322	0.324
Modification indices								
Physical health W2	**0.293*****	0.012	**0.269**	**0.316**				
Retirement W4	ON				ON			
Physical health W3	**-0.017+**	0.010	**-0.037**	**0.002**	**-0.035****	0.013	**-0.061**	**-0.010**
Retirement W3	**1.599*****	0.159	**1.288**	**1.911**	**1.613*****	0.165	**1.291**	**1.936**
Retirement W1	-0.233	0.278	-0.778	0.312	-0.382	0.363	-1.093	0.329
Gross household income W1	0.016	0.051	-0.085	0.116	0.018	0.052	-0.085	0.120
Age W1	**0.066*****	0.016	**0.036**	**0.097**	**0.066*****	0.016	**0.035**	**0.097**
Women W1 (Reference: men)	0.226	0.158	-0.083	0.535	0.230	0.159	-0.082	0.541
Divorced, widowed, separated W1 (Reference: married/ coupled)	-0.068	0.177	-0.414	0.278	-0.069	0.179	-0.418	0.281
Never married W1 (Reference: married/ coupled)	0.397	0.413	-0.413	1.207	0.387	0.417	-0.43	1.204
No qualification W1 (Reference: Degree)	0.231	0.386	-0.526	0.987	0.239	0.390	-0.526	1.004
GCSE W1 (Reference: Degree)	-0.040	0.182	-0.396	0.316	-0.054	0.184	-0.414	0.305
A Level W1 (Reference: Degree)	0.290	0.191	-0.084	0.664	0.281	0.192	-0.097	0.658
Owned with mortgage W1 (Reference: Owned outright)	-0.234	0.159	-0.545	0.078	-0.241	0.160	-0.555	0.073

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**
Social renting W1 (Reference: Owned outright)	0.080	0.660	-1.214	1.373	0.048	0.666	-1.258	1.353
Private renting W1 (Reference: Owned outright)	-0.138	0.522	-1.161	0.884	-0.161	0.526	-1.192	0.871
Non-White W1(Reference: White)	-0.554	0.369	-1.277	0.169	-0.576	0.373	-1.308	0.156
Physical health W5	ON				ON			
Physical health W4	**0.474*** **	0.011	**0.452**	**0.495**	**0.810*** **	0.014	**0.783**	**0.838**
Retirement W4	**-0.194***	0.092	**-0.373**	**-0.015**	**-0.502*** **	0.105	**-0.708**	**-0.297**
Physical health W1	**0.091*** **	0.013	**0.066**	**0.117**	**0.055*** **	0.014	**0.028**	**0.083**
Gross household income W1	0.091	0.120	-0.144	0.326	0.135	0.137	-0.133	0.403
Age W1	0.008	0.023	-0.037	0.053	**0.079** **	0.026	**0.029**	**0.129**
Women W1 (Reference: men)	0.163	0.201	-0.231	0.557	0.368	0.230	-0.082	0.818
Divorced, widowed, separated W1 (Reference: married/ coupled)	**-0.772** **	0.257	**-1.276**	**-0.269**	-0.546	0.290	-1.114	0.022
Never married W1 (Reference: married/ coupled)	0.126	0.410	-0.679	0.930	0.246	0.463	-0.662	1.154
No qualification W1 (Reference: Degree)	**-1.095** **	0.383	**-1.845**	**-0.345**	-0.837+	0.444	-1.706	0.033
GCSE W1 (Reference: Degree)	-0.443+	0.262	-0.957	0.070	-0.353	0.296	-0.933	0.227
A Level W1 (Reference: Degree)	**-0.524***	0.263	**-1.039**	**-0.009**	-0.466	0.296	-1.047	0.114
Owned with mortgage W1 (Reference: Owned outright)	0.345	0.271	-0.187	0.876	0.218	0.303	-0.376	0.811
Social renting W1 (Reference: Owned outright)	-0.114	0.403	-0.903	0.675	-0.139	0.502	-1.123	0.846
Private renting W1 (Reference: Owned outright)	0.138	0.556	-0.951	1.228	0.020	0.626	-1.207	1.246
Non-White W1(Reference: White)	-0.942*	0.418	-1.761	-0.123	-0.836	0.510	-1.835	0.163
Modification indices								
Physical health W3	**0.264*** **	0.011	**0.242**	**0.286**				

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**
Retirement W5	ON				ON			
Physical health W4	0.014	0.011	-0.007	0.036	0.016	0.014	-0.011	0.043
Retirement W4	**1.096*** **	0.123	**0.854**	**1.338**	1.072***	0.122	**0.834**	**1.311**
Retirement W1	-0.362	0.328	-1.004	0.281	-0.329	0.422	-1.157	0.499
Gross household income W1	0.075	0.069	-0.060	0.210	0.072	0.068	-0.061	0.206
Age W1	**0.037***	0.015	**0.008**	**0.065**	0.037**	0.014	**0.009**	**0.066**
Women W1 (Reference: men)	0.018	0.150	-0.275	0.311	0.026	0.148	-0.264	0.316
Divorced, widowed, separated W1 (Reference: married/ coupled)	-0.226	0.170	-0.560	0.107	-0.237	0.168	-0.566	0.093
Never married W1 (Reference: married/ coupled)	-0.090	0.298	-0.674	0.494	-0.085	0.295	-0.662	0.493
No qualification W1 (Reference: Degree)	0.070	0.360	-0.637	0.776	0.050	0.357	-0.648	0.749
GCSE W1 (Reference: Degree)	0.083	0.186	-0.282	0.448	0.089	0.185	-0.274	0.452
A Level W1 (Reference: Degree)	-0.114	0.174	-0.455	0.227	-0.118	0.172	-0.455	0.22
Owned with mortgage W1 (Reference: Owned outright)	-0.058	0.151	-0.355	0.238	-0.058	0.150	-0.351	0.236
Social renting W1 (Reference: Owned outright)	-0.516	0.490	-1.476	0.443	-0.535	0.485	-1.486	0.415
Private renting W1 (Reference: Owned outright)	0.196	0.559	-0.899	1.291	0.234	0.555	-0.853	1.321
Non-White W1(Reference: White)	-0.675	0.761	-2.167	0.818	-0.656	0.754	-2.134	0.823
Physical health W6	ON				ON			
Physical health W5	**0.744*** **	0.013	**0.719**	**0.770**	**0.884*** **	0.014	**0.857**	**0.912**
Retirement W5	**0.183***	0.076	**0.035**	**0.332**	**0.315*** **	0.081	**0.157**	**0.473**
Physical health W1	**0.060*** **	0.013	**0.034**	**0.086**	0.021	0.015	-0.008	0.049
Gross household income W1	0.004	0.099	-0.191	0.198	0.001	0.110	-0.214	0.217
Age W1	**-0.097*** **	0.024	**-0.144**	**-0.050**	**-0.122*** **	0.025	**-0.170**	**-0.073**

			95% CI				95% CI	
	Estimate	Cluster-robust standard error	Lower2.5%	Upper2.5%	Estimate	Cluster-robust standard error	Lower2.5%	Upper2.5%
Women W1 (Reference: men)	-0.082	0.211	-0.495	0.331	-0.105	0.225	-0.547	0.336
Divorced, widowed, separated W1 (Reference: married/ coupled)	-0.279	0.282	-0.832	0.275	-0.074	0.303	-0.668	0.52
Never married W1 (Reference: married/ coupled)	-0.440	0.420	-1.263	0.384	-0.500	0.452	-1.386	0.385
No qualification W1 (Reference: Degree)	0.537	0.413	-0.271	1.346	0.777+	0.442	-0.089	1.644
GCSE W1 (Reference: Degree)	**-0.569***	0.269	**-1.095**	**-0.043**	-0.399	0.289	-0.966	0.168
A Level W1 (Reference: Degree)	-0.114	0.282	-0.667	0.439	-0.015	0.302	-0.608	0.577
Owned with mortgage W1 (Reference: Owned outright)	0.049	0.288	-0.515	0.613	0.137	0.306	-0.462	0.736
Social renting W1 (Reference: Owned outright)	-0.405	0.428	-1.244	0.434	-0.149	0.463	-1.057	0.758
Private renting W1 (Reference: Owned outright)	-0.245	0.549	-1.322	0.832	-0.078	0.603	-1.259	1.103
Non-White W1(Reference: White)	**1.022***	0.498	**0.046**	**1.999**	**1.283***	0.552	**0.201**	**2.365**
Modification indices								
Physical health W2	**0.156*****	0.012	**0.134**	**0.179**				
Retirement W6	ON				ON			
Physical health W5	-0.004	0.010	-0.025	0.016	0.001	0.011	-0.02	0.021
Retirement W5	**0.822*****	0.087	**0.652**	**0.992**	**0.821*****	0.085	**0.655**	**0.988**
Retirement W1	-0.056	0.288	-0.620	0.507	0.086	0.308	-0.519	0.691
Gross household income W1	0.024	0.044	-0.062	0.110	0.025	0.043	-0.059	0.110
Age W1	**0.045*****	0.012	**0.021**	**0.068**	**0.045*****	0.012	**0.022**	**0.068**
Women W1 (Reference: men)	0.126	0.123	-0.115	0.367	0.116	0.122	-0.123	0.354
Divorced, widowed, separated W1 (Reference: married/ coupled)	-0.223	0.152	-0.522	0.076	-0.206	0.151	-0.502	0.090
Never married W1 (Reference: married/ coupled)	-0.233	0.227	-0.679	0.212	-0.221	0.225	-0.662	0.221

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**
No qualification W1 (Reference: Degree)	-0.037	0.321	-0.666	0.592	-0.025	0.318	-0.648	0.598
GCSE W1 (Reference: Degree)	-0.090	0.158	-0.400	0.219	-0.090	0.157	-0.397	0.218
A Level W1 (Reference: Degree)	0.129	0.167	-0.198	0.456	0.127	0.165	-0.197	0.451
Owned with mortgage W1 (Reference: Owned outright)	-0.130	0.132	-0.388	0.128	-0.120	0.131	-0.375	0.136
Social renting W1 (Reference: Owned outright)	-0.035	0.356	-0.733	0.664	-0.033	0.353	-0.725	0.659
Private renting W1 (Reference: Owned outright)	-0.033	0.479	-0.973	0.906	-0.053	0.475	-0.984	0.878
Non-White W1(Reference: White)	-0.097	0.595	-1.264	1.069	-0.047	0.590	-1.204	1.110
Physical health W7	ON				ON			
Physical health W6	**0.664*** **	0.013	**0.638**	**0.689**	**0.843*** **	0.013	**0.817**	**0.870**
Retirement W6	**-0.207***	0.091	**-0.385**	**-0.030**	**-0.204***	0.094	**-0.388**	**-0.020**
Physical health W1	**0.079*** **	0.012	**0.056**	**0.103**	**0.030***	0.013	**0.004**	**0.055**
Gross household income W1	-0.102	0.134	-0.365	0.162	-0.101	0.134	-0.365	0.162
Age W1	0.044	0.027	-0.008	0.097	**0.061***	0.028	**0.007**	**0.115**
Women W1 (Reference: men)	-0.101	0.213	-0.519	0.317	-0.074	0.223	-0.511	0.363
Divorced, widowed, separated W1 (Reference: married/ coupled)	**-0.634***	0.285	**-1.192**	**-0.075**	-0.424	0.298	-1.009	0.161
Never married W1 (Reference: married/ coupled)	-0.659+	0.368	-1.381	0.062	-0.605	0.398	-1.386	0.175
No qualification W1 (Reference: Degree)	-0.743+	0.390	-1.507	0.021	-0.628	0.409	-1.429	0.174
GCSE W1 (Reference: Degree)	-0.315	0.271	-0.846	0.216	-0.057	0.283	-0.611	0.497
A Level W1 (Reference: Degree)	-0.118	0.275	-0.658	0.422	0.007	0.291	-0.563	0.578
Owned with mortgage W1 (Reference: Owned outright)	-0.450	0.282	-1.002	0.102	-0.462	0.295	-1.04	0.116
Social renting W1 (Reference: Owned outright)	**-0.877***	0.443	**-1.745**	**-0.009**	-0.653	0.462	-1.559	0.253

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**
Private renting W1 (Reference: Owned outright)	-0.830	0.554	-1.916	0.257	-0.698	0.581	-1.836	0.440
Non-White W1(Reference: White)	-0.039	0.485	-0.990	0.911	0.018	0.508	-0.977	1.013
Modification indices								
Physical health W2	**0.172*** **	0.013	**0.147**	**0.197**				
Retirement W7	ON				ON			
Physical health W6	**-0.023***	0.011	**-0.044**	**-0.001**	**-0.027***	0.012	**-0.050**	**-0.003**
Retirement W6	**1.326*** **	0.133	**1.066**	**1.587**	**1.313*** **	0.127	**1.063**	**1.563**
Retirement W1	0.439	0.336	-0.219	1.097	0.305	0.331	-0.345	0.954
Gross household income W1	**0.13***	0.053	**0.026**	**0.235**	**0.125***	0.052	**0.022**	**0.227**
Age W1	**0.045****	0.016	**0.013**	**0.077**	**0.044****	0.016	**0.013**	**0.075**
Women W1 (Reference: men)	-0.413*	0.169	**-0.745**	**-0.081**	**-0.394***	0.167	**-0.720**	**-0.067**
Divorced, widowed, separated W1 (Reference: married/ coupled)	0.163	0.199	-0.226	0.553	0.158	0.195	-0.224	0.540
Never married W1 (Reference: married/ coupled)	0.112	0.354	-0.582	0.807	0.132	0.348	-0.550	0.815
No qualification W1 (Reference: Degree)	0.227	0.411	-0.578	1.032	0.235	0.404	-0.557	1.027
GCSE W1 (Reference: Degree)	-0.166	0.204	-0.566	0.234	-0.155	0.201	-0.548	0.239
A Level W1 (Reference: Degree)	-0.272	0.198	-0.661	0.117	-0.260	0.195	-0.642	0.122
Owned with mortgage W1 (Reference: Owned outright)	-0.128	0.163	-0.448	0.191	-0.137	0.160	-0.451	0.177
Social renting W1 (Reference: Owned outright)	-0.208	0.533	-1.252	0.835	-0.187	0.523	-1.213	0.839
Private renting W1 (Reference: Owned outright)	-0.405	0.732	-1.839	1.029	-0.332	0.719	-1.741	1.077
Non-White W1(Reference: White)	0.031	0.626	-1.197	1.258	-0.117	0.614	-1.321	1.086
Physical health W8	ON				ON			

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**
Physical health W7	**0.457*** **	0.010	**0.437**	**0.477**	**0.874*** **	0.015	**0.846**	**0.903**
Retirement W7	0.073	0.054	-0.032	0.178	0.038	0.062	-0.083	0.159
Physical health W1	0.004	0.013	-0.022	0.029	0.021	0.013	-0.005	0.047
Gross household income W1	0.022	0.101	-0.176	0.221	0.073	0.119	-0.160	0.306
Age W1	**-0.071** **	0.025	**-0.119**	**-0.023**	**-0.055** *	0.028	**-0.109**	**-0.001**
Women W1 (Reference: men)	0.071	0.200	-0.322	0.464	0.098	0.218	-0.329	0.526
Divorced, widowed, separated W1 (Reference: married/ coupled)	-0.405	0.254	-0.903	0.093	-0.264	0.277	-0.806	0.278
Never married W1 (Reference: married/ coupled)	-0.582+	0.345	-1.258	0.093	-0.200	0.359	-0.905	0.504
No qualification W1 (Reference: Degree)	0.267	0.374	-0.466	1.000	0.188	0.404	-0.605	0.98
GCSE W1 (Reference: Degree)	-0.092	0.265	-0.611	0.427	-0.072	0.290	-0.640	0.496
A Level W1 (Reference: Degree)	-0.017	0.264	-0.533	0.500	-0.087	0.284	-0.644	0.471
Owned with mortgage W1 (Reference: Owned outright)	-0.102	0.27	-0.630	0.427	0.016	0.302	-0.575	0.607
Social renting W1 (Reference: Owned outright)	-0.117	0.405	-0.911	0.677	0.050	0.437	-0.806	0.906
Private renting W1 (Reference: Owned outright)	0.094	0.546	-0.976	1.163	0.300	0.572	-0.821	1.422
Non-White W1(Reference: White)	0.688	0.434	-0.162	1.539	0.113	0.491	-0.849	1.075
Modification indices								
Physical health W3	**0.117*** **	0.012	**0.094**	**0.140**				
Physical health W5	**0.342*** **	0.014	**0.315**	**0.369**				
Retirement W8	ON				ON			
Physical health W7	0.014	0.011	-0.007	0.035	0.011	0.011	-0.010	0.032
Retirement W7	**1.08*** **	0.120	**0.845**	**1.315**	**0.988*** **	0.097	**0.797**	**1.178**
Retirement W1	0.199	0.387	-0.560	0.959	0.248	0.350	-0.438	0.933
Gross household income W1	**0.191** **	0.060	**0.074**	**0.308**	0.177**	0.053	**0.073**	**0.281**

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**
Age W1	**0.033***	0.016	**0.001**	**0.064**	0.034*	0.015	**0.005**	**0.062**
Women W1 (Reference: men)	0.296+	0.170	-0.038	0.629	0.286+	0.153	-0.014	0.586
Divorced, widowed, separated W1 (Reference: married/ coupled)	0.121	0.228	-0.326	0.567	0.054	0.206	-0.349	0.458
Never married W1 (Reference: married/ coupled)	-0.348	0.371	-1.076	0.380	-0.337	0.336	-0.997	0.322
No qualification W1 (Reference: Degree)	-0.228	0.350	-0.914	0.458	-0.200	0.317	-0.821	0.421
GCSE W1 (Reference: Degree)	-0.089	0.200	-0.482	0.303	-0.110	0.181	-0.465	0.245
A Level W1 (Reference: Degree)	0.030	0.210	-0.381	0.441	0.033	0.190	-0.339	0.404
Owned with mortgage W1 (Reference: Owned outright)	0.224	0.184	-0.136	0.585	0.166	0.166	-0.158	0.491
Social renting W1 (Reference: Owned outright)	-0.465	0.592	-1.625	0.695	-0.406	0.535	-1.454	0.643
Private renting W1 (Reference: Owned outright)	0.161	0.873	-1.551	1.872	-0.003	0.790	-1.551	1.545
Non-White W1(Reference: White)	1.035	0.768	-0.47	2.540	0.996	0.693	-0.363	2.355
Physical health W9	ON				ON			
Physical health W8	**0.831*****	0.015	**0.802**	**0.859**	**0.851*****	0.014	**0.822**	**0.879**
Retirement W8	-0.039	0.056	-0.148	0.071	-0.030	0.062	-0.151	0.091
Physical health W1	**0.029***	0.014	**0.002**	**0.057**	0.025+	0.014	-0.003	0.052
Gross household income W1	-0.016	0.122	-0.255	0.223	-0.019	0.122	-0.258	0.220
Age W1	0.004	0.030	-0.054	0.062	0.001	0.030	-0.057	0.059
Women W1 (Reference: men)	0.034	0.220	-0.396	0.464	0.034	0.221	-0.4	0.467
Divorced, widowed, separated W1 (Reference: married/ coupled)	-0.393	0.274	-0.930	0.144	-0.361	0.276	-0.901	0.179
Never married W1 (Reference: married/ coupled)	0.223	0.392	-0.545	0.991	0.235	0.394	-0.537	1.007
No qualification W1 (Reference: Degree)	**-0.967***	0.426	**-1.802**	**-0.133**	**-0.951***	0.428	**-1.791**	**-0.112**

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**
GCSE W1 (Reference: Degree)	**-0.725***	0.295	**-1.303**	**-0.147**	**-0.692***	0.297	**-1.274**	**-0.11**
A Level W1 (Reference: Degree)	-0.472	0.288	-1.037	0.093	-0.455	0.290	-1.024	0.114
Owned with mortgage W1 (Reference: Owned outright)	0.241	0.287	-0.322	0.804	0.254	0.290	-0.313	0.822
Social renting W1 (Reference: Owned outright)	-0.076	0.429	-0.916	0.764	-0.012	0.430	-0.856	0.831
Private renting W1 (Reference: Owned outright)	0.290	0.613	-0.912	1.491	0.309	0.619	-0.903	1.522
Non-White W1(Reference: White)	-0.249	0.476	-1.182	0.684	-0.263	0.479	-1.201	0.675
Modification indices								
Physical health W2	**0.123*****	0.012	**0.101**	**0.146**				
Retirement W9	ON				ON			
Physical health W8	-0.020	0.013	-0.046	0.006	-0.055	0.054	-0.161	0.051
Retirement W8	**1.079*****	0.131	**0.821**	**1.336**	3.550	2.756	-1.852	8.951
Retirement W1	-0.574	0.576	-1.703	0.555	-2.021	2.181	-6.296	2.253
Gross household income W1	-0.071	0.059	-0.186	0.045	-0.24	0.258	-0.746	0.266
Age W1	**0.034***	0.017	**0.001**	**0.066**	0.051	0.052	-0.052	0.154
Women W1 (Reference: men)	0.022	0.173	-0.317	0.361	-0.142	0.506	-1.134	0.849
Divorced, widowed, separated W1 (Reference: married/ coupled)	-0.368	0.23	-0.819	0.084	-0.789	0.873	-2.501	0.923
Never married W1 (Reference: married/ coupled)	**-0.701***	0.283	**-1.256**	**-0.147**	-1.983	1.644	-5.206	1.240
No qualification W1 (Reference: Degree)	-0.668	0.408	-1.468	0.132	-2.05	2.035	-6.039	1.938
GCSE W1 (Reference: Degree)	-0.023	0.232	-0.478	0.432	0.018	0.681	-1.317	1.354
A Level W1 (Reference: Degree)	0.116	0.222	-0.318	0.551	0.328	0.654	-0.954	1.611
Owned with mortgage W1 (Reference: Owned outright)	-0.044	0.184	-0.404	0.316	0.104	0.552	-0.977	1.185

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**
Social renting W1 (Reference: Owned outright)	0.280	0.776	-1.241	1.802	0.669	2.301	-3.841	5.179
Private renting W1 (Reference: Owned outright)	**-1.029***	0.523	**-2.055**	**-0.003**	-2.473	2.324	-7.028	2.083
Non-White W1(Reference: White)	0.320	0.614	-0.885	1.524	0.948	1.978	-2.928	4.825
Physical health W10	ON				ON			
Physical health W9	0.823***	0.014	**0.795**	**0.851**	**0.822*** **	0.014	**0.793**	**0.850**
Retirement W9	0.015	0.049	-0.081	0.111	0.004	0.017	-0.029	0.037
Physical health W1	0.057***	0.013	**0.031**	**0.083**	**0.057*** **	0.013	**0.031**	**0.083**
Gross household income W1	-0.008	0.108	-0.219	0.204	-0.012	0.108	-0.224	0.199
Age W1	-0.051+	0.029	-0.108	0.007	-0.05+	0.029	-0.106	0.007
Women W1 (Reference: men)	0.052	0.209	-0.358	0.463	0.048	0.209	-0.362	0.458
Divorced, widowed, separated W1 (Reference: married/ coupled)	0.093	0.266	-0.429	0.615	0.094	0.266	-0.428	0.615
Never married W1 (Reference: married/ coupled)	-0.265	0.375	-1.001	0.471	-0.259	0.375	-0.994	0.477
No qualification W1 (Reference: Degree)	-0.671	0.408	-1.47	0.128	-0.673+	0.407	-1.471	0.125
GCSE W1 (Reference: Degree)	-0.056	0.281	-0.608	0.495	-0.062	0.281	-0.613	0.489
A Level W1 (Reference: Degree)	-0.108	0.277	-0.651	0.434	-0.107	0.277	-0.650	0.435
Owned with mortgage W1 (Reference: Owned outright)	-0.641*	0.277	**-1.183**	**-0.099**	**-0.637***	0.276	**-1.178**	**-0.096**
Social renting W1 (Reference: Owned outright)	-1.008*	0.430	**-1.850**	**-0.166**	**-1.007***	0.430	**-1.849**	**-0.164**
Private renting W1 (Reference: Owned outright)	-0.852	0.568	-1.965	0.262	-0.885	0.567	-1.997	0.226
Non-White W1(Reference: White)	-0.153	0.47	-1.074	0.768	-0.152	0.470	-1.073	0.769
Retirement W10	ON				ON			

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**
Physical health W9	**0.037***	0.015	**0.008**	**0.065**	**0.034***	0.013	**0.008**	**0.060**
Retirement W9	**0.944*****	0.132	**0.686**	**1.202**	0.288	0.226	-0.154	0.730
Retirement W1	-0.568	0.533	-1.613	0.476	-0.477	0.475	-1.407	0.453
Gross household income W1	-0.059	0.115	-0.285	0.167	-0.049	0.102	-0.250	0.152
Age W1	**0.045****	0.016	**0.015**	**0.076**	**0.045****	0.014	**0.018**	**0.072**
Women W1 (Reference: men)	**-0.367***	0.179	**-0.718**	**-0.016**	-0.298+	0.158	-0.608	0.012
Divorced, widowed, separated W1 (Reference: married/ coupled)	0.107	0.263	-0.408	0.622	0.061	0.234	-0.397	0.519
Never married W1 (Reference: married/ coupled)	0.496	0.450	-0.385	1.378	0.417	0.399	-0.365	1.198
Owned with mortgage W1 (Reference: Owned outright)	0.110	0.188	-0.258	0.479	0.069	0.168	-0.260	0.397
Social renting W1 (Reference: Owned outright)	-0.171	0.741	-1.624	1.282	-0.148	0.657	-1.437	1.140
Private renting W1 (Reference: Owned outright)	-0.111	0.575	-1.237	1.016	-0.181	0.511	-1.183	0.821
Non-White W1(Reference: White)	**-0.753*****	0.182	**-1.109**	**-0.397**	**-0.62*****	0.161	**-0.936**	**-0.303**
Physical health W10	WITH				WITH			
Retirement W10	-0.116	0.672	-1.433	1.200	-0.012	0.594	-1.176	1.151
Intercepts								
Physical health W3	**16.339*****	1.353	**13.687**	**18.991**	**16.452*****	1.353	**13.800**	**19.104**
Physical health W4	**11.291*****	1.475	**8.399**	**14.183**	**5.079****	1.576	**1.989**	**8.168**
Physical health W5	**6.457*****	1.328	**3.854**	**9.061**	**4.600****	1.435	**1.788**	**7.412**
Physical health W6	**5.967*****	1.312	**3.396**	**8.538**	**3.276***	1.403	**0.526**	**6.025**
Physical health W7	**6.555*****	1.501	**3.614**	**9.496**	**3.099***	1.553	**0.055**	**6.143**
Physical health W8	**4.295****	1.358	**1.633**	**6.956**	**4.158****	1.516	**1.187**	**7.129**
Physical health W9	**4.028****	1.489	**1.110**	**6.946**	**3.906****	1.498	**0.971**	**6.841**

			95% CI				95% CI	
	Estimate	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**	**Estimate**	**Cluster-robust standard error**	**Lower2.5%**	**Upper2.5%**
Physical health W10	**5.779*** **	1.398	**3.040**	**8.519**	**5.595*** **	1.397	**2.856**	**8.333**
Thresholds								
Retirement W3	**5.785*** **	0.805	**4.207**	**7.363**	**5.793*** **	0.805	**4.215**	**7.370**
Retirement W4	**12.862*** **	1.639	**9.650**	**16.075**	**12.624*** **	1.656	**9.378**	**15.870**
Retirement W5	**16.232*** **	1.894	**12.520**	**19.944**	**15.792*** **	1.850	**12.167**	**19.417**
Retirement W6	**16.278*** **	1.686	**12.973**	**19.582**	**15.85*** **	1.652	**12.612**	**19.087**
Retirement W7	**24.112*** **	2.454	**19.302**	**28.923**	**23.371*** **	2.354	**18.758**	**27.985**
Retirement W8	**28.966*** **	3.051	**22.985**	**34.946**	**25.976*** **	2.448	**21.179**	**30.773**
Retirement W9	**31.255*** **	3.354	**24.681**	**37.830**	92.673	71.188	-46.855	232.202
Retirement W10	**31.022*** **	3.462	**24.236**	**37.808**	**27.551*** **	2.677	**22.304**	**32.799**
Residual Variances								
Physical health W3	**37.717*** **	0.637	**36.469**	**38.965**	**27.599*** **	0.672	**26.283**	**28.915**
Physical health W4	**35.008*** **	0.551	**33.929**	**36.087**	**13.247*** **	0.590	**12.092**	**14.403**
Physical health W5	**22.202*** **	0.610	**21.006**	**23.398**	**12.592*** **	0.559	**11.496**	**13.689**
Physical health W6	**25.213*** **	0.617	**24.005**	**26.421**	**12.263*** **	0.521	**11.241**	**13.285**
Physical health W7	**30.889*** **	0.620	**29.674**	**32.103**	**12.175*** **	0.497	**11.200**	**13.150**
Physical health W8	**19.027*** **	0.533	**17.982**	**20.072**	**12.188*** **	0.493	**11.222**	**13.155**
Physical health W9	**18.991*** **	0.578	**17.857**	**20.125**	**18.163*** **	0.557	**17.071**	**19.255**
Physical health W10	**24.278*** **	0.595	**23.112**	**25.443**	**24.302*** **	0.591	**23.145**	**25.460**
Goodness of fit								
RMSEA	**0.045**				**0.081**			
CFI	**0.984**				**0.947**			
TLI	**0.955**				**0.856**			

Note: The letter "W" denotes wave of longitudinal data.All models controlled for educational qualifications, specifically no qualifications, GCSEs, and A-Levels. However, the model for retirement at Wave 10 did not include these controls, as the model could not converge when these variables were included.
$+p < 0.10$ $*p < 0.05$ $**p < 0.01$ $***p < 0.001$

Chapter 3. The associations between area deprivation and physical health outcomes in England: Area social capital elements as mediators

Abstract

Background: Previous studies have identified an association between socioeconomic status in small area units and poor health. However, the association between residing in deprived local authority districts (LADs) and poor physical health has been less investigated. This study examines the relationships between the Index of Multiple Deprivation (IMD) within LADs and physical health and examines the mediating role of area social capital in the relationships.

Methods: The study integrated data from Waves 3 and 6 of Understanding Society with English Indices of Deprivation (2015) from National Statistics to conduct three-level multilevel analyses. The dependent variables included the SF-12 PCS and its heavy weighed subscales: physical functioning, general health, bodily pain, and role physical. Individual-level variables (Level 1)—including the SF-12 PCS and its subscales, household income, housing tenure, employment status, gender, age, marital status, educational qualifications, ethnic minority status, and social capital elements —were analysed for adults (Level 2) nested in Local Authority Districts (LADs) (Level 3). The mediating effect was considered definitive of the main associations between area SES and physical health outcomes become non-significant upon including the area social capital elements as potential mediators.

Results: Residing in deprived LADs was associated with poorer physical health outcomes, including SF-12 PCS and its subscales (i.e., physical functioning, general health, bodily pain, and role-physical). Neither area homogenous friendship networks nor area trust and cooperative norms were significantly associated with physical health outcomes. Furthermore, these variables did not mediate the primary associations, as changes in the main associations when including these potential mediators were negligible. However, area civic engagement demonstrated a significant positive association with SF-12 PCS scores (Estimate = 2.033, 95% CI = 1.303, 2.763, $p < 0.001$) and its subscales. Despite this, the mediating role of area

civic engagement in the primary associations was not definitive, as the main associations remained significant even when area civic engagement was included in the analysis.

Conclusion: In line with previous research associating deprivation in small area units with health outcomes, this study found that deprived LADs were associated with poorer physical health outcomes. This research further suggests that lower civic engagement in LADs is predictive of reduced physical health outcomes. However, contrasting these findings, Snelgrove et al. (2009) reported no significant association between civic engagement and self-rated health among individuals in Great Britain's postcode sectors. Policymakers should use the IMD as a benchmark for public health funding distribution, ensuring enhanced support for deprived LADs. Additionally, it is advisable for local authorities to collaborate with organisations in deprived areas to foster area civic engagement, which in turn could increase physical health.

Introduction

A handful of studies have examined the association between living areas and physical health (Ross and Mirowsky, 2008; Chaparro *et al.*, 2018; Prior, Manley and Jones, 2018). In the UK, research using small area units[5], such as 2001 Census Area Statistic (CAS) wards (N = 4,929 CAS wards; average 4.2 individuals per CAS Ward) and Lower Super Output Areas (LSOAs) (11,387 individuals in 6,629 neighbourhoods), along with Scottish Data Zones (DZs, equivalent to LSOAs), has demonstrated a relationship between socioeconomically deprived neighbourhoods and poorer physical health outcomes, controlling for socioeconomic status at the individual level (Chaparro *et al.*, 2018; Prior, Manley and Jones, 2018). These health outcomes include lung function, blood pressure, body mass index, level of C-reactive protein, and allostatic load [6](Chaparro *et al.*, 2018; Prior, Manley and Jones, 2018). However, local authority districts (LADs) have received less attention in the investigation of the association between area deprivation and physical health. Seventy LADs are the spearhead areas of NHS resources allocation policy as they are the bottom fifth nationally for three or more of the five health and deprivation indicators, including male life

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[5]In England, there are 317 Local Authority Districts (LADs) in total. Below LADs are smaller area units used for statistical and administrative purposes. One key category of these is Census Geography, which includes Output Areas (OAs) and Super Output Areas (SOAs) (Association of Public Health Observatories, 2009).

Output Areas (OAs) are the smallest units, each consisting of approximately 150 households and 400 residents, based on 2001 in England. These OAs nest within Lower Super Output Areas (LSOAs), which typically comprise around 1,500 residents. LSOAs, in turn, nest within Middle Super Output Areas (MSOAs), which have an average population of 7,200 residents (Association of Public Health Observatories, 2009).

Another important category is Electoral Areas, also known as wards. Wards are used for local elections and generally have populations of around 6,000 residents. They are entirely contained within Local Authority Districts (LADs). However, wards may not align perfectly with Output Areas (OAs) or Lower Layer Super Output Areas (LSOAs), potentially leading to overlaps and boundary discrepancies between these small area units (Association of Public Health Observatories, 2009).

[6] Allostatic load, indicative of physiological wear-and-tear, manifests as dysregulations in multiple body systems: the cardiovascular (measured through systolic and diastolic blood pressure, and pulse rate), lipid metabolism (measured through HDL cholesterol, HDL cholesterol ratio, triglycerides, BMI, waist, and circumference) and glucose metabolism (HbA1c), inflammation (measured through C-Reactive Protein, Fibrinogen, and Albumin), and the hypothalamic-pituitary-adrenal (HPA) axis (measured through DHEAs) (Prior et al., 2018). In their research, Prior et al. (2018) investigated the connections between living in deprived areas in Great Britain, the level of stress-related biomarkers (defined as 'allostatic load'), and physical health.

expectancy at birth, female life expectancy at birth, cancer mortality rate in under 75s, cardiovascular disease mortality rate in under 75s, and the index of multiple deprivation (Department of Health and Social Care, 2011). This indicates that there might be a high proportion of individuals in the 70 deprived LADs who have poor physical health, underscoring a relationship between area deprivation and physical health in LADs. Understanding the mechanisms underlying these associations is vital. Moreover, under the Health and Social Care Act 2012, upper-tier (i.e., 24 County Councils) and unitary local authorities have new responsibilities to enhance the health of their residents (Sarah Heath, 2014) (see Chapter One, *Why LADs and Counties Matter*, for further detail). Identifying the factors contributing to poor physical health in deprived LADs is essential for developing effective preventive strategies.

Prior studies have investigated the role of mediators at both the individual (such as allostatic load[7] and social capital) and area (including exposure to air pollution and availability of green spaces) levels in explaining the associations between area deprivation and health (Verhaeghe and Tampubolon, 2012; Chaparro *et al.*, 2018; Prior, Manley and Jones, 2018). However, less attention has been paid to the mediating effect of area social capital on these associations among adults in England. For example, a study has examined the mediating effects of individual social capital on the associations between neighbourhood deprivation at LSOAs and self-rated health (Verhaeghe and Tampubolon, 2012). Their analysis, based on the Taking Part Survey of England, shows that individual social capital factors – such as trust, participation with relatives and friends, and resources associated with the salariat class – partially mediate the association between neighbourhood deprivation and self-rated health. It has been suggested that in certain disadvantaged neighbourhoods, a correlation exists between diminished trust amongst residents and negative health outcomes. However, the results might alter when accounting for mediators at the collective level.

Jonsson et al. (2020) found that in young adolescents aged 10-15, as sampled from Understanding Society, neighbourhood social capital (specifically, homogeneous friendship networks) mediates the associations between area deprivation and psychological well-being, including life satisfaction and mental health. These results suggest that homogeneity in friendship networks is associated with protecting adolescents from the adverse psychological effects of neighbourhood deprivation. Nevertheless, the study overlooked the role of individual social capital when examining these associations. This omission raises the possibility that the observed mediating effects might be attributed to a compositional effect (see chapter one for definition) stemming from individual social capital (Subramanian, Lochner and Kawachi, 2003; Ross and Mirowsky, 2008; Snelgrove, Pikhart and Stafford, 2009). Moreover, stress can manifest in diverse forms, with different social arrangements triggering distinct stress responses, a concept noted by Horwitz (2002). When considering physical health as a health outcome, the mediating effect of area social capital on the association may not align with Jonsson et al. (2020) findings. Additionally, the results may not necessarily be generalised to the adults in England. Ehsan et al. (2019) point out differences in social settings between actors, and Jonsson et al. (2020) note that adults exhibit greater mobility and autonomy compared to adolescents.

Previous studies have predominantly focused on neighbourhood units, such as middle super output areas and postcode sectors, to measure social capital and its correlation with health (Fone *et al.*, 2007; Stafford *et al.*, 2008; Snelgrove, Pikhart and Stafford, 2009; Jonsson *et al.*, 2020). However, to date, no research has explored the mediating role of social capital in LADs, concerning the link between area deprivation and health. Research employing small area units like postcode sectors tends to overlook local government influences. Additionally, discrepancies in results might arise when variables are measured at different geographical scales (Jivraj *et al.*, 2020). For instance, Pattie et al. (2004) show a correlation between higher associational activity in 101 LADs, measured by the number of associational groups joined, time watching television, and proportion in an informal network, with less favourable health outcomes. The association controlled for the average number of political actions, sense of obligations, and socio-economic status. In contrast, a study using data from the British Household Panel Survey (BHPS) encompassing 3,075 individuals across 250 postcode sectors found no significant relationship between civic participation at the postcode sector level and self-rated health, controlling for individual civic participation (Snelgrove, Pikhart and Stafford, 2009).

This study has two goals. The first is to investigate the association between area deprivation and physical health. The second objective is to examine the mediating role of area social capital in this association. To achieve the goals, I linked data from *Understanding Society*: the UK Household Longitudinal Study (University of Essex *et al.*, 2020) with the English indices of multiple deprivation to perform multilevel analyses. The following are the hypotheses:

H1: Individuals residing in deprived areas exhibit poorer physical health outcomes compared to those living in less deprived areas.

H2a: Deprived areas are likely to exhibit more homogenous friendship networks compared to less deprived areas. Consequently, residents in these more homogenous network areas tend to have poorer health outcomes than those in less homogenous network areas.

H2b: Deprived areas tend to exhibit lower civic engagement compared to less deprived areas. Consequently, residents in areas with lower civic engagement are likely to have poorer health outcomes than those in areas with higher civic engagement.

H2c: Deprived areas are likely to exhibit lower levels of trust and cooperative norms compared to less deprived areas. Consequently, individuals living in areas with lower trust and cooperative norms tend to have poorer health outcomes than those in areas with higher levels of trust and cooperation.

Background

Area socioeconomic status and health

Similar to individual SES, area SES comprises three dimensions: education, occupation, and economic resources (Ross and Mirowsky, 2008). At a collective level, these dimensions may influence health outcomes. For instance, collective education, encompassing knowledge, skills, and values acquired in schools, can benefit residents' health when they collaborate to utilise these resources (Ross and Mirowsky, 2008). Occupation, defined as a salaried job, is correlated with individual well-being (Ross and Mirowsky, 2008). In Ireland, research indicates that regions with higher unemployment rates tend to report lower self-rated health (Briody, Doyle and Kelleher, 2020). Local unemployment may be associated with feelings of pessimism regarding future prospects and a sense of economic insecurity among both the employed and student populations (Novo, Hammarström and Janlert, 2001; Briody, Doyle and Kelleher, 2020). These conditions are often associated with negative health outcomes, suggesting a potential link between area unemployment rate and health (Novo, Hammarström and Janlert, 2001; Briody, Doyle and Kelleher, 2020). Psychosocial stressors, stemming from economic uncertainties, may contribute to allostatic load, a term referring to the detrimental effects on physiological functioning due to repeated and prolonged exposure to stress (McEwen and Seeman, 1999). Similar to collective education, economic resources may benefit personal health when residents in the areas work together to mobilise them. For example, residents could use economic resources in residential areas to repair health facilities.

Is living in deprived areas detrimental to health (Stafford and Marmot, 2003; Ross and Mirowsky, 2008)? Contextual explanation posits that differences in health resources, such as services and facilities, render residents in disadvantaged neighbourhoods more vulnerable in terms of health (Macintyre, Ellaway and Cummins, 2002). Deprived areas signify a higher proportion of poverty among residents (Ross and Mirowsky, 2008). To assess the association between area deprivation and individual health, studies must control for individual SES. Otherwise, the association could be attributed to personal SES—known as compositional effect (Ross and Mirowsky, 2008). Studies in the US and UK demonstrated that area deprivation is associated with poor health outcomes, adjusting for SES (e.g., income, education, assets, social class) (Jones and Duncan, 1995; Robert, 1998; Stafford and Marmot, 2003). Knies and Kumari (2022) found that education, income, and employment deprivation at LSOAs, in the domains of IMD, were associated with multimorbidity in physical conditions. They explained their findings through a compositional lens or health-selective migration, suggesting that early retirees and unemployed individuals with poor health are more likely to reside in areas with low income and high unemployment rates. Our study controls for baseline personal SES (e.g., employment status). The approach may help reduce the influence of compositional factors on the associations area deprivation and health.

Previous studies predominantly utilised neighbourhoods or communities, such as MSOAs, LSOAs, and wards, to investigate the association between place and health (Jones and Duncan, 1995; Jonsson *et al.*, 2020). Moreover, this study measures area socioeconomic status using LADs. Residents in neighbourhoods, such as MSOAs and LSOAs, might access shared health resources, including health services and green spaces, within their LADs.

Area socioeconomic status and health: area social capital elements as mediators

This study examines how residing in deprived areas can negatively relate to health, with a specific focus on the mediating role of area social capital, encompassing both bonding (such as homogenous friendship networks) and bridging (including civic engagement, trust, and cooperative norms). In socioeconomically deprived areas, residents may be less inclined to participate in civic activities, and their friendship networks may be more homogenous. Furthermore, these areas typically exhibit low trust and cooperative norms. Neighbourhoods characterised by multiple forms of disadvantage, such as those with predominantly low-income families, can exacerbate social isolation among minority groups. This isolation limits their interactions with broader social networks and undermines collective social control (McCulloch, 2003). Furthermore, extreme deprivation can impair mutual trust and the willingness to work towards the common good (McCulloch, 2003). Kawachi et al. (1997) indicate that in the US income inequality negatively correlates with civic engagement and social trust in the areas. Kelly (2007) found a correlation between low social cohesion and high area deprivation, using data from the English indices of multiple deprivations in 2004. Therefore, it is posited that friendship networks in deprived areas are more homogenous than those in less deprived areas, and these areas possess less bridging social capital.

Distinct types of area social capital, including bonding and bridging, show varied associations with health outcomes. Bonding social capital, characterised by strong ties and support within homogenous groups, may limit access to diverse information and negatively impact health in areas. In contrast, neighbourhoods rich in bridging social capital facilitate access to novel information through diverse group interactions and weak ties (Poortinga, 2012). This form of area social capital, differing from bonding social capital, may correlate with good health. Pattie et al. (2004) show that residing in 101 LADs with higher civic engagement is associated with better health outcomes compared to those with lower engagement. However, these findings, based on data from a limited sample of 101 unitary and district authorities in late 2000 and early 2001, may not be generalisable to all LADs across England, as the demographic characteristics of these selected LADs may differ from others not included in the study. Similarly, a study using the British Household Panel Survey (BHPS) by Snelgrove et al. (2009) indicates that civic participation in postcode sectors in the UK is not significantly associated with self-rated health. The finding may not be generalisable to residents in local authority districts (LADs) in England, where demographic pattern exhibits greater variation between LADs and postcode sectors.

Area social cohesion, characterised by trust and cooperative norms, may relate to health outcomes. Moore and Kawachi (2017) explained it as the absence of latent social conflicts, like economic and racial tensions, and the existence of strong social bonds, which are measured by trust, reciprocity norms, and ties that bridge divisions between different social groups. In neighbourhoods with strong social cohesion, there may be a dissemination of health information and adoption of healthy behaviours due to the connectedness and trust that exists among residents (Echeverría *et al.*, 2008). Residents in these neighbourhoods also advocate changes that are beneficial to communities (Echeverría *et al.*, 2008). Conversely, the research also associates lower social cohesion in six U.S. communities (i.e., Baltimore City and Baltimore Country, Maryland; Chicago, Illinois; and others) with increased depression, smoking, and less physical activity (i.e., walking). However, the cross-sectional nature of this study limits its ability to determine whether changes in area social cohesion are associated with changes in health behaviours and mental health. Additionally, findings from this US based sample may lack generalisability to populations in England. The study did not adjust for individual social cohesion, a compositional factor. Furthermore, the cross-sectional methods (such as linear and binomial regressions) and generalised estimating equations (GEE) were used. While the GEE can deal with correlations between residents who live in the same neighbourhoods, it does not model the variance attributed to different levels as multilevel modelling does.

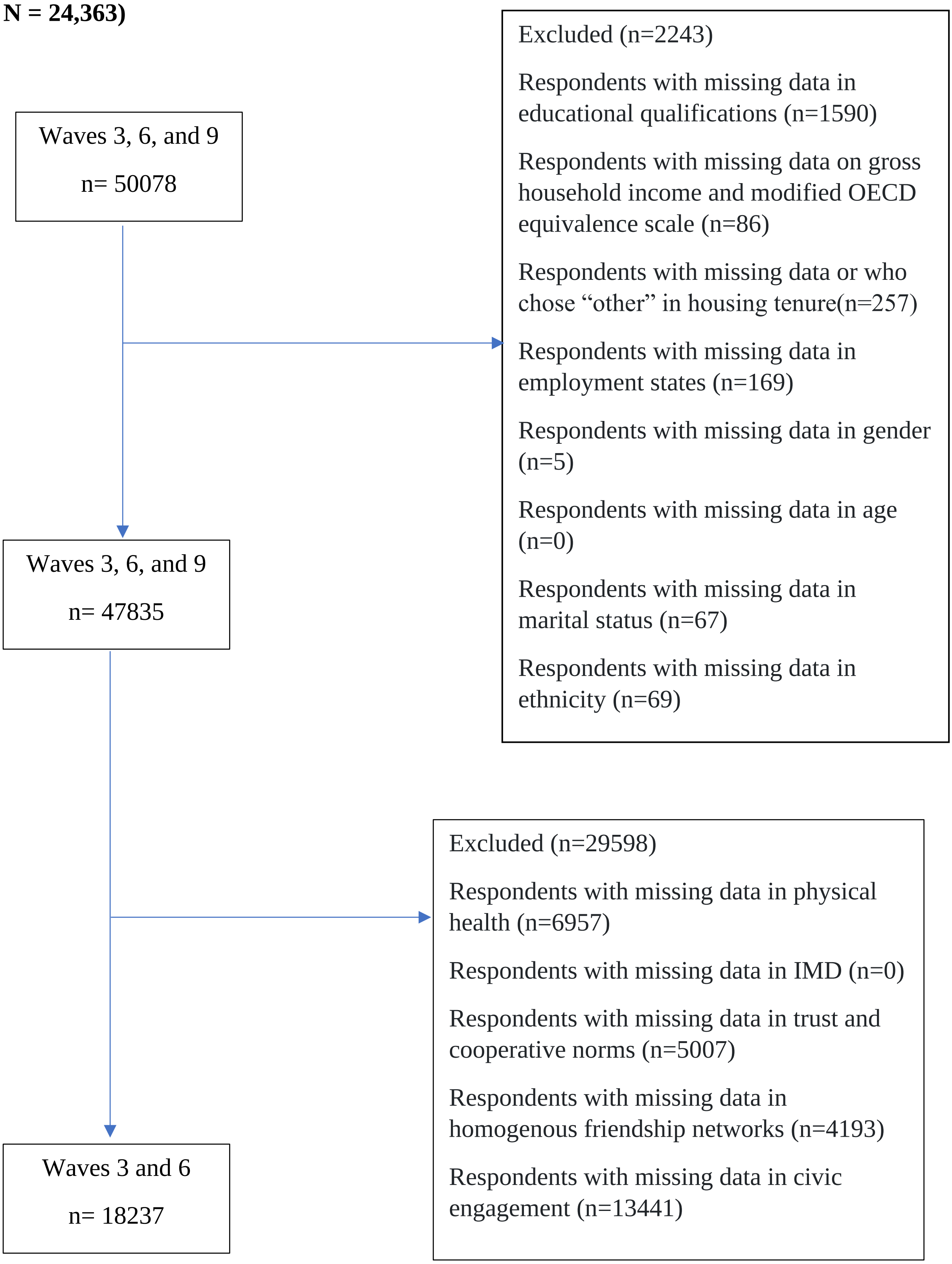
Methods

Data

This study utilised data from Waves 3 and 6of Understanding Society, the UK Household Longitudinal Study (UKHLS) (University of Essex *et al.*, 2020). These specific waves, collected in 2011 and 2014respectively, were chosen because they contain social capital indicators, which are absent in other waves. The UKHLS, initiated in 2009, includes households from all four UK countries, but this study focused solely on households in England, with sample sizes of 18237 unique individual from Waves 2 and 3. The data collection method evolved over time; while Waves 3 and 6 primarily used face-to-face interviews.

Complete cases were used to select the samples. Observations with missing data in control and key variables were excluded, as shown in Figure 3.1. Initially, data were drawn from Waves 3, 6, and 9. However, trust and cooperative norms, which are the control and key variables in this study, were not collected in Wave 9. As a result, only Waves 3 and 6 were included in the analytic sample. The initial sample consisted of 50,078 unique individuals. After excluding cases with missing data in control variables, the sample size was reduced to 47,835 unique individuals. Following the exclusion of cases with missing data in key variables, the final analytic sample comprised 18,237 unique individuals (N= 24363 panel observations). LADs, a geographical identifier from the UK Household Longitudinal Study (UKHLS), were utilised to select English households for the study. The 2015 Index of Multiple Deprivation (IMD) and the 2011 ethnicity density data, sourced from National Statistics, were incorporated into the analysis (Department for Communities and Local Government, 2015; Office for National Statistics, 2020). The 2015 IMD was selected because the 2019 version did not include data on Waveney, a key area of interest for this study's sponsor, the National Institute for Health Research (NIHR) Applied Research Collaboration (ARC) East of England (EoE).

Figure 3.1 Flowchart of exclusions (unique individuals: n = 18,237; panel observations: N = 24,363)



Note: These three sample includes only respondents from England. When combining ethnicity density data for England, the Local Authority Districts (LADs) of Wales, Northern Ireland, and Scotland were removed from the geographical dataset. Therefore, after appending datasets, only respondents with ethnicity density data from England remained.

Measures

Dependent Variable. In addition to using the Short Form (SF-12) Physical Component Summary (PCS), this study also examines the SF-12 PCS subscales, which include physical functioning, role limitations due to physical health, bodily pain, and general health (see Chapter One for detailed descriptions of each subscale). These health outcomes were derived from Waves 3 and 6 of the UKHLS. Notably, these subscales carry more weight in the PCS score compared to other domains, such as vitality, social functioning, role emotional, and mental health. Fourteen percent of cases with missing responses for the SF-12 PCS were excluded from the analysis. The total SF-12 PCS score ranges from 0 to 100, with higher scores indicating better physical health. The focus on the SF-12 PCS subscale is motivated by policy considerations, as it allows policymakers to better understand the relationship between area deprivation, area social capital, and specific physical health outcomes.

Independent variable. The study used the 2015 English Indices of Multiple Deprivation (IMD) (Department for Communities and Local Government, 2015) to measure socioeconomic status (SES) in areas, as described by Ramsay et al. (2015). The IMD combines seven domains: income deprivation, employment deprivation, education/skills/ training deprivation, health deprivation and disability, crime, barriers to housing and services, and living environment deprivation (See Chapter One for details). The average IMD scores were categorised into five quintiles, ranging from the least deprived (0-20%) to the most deprived areas (80-100%).

While Townsend deprivation index is also commonly used as a proxy for SES in areas, the IMD is arguably more effective in capturing deprivation in rural contexts, as noted by Jordan et al. (2004). This is because the Townsend index includes car ownership as an indicator, which may not effectively reflect rural deprivation, given the prevalence of car ownership among affluent and less affluent residents in rural areas. Additionally, Townsend index may serve as a proxy for the income in areas (Townsend, Phillimore and Beattie, 2023); however, it lacks the broader range of domains encompassed by the IMD. The IMD incorporates multiple domains, offering a more comprehensive picture of deprivation that includes education, employment, income, and others (Jordan, Roderick and Martin, 2004).

Potential Mediators. In this study, potential mediators are components of area social capital: homogenous friendship networks, civic engagement, and trust and cooperative norms. New area-level variables were created by aggregating individual-level responses, as detailed below:

1. **Homogeneous Friendship Networks:** This variable is based on respondents' similarity in their social networks, considering aspects like age, education level, income, and race as described by Ramos *et al.*, (2024). Four items were used, with a four-point scale ranging from 1 (less than half similar) to 4 (all similar). Higher scores indicate greater network homogeneity in local authority districts.

2. **Civic Engagement:** This variable was measured by membership in any of 16 types of organisations, such as political party, trade unions, environmental group, parents / school association, tenant / resident group, religious / church organisation, voluntary services group, pensioners group or organisation, scouts / guides organisation, professional organisation, other community group, social / working men club, sports club, WI/Townswomen’s Guild, Women’s Group, and others. Participation was coded as 1, non-participation as 0. Aggregated scores represent the level of civic engagement in local authority districts. Area civic engagement was calculated using an average of 113 participants per LAD, and the standard deviation was 75.98. The number of unique individuals ranged from 8 to 359 across LADs.

3. **Trust and Cooperative Norms:** This variable was assessed using four items, with responses on a five-point scale from 1 (strongly disagree) to 5 (strongly agree), including (1) this is a close-knit neighbourhood, (2) people willing to help their neighbours, (3) people in this neighbourhood can be trusted, and (4) people in this neighbourhood don't get along with each other. The first three items were reverse-scored. Higher aggregate scores indicate stronger trust and cooperative norms in the area.

Covariates. The study considers several covariates due to their potential independent associations with both deprived areas and health (Ross and Mirowsky, 2008; Snelgrove, Pikhart and Stafford, 2009; Bécares, Dewey and Das-Munshi, 2018). These include household income, housing tenure, employment status, sex, age, marital status, ethnicity, ethnicity density, educational qualification, social class, and individual social capital. Household income is a continuous variable, calculated using the ratio of gross household income to the modified OECD equivalence scale. This scale adjusted for different household sizes, with income data transformed using the IHSTRAN package in Stata for inverse hyperbolic sine transformation. Housing tenure was categorised as owned or rented, with "owned" as the reference group. Employment status was divided into employed (including self-employment and paid employment), unemployed, and other states (i.e., being retired, on maternity leave, family care or home, full-time student, long-term sick or disabled, unpaid, family business, and on apprenticeship), with being employed as the reference.

Gender was classified as men (reference group) or women. Age was capped at 90 for those above 89 years. Marital status categories are married/coupled (reference), divorced/separated, widowed, and never married. Ethnicity was split into white (reference) and ethnic minorities. Ethnic density in local authority districts (LADs) was categorised based on white density, distinguishing between higher-than-average (high white density) and lower-than-average (low white density, the reference group). Catney *et al.*, (2023) utilised white concentration as a proxy for ethnic density, finding that lower proportions of White British residents in LADs correlate with higher levels of ethnic diversity. Educational qualifications were grouped into degree (reference), A level/other higher degrees, GCSE/other qualifications, and no qualification. Social class was divided into six categories: professional occupations (reference), managerial and technical, skilled non-manual, skilled manual, partly skilled, and unskilled occupations. Individual social capital includes homogenous friendship networks, civic engagement, and trust and cooperative norms at the individual level, all treated as continuous variables.

Analysis

This study employed multilevel analyses to test its hypotheses on the Short Form (SF-12) Physical Component Summary (PCS) as one of the dependent variables. Additionally, it examined the mediating effects of area social capital on the associations between IMD and heavily weighted subscales of the SF-12 PCS. These subscales include physical functioning, general health, bodily pain, and role physical. The modelling strategy of these subscale are same as that used for the SF-12 PCS. Multilevel models were fitted using the mixed command in Stata, with maximum likelihood estimation (MLE) employed for parameter estimation.

Modelling strategy

In this study, multilevel models were examined sequentially. All regressions, except for the physical functioning model (Table 3.3), consisted of five models. The physical functioning analysis included only four models due to convergence issues.

The first model included only the survey wave, along with random effects for individuals and areas to account for clustering. This model served as a baseline. The second model introduced the independent variable (IMD), individual-level covariates, and individual-level measures of social capital. This model assessed the relationship between area deprivation and physical health outcomes, adjusting for compositional factors (e.g., household income, employment status, and education) as well as control variables. The third model included area homogeneous friendship networks, enabling an exploration of whether these networks potentially mediated the relationship between area deprivation and physical health. To identify potential mediator, the associations between IMD and health outcomes were compared between models 3 and 2 as described by Jonsson et al. (2020). The fourth model added area civic engagement alongside area homogeneous friendship networks, using the same approach to observe civic engagement as a potential mediator. The fifth and most comprehensive model included all individual-level covariates and area-level social capital elements, including area trust and cooperative norms.

Multilevel data structure

This multilevel study included repeated variables of individual-level variables, including SF-12 PCS and its heavily weighted subscales along with household income, housing tenure, employment status, gender, age, marital status, educational qualifications, ethnic minority status, and social capital elements (Level 1). These were modelled for adults (Level 2) nested in local authority districts (Level 3) (Jonsson et al., 2020).

Justification for multilevel approach

Multilevel models were applied to examine dependencies and contextual factors in the longitudinal data. In this study, ICCs measure the physical health correlation of residents who live in same areas (dependency) and physical health correlation of residents who live in different areas (Merlo *et al.*, 2005). Ignoring the multilevel structure of the data could result in violations of independence assumptions in statistical procedures, leading to inaccurate inferences (Holodinsky, Austin and Williamson, 2020). Furthermore, multilevel approach also addressed dependencies arising from repeated observations of the same persons across waves (Steele, 2008).

The multilevel approach enabled the investigation of associations between cluster-level variables, such as the Index of Multiple Deprivation (IMD), and physical health, along with the potential mediating role of area social capital. This included examining whether area-level variables like the IMD contributed to variations in health outcomes across Local Authority Districts (LADs) and assessing whether individual-level factors explained health outcome variations between residents. The study utilised the Proportion Change in Variance (PCV) in random intercepts across models to compare changes (Merlo, 2005). Specifically, PCV was employed to evaluate whether compositional factors in Model 2 explained between-area variances in the SF-12 Physical Component Summary (PCS) and its heavily weighted subscales (between-area variance). In Models 3, 4, and 5, PCV was used to investigate whether elements of area social capital explained between-area variations in health outcomes. Furthermore, PCV assessed the extent to which individual-level variables accounted for between-person variations in health outcomes across areas.

Results

Descriptive analysis

Table 3.1 provides a descriptive analysis of key variables (i.e., dependent variable, independent variable, and potential mediators) and covariates, covering the total sample (N = 24,363), the Wave 3 sample (N = 13,519), and the Wave 6 sample (N = 10,844). Across these samples, there were 18,237 unique individuals.

Key variables

The mean scores for the SF-12 PCS were consistent, with a mean of 51.21 (SD = 9.97) in the total sample, 51.28 (SD = 9.86) at Wave 3, and 51.12 (SD = 10.10) at Wave 6, indicating only minimal changes in physical health across waves. A similar pattern was observed in the distributions of the SF-12 PCS subscales, which showed stability across the total sample and the two waves. Specifically, the mean for physical functioning in the total sample was 51.51, with a slight decrease from 51.60 at Wave 3 to 51.40 at Wave 6. Similarly, the general health subscale showed a decline, decreasing from 50.26 at Wave 3 to 50.10 at Wave 6. The role physical subscale also decreased slightly, from 51.40 at Wave 3 to 51.28 at Wave 6. In contrast, the bodily pain subscale showed an increase, rising from 49.81 at Wave 3 to 50.57 at Wave 6.

The distribution of IMD levels remained consistent across the total sample, Wave 3, and Wave 6, with percentages fluctuating between 19% and 21%. This indicates that deprivation levels within the sample underwent only minor variations over time. Notably, from Wave 3 to Wave 6, there was a reduction in the proportions of individuals in the lowest (0–20%) and highest (80–100%) IMD quintiles, coupled with an increase in those within the intermediate quintiles. Specifically, for the 0–20% IMD quintile, 20.56% of respondents lived in these areas at Wave 3, compared to 19.90% at Wave 6. Similarly, for the 80–100% quintile, the proportion decreased from 20.15% at Wave 3 to 19.19% at Wave 6. In contrast, for the 20–40% IMD quintile, the proportion increased from 19.78% at Wave 3 to 20.29% at Wave 6. Likewise, for the 40–60% quintile, the proportion rose from 20.03% at Wave 3 to 20.41% at Wave 6. However, for the 60–80% quintile, the proportion decreased from 20.15% at Wave 3 to 19.19% at Wave 6.

The mean scores of area social capital elements remained stable across waves. In the total sample, the mean score for area homogenous friendship networks was 11.42 points (SD = .57), with scores of 11.41 (SD = 0.57) and 11.44 (SD = 0.57) at Waves 3 and 6, respectively. The mean score for area civic engagement was consistently 1.79 points (SD = 0.19) across the total sample, Wave 3, and Wave 6. Similarly, the mean score for area trust and cooperative norms was 14.80 points (SD =0.60) in the total sample, with scores of 14.79 (SD =0.60) and 14.81(SD =0.60) at Waves 3 and 6, respectively.

Covariates

The following presents the descriptive analysis of housing tenure, employment status, educational qualifications, marital status, ethnicity, ethnic density, gender, age, gross household income, and individual social capital elements. The proportions of ownership outright, owned with mortgage, social renting, and private renting were 33.94%, 45.59, 9.79%, and 10.68%, respectively. Ownership outright was more common at Wave 6, accounting for 35.37% of the sample, compared to 32.81% at Wave 3. Conversely, ownership with a mortgage was slightly higher at Wave 3, at 45.92%, compared to 45.18% at Wave 6. Social renting showed a decline from 10.22% at Wave 3 to 9.25% at Wave 6. A similar downward trend was observed in private renting, which decreased from 11.06% at Wave 3 to 10.21% at Wave 6.

In the total sample, 64.11% of respondents were employed, while 35.89% were unemployed or economically inactive. Employment levels showed a slight increase over time, rising from 63.64% at Wave 3 to 64.69% at Wave 6. Correspondingly, the proportion of respondents who were unemployed or inactive decreased from 36.36% at Wave 3 to 35.31% at Wave 6. These trends indicate a modest improvement in employment over the study period. There was an upward trend in educational qualifications between Waves 3 and 6. Within the total sample, 35.51% of respondents held a degree, while 34.24% possessed A Level or equivalent qualifications. Additionally, 24.50% of respondents had GCSE or equivalent qualifications, and 5.75% reported having no formal qualifications. The proportion of respondents holding a degree increased from 34.20% at Wave 3 to 37.14% at Wave 6, reflecting an improvement in higher educational attainment. Similarly, the percentage of respondents with A Level or equivalent qualifications rose from 33.85% at Wave 3 to 34.74% at Wave 6. In contrast, the proportion of individuals with GCSE or equivalent qualifications declined from 25.43% at Wave 3 to 23.33% at Wave 6. Notably, the percentage of respondents with no qualifications decreased, from 6.52% at Wave 3 to just 4.80% at Wave 6.

In the total sample, 68.81% of respondents were married, 12.27% were divorced, separated, or widowed, and 18.92% had never been married. Over time, the percentage of married individuals increased from 68.16% at Wave 3 to 69.61% at Wave 6. Conversely, the proportion of respondents who had never married declined from 19.29% at Wave 3 to 18.46% at Wave 6.

In the total sample, the majority of respondents were White (82.96%), compared to 17.04% from ethnic minority groups. Over time, the percentage of White respondents decreased slightly, from 84.26% at Wave 3 to 83.54% at Wave 6. Conversely, the proportion of ethnic minority respondents increased, from 15.74% at Wave 3 to 16.46% at Wave 6. The majority of respondents lived in areas with less diverse ethnic groups, with only approximately 33.67% residing in areas characterised by greater ethnic diversity. Specifically, 34.15% of respondents were in areas with more diverse ethnic groups at Wave 3, but this proportion decreased slightly to 33.07% at Wave 6.

Women comprised 52.07% of the total sample, with the proportion slightly decreasing from 52.44% at Wave 3 to 51.60% at Wave 6. The average age in the total sample was 48 years. At Wave 3, the average age was 47 years, increasing to 49 years at Wave 6. Regarding gross household income, the mean in the total sample was 8.29 (SD = 0.78). Income increased from 8.23 (SD = 0.81) at Wave 3 to 8.37 (SD = 0.72) at Wave 6.

In the total sample, the mean scores for homogenous friendship networks, civic engagement, and trust and cooperative norms were 11.42, 1.79, and 14.80 points, respectively, and these remained stable across waves. Specifically, the mean score for homogenous friendship networks was 11.43 points at Wave 3 and 11.41 points at Wave 6. Civic engagement scored 1.80 points at Wave 3 and slightly decreased to 1.78 points at Wave 6. Trust and cooperative norms, on the other hand, increased from 14.61 points at Wave 3 to 15.05 points at Wave 6.

Table 3.1 Descriptive statistics for total sample and sample at Waves 3 and 6: UK Household Longitudinal Survey (N= 24,363)

	Total (N= 24,363)	Wave 3 (N= 13,519)	Wave 6 (N= 10,844)
		Mean (SD) / %	Mean (SD) / %
Dependent variable			
SF-12 PCS (0 -100)	51.21 (9.97)	51.28 (9.86)	51.12 (10.10)
Subscales of SF-12 PCS			
Physical functioning (0-100)	51.51 (8.96)	51.60 (8.84)	51.40 (9.11)
General health (0-100)	50.19 (11.14)	50.26 (11.16)	50.10 (11.11)
Role physical (0-100)	51.35 (8.75)	51.40 (8.77)	51.28 (8.71)
Bodily pain (0-100)	50.15 (10.70)	49.81 (11.22)	50.57 (10.00)
Independent variable			
IMD (0-20%) (%)	20.26	20.56	19.90
IMD (20%-40%) (%)	20.01	19.78	20.29
IMD (40%-60%) (%)	20.20	20.03	20.41
IMD (60%-80%) (%)	19.81	19.48	20.21
IMD (80%-100%) (%)	19.72	20.15	19.19
Covariates			
Housing tenure			
Owned outright (%)	33.94	32.81	35.37
Owned with mortgage (%)	45.59	45.92	45.18
social renting (%)	9.79	10.22	9.25
private renting (%)	10.68	11.06	10.21
Employment states			
Employment (%)	64.11	63.64	64.69
Unemployment & Inactive & Others (%)	35.89	36.36	35.31
Educational qualification			
Degree (%)	35.51	34.20	37.14
A level and others (%)	34.24	33.85	34.74
GCSE and lower (%)	24.50	25.43	23.33
No qualification (%)	5.75	6.52	4.80
Marital status			
Married (%)	68.81	68.16	69.61
Divorced/separated / Widowed (%)	12.27	12.55	11.92
Never married (%)	18.92	19.29	18.46

	Total (N= 24,363)	Wave 3 (N= 13,519)	Wave 6 (N= 10,844)
Ethnicity			
White (%)	82.96	84.26	83.54
Ethnic minorities (%)	17.04	15.74	16.46
Ethnic density			
More diverse (%)	33.67	34.15	33.07
Less diverse (%)	66.33	65.85	66.93
Gender			
Men (%)	47.93	47.56	48.40
Women (%)	52.07	52.44	51.60
Age	48 (17)	47 (17)	49 (17)
Household income	8.29 (0.78)	8.23 (0.81)	8.37 (0.72)
Individual social capital			
Homogenous friendship networks (4-16)	11.42 (2.40)	11.43 (2.40)	11.41 (2.39)
Civic engagement (0-16)	1.79 (1.09)	1.80 (1.10)	1.78 (1.08)
Trust and cooperative norms (5-20)	14.80 (2.48)	14.61 (2.50)	15.04 (2.43)
Mediators			
Area social capital			
Homogenous in friendship network (4-28)	11.42 (0.57)	11.41 (0.57)	11.44 (0.57)
Civic engagement*** (0-16)	1.79 (0.19)	1.79 (0.19)	1.79 (0.19)
Trust and cooperative norms (5-20)	14.80 (0.60)	14.79 (0.60)	14.81 (0.60)

The associations between quintiles of area SES and physical health: Mediating roles of area social capital elements

Table 3.2 presents multilevel regression models, analysing the relationships between area socioeconomic status (SES), social capital, and physical health. The initial model shows that 68% of the variance in physical health was related to intra-individual differences within the same LADs, while only 0.9% was associated with differences between LADs.

Model 2 examines the association between area SES and physical health, adjusting for a range of covariates. It shows a correlation between living in median to highly deprived areas and SF-12 PCS scores, controlling for SES and other variables. For instance, individuals in median-deprived areas (40-60%) had SF-12 PCS scores that were -1.034 points lower than those in the least deprived areas (0-20%). This pattern was more pronounced in the more deprived areas, with individuals in the second-most and most deprived areas having scores of -1.128 and -1.552 points lower, respectively. Model 2 additionally shows that various control variables were significantly associated with physical health. Controls such as living in home owned with a mortgage, social renting, rented house, being inactive in employment, older age, lower educational qualifications, and being from an ethnic minority were associated with poorer physical health. Conversely, higher household income and possessing higher levels of individual social capital elements were linked to better physical health.

Area socioeconomic status (SES) was found to explain the variance in physical health between LADs, while control variables accounted for the variance among residents within these LADs. When area SES and controls were included in the analysis, there was a decrease in both ICCs and variance components. In terms of ICC for LADs, the difference of physical health reduced from 0.9% in Model 1 to 0.3% in Model 2, reflecting a reduction in different of physical health across LADs. Furthermore, the between-area variance declined from 0.950

in Model 1 to 0.255 in Model 2, and the between-resident variance decreased from 68.277 to 48.079. The reductions indicate that area SES and compositional factors accounted for 73%[(0.950-0.255)/0.950] of the between-area variance in physical health, and the control variables explained 30% [(68.277-48.079)/68.277] of the variance among residents, compared to the baseline model.

Models 3 to 5 introduce area-level social capital elements. Both area homogeneous friendship networks and area trust and cooperative norms did not significantly associate with physical health. However, in Model 4, the result shows that a one-point increase in area civic engagement was associated with a 2.033-point rise in physical health scores (95% CI = 1.303, 2.763, $p < 0.001$), controlling for civic engagement and other variables.

Area homogenous friendship networks did not mediate the association between area deprivation and physical health. Specifically, the coefficients reflecting the associations between area SES and physical health reduced only 0.001 to 0.002 between Models 2 and 3 when area homogenous friendship networks were included. Additionally, the ICCs for LADs and residents within LADs, as well as the between-area variance, remained unchanged between Models 2 and 3.

Additionally, the mediator effects of area civic engagement cannot be definitive, as the main associations did not turn non-significant when including potential mediators. Specifically, in median-deprived areas (40-60%), the coefficient reflecting the relationship between area SES and physical health changed from -1.035 (95% CI = -1.467, -0.602, $p < 0.001$) in Model 3 to -0.895 (95% CI = -1.316, -0.474, $p < 0.001$) when area civic engagement was considered. This indicates that area civic engagement explained the relationship between area SES and physical health by 14% [(1.035-0.895)/1.035]. A similar pattern emerged in the second-most deprived areas, where the coefficient changed from -

1.127 (95% CI = -1.590, -0.664) in Model 3 to -0.901 (-1.354, -0.449) in Model 4, suggesting area civic engagement explained 20% [(1.127-0.901)/1.127] of the relationship. Moreover, in the most deprived areas (80-100%), the coefficient altered from -1.554 in Model 3 to -1.214 in Model 4, indicating area civic engagement explained 22% [(1.551-1.214)/1.554] of the association between area SES and physical health.

In Model 4, in terms of both ICCs for LADs and residents within these LADs, the variances remained at 0.2% and 60%, respectively. ICC for residents within LADs similar with the values observed in Model 2, while the ICC for LADs dropped 0.1%. The result suggests that area civic engagement may explain the differences of physical health between LADs. Additionally, the between-area variance decreased from 0.255 in Model 3 to 0.160 in Model 4, indicating that 37% [(0.255-0.160)/0.255] of the physical health variation was explained by area civic engagement.

Area trust and cooperative norms did not mediate the association between area deprivation and physical health. In Model 5, the main associations between different levels of deprivation and physical health were more or less similar to those observed in Model 4, even after including area trust and cooperative norms. As mentioned earlier, area trust and cooperative norms were also not directly related to physical health. Furthermore, the ICCs for LADs and the between-area variance remained unchanged between Models 4 and 5.

In summary, area SES, from median to highly deprived, significantly correlated with physical health outcomes. Only area civic engagement could predict SF-12 PCS. However, the mediator effect of area civic engagement on the association between area deprivation and physical health was uncertain. Area homogenous friendship networks and area trust and cooperative norms were not related to physical health. Both social capital elements did not mediate the relationship between area deprivation and physical health.

Table 3.2 Multilevel regression analyses of the mediating roles of area social capital elements in the associations between quintiles of area SES and physical health (N= 24,363)

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.
Fixed part										
Intercepts	51.848*** (51.534, 52.163)	0.160	58.863*** (57.088, 60.637)	0.906	59.192*** (55.362, 63.023)	1.954	55.093*** (51.093 59.092)	2.041	55.104*** (50.106, 60.102)	2.550
Wave	-0.164*** (-0.223, -0.104)	0.030	-0.076* (-0.135, -0.017)	0.030	-0.076* (-0.135, -0.017)	0.030	-0.073* (-0.132, -0.014)	0.030	-0.073* (-0.132, -0.014)	0.030
Area SES										
Index of multiple deprivation (Reference: 0-20%)										
20-40%			-0.422+ (-0.859, 0.014)	0.223	-0.424+ (-0.861, 0.013)	0.223	-0.392+ (-0.814, 0.030)	0.215	-0.392+ (-0.815, 0.031)	0.216
40-60%			-1.034*** (-1.466, -0.601)	0.220	-1.035*** (-1.467, -0.602)	0.220	-0.895*** (-1.316, -0.474)	0.215	-0.895*** (-1.329, -0.462)	0.221
60-80%			-1.128*** (-1.591, -0.666)	0.236	-1.127*** (-1.590, -0.664)	0.236	-0.901*** (-1.354, -0.449)	0.231	-0.902*** (-1.371, -0.433)	0.239
80-100%			-1.552*** (-2.028, -1.075)	0.243	-1.554*** (-2.030, -1.077)	0.243	-1.214*** (-1.689, -0.738)	0.243	-1.214*** (-1.716, -0.713)	0.256
Household income			0.337***	0.080	0.336	0.080	0.330*** (0.173, 0.487)	0.080	0.330*** (0.173, 0.487)	0.080

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.
Housing tenure (Reference: owned)										
Owned with mortgage			-0.753*** (-1.073, -0.434)	0.163	-0.754*** (-1.073, -0.435)	0.163	-0.754*** (-1.073, -0.435)	0.163	-0.754*** (-1.073, -0.435)	0.163
Social renting			-3.631*** (-4.100, -3.162)	0.239	-3.633*** (-4.103, -3.163)	0.240	-3.641*** (-4.110, -3.172)	0.239	-3.641*** (-4.110, -3.172)	0.239
Private renting			-1.303*** (-1.760, -0.847)	0.233	-1.304*** (-1.761, -0.848)	0.233	-1.324*** (-1.781, -0.868)	0.233	-1.324*** (-1.781, -0.868)	0.233
Employment states (Reference: employment)										
Unemployment, inactive, and others			-2.805*** (-3.085, -2.525)	0.143	-2.805*** (-3.085, -2.525)	0.143	-2.816*** (-3.096, -2.536)	0.143	-2.816*** (-3.096, -2.536)	0.143
Sex (Reference: men)										
Women			-0.291* (-0.542, -0.040)	0.128	-0.291* (-0.541, -0.040)	0.128	-0.295* (-0.546, -0.044)	0.128	-0.295* (-0.546, -0.044)	0.128
Age			-0.201*** (-0.211, -0.190)	0.005	-0.201*** (-0.211, -0.190)	0.005	-0.201*** (-0.212, 0-.191)	0.005	-0.201*** (-0.212, -0.191)	0.005
Marital status										

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.
(Reference: married)										
Divorced/separated / Widowed			-0.705*** (-1.093, -0.317)	0.198	-0.705*** (-1.093, -0.318)	0.198	-0.692*** (-1.080, -0.305)	0.198	-0.692 (-1.080, -0.305)	0.198
Never married			-0.204 (-0.571, 0.162)	0.187	-0.205 (-0.572, 0.162)	0.187	-0.230 (-0.596, 0.137)	0.187	-0.230 (-0.596, 0.137)	0.187
Educational qualification (Reference: Degree)										
A level and other higher degree			-0.954*** (-1.259, -0.648)	0.156	-0.952*** (-1.258, -0.647)	0.156	-0.922*** (-1.228, -0.617)	0.156	-0.922*** (-1.228, -0.617)	0.156
GCSE and other qualification			-1.678*** (-2.023, -1.333)	0.176	-1.677*** (-2.022, -1.331)	0.176	-1.639*** (-1.985, -1.294)	0.176	-1.639*** (-1.985, -1.294)	0.176
No qualification			-3.565*** (-4.157, -2.973)	0.302	-3.564*** (-4.156, -2.971)	0.302	-3.501*** (-4.093, -2.909)	0.302	-3.501*** (-4.093, -2.909)	0.302
Ethnicity										
Ethnic minorities (Reference: White)			-0.974*** (-1.351, -0.598)	0.192	-0.979***	0.194	-0.988*** (-1.366, -0.611)	0.193	-0.988*** (-1.366, -0.610)	0.193
Ethnic density										
Less diverse (Reference: More diverse)			-0.525** (-0.878, -0.172)	0.180	-0.504*	0.209	-0.409* (-0.804, -0.015)	0.201	-0.409* (-0.806, -0.012)	0.202

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.
Individual social capital										
Homogenous friendship network			0.154*** (0.106, 0.202)	0.024	0.155***	0.025	0.154*** (0.106, 0.202)	0.025	0.154*** (0.106, 0.202)	0.025
Civic engagement			0.226** (0.118, 0.333)	0.055	0.226***	0.055	0.193*** (0.085, 0.301)	0.055	0.193*** (0.085, 0.301)	0.055
Trust and cooperative norms			0.114*** (0.067, 0.161)	0.024	0.114***	0.024	0.110*** (0.063, 0.157)	0.024	0.110*** (0.062, 0.158)	0.024
Area social capital										
Homogenous friendship networks					-0.030 (-0.342, 0.281)	0.159	0.008 (-0.293, 0.309)	0.008	0.008 (-0.304, 0.321)	0.160
Civic engagement							2.033*** (1.303, 2.763)	2.033	2.034*** (1.280, 2.788)	0.385
Trust and cooperative norms									-0.001 (-0.292, 0.290)	0.149
Random part: Area-level										
Intercept variance (Between-area variance)	0.950 (0.611, 1.477)	0.214	0.255 (0.105, 0.620)	0.116	0.255 (0.105, 0.620)	0.116	0.160 (0.047, 0.550)	0.101	0.160 (0.047, 0.550)	0.101
Random part: residents										

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.
Intercept variance (Between-resident variance)	68.277 (66.128, 70.496)	1.114	48.079 (46.317, 49.908)	0.916	48.078 (46.317, 49.907)	0.916	48.045 (46.285, 49.873)	0.915	48.045 (46.285, 49.873)	0.915
Residual variance (Within-resident variance)	31.732 (30.577, 32.931)	0.600	31.891 (30.745, 33.080)	0.596	31.891 (30.745, 33.080)	0.596	31.888 (30.742, 33.077)	0.596	31.888 (30.742, 33.077)	0.596
Intra-class correlation (Areas)	.009 (.006, .015)	.002	.003 (.001, 0.008)	.001	.003 (.001, 0.008)	.001	.002 (.001, 0.007)	.001	.002 (.001, 0.007)	.001
Intra-class correlation (Residents | Areas)	.686 (.673, 0.698)	.006	.602 (.587, 0.618)	.008	.602 (0.587, 0.618)	.008	.602 (.586, 0.617)	.008	.602 (.586, 0.618)	.008
AIC	177897		173432		173434		173406.9		173408.9	
BIC	177937.5		173642.6		173652.7		173633.8		173643.9	
Deviance	177887.01		173380		173379.96		173350.94		173350.94	

+p < 0.10, *p < 0.05, **p < 0.01, ***p < 0.00

The associations between quintiles of area SES and physical functioning: Mediating roles of area social capital elements

Table 3.3 examines the relationships between area SES, area social capital, and physical functioning, one of the subscales of SF12 PCS. Due to non-convergence, only four models are included. In Model 1, the ICC for LADs indicates that a minimal 0.6% of the difference in physical functioning scores was associated with differences between LADs. Conversely, the ICC for individuals in LADs shows that a substantial 66.9% of the difference was linked to intra-individual variations within LADs. This suggests that individual-level factors were more strongly associated with physical functioning scores than area-level factors.

Model 2 shows that residents in disadvantaged areas exhibited poorer physical functioning. Controlling for SES and other variables, the model shows that living in median deprived areas (40-60%) was associated with a -0.902-point lower physical functioning score compared to those in the least deprived areas (0-20%) (95% CI = -1.271, -0.534, $p < 0.001$). This decline was slightly more pronounced in the second most deprived areas (60-80%), with a reduction of -1.032 points (95% CI = -1.747, -0.938, $p < 0.001$), and more in the most deprived areas (-1.342 points (95% CI = -1.747, -0.938, $p < 0.001$). Control variables or compositional elements, including household income, housing tenure, employment states, gender, age, marital status, educational qualifications, ethnicity, and social capital elements, predicted role physical.

Area SES was associated with physical functioning variance in LADs, while the control variables in this study primarily account for the variance among residents within these LADs. Specifically, in terms of the ICC for LADs, there was a decrease in physical functioning variance from 0.6% in Model 1 to 0.1% in Model 2. This indicates a reduction in physical functioning variance in LADs when considering area SES and other compositional elements. Moreover, the between-area variance dropped from 0.455 in Model 1 to 0.053 in Model 2, and the between-resident variance also decreased from 54.087 in Model 1 to 39.816 in Model 2. The reductions suggest that area SES and other compositional elements account for 88% of the variance in physical functioning between LADs, while the control variables explain 26% of the variance among residents within these LADs, compared to the baseline model.

In Model 3, this study found that area homogenous friendship networks was not associated with physical functioning, and area homogenous friendship networks did not mediate the relationship between living in deprived areas and physical functioning. Similarly, Model 4 demonstrates that high levels of area trust and cooperative norms were not associated with better physical functioning, and this factor did not serve as a mediator in the relationship between area SES and physical functioning.

However, in Model 4, high area civic engagement was associated with better physical functioning (Estimate = 1.567, $p < 0.001$, 95% CI = 0.912, 2.221). The association between area SES and physical functioning varied across different area SES levels. The observed changes in the association between area SES and physical functioning cannot demonstrate a mediating role for area civic engagement. Specifically, in median SES areas (40–60%), the association between area SES and physical functioning weakened from -0.907 ($p < 0.001$, 95% CI = -1.275, -0.539) in Model 3 to -0.809 ($p < 0.001$, 95% CI = -1.182, -0.436) in Model 4, with area civic engagement explaining 11% of this change. In the second most deprived areas, the association between area SES and physical functioning decreased from -1.024 ($p < 0.001$, 95% CI = -1.413, -0.636) in Model 3 to -0.858 ($p < 0.001$, 95% CI = -1.256, -0.460) in Model 4, with area civic engagement accounting for 16% of this reduction. Finally, in the most deprived areas, the association decreased from -1.351 ($p < 0.001$, 95% CI = -1.755, -

0.948) in Model 3 to -1.101 ($p < 0.001$, 95% CI = -1.531, -0.672) in Model 4, with area civic engagement explaining 19% of this change.

Furthermore, the ICC for LADs decreased from 0.1% in Model 3 to 0.0% in Model 4, while the between-area variance declined from 0.048 in Model 4 to 0.006 in Model 5. The differences in physical functioning across LADs disappeared after the inclusion of area civic engagement, although the reduction was only 0.1, which may not be meaningful. These reductions in between-area variance suggest that area civic engagement accounted for 88% of the variance in physical functioning within LADs.

In conclusion, the study identifies an association between living in deprived areas and poorer physical functioning, ranging from median (40%-60%) to the most deprived areas (80%-100%). Area civic engagement were found to be associated to physical functioning. However, the mediating role of area civic engagement in this relationship cannot be substantiated. Compositional elements and area SES collectively accounted for 88% of the variance in physical functioning across LADs, while area civic engagement alone also contributed 88% to this variance.

Table 3.3 Multilevel regression analyses of the mediating roles of area social capital elements in the associations between quintiles of area SES and physical functioning (N= 24,363)

	Model 1		Model 2		Model 3		Model 4	
	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.
Fixed part								
Intercepts	52.064*** (51.785, 52.342)	0.142	57.972*** (56.352, 59.591)	0.826	59.250*** (55.944, 62.556)	1.687	56.242*** (51.916, 60.567)	2.207
Wave	-0.145*** (-0.200, -0.091)	0.028	-0.089** (-0.143, -0.035)	0.028	-0.088** (-0.142, -0.034)	0.028	-0.086** (-0.140, -0.032)	0.028
Area SES								
Index of multiple deprivation (Reference: 0-20%)								
20-40%			-0.265 (-0.636, 0.106)	0.189	-0.272 (-0.643, 0.099)	0.189	-0.248 (-0.611, 0.116)	0.186
40-60%			-0.902*** (-1.271, -0.534)	0.188	-0.907*** (-1.275, -0.539)	0.188	-0.809*** (-1.182, -0.436)	0.190
60-80%			-1.032*** (-1.421, -0.642)	0.199	-1.024*** (-1.413, -0.636)	0.198	-0.858*** (-1.256, -0.460)	0.203
80-100%			-1.342*** (-1.747, -0.938)	0.206	-1.351*** (-1.755, -0.948)	0.206	-1.101*** (-1.531, -0.672)	0.219
Household income			0.289*** (0.145, 0.433)	0.073	0.287*** (0.143, 0.431)	0.074	0.281*** (0.137, 0.425)	0.074

	Model 1		Model 2		Model 3		Model 4	
	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.
Housing tenure (Reference: owned)								
Owned with mortgage			-0.858*** (-1.150, -0.565)	0.149	-0.861*** (-1.153, -0.568)	0.149	-0.863*** (-1.155, -0.570)	0.149
Social renting			-3.409*** (-3.838, -2.981)	0.219	-3.419*** (-3.848, -2.990)	0.219	-3.427*** (-3.855, -2.988)	0.219
Private renting			-1.319*** (-1.737, -0.901)	0.213	-1.323*** (-1.741, -0.905)	0.213	-1.344*** (-1.762, -0.926)	0.213
Employment states (Reference: employment)								
Unemployment, inactive, and others			-2.522*** (-2.778, -2.265)	0.131	-2.520*** (-2.777, -2.264)	0.131	-2.530*** (-2.787, -2.274)	0.131
Sex (Reference: men)								
Women			-0.915*** (-1.145, -0.686)	0.117	-0.915*** (-1.145, -0.686)	0.117	-0.920*** (-1.149, -0.691)	0.117
Age			-0.158*** (-0.168, -0.149)	0.005	-0.158*** (-0.168, -0.149)	0.005	-0.159*** (-0.169, -0.150)	0.005

	Model 1		Model 2		Model 3		Model 4	
	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.
Marital status (Reference: married)								
Divorced/separated / Widowed			-0.901*** (-1.256, -0.546)	0.181	-0.902*** (-1.257, -0.547)	0.181	-0.891*** (-1.246, -0.536)	0.181
Never married			-0.338* (-0.674, -0.003)	0.171	-0.342* (-0.678, -0.006)	0.171	-0.366* (-0.702, -0.031)	0.171
Educational qualification (Reference: Degree)								
A level and other higher degree			-0.677*** (-0.956, -0.398)	0.142	-0.673*** (-0.952, -0.393)	0.142	-0.644*** (-0.923, -0.365)	0.143
GCSE and other qualification			-1.270*** (-1.585, -0.955)	0.161	-1.265*** (-1.581, -0.950)	0.161	-1.229*** (-1.545, -0.913)	0.161
No qualification			-3.126*** (-3.667, -2.585)	0.276	-3.121*** (-3.662, -2.580)	0.276	-3.061*** (-3.603, -2.520)	0.276
Ethnicity								
Ethnic minorities (Reference: White)			-0.827*** (-1.168, -0.486)	0.174	-0.847*** (-1.190, -0.503)	0.175	-0.865*** (-1.208, -0.522)	0.175
Ethnic density								
Less diverse (Reference: More diverse)			-0.400** (-0.698, -0.102)	0.152	-0.324+ (-0.667, 0.018)	0.175	-0.256 (-0.592, 0.080)	0.171

	Model 1		Model 2		Model 3		Model 4	
	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.
Individual social capital								
Homogenous friendship network			0.123*** (0.079, 0.167)	0.022	0.126*** (0.081, 0.170)	0.023	0.125*** (0.080, 0.169)	0.023
Civic engagement			0.181*** (0.083, 0.279)	0.050	0.181*** (0.083, 0.279)	0.050	0.152** (0.053, 0.251)	0.050
Trust and cooperative norms			0.107*** (0.064, 0.150)	0.022	0.108*** (0.065, 0.151)	0.022	0.105*** (0.061, 0.149)	0.022
Area social capital								
Homogenous friendship networks					-0.118 (-0.382, 0.147)	0.135	-0.089 (-0.357, 0.180)	0.137
Civic engagement							1.567*** (0.912, 2.221)	0.334
Trust and cooperative norms							-0.007 (-0.258, 0.244)	0.128
Random part: Area-level								
Intercept variance (Between-area variance)	0.455 (0.247, 0.837)	0.142	0.053 (0.003, 0.968)	0.079	0.048 (0.002, 1.193)	0.079	0.006 (0.001, 0.055)	0.007
Random part: residents								
Intercept variance	54.087	0.913	39.816	0.778	39.817	0.778	39.778	0.774

	Model 1		Model 2		Model 3		Model 4	
	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.
(Between-resident variance)	(52.326, 55.907)		(38.321, 41.370)		(38.321, 41.371)		(38.289, 41.325)	
Residual variance (Within-resident variance)	27.038 (26.050, 28.063)	0.514	27.294 (26.305, 28.320)	0.514	27.295 (26.306, 28.321)	0.514	27.297 (26.308, 28.323)	0.514
Intra-class correlation (Areas)	0.006 (0.003, 0.010)	0.002	0.001 (0.000, 0.014)	0.001	0.001 (0.000, 0.018)	0.001	0.000 (0.000, 0.001)	0.000
Intra-class correlation (Residents | Areas)	0.669 (0.655, 0.682)	0.007	0.594 (0.578, 0.609)	0.008	0.594 (0.578, 0.609)	0.008	.593 (0.577, 0.609)	0.000
AIC	172977.1		169203.9		169205.1		169186.1	
BIC	173017.6		169414.5		169423.9		169421.1	
Deviance	172967.09		169151.9		169151.15		169128.13	

+p < 0.10, *p < 0.05, **p < 0.01, ***p < 0.001

The associations between quintiles of area SES and general health: Mediating roles of area social capital elements

Table 3.4 delves into the relationships between area SES, area social capital, and general health using multilevel regression models. Model 1, utilising the ICC for LADs, shows that 1.1% of the variance in general health scores was associated with differences between LADs. Conversely, a significant majority, constituting 63.8% of the variance, was found to be related to intra-individual differences within the LADs, as shown by the ICC for individuals within LADs. This finding underscores the predominant role of individual-level factors over LAD-level factors in explaining the variation in general health scores.

Model 2 indicates that residing in areas with varying levels of deprivation was associated with general health, adjusting for SES and other variables. Residents of the median and second most deprived areas exhibited poorer general health ($B = -1.223$, $p < 0.001$, 95% CI = -1.743, -0.704; $B = -1.114$, $p < 0.01$, 95% CI = -1.674, -0.555, respectively). A similar pattern was observed in the most deprived areas, where general health scores were, on average, -1.530 points lower (95% CI = -2.104, -0.956, $p < 0.001$) than those in the least deprived areas. Control variables or compositional elements, such as household income and individual social capital, were associated with increased general health. In contrast, factors including owning a home with a mortgage (compared to owning outright), social renting (compared to owning outright), private renting (compared to owning outright), unemployment or economic inactivity (compared to employment), being female, increasing age, being divorced, separated, or widowed, and lower educational qualifications—such as A-levels, GCSEs, or equivalent qualifications (compared to a degree)—were associated with decreased general health.

In terms of ICC for LADs, there was a decrease in the variance of general health from 1.1% in Model 1 to 0.4% in Model 2. Additionally, the between-area variance declined from

1.432 in Model 1 to 0.490 in Model 2, indicating a 66% reduction, compared to the baseline model. These findings indicate that the variance in general health across LADs can be explained by differences in area SES and compositional factors.

The study further identifies positive associations between area civic engagement with general health. Specifically, a one-point increase in area civic engagement was associated with a 2.093 increase in general health ($p < 0.001$), accounting for civic engagement. However, area civic engagement as a mediating role in the main associations cannot be demonstrated. For instance, in median areas (40-60%), the coefficient for the association between IMD and general health decreased from -1.217 ($p < 0.001$, 95% CI = -1.738, -0.697) in Model 3 to -1.071 ($p < 0.001$, 95% CI = -1.583, -0.558) in Model 4. Similarly, in the second most deprived areas (60 -80%), this coefficient reduced from -1.119 ($p < 0.001$, 95% CI = -1.679, -0.560) in Model 3 to a -0.893 ($p < 0.01$, 95% CI = -1.448, -0.339) in Model 4. Additionally, in the most deprived areas (80-100%), the coefficient changed from -1.519 ($p < 0.001$, 95% CI = -2.094, -0.944) in Model 3 to -1.171($p < 0.001$, 95% CI = -1.752, -0.591) in Model 4. These changes suggest that area civic engagement accounts for 12%, 20%, and 23% of the associations in the median, second most deprived, and most deprived areas, respectively. Moreover, regarding the ICC for LADs, the variance of general health decreased from 0.05% to 0.04% across LADs. The between-area variance also showed a reduction, from 62.829 in Model 3 to 62.805 in Model 4, indicating a 0.0004% reduction. These findings highlight the area civic engagement does not contribute to the differences in general health across LADs and did not explain the variance in general health across LADs.

Model 5 did not demonstrate a positive correlation between area trust, cooperative norms, and general health. Additionally, it did not indicate a potential mediating effect of area trust and cooperative norms in the relationship between area SES and general health. The main associations of area SES and general health increased when including area trust and cooperative norms. For example, in median areas, the association increased from -1.071 ($p < 0.001$, 95% CI = -1.583, -0.558) in Model 4 to -1.077 in Model 5 ($p < 0.001$, 95% CI = -1.605, -0.549). Furthermore, the between-area variance showed a slight reduction from 0.398 in Model 4 to 0.397 in Model 5; however, this change may be not meaningful.

In summary, residing in areas ranging from the median to the most deprived quintiles was associated with poorer general health outcomes. This study sought to investigate the potential mediating role of area civic engagement in the relationship between living in disadvantaged areas and adverse general health outcomes. However, the findings do not confirm such a mediation effect, although lower levels of civic engagement were associated with poorer general health. Importantly, area SES and compositional elements accounted for a substantially larger proportion of the variance in general health (66%) compared to the negligible contribution of area civic engagement (0.0004%) across LADs. This highlights that area civic engagement contributed virtually nothing to the variance in general health outcomes across LADs.

Table 3.4 Multilevel regression analyses of the mediating roles of area social capital elements in the associations between quintiles of area SES and general health (N= 24,363)

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.
Fixed part										
Intercepts	50.910*** (50.543, 51.277)	0.036	47.130*** (44.28, 0.000)	1.064	45.301*** (40.712, 49.889)	2.341	41.152*** (36.313, 45.990)	2.469	41.333*** (35.270, 47.396)	3.093
Wave	-0.180*** (-0.250, -0.111)	0.036	-0.165*** (-0.235, -0.096)	0.036	-0.166*** (-0.235, -0.096)	0.036	-0.163*** (-0.232, -0.093)	0.036	-0.163*** (-0.232, -0.093)	0.036
Area SES										
Index of multiple deprivation (Reference: 0-20%)										
20-40%			-0.357 (-0.883, 0.168)	0.268	-0.346 (-0.87, 0.180)	0.269	-0.317 (-0.832, 0.198)	0.263	-0.319 (-0.835, 0.197)	0.263
40-60%			-1.223*** (-1.743, -0.704)	0.265	-1.217*** (-1.738, -0.697)	0.265	-1.071*** (-1.583, -0.558)	0.261	-1.077*** (-1.605, -0.549)	0.270
60-80%			-1.114*** (-1.674, -0.555)	0.285	-1.119*** (-1.679, -0.560)	0.286	-0.894** (-1.448, -0.339)	0.283	-0.901** (-1.477, -0.325)	0.294
80-100%			-1.530*** (-2.104, -0.956)	0.293	-1.519*** (-2.094, -0.944)	0.293	-1.171*** (-1.752, -0.591)	0.296	-1.181*** (-1.794, -0.569)	0.312

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.
Household income			0.707*** (0.523, 0.892)	0.094	0.710*** (0.525, 0.895)	0.094	0.703*** (0.519, 0.888)	0.094	0.703*** (0.518, 0.888)	0.094
Housing tenure (Reference: owned)										
Owned with mortgage			-1.100*** (-1.474, -0.727)	0.191	-1.097*** (-1.470, -0.723)	0.191	-1.099*** (-1.472, -0.726)	0.191	-1.099*** (-1.473, -0.726)	0.191
Social renting			-3.827*** (-4.375, -3.280)	0.279	-3.815*** (-4.363, -3.266)	0.280	-3.828*** (-4.376, -3.280)	0.279	-3.828*** (-4.376, -3.281)	0.279
Private renting			-1.483*** (-2.016, -0.949)	0.272	-1.477*** (-2.011, -0.944)	0.272	-1.501*** (-2.035, -0.968)	0.272	-1.501*** (-2.035, -0.968)	0.272
Employment states (Reference: employment)										
Unemployment, inactive, and others			-2.209*** (-2.537, -1.881)	0.167	-2.211*** (-2.539, -1.883)	0.167	-2.222*** (-2.550, -1.894)	0.167	-2.222*** (-2.549, -1.894	0.167
Sex (Reference: men)										
Women			-0.368* (-0.660, -0.077)	0.149	-0.369* (-0.660, -0.077)	0.149	-0.373* (-0.664, -0.081)	0.149	-0.373* (-0.664, -0.081)	0.149

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.
Age			-0.161*** (-0.173, -0.149)	0.006	-0.161*** (-0.173, -0.149)	0.006	-0.162*** (-0.174, -0.150)	0.006	-0.162*** (-0.174, -0.150)	0.006
Marital status (Reference: married)										
Divorced/separated / Widowed			-0.615** (-1.068, -0.162)		-0.614** (-1.067, -0.162)	0.231	-0.603** (-1.056, -0.150)	0.231	-0.603** (-1.056, -0.150)	0.231
Never married			-0.114 (-0.542, 0.314)	0.218	-0.109 (-0.537, 0.319)	0.218	-0.136 (-0.564, 0.292)	0.218	-0.136 (-0.565, 0.292)	0.218
Educational qualification (Reference: Degree)										
A level and other higher degree			-0.839*** (-1.195, -0.483)	0.181	-0.845*** (-1.201, -0.489)	0.182	-0.811 (-1.167, -0.456)	0.182	-0.811*** (-1.167, -0.455)	0.182
GCSE and other qualification			-1.656*** (-2.058, -1.254)	0.205	-1.663*** (-2.065, -1.260)	0.205	-1.621 (-2.023, -1.218)	0.205	-1.621*** (-2.023, -1.218)	0.205
No qualification			-3.255*** (-3.945, -2.565)	0.352	-3.261*** (-3.951, -2.572)	0.352	-3.196 (-3.886, -2.506)	0.352	-3.196*** (-3.886, -2.506)	0.352

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.
Ethnicity										
Ethnic minorities (Reference: White)			-0.018 (-0.458, 0.422)	0.225	0.004 (-0.439, 0.447)	0.226	-0.008 (-0.450, 0.433)	0.225	-0.009 (-0.451, 0.433)	0.226
Ethnic density										
Less diverse (Reference: More diverse)			-0.274 (-0.700, 0.152)	0.217	-0.387 (-0.882, 0.108)	0.253	-0.282 (-0.766, 0.202)	0.247	-0.279 (-0.767, 0.208)	0.249
Individual social capital										
Homogenous friendship network			0.333*** (0.277, 0.389)	0.029	0.330*** (0.273, 0.387)	0.029	0.329*** (0.272, 0.386)	0.029	0.329*** (0.272, 0.386)	0.029
Civic engagement			0.363*** (0.238, 0.489)	0.064	0.363*** (0.238, 0.489)	0.064	0.332*** (0.205, 0.458)	0.065	0.331*** (0.205, 0.458)	0.065
Trust and cooperative norms			0.349*** (0.294, 0.405)	0.028	0.349*** (0.294, 0.404)	0.028	0.345*** (0.290, 0.400)	0.028	0.346*** (0.290, 0.401)	0.029
Area social capital										
Homogenous friendship networks					0.168 (-0.207, 0.543)	0.191	0.201 (-0.166, 0.568)	0.187	0.206 (-0.174, 0.587)	0.194

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.
Civic engagement							2.093*** (1.210, 2.977)	0.451	2.105*** (1.192, 3.017)	0.465
Trust and cooperative norms									-0.018 (-0.371, 0.336)	0.180
Random part: Area-level										
Intercept variance (Between-area variance)	1.432 (0.974, 2.106)	0.282	0.490 (0.249, 0.967)	0.170	0.493 (0.251, 0.965)	0.169	0.398 (0.186, 0.852)	0.155	0.397 (0.185, 0.853)	0.155
Random part: residents										
Intercept variance (Between-resident variance)	78.562 (75.854, 81.366)	1.406	62.828 (60.414, 65.338)	1.256	62.829 (60.415, 65.338)	1.256	62.805 (60.394, 65.313)	1.255	62.805 (60.393, 65.313)	1.255
Residual variance (Within-resident variance)	45.356 (43.713, 47.060)	0.853	45.816 (44.174, 47.519)	0.853	45.811 (44.169, 47.515)	0.853	45.798 (44.156, 47.500)	0.853	45.798 (44.157, 47.501)	0.853
Intra-class correlation (Areas)	.011 (0.008, 0.0167)	.002	.004 (0.002, 0.009)	.002	.005 (.002, .009)	.002	.004 (0.002, 0.008)	.001	.004 (0.002, 0.008)	.001
Intra-class correlation (Residents | Areas)	.638 (0.623, 0.652)	.007	.580 (0.564, 0.596)	.008	.580 (.564, .596)	.008	.580 (0.564, 0.596)	.008	.580 (0.564, 0.596)	.008
AIC	183792		181155.1		181156.3		181137.1		181139.1	
BIC	183832.5		181365.7		181375.1		181363.9		181374	
Deviance	183782.04		181103.11		181102.34		181081.12		181081.11	

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

The associations between quintiles of area SES and bodily pain: Mediating roles of area social capital elements

Table 3.5 presents the findings from multilevel regression models that explore the relationships between area socioeconomic status, area social capital, and bodily pain (or the absence of pain). Model 1 reveals that, in terms of the ICCs for LADs and residents within these LADs, 0.6% and 43.3% of the variance in absence of pain were associated with LADs and intra-individual differences within LADs, respectively. This result indicates a minimal association between multilevel data factors and the absence of pain at the LAD level. However, the observed correlation in absence of pain among the residents suggests intra-individual differences.

In Model 2, living in the median, second most, and most deprived areas was found to be associated with higher levels of the of bodily pain, compared to living in the least deprived areas. In these areas, the scores indicating the absence of pain were lower by -0.836 ($p < 0.01$, 95% CI = -1.311, -0.360) and -0.880 ($p < 0.01$, 95% CI = -1.388, -0.372) respectively, compared to those in the least deprived areas. These scores imply a greater experience of pain among residents of more deprived areas. Additionally, control variables or compositional factors, such as household income and individual social capital, were associated with the absence of bodily pain. In contrast, control variable or compositional factors including owning a home with a mortgage (compared to owning outright), social renting (compared to owning outright), private renting (compared to owning outright), unemployment or economic inactivity (compared to employment), being female, increasing age, being divorced, separated, or widowed (compared to being married or in a couple), lower educational attainment—such as A-levels, GCSEs, or no qualifications (compared to a degree)—and belonging to an ethnic minority were associated with a lower likelihood of experiencing an absence of bodily pain.

Regarding the ICC for LADs, the variance in the absence of pain decreased from 0.6% in Model 1 to 0.2% in Model 2. Additionally, the between-area variance showed a reduction from 0.727 in Model 1 to 0.250 in Model 2, indicating a 66% decrease, compared to the baseline model. These reductions suggest that area socioeconomic status and compositional elements were key factors in explaining the variance in the absence of pain observed between different LADs.

Model 4 illuminates the mediating role of area civic engagement in the association between area SES and bodily pain. A significant finding is that a one-point increase in area civic engagement correlated with a 1.402-point increase in the absence of pain score, indicating a reduction in pain ($p < 0.01$). The association living in the median areas and bodily pain decreased from -0.839 ($p < 0.01$, 95% CI = -1.315, -0.364) to -0.746 ($p < 0.01$, 95% CI = -1.218, -0.274). Additionally, the association between living in the second most deprived areas and bodily pain diminishes from -0.876 ($p < 0.01$, 95% CI = -1.384, -0.368) in Model 3 to -0.724 ($p < 0.01$, 95% CI = -1.231, -0.217) in Model 4. Similarly, in the most deprived areas, the association between IMD and bodily pain decreases from -1.315 ($p < 0.001$, 95% CI = -1.839, -0.790) in Model 3 to -1.085 ($p < 0.001$, 95% CI = -1.618, -0.551) in Model 4. These changes imply that area civic engagement accounts for 11%, 17%, and 17% of these associations, respectively. The variance between areas also shows a reduction, dropping from 0.248 in Model 3 to 0.196 in Model 4. This suggests that around 21% of the variance in bodily pain between LADs was associated with differences in area civic engagement.

In Model 5, area trust and cooperative norms did not predict the absence of bodily pain. However, their inclusion strengthened the associations between area deprivation and bodily pain. For instance, the association between living in median areas and the absence of bodily pain increased from -0.746 ($p < 0.01$, 95% CI = -1.218, -0.274) in Model 4 to -0.767

($p < 0.01$, 95% CI = -1.253, -0.224) in Model 5. The ICCs for LADs and residents within LADs in Model 5 remained unchanged from Model 4. The between-area variance decreased slightly, from 0.196 in Model 4 to 0.194 in Model 5, suggesting that only 1% of the variance in bodily pain between LADs can be attributed to area trust and cooperative norms.

In summary, living in median, the second most and the most deprived areas was associated with lower levels of the absence of pain. Although area civic engagement was associated with absence of bodily pain, the mediating role of area civic engagement cannot be demonstrated. While both low area SES and limited area civic engagement were associated to lower level of the absence of pain, it was area SES that has a more substantial role in explaining the differences in the absence of pain across LADs than area civic engagement.

Table 3.5 Multilevel regression analyses of the mediating roles of area social capital elements in the associations between quintiles of area SES and bodily pain (N= 24,363)

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.
Fixed part										
Intercepts	49.172*** (48.792, 49.551)	0.193	50.808*** (48.701, 52.915)	1.075	51.887*** (47.591, 56.182)	2.192	49.098*** (44.554, 53.642)	2.318	49.706*** (44.059, 55.353)	2.881
Wave	0.217*** (0.139, 0.294)	0.040	0.200*** (0.122, 0.277)	0.040	0.200*** (0.122, 0.277)	0.040	0.202*** (0.125, 0.280)	0.040	0.202*** (0.125, 0.280)	0.040
Area SES										
Index of multiple deprivation (Reference: 0-20%)										
20-40%			-0.356 (-0.835, 0.124)	0.245	-0.362 (-0.842, 0.118)	0.245	-0.342 (-0.815, 0.130)	0.241	-0.349 (-0.823, 0.125)	0.242
40-60%			-0.836** (-1.311, -0.360)	0.243	-0.839** (-1.315, -0.364)	0.243	-0.746** (-1.218, -0.274)	0.241	-0.767** (-1.253, -0.281)	0.248
60-80%			-0.880** (-1.388, -0.372)	0.259	-0.876** (-1.384, -0.368)	0.259	-0.724** (-1.231, -0.217)	0.259	-0.749** (-1.275, -0.224)	0.268
80-100%			-1.308*** (-1.832, -0.783)	0.268	-1.315*** (-1.839, -0.790)	0.268	-1.085*** (-1.618, -0.551)	0.272	-1.117*** (-1.680, -0.555)	0.287
Household income			0.342*** (0.153, 0.531)	0.097	0.340*** (0.15, 0.529)	0.097	0.333** (0.144, 0.523)	0.097	0.333** (0.144, 0.522)	0.097

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.
Housing tenure (Reference: owned)										
Owned with mortgage			-0.792*** (-1.164, -0.419)	0.190	-0.794*** (-1.167, -0.422)	0.190	-0.795*** (-1.167, -0.423)	0.190	-0.795*** (-1.168, -0.423)	0.190
Social renting			-3.360*** (-3.897, -2.823)	0.274	-3.368*** (-3.906, -2.830)	0.275	-3.380*** (-3.918, -2.842)	0.274	-3.381*** (-3.919, -2.843)	0.274
Private renting			-1.350*** (-1.879, -0.821)	0.270	-1.35*** (-1.883, -0.824)	0.270	-1.371*** (-1.901, -0.842)	0.270	-1.372*** (-1.901, -0.842)	0.270
Employment states (Reference: employment)										
Unemployment, inactive, and others			-1.858*** (-2.188, -1.528)	0.168	-1.857*** (-2.187, -1.527)	0.168	-1.866*** (-2.196, -1.536)	0.168	-1.866*** (-2.196, -1.536)	0.168
Sex (Reference: men)										
Women			-0.701*** (-0.983, -0.419)	0.144	-0.701*** (-0.983, -0.419)	0.144	-0.704*** (-0.986, -0.422)	0.144	-0.704*** (-0.986, -0.422)	0.144
Age			-0.098*** (-0.110, -0.086)	0.006	-0.098*** (-0.110, -0.086)	0.006	-0.098*** (-0.110, -0.086)	0.006	-0.098*** (-0.110, -0.086)	0.006
Marital status (Reference: married)										
Divorced/separated / Widowed			-0.898*** (-1.345, -0.451)	0.228	-0.898*** (-1.345, -0.451)	0.228	-0.889*** (-1.336, -0.442)	0.228	-0.889*** (-1.336, -0.442)	0.228

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.
Never married			0.019 (-0.402, 0.441)	0.215	0.016 (-0.406, 0.438)	0.215	-0.004 (-0.425, 0.418)	0.215	-0.005 (-0.426, 0.417)	0.215
Educational qualification (Reference: Degree)										
A level and other higher degree			-0.965*** (-1.311, -0.620)	0.176	-0.962*** (-1.307, -0.616)	0.176	-0.939*** (-1.285, -0.593)	0.176	-0.938*** (-1.284, -0.593)	0.177
GCSE and other qualification			-1.454*** (-1.845, -1.063)	0.199	-1.450*** (-1.841, -1.059)	0.200	-1.423*** (-1.815, -1.032)	0.200	-1.423*** (-1.815, -1.032)	0.200
No qualification			-3.255*** (-3.928, -2.582)	0.343	-3.252*** (-3.925, -2.578)	0.343	-3.206*** (-3.879, -2.532)	0.344	-3.206*** (-3.879, -2.532)	0.344
Ethnicity										
Ethnic minorities (Reference: White)			-1.096*** (-1.521, -0.672)		-1.111*** (-1.538, -0.684)	0.218	-1.123*** (-1.549, -0.696)	0.218	-1.126*** (-1.553, -0.699)	0.218
Ethnic density										
Less diverse (Reference: More diverse)			-0.528** (-0.916, -0.140)	0.198	-0.463** (-0.912, -0.014)	0.229	-0.401+ (-0.843, 0.042)	0.226	-0.392 + (-0.836, 0.053)	0.227
Individual social capital										
Homogenous friendship network			0.183*** (0.126, 0.240)	0.029	0.185*** (0.128, 0.243)	0.029	0.185*** (0.127, 0.242)	0.029	0.184*** (0.127, 0.242)	0.029

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.
Civic engagement			0.061 (-0.067, 0.189)	0.065	0.061 (-0.067, 0.189)	0.065	0.034 (-0.095, 0.163)	0.066	0.034 (-0.095, 0.163)	0.066
Trust and cooperative norms			0.146*** (0.091, 0.202)	0.028	0.147*** (0.091, 0.202)	0.028	0.144*** (0.088, 0.200)	0.028	0.146*** (0.089, 0.202)	0.029
Area social capital										
Homogenous friendship networks					-0.099 (-0.443, 0.244)	0.175	-0.072	0.173	-0.055 (-0.406, 0.296)	0.179
Civic engagement							1.402**	0.418	1.440** (0.594, 2.286)	0.432
Trust and cooperative norms									-0.059 (-0.386, 0.267)	0.167
Random part: Area-level										
Intercept variance (Between-area variance)	0.727 (0.428, 1.235)	0.196	0.250 (0.086, 0.731)	0.137	0.248 (0.085, 0.730)	0.137	0.196 (0.054, 0.718)	0.130	0.194 (0.052, 0.720)	0.130
Random part: residents										
Intercept variance (Between-resident variance)	49.116 (46.341, 52.056)	1.457	41.081 (38.466, 43.873)	1.378	41.078 (38.463, 43.870)	1.378	41.055 (38.440, 43.847)	1.378	41.052 (38.437, 43.844)	1.378
Residual variance (Within-resident variance)	65.197 (62.841, 67.641)	1.224	65.432 (63.091, 67.861)	1.216	65.435 (63.093, 67.863)	1.217	65.444 (63.102, 67.873)	1.217	65.447 (63.105, 67.876)	1.217

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.
Intra-class correlation (Areas)	.006 (0.004, 0.011)	0.002	.002 (0.001, 0.007)	0.001	.002 (0.001, 0.007)	0.001	.002 (0.001, 0.007)	0.001	0.002 (0.000, 0.007)	0.001
Intra-class correlation (Residents | Areas)	.433 (.412, .455)	.011	.387 (.365, 0.410)	.011	.387 (.365, .410)	.011	.387 (.364, .409)	.011	.387 (0.364, 0.409)	.011
AIC	183542.4		182048		182049.7		182040.6		182042.5	
BIC	183582.9		182258.6		182268.4		182267.4		182277.4	
Deviance	183532.42		181996.02		181995.7		181984.62		181984.5	

+p < 0.10, *p < 0.05, **p < 0.01, ***p < 0.001

The associations between quintiles of area SES and role-physical: Mediating roles of area social capital elements

Table 3.6 delineate the results from multilevel regression models that investigated the association between area socioeconomic status, area social capital, and role-physical. Model 1 indicated that only 0.8% of the differences in role-physical were associated with LADs, while a substantial 58.9% of the variance was associated with the intra-individual differences.

Model 2 shows that individuals residing in areas from second least deprived areas to the most deprived areas were associated with lower role-physical, compared to individuals residing in the least deprived areas. Among residents in the second least deprived areas (20%-40%), role-physical was -0.419 points ($p < 0.05$) lower compared to those in the least deprived areas, even after controlling for factors such as household income, housing tenure, employment status, gender, age, marital status, educational qualifications, ethnicity, and individual social capital elements. Similarly, among residents in median deprived areas (40%-60% deprivation), role-physical was -0.880 points ($p < 0.001$) lower compared to those in the least deprived areas. In the second most deprived areas (60%-80% deprivation), the decrease in role-physical was more pronounced at -0.935 points ($p < 0.001$) compared to the least deprived areas. A similar pattern was observed in the most deprived areas (80%-100% deprivation), where role-physical was -1.537 ($p < 0.001$) points lower than in the least deprived areas.

In terms of control variables and compositional factors, household income and individual elements of social capital were positively associated with better role physical outcomes. Conversely, detrimental role physical outcomes were linked to the following factors: owning a home with a mortgage (compared to owning outright), social renting (compared to owning outright), private renting (compared to owning outright), unemployment and economic inactivity (compared to employment), being female, increasing age, being divorced, separated, or widowed (compared to being married or coupled), and never having married (compared to being married or coupled). Additionally, lower educational attainment, such as holding A-level qualifications or their equivalent, GCSE qualifications, or having no qualifications (compared to a degree-level education), as well as belonging to an ethnic minority group and having low individual social capital, were also associated with poorer role physical.

Concerning the ICC for LADs, the variance in role-physical decreased from 0.8% in Model 1 to 0.2% in Model 2. Furthermore, the between-area variance demonstrated a reduction, from 0.630 in Model 1 to 0.133 in Model 2, indicating a 79% decrease in the variance of role physical across LADs, compared to the baseline model. These results suggest that area socioeconomic status (SES) and compositional elements accounted for the variance of role physical across LADs. Control variables accounted for the variance of role physical between residents.

In Model 3, area homogenous friendship networks were not associated with role physical. However, in Model 4, area civic engagement showed significant associations with role-physical (Estimate = 1.272, 95%CI = 0.623, 1.921, $p < 0.001$). The mediating role of area civic engagement cannot be demonstrated as the main associations remain significant when including the potential mediator. Specifically, the coefficient for the association between area SES in the second least deprived areas decreased from -0.424 ($p < 0.05$, 95% CI = -0.804, -0.044) in Model 3 to -0.404 ($p < 0.05$, 95% CI = -0.779, -0.030) in Model 4, explaining 5% of this association. In median areas and role limitation decreased from -0.883 (95% CI = -1.260, -0.507, $p < 0.001$) in Model 3 to -0.797 (95% CI = -1.170, -0.423, $p < 0.001$) in Model 4, explaining 10% of this association. Similarly, for the second most deprived areas, the coefficient decreased from -0.931 ($p < 0.001$, 95% CI = -1.332, -0.530) in Model 3 to -0.791 ($p < 0.001$, 95% CI = -1.191, -0.391) in Model 4, with area civic engagement explaining 15% of this association. For the most deprived areas, the change in the coefficient from -1.543 ($p < 0.001$, 95%CI = -1.957, -1.128) in Model 3 to -1.330 ($p < 0.001$, 95% CI =-1.957, -1.128) in

Model 4 indicates a 79% explanation by area civic engagement. The between-area variance also reduced from 0.130 in Model 4 to 0.097 in Model 5, suggesting that 25% of the variation in role physical across LADs was explained by area civic engagement.

Furthermore, the study found that area trust and cooperative norms were not associated to role-physical and may not mediate the associations between area SES and role-physical. The association between area SES and role-physical in the second least deprived areas decreased from -0.404 ($p < 0.05$, 95% CI = -0.779, -0.030) in Model 4 to -0.402 ($p < 0.05$, 95% CI = -0.778, -0.027). The associations between area SES and role-physical in median areas changed from -0.797 ($p < 0.001$, 95% CI = -1.170, -0.423) in Model 4 to -0.791 ($p < 0.001$, 95% CI = -1.176, -0.406) in Model 5. In the second most deprived area, the change was from -0.791 ($p < 0.001$, 95% CI = -1.191, -0.391) to -0.784 ($p < 0.001$, 95%CI = -1.199, -0.369), and in the most deprived area, the coefficient shifted from -1.330 ($p < 0.001$, 95% CI = -1.752, -0.909) to -1.321 ($p < 0.001$, 95% CI =-1.766, -0.876). The reductions may be negligible. Area trust and cooperative norms explained the associations in the second least deprived, the median, second most deprived, and most deprived areas by 0.5%, 0.8%, 0.9%, 0.7%, respectively. The between-area variance and ICCs remain the same between Models 4 and 5, indicating area trust and cooperative norms was not explain the variance of physical health between LADs. Model 2 was highlighted as the most effective model due to its lowest AIC and BIC.

In summary, residing in deprived areas was associated with reduced role-physical. This study also identifies area civic engagement as a significant predictor of role-physical. However, the mediating role of area civic engagement cannot be substantiated. However, it is important to note that area SES explained the variance in role-physical to a greater extent than area civic engagement.

Table 3.6 Multilevel regression analyses of the mediating roles of area social capital elements in the associations between quintiles of area SES and role-physical (N= 24,363)

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.
Fixed part										
Intercepts	51.760*** (51.468, 52.052)	0.149	54.429*** (52.792, 56.067)	0.835	55.375*** (51.994, 58.756)	1.725	52.849*** (49.271, 56.428)	1.826	52.676*** (48.220, 57.132)	2.273
Wave	-0.109*** (-0.166, -0.051)	0.029	-0.084** (-0.141, -0.027)	0.029	-0.084** (-0.141, -0.027)	0.029	-0.082** (-0.139, -0.025)	0.029	-0.082** (-0.139, -0.025)	0.029
Area SES										
Index of multiple deprivation (Reference: 0-20%)										
20-40%			-0.419* (-0.799, -0.039)	0.194	-0.424* (-0.804, -0.044)	0.194	-0.404* (-0.779, -0.030)	0.191	-0.402* (-0.778, -0.027)	0.191
40-60%			-0.880*** (-1.257, -0.503)	0.192	-0.883*** (-1.260, -0.507)	0.192	-0.797*** (-1.170, -0.423)	0.191	-0.791*** (-1.176, -0.406)	0.196
60-80%			-0.935*** (-1.336, -0.534)	0.205	-0.931*** (-1.332, -0.530)	0.205	-0.791*** (-1.191, -0.391)	0.204	-0.784*** (-1.199, -0.369)	0.212
80-100%			-1.537*** (-1.952, -1.122)	0.212	-1.543*** (-1.957, -1.128)	0.212	-1.330*** (-1.752, -0.909)	0.215	-1.321**** (-1.766, -0.876)	0.227
Household income			0.345***	0.075	0.343***	0.075			0.338***	0.075

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.
			(0.199, 0.491)		(0.197, 0.489)				(0.192, 0.484)	
Housing tenure (Reference: owned)										
Owned with mortgage			-0.874*** (-1.167, -0.582)	0.149	-0.876*** (-1.169, -0.584)	0.149	-0.878*** (-1.170, -0.585)	0.149	-0.878*** (-1.170, -0.585)	0.149
Social renting			-3.141*** (-3.567, -2.715)	0.217	-3.148*** (-3.575, -2.722)	0.218	-3.157*** (-3.583, -2.731)	0.217	-3.157*** (-3.583, -2.731)	0.217
Private renting			-1.471*** (-1.888, -1.054)	0.213	-1.474*** (-1.891, -1.056)	0.213	-1.490*** (-1.907, -1.073)	0.213	-1.490*** (-1.907, -1.072)	0.213
Employment states (Reference: employment)										
Unemployment, inactive, and others			-2.822*** (-3.079, -2.564)	0.132	-2.821*** (-3.078, -2.563)	0.132	-2.829*** (-3.087, -2.571)	0.132	-2.829*** (-3.087, -2.571)	0.132
Sex (Reference: men)										
Women			-0.511*** (-0.737, -0.285)	0.115	-0.511*** (-0.737, -0.285)	0.115	-0.514*** (-0.740, -0.288)	0.115	-0.514*** (-0.740, -0.288)	0.115
Age			-0.132*** (-0.142, -0.122)	0.005	-0.132*** (-0.142, -0.122)	0.005	-0.133*** (-0.142, -0.123)	0.005	-0.133*** (-0.142, -0.123)	0.005

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.
Marital status (Reference: married)										
Divorced/separated / Widowed			-0.889*** (-1.243, -0.536)	0.180	-0.890*** (-1.243, -0.536)	0.180	-0.881*** (-1.234, -0.527)	0.180	-0.880*** (-1.234, -0.527)	0.180
Never married			-0.508** (-0.842, -0.174)	0.170	-0.511** (-0.845, -0.177)	0.170	-0.529** (-0.863, -0.195)	0.170	-0.529** (-0.863, -0.195)	0.170
Educational qualification (Reference: Degree)										
A level and other higher degree			-0.539*** (-0.815, -0.263)	0.141	-0.536*** (-0.812, -0.260)	0.141	-0.514*** (-0.790, -0.237)	0.141	-0.514*** (-0.790, -0.238)	0.141
GCSE and other qualification			-0.981*** (-1.293, -0.669)	0.159	-0.977*** (-1.289, -0.665)	0.159	-0.950*** (-1.262, -0.638)	0.159	-0.950*** (-1.262, -0.638)	0.159
No qualification			-2.124*** (-2.660, -1.588)	0.273	-2.121*** (-2.656, -1.585)	0.273	-2.075*** (-2.611, -1.539)	0.274	-2.075*** (-2.611, -1.539)	0.274
Ethnicity										
Ethnic minorities (Reference: White)			-0.576** (-0.914, -0.238)	0.173	-0.589** (-0.930, -0.248)	0.174	-0.602** (-0.942, -0.261)	0.174	-0.601** (-0.941, -0.260)	0.174
Ethnic density										

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.
Less diverse (Reference: More diverse)			-0.352* (-0.659, -0.045)	0.157	-0.295 (-0.649, 0.059)	0.181	-0.238 (-0.587, 0.111)	0.178	-0.241 (-0.591, 0.110)	0.179
Individual social capital										
Homogenous friendship network			0.176*** (0.131, 0.220)	0.023	0.178*** (0.133, 0.223)	0.023	0.177*** (0.132**, 0.222)**	0.023	0.177*** (0.132, 0.222)	0.023
Civic engagement			0.105* (0.006, 0.205)	0.051	0.105* (0.006, 0.205)	0.051	0.082 (-0.018, 0.182)	0.051	0.082 (-0.018, 0.183)	0.051
Trust and cooperative norms			0.168*** (0.125, 0.212)	0.022	0.169*** (0.125, 0.212)	0.022	0.166*** (0.123, 0.210)	0.022	0.166*** (0.122, 0.210)	0.022
Area social capital										
Homogenous friendship networks					-0.087 (-0.358, 0.184)	0.138	-0.064 (-0.331, 0.203)	0.136	-0.069 (-0.346, 0.209)	0.142
Civic engagement							1.272*** (0.623, 1.921)	0.331	1.261*** (0.591, 1.931)	0.342
Trust and cooperative norms									0.017 (-0.242, 0.275)	0.132
Random part: Area-level										
Intercept variance (Between-area variance)	0.630 (0.389, 1.021)	0.155	0.133 (0.037, 0.477)	0.087	0.130 (0.035, 0.480)	0.087	0.097 (0.019, 0.497)	0.081	0.097 (0.019, 0.499)	0.081

	Model 1		Model 2		Model 3		Model 4		Model 5	
	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.	Coef. (95% CI)	Std. Err.
Random part: residents										
Intercept variance (Between-resident variance)	45.073 (43.327, 46.890)	0.909	34.117 (32.582, 35.724)	0.801	34.117 (32.582, 35.724)	0.801	34.099 (32.564, 35.706)	0.801	34.100 (32.565, 35.707)	0.801
Residual variance (Within-resident variance)	31.926 (30.755, 33.141)	0.609	32.054 (30.893, 33.258)	0.603	32.055 (30.894, 33.259)	0.603	32.054 (30.893, 33.258)	0.603	32.053 (30.893, 33.257)	0.603
Intra-class correlation (Areas)	0.008 (0.005, 0.013)	0.002	.002 (0.001, 0.007)	0.001	.002 (0.001, 0.007)	0.001	.001 (0.000, 0.007)	0.001	.001 (0.000, 0.008)	0.001
Intra-class correlation (Residents | Areas)	.589 (0.572, 0.605)	.008	.517 (0.498,0 .5 35)	.009	.517 (0.498, 0.535)	.009	.516 (0.498, 0.535)	.009	.516 (0.498, 0.534)	.009
AIC	172702.9		169596.8		169598.4		169585.8		169587.8	
BIC	172743.4		169807.4		169817.1		169812.6		169822.7	
Deviance	172692.94		169544.8		169544.41		169529.82		169529.8	

*p < 0.05, **p < 0.01, ***p < 0.001

Discussion

This study contributes to the literature on area social capital elements, area SES, and LADs in England. While previous studies have focused on the relationships between area deprivation and health in smaller geographical units, this research emphasises the associations within Local Authority Districts (LADs) that have received less attention. An important gap addressed here is the absence of research on the potential mediating role of area social capital elements in the relationship between area SES and health outcomes in England. Previous studies, such as Verhaeghe and Tampubolon (2012), have predominantly examined individual social capital's mediating effects on the connection between area deprivation and health. Jonsson et al. (2020) investigated the relationship between area SES, area social capital, and well-being in UK adolescents. However, the study did not consider potential compositional effects. Additionally, the findings may not be generalizable to the adult population in England, as their sample was specific to adolescents.

This study shows a significant association between SES in LADs and physical health outcomes (i.e., SF12-PCS, physical functioning, general health, bodily pain, and role-physical) among adults. It found that area civic engagement was associated with these physical health outcomes. The study demonstrates that area socioeconomic status (SES) accounted for a greater proportion of the variance in bodily pain, role physical, and general health across LADs, compared to area civic engagement. Notably, area SES and area civic engagement accounted for equivalent proportions of the variance in physical functioning between LADs. Additionally, the study highlights that the potential mediating role of area civic engagement in the relationship between area socioeconomic status (SES) and physical health outcomes remains inconclusive. The main findings and implications of these findings are discussed in detail below.

Firstly, this study identified a correlation between area SES in most quintiles within LADs and a range of health outcomes (e.g., SF-12 PCS, physical functioning, general health, bodily pain, role-physical). In the UK, earlier research predominantly focused on the relationship between area SES and health outcomes within smaller areal units, such as CAS wards and MSOAs (Chaparro *et al.*, 2018; Prior, Manley and Jones, 2018; Jonsson *et al.*, 2020). Our findings consistent with these studies, demonstrating that deprived areas are often associated to poorer health outcomes (Robert, 1998; Stafford and Marmot, 2003; Knies and Kumari, 2022). Future research should focus on examining the association between area deprivation in LADs and various health outcomes, taking into consideration the different ways in which stress from living in such deprived areas can manifest (Horwitz, 2002). Concerning the allocation of public health funding, it is recommended that government continue using the IMD as a guiding benchmark (Sarah Heath, 2014), with a focus on increasing funding for deprived LADs[8].

Secondly, the finding of this Chapter suggests that socioeconomic status at LADs accounts for a larger proportion of the variance in physical health. Specifically, this Chapter found that variations in physical health can be attributed to socioeconomic status in LADs. This research measured area socioeconomic status, using the IMD 2015, at a single time point due to data limitations. Future studies could focus on the association between both accumulated area socioeconomic status at the LAD level with health outcomes when data become available in the UK.

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[8] In 2013, it was observed that some of England's less disadvantaged areas received a larger portion of public health funding, while the more disadvantaged areas were allocated less. The Advisory Committee on Resource Allocation (ACRA) recommended that funding should be allocated based on the benchmark of the 'under-75 years standardised mortality ratio' (SMR). However, the adoption of SMRs as a criterion has resulted in a shift of funding away from the most disadvantaged Local Authority Districts (Sarah Heath, 2014).

Thirdly, no evidence was found to suggest that either area trust and cooperative norms or area homogeneity in friendship networks mediates the relationship between area socioeconomic status (SES) and physical health. Instead, while the mediating role of area civic engagement could not be confirmed, the association between area SES and physical health outcomes (e.g., physical functioning, general health, bodily pain, and role physical) was observed to change when area civic engagement was included. This suggested that area civic engagement may be the potential mediator of the main associations. These findings imply that areas with greater disadvantage are likely to exhibit lower levels of civic engagement, in comparison to less disadvantaged areas, as detailed in Appendix Table 1. Consequently, individuals living in areas characterised by lower levels of civic engagement report poor physical health compared to those in areas with higher levels of civic engagement. This pattern is consistent with the findings of previous research (Kawachi *et al.*, 1997). Specifically, Kawachi et al. (1997) discovered that in the US, regions with high income inequality tend to have lower levels of area civic engagement.

The observed positive correlation between area-level civic engagement and physical health corroborates the findings of Pattie et al. (2004), which demonstrated a positive association between civic participation at the LAD level and health outcomes. However, Pattie et al.'s study did not incorporate social capital at the individual level, potentially overlooking a compositional effect. Our research addresses this limitation by analysing the association between civic engagement at the LAD level and physical health outcomes, whilst controlling for individual-level civic participation. These findings suggest that improving civic engagement at the LAD level may enhance physical health outcomes. Policymakers should consider collaborating with organisations like political parties, professional groups, and voluntary service organizations. Such collaboration can provide residents with diverse information and improve overall physical health in LADs.

This study has several limitations. Firstly, a potential limitation is the risk of overestimating the correlation between the IMD and physical health outcomes. This potential overestimation may stem from the IMD's inclusion of health deprivation and disability domains, which are inherently related to physical health. Nonetheless, Jordan et al. (2004) found that the IMD and Townsend score exhibit similar correlations with premature mortality and morbidity (Jordan, Roderick and Martin, 2004). Secondly, although changes in the associations between area socioeconomic status (SES) and physical health outcomes were observed when area civic engagement was controlled, the mediating role of area civic engagement was not confirmed as the main associations remained statistically significant. Furthermore, the current method could produce invalid estimates of the main associations if not all relevant factors affecting outcomes and mediators are controlled (Richiardi, Bellocco and Zugna, 2013). Future studies should consider using more advanced mediation analyses, such as employing a counterfactual framework to define natural direct and indirect effects, which can help address potential biases caused by confounding variables that affect both mediators and outcomes (Richiardi, Bellocco and Zugna, 2013).

In summary, this research demonstrates a correlation between SES at the LAD level and a range of physical health outcomes, including physical functioning, general health, bodily pain, and role-physical. The findings indicate that deprived areas in LADs may be characterised by lower levels of civic engagement. Notably, civic engagement at the LAD level were found to change the associations between area SES and physical health outcomes, specifically in terms of physical functioning, general health, and role-physical. However, it is crucial to note that this study cannot confirm that area civic engagement mediate the association between area SES and physical health outcomes.

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Appendix

Table1. Random effects regression models: the associations between quintiles of area SES and area social capital elements (N= 24,363)

	Area civic engagement	
	Coef. (95% CI)	Std. Err.
Area SES		
Index of multiple deprivation (Reference: 10-20%)		
20-40%	-0.007*** (-0.014, 0.001)	0.004
40-60%	-0.018*** (-0.025, -0.045)	0.004
60-80%	-0.053*** (-0.061, -0.045)	0.004
80-100%	-0.092*** (-0.101, -0.084)	0.004
White density	-0.064** (-0.071, -0.058)	0.003
Area social capital		
Homogenous in friendship networks	-0.047*** (-0.052, -0.041)	0.003
Trust and cooperative norms	0.099*** (0.094, 0.104)	0.002

**p < 0.01, ***p < 0.001

Chapter 4. The bi-directional associations between social capital elements and mental health: considering area and individual characteristics

Abstract

Aims: Previous research has identified a bi-directional association between social capital and mental health. Notably, cognitive social capital has been found to correlate with mental health outcomes in most high-income countries, while the relationship involving structural social capital and mental health has yielded mixed results. Moreover, existing studies have not fully explored the relationships between area characteristics, such as area social capital and area mental health, and individual traits, including personal social capital and mental health. This study seeks to bridge these gaps by testing the reciprocal associations between cognitive and structural social capital and mental health. Furthermore, it also examines how area-level characteristics correlate with personal social capital and mental health outcomes.

Methods: The analytic sample was drawn from Waves 1, 3, 6, 9, and 12 (2009-2022) of Understanding Society: the UK Household Longitudinal Study (UKHLS), a 14-year study. However, for the trust and cooperative norms models, the sample was limited to Waves 1, 3, and 6 (2009-2016) due to the absence of relevant variables. Area characteristics were constructed based on counties of England. Autoregressive cross-lagged models were applied, with estimates adjusted for covariates and mental health at baseline (Wave 1). Sensitivity analyses were conducted using the same approach but excluded counties with fewer than 100 respondents.

Results: Findings from the main analyses and sensitivity analyses are similar. Firstly, main analyses and sensitivity analyses revealed a bi-directional association between homogenous friendship networks and mental health. For instance, in main analysis, good mental health at Wave 3 was associated with higher homogenous friendship networks after 3 years at Wave 6 (coefficient = 0.007, $p < 0.05$, 95% CI = 0.001, 0.013), which in turn were associated with better mental health 3 years later at Wave 9 (coefficient = 0.156, $p < 0.001$, 95% CI = 0.077, 0.235). Secondly, main analyses and sensitivity analyses provided no evidence to support

reciprocal relationships between civic engagement and later mental health outcomes. Thirdly, these analyses found bi-directional associations between trust and cooperative norms and mental health. Specifically, higher levels of trust and cooperative norms at Wave 3 were associated with better mental health three years later at Wave 6. Moreover, good mental health at Wave 3 was related to increased trust and cooperative norms three years later at Wave 6. Lastly, area-level characteristics, including mental health and social capital elements, were associated with personal mental health and social capital elements.

Conclusion: The study's findings regarding the association between civic engagement and mental health are in line with the results of a meta-analysis (Ehsan and Silva, 2015). Similarly, our study concerning the association between homogenous friendship networks and mental health correspond with the research conducted by Awaworyi Churchill and Smyth (2020). Our approach to measuring homogenous friendship networks encompassed a variety of factors, including age, educational attainment, incomes, and race, offering a broader perspective compared to Awaworyi Churchill and Smyth’s focus on ethnicity and religion. Additionally, our findings regarding the bi-directional associations between trust, cooperative norms, and mental health are consistent with previous studies.

Introduction

The literature documents associations between social capital and mental health, distinguishing between structural and cognitive social capital (Ehsan and Silva, 2015). Structural social capital pertains to an individual's participation in networks, while cognitive social capital concerns the perceived quality of social relationships, encompassing trust, support, and mutuality (Moore and Kawachi, 2017; Flores *et al.*, 2018). A meta-analysis by Ehsan and Silva (2015), primarily including studies from high-income countries, revealed a positive association between cognitive social capital and various mental health aspects in both cross-sectional and longitudinal studies. However, it did not find a similar association with structural social capital.

Moreover, Ehsan and Silva (2015) show a lack of longitudinal evidence regarding social capital and mental health in the UK, noting that only six out of several relevant cohort studies are UK-based. While Yu et al., (2015) utilised a sample from the British Household Panel Study (BHPS) and indicated a bi-directional association between social participation (e.g., environmental groups, trade unions, religious groups) and mental health using autoregressive cross-lagged models, their findings do not clarify the relationships between various types of social capital (e.g., homogeneity of friendship networks, trust, and cooperative norms) and mental health. Yu et al., (2015) also did not account for area-level social capital in their analysis. Additionally, while the association between individual social capital and mental health is established, there remains a gap in research exploring the relationship between neighbourhood characteristics, such as high area social capital, and individual social capital, as well as the associations between area mental health and individual mental health. Theoretical perspectives including social contagion and collective socialization could potentially explain the underlying mechanisms of this relationship (Rosenquist, Fowler and Christakis, 2011; Galster, 2012; Moussaïd *et al.*, 2017). These findings and gaps highlight the unresolved question of how neighbourhood characteristics are associated with both structural (i.e., civic engagement and homogeneous friendship networks) and cognitive (i.e., trust and cooperative norms) aspects of social capital at the individual level, and how these, in turn, relate to mental health in England.

Previous studies in health research have predominantly focused on smaller areal units, such as electoral wards and postcode sectors (Mohan *et al.*, 2005; Snelgrove, Pikhart and Stafford, 2009) , while larger units like counties and local authorities districts (LADs) have received less attention. Such a scope presents challenges, particularly regarding sample sizes when constructing contextual variables (e.g., area social capital) within LADs. The rationale of prioritising counties over smaller units is multi-faceted. Firstly, residents utilise not only infrastructures and resources within their immediate postcode sectors, such as public events, sport facilities, and schools, but also those available in their counties. Utilising resources in counties creates opportunities for residents to develop social networks and social capital, which may correlate with their mental health. Secondly, given the UK government's emphasis on evidence-based approaches to strengthen social capital through community infrastructure, aimed at improving mental health, exploring these larger areal units becomes increasingly relevant (Digital, Culture, and Media & Sport, 2022). However, there remains a notable gap in evidence supporting policies that leverage social capital across larger areas to enhance mental health outcomes(Silva et al., 2005; Ehsan and Silva, 2015).

This study has three aims. Using Understanding Society: the UK Household Longitudinal Study, I utilise autoregressive cross-lagged models to test the followings: firstly, the association between social capital elements (i.e., cognitive, and structural) and mental health; Second, the association between mental health and social capital elements; thirdly, the association between area and personal characteristics.

Hypotheses:

H1a: There is a positive association between civic engagement and mental health.

H1b: Individuals with poor mental health tend to exhibit lower levels of civic engagement.

H2a: A positive association exists between homogeneous friendship networks and mental health.

H2b: Individuals with poor mental health are likely to have less homogeneous friendship networks.

Hypotheses:

H3a: A positive association is expected between trust and cooperative norms and mental health.

H3b: Individuals with poor mental health tend to exhibit lower levels of trust and cooperative norms.

H4a: Residing in areas characterized by highly homogeneous friendship networks is associated with the individual's integration into similarly homogeneous friendship networks.

H4b: Residing in areas exhibiting high levels of civic engagement is positively correlated with the individual's own civic engagement.

H4c: Residing in areas with pronounced trust and cooperative norms is positively correlated with the individual's adoption of high trust and cooperative norms.

H4d: Residing in areas marked by poor mental health is associated with a higher likelihood of the individual experiencing poor mental health.

Background

The relationships between structural social capital and mental health: homogenous friendship network and civic engagement

Structural social capital, which includes aspects like civic engagement and the homogeneity of friendship networks, is hypothesised to have beneficial effects on mental health. Pancer (2015) highlights that individuals who are more engaged in civic activities tend to exhibit higher levels of empowerment compared to those less involved. This empowerment emerges from their contributions to improving the lives of individuals and communities. Furthermore, a direct correlation is found between the degree of civic activity and the level of control individuals perceive over their lives (Pancer, 2015). Consequently, this increased sense of empowerment and control, derived from active civic participation, is believed to positively relate to mental health.

However, previous studies have yielded mixed outcomes regarding the relationship between structural social capital and mental health (Berry and Welsh, 2010; Ehsan and Silva, 2015). A meta-analysis by Ehsan and Silva (2015) demonstrated that in the US and Greece, structural social capital, defined as volunteer work, community participation, and overall community engagement, showed no significant correlation with common mental health disorders. Specifically, an analysis using a nationally representative US sample, included in the aforementioned meta-analysis, revealed no significant association between the duration of volunteer work or the frequency of community involvement (including participation in religious services and meetings of unions or professional groups) and mental health (Fujiwara and Kawachi, 2008). In contrast, a study utilising data from the Household, Income, and Labour Dynamics in Australia Survey (HILDA) found that frequent engagement in informal social connections (e.g., interactions with friends and family), a form of structural social capital, and civic engagement activities (such as volunteering and charitable donations) were positively associated to mental health (Berry and Welsh, 2010). Similarly, Yu et al., (2015) found that social participation (e.g., member of political party, voluntary service group, and others) is associated with positive changes in perceived mental health in British. These findings indicate that greater frequency of involvement in structural social capital activities, including social connectedness and civic engagement, could be relevant to good mental health.

Homogeneity of friendship networks has received insufficient attention in research examining the association between structural social capital and mental health. Heterogenous friendship networks have been associated with lower subjective well-being (Awaworyi Churchill and Smyth, 2020). This phenomenon, known as assortative matching, occurs when individuals tend to select friends similar to themselves in aspects such as ethnicity and socio-economic status (Awaworyi Churchill and Smyth, 2020). Such matching facilitates the mutual confirmation of worldviews, a process that validates individuals' self-worth, and positively affects well-being (Awaworyi Churchill and Smyth, 2020). Awaworyi Churchill and Smyth (2020) used instruments and propensity score matching (PSM) to address potential selection biases, particularly the likely overrepresentation of majority ethnic groups. They noted that the level of heterogeneity in friendship networks might vary significantly between ethnic majority and minority groups. Their findings showed that increases in the standard deviation of the proportion of friends from different ethnic and religious backgrounds corresponded with decreases of 0.276 and 0.451 in the standard deviation of subjective well-being, respectively. This research employed data from the UK's Community Life Survey (CLS), a nationally representative survey. However, previous studies did not examine whether homogeneity in other aspects, such as income and educational attainment, was associated with mental health.

Does a homogeneous friendship network correspond with poorer mental health? While such networks are often associated with better mental health outcomes, excessive homogeneity may correspond with poorer mental health, potentially mediated by reduced social cohesion at the Lower Super Output Area (LSOA) level, as suggested by data from the UK Household Longitudinal Study (UKHLS) on an English sample (Ramos *et al.*, 2024). Both homophily and in-group favouritism may explain this association. Specifically, highly homogeneous networks (homophily) can foster divisions between groups and promote antagonism towards out-groups, thereby undermining social cohesion within communities. Furthermore, in-group favouritism in intergroup contexts may further accentuate group distinctions and create more rigid group boundaries. These mechanisms may contribute to poorer mental health outcomes in England.

Several studies have investigated the association between poor mental health and civic engagement, as well as social connectivity (Ding, Berry and O'Brien, 2015; Yu *et al.*, 2015; Downward, Rasciute and Kumar, 2020). Using data from the British Household Panel Study and employing multilevel autoregressive cross-lagged panel models, Yu et al. (2015) found that individuals experiencing a decline in mental health tended to participate less in civic activities, a trend that was accompanied by a noticeable reduction in interactions within their social networks. These activities encompassed involvement in political parties, trade unions, environmental groups, and parental associations. The study also substantiated that low civic engagement is correlated with poor changes in mental health. Social networks were gauged by the frequency of contact with their three closest friends. Downward, Rasciute and Kumar (2020) explored the relationship between mental health and civic engagement using a fixed effect instrumental variable panel data regression analysis, where mental health was assessed using the General Health Questionnaire (GHQ). Their findings suggest a correlation between changes in mental health and levels of civic engagement in both men and women.

The relationship between cognitive social capital and mental health: trust and cooperative norms

Cognitive social capital is positively associated with mental health (Fujiwara and Kawachi, 2008; Giordano and Lindström, 2011; Ehsan and Silva, 2015), and vice versa (Roychowdhury, 2021). Yu et al. (2015) outline three perspectives on how trust and cooperative norms might bolster mental health. Firstly, the presence of sympathetic relationships and a trusting environment can enhance mental health. Secondly, the dissemination of health-relevant information within these social circles, including insights on healthcare and health behaviours, plays a crucial role. Thirdly, enhanced social capital may foster a heightened sense of personal and communal responsibility, subsequently improving mental health. In their analysis using the British Household Panel Study (BHPS), Giordano and Lindström (2011) employed bivariate analyses with a generalised estimating equation and an autoregressive working correlation structure. Their research shows that generalised trust is associated with positive psychological health over time. Furthermore, Roychowdhury (2021), utilizing data from the European Social Survey (ESS) which included 37,515 observations from 28 European countries, including the UK, found that poor mental health is correlated with low social trust, a decline attributed to reduced levels of optimism and hope.

The relationships between neighbourhood characteristics and personal traits: collective socialisation and social contagion

Residing in areas characterized by elevated social capital may correlate with an individual's possession of high personal social capital. In areas abundant in trust and cooperative norms, it is presumed that a significant proportion of residents have substantial social capital. For example, individuals in such areas, influenced by their neighbours, are more inclined to seek and offer assistance, particularly in areas where high trust prevails due to collective socialisation – conformity to norms in the areas. These interactions inherently bolster mutual trust.

Social contagion elucidates how areas with pronounced civic engagement can foster personal civic engagement. The propagation of judgment often requires more than a single interaction between a sender and a receiver (Moussaïd *et al.*, 2017). Senders must win over the receivers to adopt their judgments (Moussaïd *et al.*, 2017). Several social factors can reduce the receiver's uncertainty about the quality of the sender's judgment, thereby facilitating its propagation (Moussaïd *et al.*, 2017). First, exposure to the same judgment from multiple senders increases the likelihood of its adoption (Moussaïd *et al.*, 2017). Second, the sender's reputation significantly influences the extent of social impact (Moussaïd *et al.*, 2017). Third, the ability to consistently observe the sender's successful performance reduces uncertainty about the quality of their judgment (Moussaïd *et al.*, 2017). Local interactions serve as a platform for individuals to observe and emulate others' behaviours. Observing residents participate in civic activities and the resultant positive outcomes can inspire individuals to partake in similar activities.

Furthermore, the phenomenon of social contagion in mental health, defined as the clustering of poor mental health within neighbourhood populations, has been less emphasised in studies exploring the impact of social capital on mental health. Areas with low mental health scores typically indicate a high prevalence of mental health issues among the residents, suggesting that individuals in these areas are more likely to suffer from poor mental health. To explain this clustering of similar traits, three perspectives are considered: (1) depression in one individual may induce depression in their contacts (induction); (2) Individuals experiencing depression tend to establish friendships with others who are depressed (homophily); (3) individuals within a social network, such as those residing in certain areas, might encounter unobserved factors, like living in socioeconomically deprived areas, leading to the clustering of poor mental health (Rosenquist, Fowler and Christakis, 2011). This raises the question: how does the clustering of poor mental health at area level influence individual mental health? The clustering of either positive or negative mental health can reinforce behaviours and attitudes that are either beneficial or detrimental to mental health. Empirical studies indicate that changes in depression level are strongly associated with the mental health of neighbouring individuals (Rosenquist, Fowler and Christakis, 2011). In this study, the primary investigation focuses on the association between social capital and mental health. Additionally, the study explores the relationship between socially contagious mental health at the area level and individual mental health. Finally, areas marked by homogeneous friendship networks suggest a less diverse composition in residents' social networks, a factor that could reinforce existing social patterns (homophily)(Ramos *et al.*, 2024).

Methods

Data

The analytic sample for the present study was derived from UKHLS data (University of Essex, Institute for Social and Economic Research, 2022) and National Statistics (Ministry of Housing, Communities & Local Government, 2011). The analytic data were drawn from Waves 1, 3, 6, 9, and 12, as these waves contain the key variables of interest related to various forms of social capital. The analytic sample comprised 10,060 unique individuals, selected based on the following criteria (Table 4.1): respondents aged 16 and under with complete data control variables at baseline (Wave 1), including employment status (economically active or inactive), physical health, gender, ethnicity, educational attainment, marital status, gross household income, modified OECD equivalence scale, urban or rural residence, and long-standing illness and disability. Area-level variables were linked to counties (e.g., Essex and Norfolk) in England. Only households located in England were selected. In sensitivity analyses, the analytic sample remained at 8,920 respondents after excluding counties with fewer than 100 respondents.

Table 4.1 Exclusions and total observations (n = 10,060)

Waves / Variables	Number of observations excluded	Total observation
Respondents of Waves 1, 3, 6, 9, 12		10,430
Wave 1 (Baseline)		
Age below 16 and missing data	2	10428
Elements of control variables		
Employment states (missing, refusal, don't know)	1	10427
Physical health (missing, inappropriate, and proxy)	5	10422
Gender (inconsistent)	0	10422
Ethnic minority (missing)	0	10422
Educational attainment (missing)	9	10413
Marital status (missing and Under 16 years)	4	10409
Gross household income (missing)	0	10409
Modified OECD equivalence scale (missing)	4	10405
Urban	0	10405
Long-standing illness and disability	345	10060

Measures

Health outcome. Mental health is the health outcome in this study, measured using the SF12-Mental Component Summary (MCS) (Refer to Chapter 1 Definitions for details). A higher MCS score indicates better mental health, with scores ranging from 0 to 100.

Social capital elements. Social capital, a multifaceted construct in this study, is divided into two components: structural and cognitive social capital (Moore and Kawachi, 2017; Flores *et al.*, 2018). Structural social capital, emphasising the nature and intensity of participation in networks and memberships, facilitates connections among groups and individuals (Flores *et al.*, 2018). In contrast, cognitive social capital focuses on the perceived quality of social relationships, encompassing norms and reciprocity (Moore and Kawachi, 2017; Flores *et al.*, 2018).

In this study, I utilised homogenous friendship networks and civic engagement to represent structural social capital, while trust and cooperative norms were used to signify cognitive social capital. Homogenous friendship networks, a dimension of structural social capital, were assessed based on the proportion of friends sharing similarities in age, educational level, income, and race. The responses were reverse-coded, ranging from 1 (indicating a low homogeneity in friendship networks) to 4 (indicating high homogeneity). This variable appears in the UKHLS at Waves 3, 6, and 9. Civic engagement, another aspect of structural social capital, was quantified based on the extent of respondents' participation in 16 different organisations, including political party, trade unions, member of environmental group, member of environmental group, parents / school association, tenants / residents group, religious / church organisation, voluntary services group, pensioners group / organisations, scouts / guides organisation, professional organisation, other community group, social / working men club, sport club, WI/Townswomen's Guild, Women's group / Fem organisation, and others.

The scoring ranged from 0 to 16, where higher scores indicate greater participation. This measure is included in the UKHLS at Waves 3, 6, 9, and 12. For cognitive social capital, trust and cooperative norms were gauged using the neighbourhood social cohesion scale from the Project on Human Development in Chicago Neighborhoods (PHDCN). This scale is present in the UKHLS at Waves 3 and 6 and consists of four items: close-knit neighbourhood, willingness to help neighbours, trustworthiness of neighbours, and neighbourhood harmony, with the first three items being reverse-coded. Scores range from 1 (strongly disagree) to 5 (strongly agree).

Contextual variables. In this study, four contextual variables were used: homogeneous friendship networks, civic engagement, trust and cooperative norms, and mental health at the collective level. These variables were aggregated at the level of counties from corresponding individual-level data. In main analyses, the sample sizes of these contextual variables across counties ranged from 2 to 1457 respondents (refer to Appendix Table 1), whereas in sensitivity analyses, sample size ranged from 112 to 1,438 respondents (refer to Appendix Table 2).

Control variables. Control variables in this study include IMD 2010, gender, ages, socioeconomic status (i.e., household income, educational attainment, and employment status), urbanity, marital status, and long-standing illness and disability, mental health at baseline (Wave 2) (Araya *et al.*, 2006; Ziersch *et al.*, 2009; Berry and Welsh, 2010; Hamano *et al.*, 2010; Nieminen *et al.*, 2010; Bassett and Moore, 2013). These adjustments were made to mitigate spurious correlations in three key associations: the relationship between area mental health and individual mental health, the association between area social capital elements and individual social capital elements, and the relationship between social capital elements and mental health. In selecting control variables, the study carefully excluded those that might mediate these key relationships (van Zwieten *et al.*, 2022). IMD in 2010, categorised into five quintiles, measured area deprivation, with higher quintiles indicating poorer areas. Gender was categorised into men (reference) and women. Age was recorded as 90 for participants older than 89, and observations of those younger than 16 were excluded. Household income was divided by the value of the modified OECD equivalence scale, resulting in the calculation of equivalised household income. This equivalised income accounts for the varying needs of households of different sizes. Subsequently, the hyperbolic sine transformation was applied to these equivalised incomes to address skewness in the income distribution (Jan Helmdag, 2017). Educational attainment was categorised into degree (reference), A level or equivalent, GCSE or equivalent, and no qualification. Employment status was grouped into employed (reference) and inactive, with the latter encompassing various conditions including unemployment, retirement, and others. Urbanity was classified into urban (reference) or rural households. Marital status includes married (reference), divorced or separated, widowed, and never married. Long-standing illness and disability were categorised into those with (reference group) and without. Finally, mental health at baseline was also adjusted.

Analysis

Autoregressive cross-lagged models, a specific category of structural equation models (SEMs) suited for longitudinal data analysis, were deployed to investigate both the direct and inverse relationships between social capital and mental health, concurrently considering the association between area characteristics and individual social capital and mental health. Both social capital elements and mental health were treated as time-varying variables, enabling the analysis of direct and inverse relationships across time points. In this integrated autoregressive cross-lagged model, autoregressive models play a crucial role in analysing the associations between variables measured repeatedly, such as the paths between social capital elements and the paths between mental health (Selig and Little, 2012; Lim, Kim and Choi, 2023). Cross-lagged models, meanwhile, were utilised to examine the relationship between social capital elements at time $t-3$ (e.g., from Wave 3 to Wave 6) and mental health at time t, as well as the association between mental health at time $t-3$ and social capital at time t (Lim, Kim, and Choi, 2023).

Furthermore, to mitigate bias from omitted variables and edge closer to causal inference, the models included adjustments for initial mental health and baseline confounders at Wave 1. This method posits that the predictors are not correlated with the error term once these unobserved variables have been adjusted for, across different waves (Jeffrey M Wooldridge, 2010). Nevertheless, the challenge of eliminating bias from unobserved variables persists due to potential omissions. Moreover, the study used cluster robust standard errors, which do not assume independence among clusters (Mansournia *et al.*, 2021).

I attempted to incorporate full information maximum likelihood (FIML) into the models to address missing data. However, certain models, such as the model of area civic engagement, failed to converge when FIML was applied. As a result, FIML was excluded from the model of area civic engagement. It is worth noting that, as Lai (2021) highlights, goodness-of-fit indices, such as RMSEA, are problematic in FIML models. Accordingly, goodness-of-fit metrics were reported only for models without FIML, including the models of area homogeneous friendship networks and area trust and cooperative norms.

Analyses of this study were done using the following: CLUSTER = pidp, TYPE = COMPLEX, and ESTIMATOR = MLR (Linda K. Muthén and Bengt O. Muthén, 2017).

Both CLUSTER = pidp and TYPE = COMPLEX were specified to set up cluster-robust standard errors in Mplus. Additionally, the integration of Type = COMPLEX and ESTIMATOR = MLR was used to adjust estimates and standard errors again violations of normality and independence in data. The same standards for goodness-of-fit are applied consistently throughout the chapters; for further details, please refer to Chapter One.

Sensitivity analyses were also performed following the same approach. It is important to note that contextual variables were reported by a relatively small number of residents in some counties. For instance, in certain counties, only two individuals responded to questions related to contextual variables. To ensure robustness, counties with fewer than 100 respondents were excluded from the analyses, resulting in a minimum of 112 respondents per county for the included data in sensitivity analyses.

Results

Descriptive Statistics

Table 4.2 presents the descriptive statistics for this study, including proportions and means. The table reports on health outcomes, individual social capital, area-level contexts, and control variables at Wave 1, which served as the study's baseline. The SF12 MCS scores ranged between 48.38 and 50.37 across Waves 3, 6, 9, and 12.

Regarding structural social capital, the scores for homogeneous friendship networks were 11.47, 11.43, and 11.66 points at Wave 3, 6, and 9, respectively. People averagely participated in 2.32, 1.85, 1.27, and 0.78 of civic engagement at Wave 3, 6, 9, and 12, respectively. These results suggest that most participants were involved in one to two societies. The cognitive social capital, measured by trust and cooperative norms, scored 14.52 at Wave 3 and 14.94 at Wave 6.

At the level of county, the average mental health scores were 49.70, 50.36, 49.48, and 48.37 at Wave 3, 6, 9, and 12, respectively. Scores for homogeneous friendship networks at the area level were 11.48 at Wave 3, 11.42 at Wave 6, and 11.66 at Wave 9. Civic engagement at the area level was 2.31, 1.84, 1.26, and 0.78 points at Waves 3, 6, 9, and 12, respectively.

Concerning control variables, 20.15% of individuals resided in the least depressed areas, while 19.86% lived in the most deprived areas. The gender distribution was 41.83% male and 58.17% female, with an average age of 47 years (SD = 15). In terms of SES, 29.17% of respondents held a degree, 31.01% had A-level qualifications, 29.47% had GCSEs, and 10.34% had no qualifications. Employment status showed that 62.64% were employed, with the remainder unemployed or inactive. A majority, 80.10%, resided in urban areas. Marital status was distributed as follows: 70.44% married, 9.59% divorced or separated, 3.84% widowed, and 16.13% never married. Additionally, 35.96% reported long-standing illnesses or disabilities. Lastly, the baseline SF-12 MCS score was 50.96.

Table 4.2 Descriptive statistics: The UK Household Longitudinal Study, Waves 1, 3, 6, and 12

Variables	Mean / %	Standard deviation (SD)	Observations
Health outcomes			
SF-12 Mental Component Summary W3 (0-100)	49.72	9.35	9,188
SF-12 Mental Component Summary W6 (0-100)	50.37	9.43	9,637
SF-12 Mental Component Summary W9 (0-100)	49.49	10.11	9,692
SF-12 Mental Component Summary W12 (0-100)	48.38	10.39	9,808
Individual Social Capital			
Structural social capital			
Homogenous friendship networks W3 (4-16)	11.47	2.46	8,458
Homogenous friendship networks W6 (4-16)	11.43	2.44	7,755
Homogenous friendship networks W9 (4-16)	11.66	2.52	8,346
Civic engagement W3 (0-16)	2.32	1.33	1,412
Civic engagement W6 (0-16)	1.85	1.15	5,896
Civic engagement W9 (0-16)	1.26	1.25	8,124
Civic engagement W12 (0-16)	.78	1.06	9,900
Cognitive social capital			
Trust and cooperative norms W3 (4-20)	14.52	2.53	9,755
Trust and cooperative norms W6 (4-20)	14.94	2.45	9,511
Area level contexts			
Area mental health W3 (0-100)	49.70	0.80	10,060

Variables	Mean / %	Standard deviation (SD)	Observations
Area mental health W6 (0-100)	50.36	0.99	10,060
Area mental health W9 (0-100)	49.48	1.02	10,060
Area mental health W12 (0-100)	48.37	.93	10,060
Area homogenous friendship networks W3 (4-16)	11.48	.46	10,060
Area homogenous friendship networks W6 (4-16)	11.42	.46	10,060
Area homogenous friendship networks W9 (4-16)	11.66	0.50	10,060
Area civic engagement W3 (0-16)	2.31	0.24	10,060
Area civic engagement W6 (0-16)	1.84	0.14	10,060
Area civic engagement W9 (0-16)	1.26	0.15	10,060
Area civic engagement W12 (0-16)	.78	0.14	10,060
Area trust and cooperative norms W3 (4-20)	14.51	0.42	10,060
Area trust and cooperative norms W6 (4-20)	14.94	0.42	10,060
Control variables			
IMD 2010			
0-20% (%)	20.15		2,027
20%-40% (%)	19.94		2,006
40%-60% (%)	19.94		2,006
60%-80% (%)	20.11		2,023
80%-90% (%)	19.86		1,998
Total			10060
Gender			
Men (%)	41.83		4,208
Women (%)	58.17		5,852
Total			10060
Age (16-89)	47	15	10,060

Variables	Mean / %	Standard deviation (SD)	Observations
SES			
Gross household income	8.05	0.99	10,060
Educational attainment			
Degree (%)	29.17		2,935
A level or equivalent (%)	31.01		3,120
GCSE or equivalent (%)	29.47		2,965
No qualification (%)	10.34		1,040
Total			10060
Employment status			
Being employed (%)	62.64		6,302
Being unemployed / inactive (%)	37.36		3,758
Total			10060
Urbanity			
Urban (%)	80.10		8,058
Rural (%)	19.90		2,002
Total			10060
Marital status			
Married (%)	70.44		7,086
Divorced/ separated (%)	9.59		965
Widowed (%)	3.84		386
Never married (%)	16.13		1,623
Total			10060
Long-standing illness and disability			
No (%)	64.04		6,442
Yes (%)	35.96		3,618
Total			10060
SF-12 Mental Component Summary (0-100)	50.96	9.21	10,060

The associations between structural social capital and mental health: homogenous friendship networks and mental health at both individual and area levels

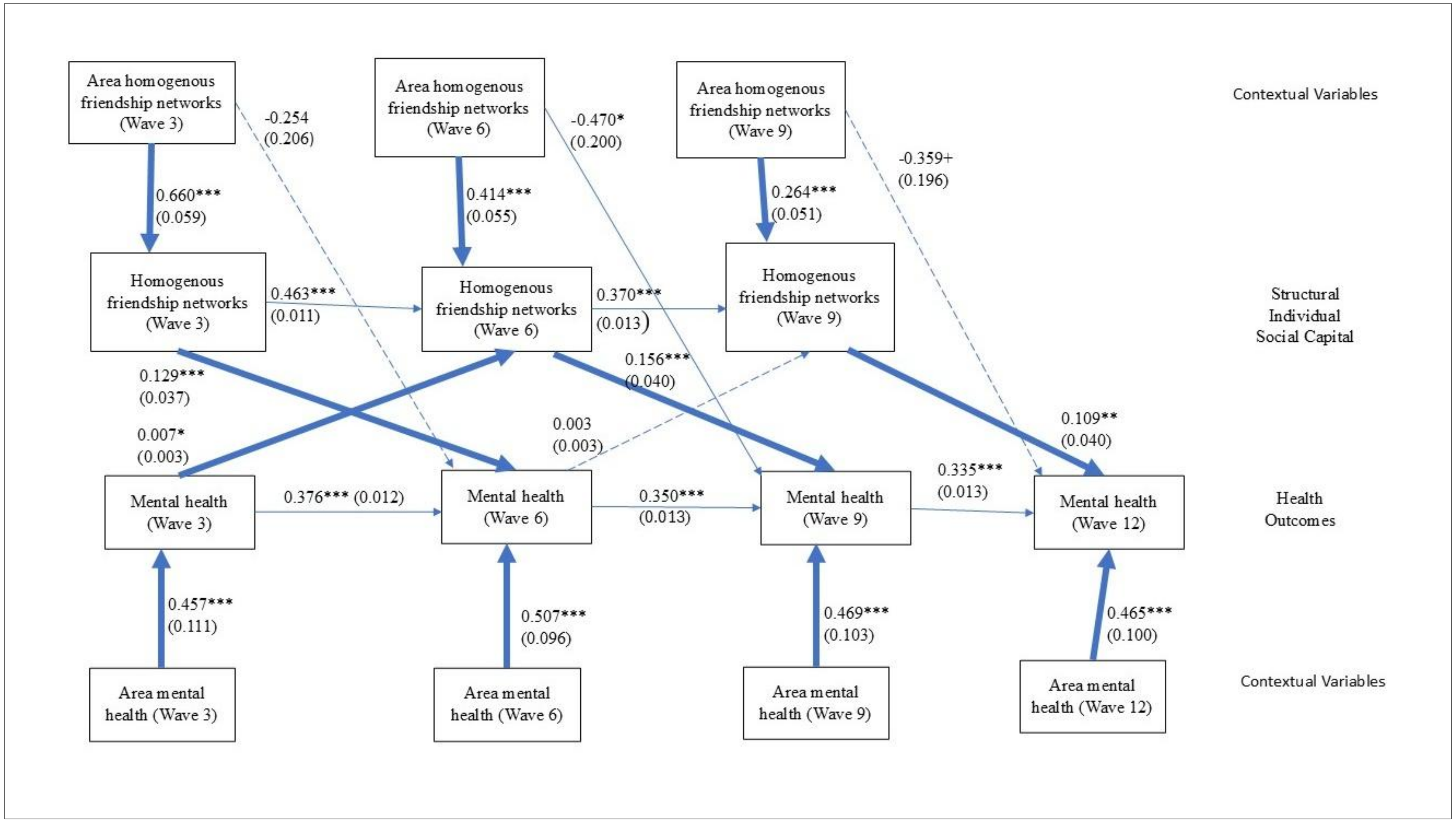
Figure 4.1 presents the results from autoregressive cross-lagged models, examining the relationships between homogenous friendship networks and mental health at both individual and area levels (See also Appendix Table 3). I will discuss the direct and reverse associations below.

There are direct associations between homogenous friendship networks and mental health outcomes. Specifically, an increase of one point in area homogenous friendship networks at Wave 3 was associated with a corresponding 0.660-point increase in homogenous friendship networks at Wave 3 ($p < 0.001$, 95% CI = 0.544, 0.776). The increase of a point in homogenous friendship networks at Wave 3 was associated with 0.129 points increase in mental health at Wave 6 ($p < 0.001$, 95% CI = 0.057, 0.202). Similarly, an increase of one point in the homogeneity of friendship networks at the county level at Wave 6 corresponded to a 0.414 -point rise in homogeneous friendship networks at Wave 6 ($p < 0.001$, 95% CI = 0.306, 0.522). A one-point increment in homogeneous friendship networks at Wave 6 was associated with a 0.156-point increase in mental health outcome by Wave 9 ($p < 0.001$, 95% CI = 0.077, 0.235). The pattern continued into Wave 9, with the results showing that a one-point increase in network homogeneity at Wave 9 was associated with a 0.109-point increase in mental health outcome by Wave 12 ($p < 0.01$, 95% CI = 0.032, 0.187).

In terms of reverse association, residing in areas with lower mental health at Wave 3 was significantly associated with a reduction in personal mental health at the same wave. Additionally, a decrease of one point in mental health at Wave 3 corresponded to a subsequent 0.007-point reduction in homogeneous friendship networks at Wave 6 ($p < 0.05$, 95% CI = 0.001, 0.013). In contrast, living in areas with poor mental health at Wave 6 was connected to a 0.507-point decrease in mental health at the same wave ($p < 0.001$, 95% CI = 0.318, 0.696). However, mental health at Wave 6 did not show a significant correlation with homogeneous friendship networks at Wave 9.

In sum, this study suggests that the relationships between homogenous friendship networks and mental health were bi-directional although the associations were not consistently significant. Moreover, residing in areas characterised by poor mental health and high levels of homogeneous friendship networks correlated with poor personal mental health and high network homogeneity. These associations were consistently significant.

Figure 4.1 The relationships between area homogeneous friendship networks, homogeneous friendship networks, area mental health, and mental health: The UK Household Longitudinal Study, Waves 1, 3, 6, 9, and 12 (N = 10060)



Note: Estimates were adjusted for IMD 2010, gender, age, socioeconomic status (i.e., gross household income, educational attainment, and employment status), urbanity, marital status, and long-standing illness and disability, as well as mental health at Wave 1 (baseline). Bold lines indicate significant paths relevant to the hypotheses; dashed lines denote non-significant paths also pertinent to the hypotheses. Solid lines represent significant paths not relevant to the hypotheses. Cluster-robust standard errors were presented in parentheses. * p<0.05, **p < 0.01, *** p<0.001

The associations between structural social capital and mental health: civic engagement and mental health at both individual and area levels

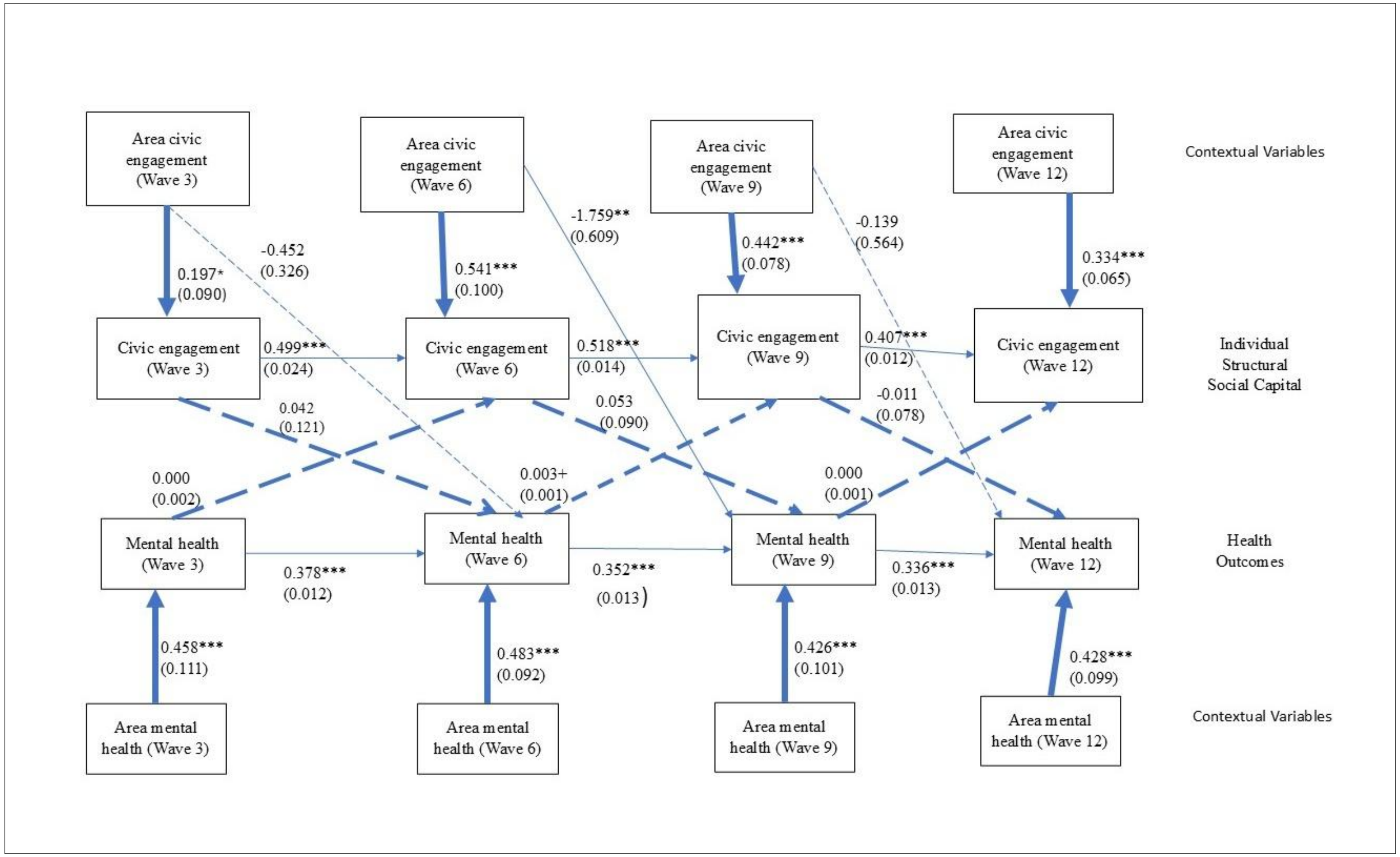
This research employed an autoregressive cross-lagged model to examine the bi-directional associations between civic engagement and mental health, taking these variables into account at both the area and individual levels (Figure 2 and Appendix Table 4). The analysis revealed no significant relationships between civic engagement and mental health outcomes.

Significant relationships were found in the associations between area civic engagement and civic engagement. Specifically, an increase in area civic engagement at Wave 3 was associated with better civic engagement (coefficient = 0.197, $p < 0.05$, 95% CI = 0.020, 0.373). Additionally, a one-point decrease in area civic engagement at Wave 6 was associated with a 0.541-point decrease in civic engagement at the same wave ($p < 0.001$, 95% CI = 0.345, 0.736). A similar trend was identified at Wave 9, where a decrease in area civic engagement corresponded with a 0.442-point decrease in civic engagement ($p < 0.001$, 95% CI = 0.290, 0.594). This pattern was also persist at Wave 12.

This study also indicated that individuals residing in areas with lower mental health scores exhibit poorer mental health. A one-point increase in area mental health at Wave 3 was associated with a 0.458-point increase in mental health. Moreover, an increase in area mental health at Wave 6 was associated with better mental health at the same wave (coefficient = 0.483, $p < 0.001$, 95% CI = 0.302, 0.664). Area mental health at Wave 9 was also associated with a 0.426-point increase in mental health ($p < 0.001$, 95% CI = 0.228, 0.624). A similar trend was observed at Wave 12, where an increase in area mental health predicted better mental health (coefficient = 0.428, $p < 0.001$, 95% CI = 0.233, 0.623). The model fit was good, with an RMSEA of 0.050, a CFI of 0.993, and the TLI of 0.972.

In summary, this study found that poor mental health was not associated with a decline in subsequent civic engagement. Similarly, no relationship was identified between civic engagement and subsequent mental health. Additionally, significant correlations were observed between area and personal civic engagement, as well as area and personal mental health.

Figure 4.2 The relationships between area civic engagement, civic engagement, area mental health, and mental health: The UK Household Longitudinal Study, Waves 1, 3, 6, 9, and 12 (N = 10057)



Note: Estimates were adjusted for IMD 2010, gender, age, socioeconomic status (i.e., gross household income, educational attainment, and employment status), urbanity, marital status, and long-standing illness and disability, as well as mental health at Wave 1 (baseline). Bold lines indicate significant paths relevant to the hypotheses; dashed lines denote non-significant paths also pertinent to the hypotheses. Solid lines represent significant paths not relevant to the hypotheses; dashed solid lines denote non-significant paths not relevant to hypotheses. Cluster-robust standard errors were presented in parentheses. * p<0.05, **p < 0.01, *** p<0.001

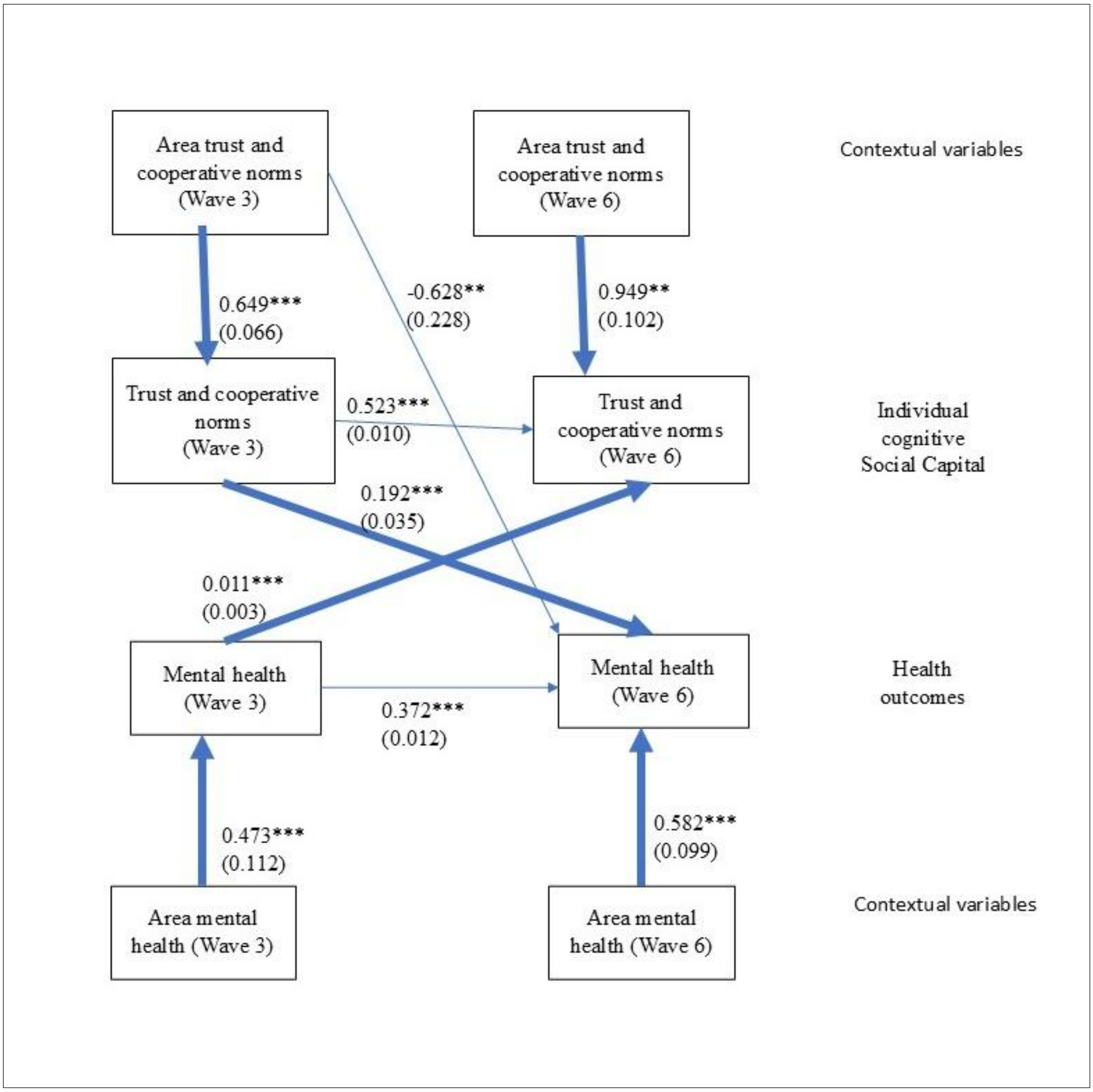
The associations between cognitive social capital and mental health: trust and cooperative norms at both individual and area levels

Figure 4.3 presents the autoregressive cross-lagged model results, exploring the reciprocal relationships between trust, cooperative norms, and mental health at both individual and area levels (See also Appendix Table 5). Both area trust and cooperative norms, as well as area mental health, were independently associated with personal trust, cooperative norms, and mental health. Specifically, a one-point increase in area trust and cooperative norms at Wave 3 correlated with a 0.649 increase in trust and cooperative norms at Wave 3 ($p < 0.001$, 95% CI = 0.521, 0.778). A similar trend was observed at Wave 6, where an increase in area trust and cooperative norms corresponded with a 0.949-point increase in trust and cooperative norms ($p < 0.001$, 95% CI = 0.750, 1.148). A one-point decline in area mental health at Wave 3 corresponded to a 0.473 reduction in mental health at Wave 3 ($p < 0.01$, 95% CI = 0.254, 0.691). Similar trend was observed between area mental health at Wave 6 and mental health at Wave 6 (Coefficient = 0.582, $p < 0.001$, 95% CI = 0.388, 0.777).

Additionally, lower trust and cooperative norms at Wave 3 was associated with a poor mental health at Wave 6 (coefficient = 0.192, $p < 0.001$, 95% CI = 0.122, 0.261). Conversely, poor mental health at Wave 3 was associated with a subsequent decrease in trust and cooperative norms at Wave 6 (coefficient = 0.011, $p < 0.001$, 95% CI = 0.005, 0.016).

In summary, enhancements in trust and cooperative norms, as well as in mental health within areas, were associated with higher levels of both characteristics at the individual level. Moreover, elevated trust and cooperative norms were associated with better mental health at subsequent wave, and individuals with good mental health similarly exhibited higher levels of trust and cooperative norms at subsequent wave.

Figure 4.3 The relationships between trust and cooperative norms and mental health: The UK Household Longitudinal Study, Waves 1, 3 and 6 (N =10060).



Note: Estimates were adjusted for IMD 2010, gender, age, socioeconomic status (i.e., household income, educational attainment, and employment status), urbanity, marital status, and long-standing illness and disability, as well as mental health at baseline. Bold lines indicate significant paths relevant to the hypotheses; dashed lines denote non-significant paths also pertinent to the hypotheses. Solid lines represent significant paths not relevant to the hypotheses. Cluster-robust standard errors were presented in parentheses. *p<0.05, **p<0.01, ***p<0.001

Sensitivity Analysis: the associations between homogenous friendship networks and mental health at both individual and area levels

Figure 4.4 examines the relationship between homogeneous friendship networks and mental health at individual and area levels (See also Appendix Table 6). The exclusion of counties with fewer than 100 respondents made little difference to the results. Sensitivity analyses indicated that most coefficients were smaller, while cluster-robust standard errors were generally larger compared to the main analyses (Shown in Appendix Table 2).

Notably, higher levels of homogeneous friendship networks were predictive of better mental health. A one-point increase in homogeneous friendship networks at Wave 3 was associated with a 0.114-point increase in mental health at Wave 6 ($p < 0.01$, cluster-robust standard error = 0.040, 95% CI: 0.037–0.191). In the main analysis, the coefficient was larger (0.129, $p < 0.001$) and the cluster-robust standard error smaller (0.037). Furthermore, homogeneous friendship networks at Wave 6 were positively associated with mental health at Wave 9, with a coefficient of 0.167 (cluster-robust standard error = 0.042, $p < 0.001$, 95% CI: 0.084, 0.250). In the main analysis, the both estimate (coefficient = 0.156) and cluster-robust standard error (0.040) were smaller. Similarly, a one-point increase in homogeneous friendship networks at Wave 9 corresponded to a 0.129-point increase in mental health at Wave 12 (cluster-robust standard error = 0.042, $p < 0.01$, 95% CI: 0.046, 0.212). For this association, the main analysis showed a smaller coefficient (0.109) and a smaller cluster-robust standard error of 0.040.

Furthermore, better mental health predicted higher levels of homogeneous friendship networks. Specifically, a one-point increase in mental health at Wave 3 corresponded to a 0.008-point increase in homogeneous friendship networks at Wave 6 ($p < 0.01$, 95% CI: 0.002, 0.015). In the main analysis, the coefficient was smaller (0.007), although the cluster-robust standard error remained the same (0.003). However, the association between mental health at Wave 6 and homogeneous friendship networks at Wave 9 was not significant in either the sensitivity or main analyses.

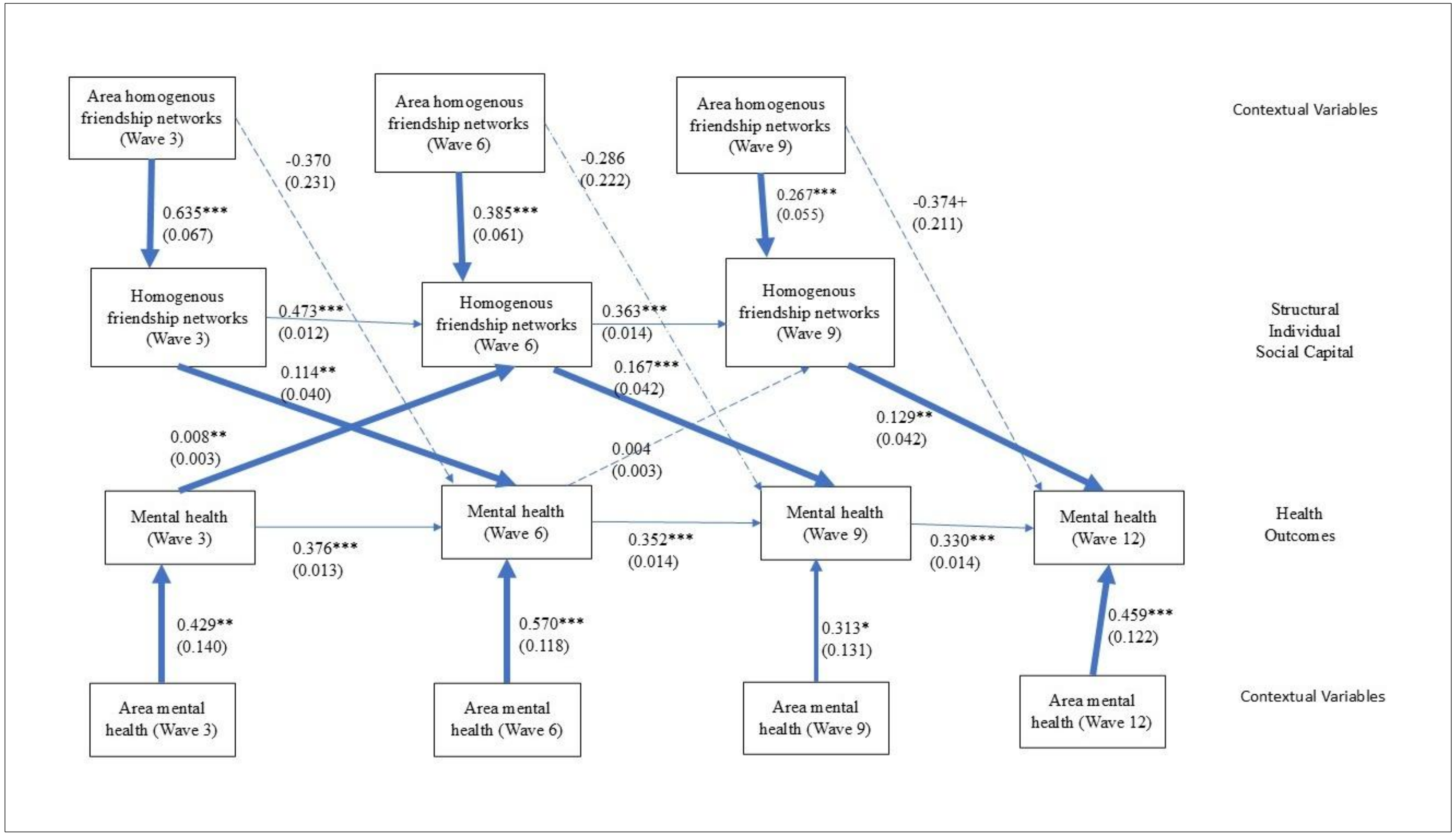
In addition, both area-level homogeneous friendship networks and area-level mental health were independently associated with individual homogeneous friendship networks and mental health. For example, a one-point increase in area-level homogeneous friendship networks at Wave 3 was associated with a 0.635-point increase in individual homogeneous friendship networks at Wave 3 (cluster-robust standard error = 0.067, $p < 0.001$, 95% CI: 0.505, 0.766). In the main analysis, the coefficient was larger (0.660, $p < 0.001$) and the cluster-robust standard error smaller (0.059). Similarly, area-level homogeneous friendship networks at Wave 6 were positively associated with individual homogeneous friendship networks at Wave 6 (coefficient = 0.385, cluster-robust standard error = 0.061, $p < 0.001$, 95% CI: 0.264, 0.505). In the main analysis, the coefficient was higher (0.414, $p < 0.001$) and the cluster-robust standard error smaller (0.055). A similar trend was observed in the association between area-level homogeneous friendship networks at Wave 9 and individual homogeneous friendship networks at Wave 9, with a coefficient of 0.363 (cluster-robust standard error = 0.055, $p < 0.001$, 95% CI: 0.335, 0.391). Compared to the main analysis, where the coefficient was smaller (0.264, cluster-robust standard error = 0.051), the sensitivity analysis produced a larger coefficient but also a larger cluster-robust standard error.

A one-point increase in area-level mental health at Wave 3 was associated with a 0.429-point increase in mental health at Wave 3 (cluster-robust standard error = 0.140, $p < 0.01$, 95% CI = 0.156, 0.703). In the main analysis, the coefficient was higher (0.457, $p < 0.001$) and the cluster-robust standard error smaller (0.111). Additionally, area-level mental health at Wave 6 was positively associated with mental health at Wave 6, with a coefficient of 0.570 (cluster-robust standard error = 0.118, $p < 0.001$, 95% CI = 0.339, 0.801). In the main analysis, the coefficient was smaller (0.507, $p < 0.001$) and the cluster-robust standard error smaller (0.096).

Similar patterns were observed in the associations between area-level mental health and individual mental health in later waves. For example, area-level mental health at Wave 9 was associated with a 0.313-point increase in individual mental health at Wave 9 (cluster-robust standard error = 0.131, $p < 0.05$, 95% CI: 0.056–0.570). Similarly, a one-point increase in area-level mental health at Wave 12 corresponded to a 0.459-point increase in individual mental health at Wave 12 (cluster-robust standard error = 0.122, $p < 0.001$, 95% CI: 0.046–0.212). In the main analyses, both associations showed larger coefficients and smaller cluster-robust standard errors. Specifically, at Wave 9, the coefficient was 0.469 with a cluster-robust standard error of 0.103. At Wave 12, the coefficient was 0.465 with a cluster-robust standard error of 0.100.

In summary, both area-level homogeneous friendship networks and area-level mental health were correlated with individual homogeneous friendship networks and individual mental health in both the main and sensitivity analyses. Notably, the reciprocal associations between homogeneous friendship networks and mental health were observed across both sets of analyses. Importantly, most hypotheses-related associations showed smaller estimates in the sensitivity analysis compared to the main analysis. Additionally, the cluster-robust standard errors were generally larger in the sensitivity analysis.

Figure 4.4 Sensitivity Analysis: The relationships between area homogeneous friendship networks, homogeneous friendship networks, area mental health, and mental health in the UK Household Longitudinal Study across Waves 1, 3, 6, 9, and 12 (N =8920)



Note: Estimates were adjusted for IMD 2010, gender, age, socioeconomic status (i.e., gross household income, educational attainment, and employment status), urbanity, marital status, and long-standing illness and disability, as well as mental health at Wave 1 (baseline). Bold lines indicate significant paths relevant to the hypotheses; dashed lines denote non-significant paths also pertinent to the hypotheses. Solid lines represent significant paths not relevant to the hypotheses. Cluster-robust standard errors were presented in parentheses. * p<0.05, **p < 0.01, *** p<0.001

Sensitivity analysis: the associations between civic engagement and mental health at both individual and area levels

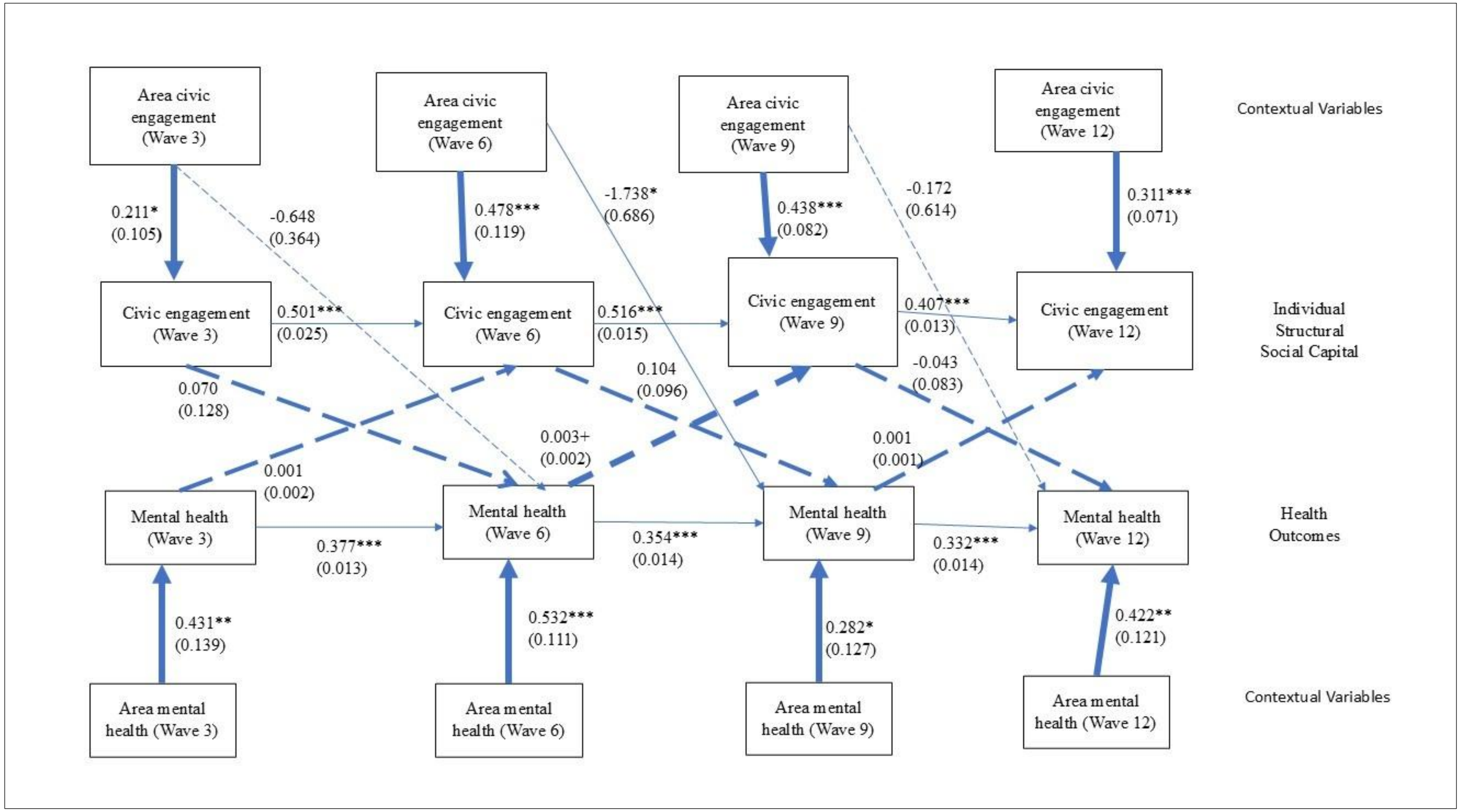
Figure 4.5 examined the associations between area civic engagement, civic engagement, area mental health, and mental health, excluding counties with fewer than 100 residents (See also Appendix Table 7). Most of the significant hypothesis relevant associations have smaller estimates and lager cluster-robust standard error in sensitivity analyses. Notably, consistent to the main analysis (See Appendix Table 3), our study found no evidence of a reciprocal relationship between civic engagement and mental health.

Moreover, area-level civic engagement was positively correlated with individual civic engagement. For example, a one-point increase in area-level civic engagement at Wave 3 was associated with a 0.211-point rise in individual civic engagement at the same wave (cluster-robust standard error = 0.105, $p < 0.05$, 95% CI: 0.005, 0.417). In the main analysis, the corresponding association was estimated at 0.197, with a cluster-robust standard error of 0.090 ($p < 0.05$), as shown in Appendix Table 3. Similarly, a one-point increase in area-level civic engagement at Wave 6 was associated with a 0.479-point increase in individual civic engagement at Wave 6 (cluster-robust standard error = 0.119, $p < 0.001$, 95% CI: 0.246, 0.710). In the main analysis, the estimate was 0.541, with a cluster-robust standard error of 0.100 ($p < 0.001$), as detailed in Appendix Table 3. At Wave 9, area-level civic engagement was positively associated with individual civic engagement (coefficient: 0.438, cluster-robust standard error = 0.082, $p < 0.001$, 95% CI: 0.278, 0.600). In the main analysis, the estimate was 0.442, with a cluster-robust standard error of 0.078 ($p < 0.001$), as shown in Appendix Table 3. Finally, at Wave 12, a one-point increase in area-level civic engagement corresponded to a 0.311-point rise in individual civic engagement (cluster-robust standard error = 0.071, $p < 0.001$, 95% CI: 0.171, 0.452). In the main analysis, the association was estimated at 0.334, with a cluster-robust standard error of 0.065 ($p < 0.001$).

Additionally, area mental health was positively associated with mental health. For instance, a one-point increase in area mental health at Wave 3 was associated with a 0.431-point increase in individual mental health at Wave 3 ($p < 0.01$, 95% CI: 0.158, 0.704). In the main analysis, the estimate was 0.458, with a cluster-robust standard error of 0.111 ($p < 0.001$). Similarly, a one-point increase in area mental health at Wave 6 was associated with a 0.532-point increase in individual mental health at Wave 6 (cluster-robust standard error = 0.111, $p < 0.001$, 95% CI: 0.315, 0.749). In the main analysis, the estimate was 0.483, with a cluster-robust standard error of 0.092 ($p < 0.001$). Higher area mental health at Wave 9 predicted better individual mental health at Wave 9 (cluster-robust standard error = 0.127, coefficient: 0.282, $p < 0.05$, 95% CI: 0.033, 0.530). In the main analysis, the estimate was 0.426, with a cluster-robust standard error of 0.101 ($p < 0.001$). A similar trend was observed at Wave 12, where a one-point increase in area mental health corresponded to a 0.422-point increase in individual mental health (cluster-robust standard error = 0.121, $p < 0.01$, 95% CI: 0.184, 0.660). In the main analysis, the estimate was 0.428, with a cluster-robust standard error of 0.099 ($p < 0.001$). This model exhibited a similar fit to the main study, with an RMSEA of 0.018, a CFI of 0.993, and a TLI of 0.975.

In summary, the findings from the sensitivity analysis were largely aligned with those of the main analysis. Specifically, civic engagement was not associated with mental health, and mental health was not associated with civic engagement. However, area-level civic engagement showed a positive relationship with individual civic engagement, while area-level mental health demonstrated a positive association with individual mental health. Most hypothesis-related estimates in the sensitivity analysis were smaller than those in the main analysis. Additionally, the sensitivity analysis yielded larger cluster-robust standard errors compared to the main analysis.

Figure 4.5 The relationships between area civic engagement, civic engagement, area mental health, and mental health: The UK Household Longitudinal Study, Waves 1, 3, 6, 9, and 12 (N =8917)



Note: Estimates were adjusted for IMD 2010, gender, age, socioeconomic status (i.e., gross household income, educational attainment, and employment status), urbanity, marital status, and long-standing illness and disability, as well as mental health at Wave 1 (baseline). Bold lines indicate significant paths relevant to the hypotheses; dashed lines denote non-significant paths also pertinent to the hypotheses. Solid lines represent significant paths not relevant to the hypotheses; dashed solid lines denote non-significant paths not relevant to hypotheses. Cluster-robust standard errors were presented in parentheses. * p< 0.05, **p < 0.01, *** p< 0.001

Sensitivity analysis: the associations between trust and cooperative norms at both individual and area levels

Figure 4.6 illustrates the association between area trust and cooperative norms, trust and cooperative norms, area mental health, and mental health, excluding counties with fewer than 10 residents (See also Appendix Table 8). The findings align closely with the main analysis. Most of the estimates in this sensitivity analysis were smaller compared to the main analysis, while the cluster-robust standard errors were larger.

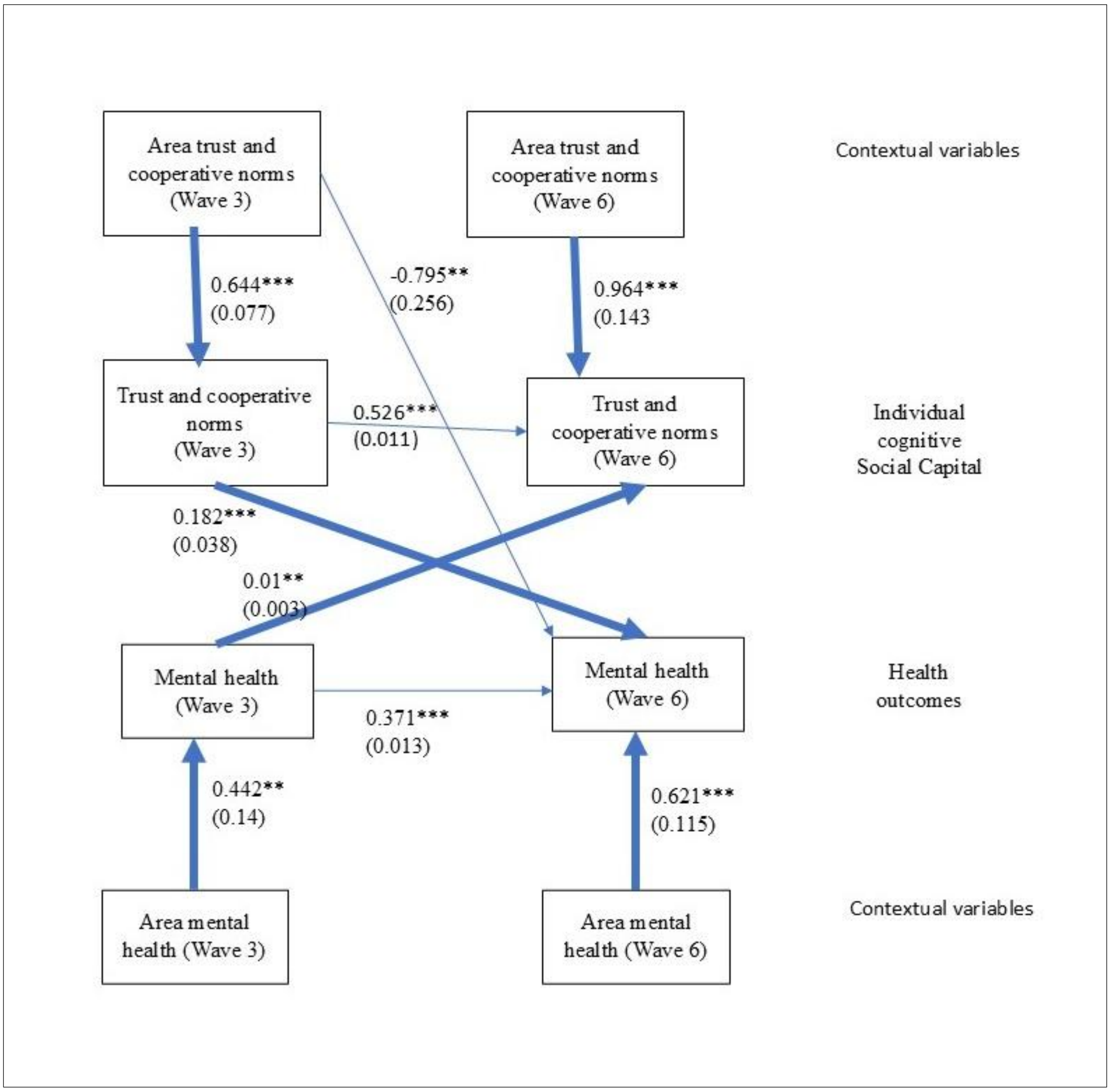
Specifically, area civic engagement was positively associated with trust and cooperative norms. For instance, a one-point increase in area trust and cooperative norms at Wave 3 corresponded to a 0.644-point increase in trust and cooperative norms at Wave 3 (cluster-robust standard error = 0.077, 95% CI = 0.494, 0.794). In the main analysis, the estimate was slightly larger at 0.649 points, and the cluster-robust standard error was smaller at 0.066. Similarly, a one-point increase in area trust and cooperative norms at Wave 6 was associated with a 0.964-point increase in trust and cooperative norms at Wave 6 ($p < 0.001$, cluster-robust standard error = 0.143, 95% CI = 0.682, 1.245).

The relationship between trust and cooperative norms was found to be reciprocal. Specifically, a one-point increase in trust and cooperative norms at Wave 3 was associated with a 0.182-point increase in mental health at Wave 6 (cluster-robust standard error = 0.038, 95% CI = 0.108, 0.256). In the main analysis, the estimate was higher at 0.192, with a cluster-robust standard error of 0.035. Conversely, in sensitivity analysis, a one-point increase in mental health at Wave 3 was associated with a 0.010-point increase in trust and cooperative norms at Wave 6 (cluster-robust standard error = 0.003, 95% CI = 0.003, 0.016). This result was highly consistent with the main analysis, which reported a coefficient of 0.011 and a cluster-robust standard error of 0.003.

Area mental health was also positively associated with mental health. Specifically, a one-point increase in area mental health at Wave 3 corresponded to a 0.442-point increase in mental health at Wave 3 ($p < 0.01$, cluster-robust standard error = 0.140). In the main analysis, the estimate was slightly higher at 0.473, with a smaller cluster-robust standard error of 0.112. Furthermore, in sensitivity analysis, a one-point increase in area mental health at Wave 6 was associated with a 0.621-point increase in individual mental health at Wave 6. In the main analysis, the corresponding estimate was 0.582 points, with a smaller cluster-robust standard error of 0.099.

In summary, the findings from both the sensitivity analysis and the main analysis were broadly consistent. However, the main analysis demonstrated smaller cluster-robust standard errors, while most hypothesis-related associations in the sensitivity analysis exhibited smaller estimates. Importantly, both area trust and cooperative norms and area mental health were positively associated with trust and cooperative norms and mental health, respectively. Moreover, the relationship between trust and cooperative norms and mental health was found to be reciprocal.

Figure 4.6 The relationships between trust and cooperative norms and mental health: The UK Household Longitudinal Study, Waves 1, 3 and 6 (N =8920)



Note: Estimates were adjusted for IMD 2010, gender, age, socioeconomic status (i.e., household income, educational attainment, and employment status), urbanity, marital status, and long-standing illness and disability, as well as mental health at baseline. Bold lines indicate significant paths relevant to the hypotheses; dashed lines denote non-significant paths also pertinent to the hypotheses. Solid lines represent significant paths not relevant to the hypotheses. Cluster-robust standard errors were presented in parentheses. *p<0.05, **p<0.01, ***p<0.001

Discussion

This study contributes to the literature concerning the relationships between area social capital, social capital and mental health. While a handful of studies have explored the association between social capital and mental health (Silva *et al.*, 2005; Stafford *et al.*, 2008; Tampubolon, 2012; Ehsan and Silva, 2015), efforts to test the direct and reverse associations between social capital and mental health have often been conducted independently (Giordano and Lindström, 2011; Yu *et al.*, 2015; Awaworyi Churchill and Smyth, 2020; Downward, Rasciute and Kumar, 2020). Notably, Yu et al. (2015) employed multilevel cross-lagged structural equation analysis to explore the bidirectional associations between social capital and mental health but did not include area-level social capital and elements such as trust, cooperative norms, and homogeneous friendship networks. The integration of social capital and mental health at both individual and area levels in understanding their interrelationships has not been examined. This study addresses this gap by analysing the association between different dimensions of social capita and mental health while considering for social capital and mental health at both the individual and area levels (i.e., counties). In the main analyses, each county of England at least has 2 to 1457 individuals across Wave 3, 6, 9, and 12 (See Appendix Table 1), while, in sensitivity analyses, each county at least has 112 to 1438 individuals across Wave 3, 6, 9, and 12 (See Appendix Table 2). The main findings and their implications are discussed in the subsequent sections.

Firstly, this study revealed that while civic engagement showed no significant association with mental health, homogeneity in friendship networks was positively correlated with mental health outcomes. These findings align with Ehsan and Silva's (2015) meta-analysis, which indicated no significant relationship between civic engagement and common mental disorders. Additionally, the positive association between homogeneous friendship networks and mental health found in this study is consistent with the findings of Awaworyi Churchill and Smyth (2020). However, this study broadens the scope of homogeneity in friendship networks beyond race and religion, as examined by Awaworyi Churchill and Smyth (2020), to encompass additional variables such as age, educational attainment, income levels, and race. Furthermore, while previous studies like Yu et al. (2015) have assessed structural social capital by examining elements such as civic participation and the frequency of social network interactions, this study takes a different approach by focusing on the similarities among network members. It suggests that health practitioners could promote mental health by encouraging clients to connect with people who share similar background in age, educational attainment, income, and race. These people may share similar values and beliefs. Such connections may facilitate mutual understanding and, potentially, better mental health outcomes.

Secondly, this study found that individuals with poorer mental health were more likely to have less homogeneous friendship networks in subsequent waves, compared to individuals with better mental health. However, mental health was not associated with later civic engagement. This contrasts with prior research (Ding, Berry and O'Brien, 2015; Yu *et al.*, 2015), which identified positive associations between good mental health and subsequent structural social capital, such as high civic engagement and strong social networks. Unlike these studies, this research also focused on the relationship between mental health and homogeneous friendship networks. These findings underscore the importance of considering potential reverse associations when examining the association between the homogeneity of friendship networks and mental health.

Thirdly, this study demonstrated an association between high trust and cooperative norms and good mental health outcomes, with good mental health also being related to subsequent high trust and cooperative norms. These results align with those of previous studies (Fujiwara and Kawachi, 2008; Giordano and Lindström, 2011; Ehsan and Silva, 2015;

Roychowdhury, 2021), highlighting the reciprocal nature of these relationships. The findings underscore the importance of considering potential reverse associations when investigating the link between trust and cooperative norms and mental health. To enhance mental health, the government should focus on developing social infrastructure, such as pubs and green spaces. Such infrastructure provides spaces for citizens to interact and build social capital (Digital, Culture, and Media & Sport, 2022). Positive interactions in these spaces can foster trust among residents, contributing to the overall social capital and mental health of the community.

Fourthly, this study shows a correlation between the characteristics of areas and those of the individuals residing in them. For instance, there is a positive relationship found across different waves between area social capital – encompassing elements like homogeneous friendship networks, civic engagement, and trust and cooperative norms – and similar aspects of personal social capital. Additionally, the research indicates that individuals living in areas with high mental health scores are more likely to report good mental health. These associations were not consistently significant. Despite the potential influence of mathematical coupling—where the dependent variable incorporates elements from the independent variables—on these associations (Knies and Kumari, 2022), variations in area social capital and mental health across different counties of England suggest differences. Without such variations, it would be impossible to discern these associations. Social contagion and collective socialisation could explain these associations (Rosenquist, Fowler and Christakis, 2011; Galster, 2012). The findings suggest that individuals with high social capital elements and poor mental health tend to live in regions that exhibit these characteristics.

Strengths and limitations. A primary strength of this study is its exploration of the bi-directional associations between elements of social capital and mental health, integrating area characteristics into the analysis. Specifically, this research delves into the less explored territory of how area characteristics correspond with personal attributes. Additionally, the study stands out for its focused examination of civic engagement and homogeneous friendship networks when examining the association between structural social capital elements and mental health. This approach broadens the scope beyond the conventional focus on social networks and civic engagement in previous research. However, the study is not without limitations. An important constraint is the challenge of establishing causal relationships due to endogeneity, even though baseline controls were included. Additionally, this study highlights the importance of exploring the association between area characteristics and individual traits. However, it remains unclear whether living in high social capital areas and high mental health areas is directly related to personal social capital and mental health, or if it is more a case of individuals with high social capital and good mental health choosing specific regions.

Furthermore, the main analyses encountered challenges related to the small sample size of contextual variables. For instance, only two respondents reported to questions on social capital in certain counties during Wave 6 (see Appendix Table 1). This limitation may affect the generalisability of the results from the main analyses. However, after excluding counties with fewer than 100 respondents and reconstructing contextual variables using data from counties with more than 100 residents, the results remained similar with those of the main analyses. We observed that cluster-robust standard errors were smaller in the main analyses, indicating more precise estimates. In contrast, the sensitivity analyses yielded smaller estimates for hypothesis-related associations. While the main analyses offer greater precision, the estimates from the sensitivity analyses may be more suitable for generalisation, as they are based on a better representation of the contextual variables.

In summary, this study has established that the relationships between mental health and both homogeneous friendship networks, as well as trust and cooperative norms, are bidirectional. This suggests a mutual association between these elements of social capital and mental health, indicating that while social capital elements are positively related to mental health, mental health might also positively relate to these social capital components. Furthermore, the study highlights the relevance of area characteristics in Regions of England, including both structural and cognitive social capital elements and mental health, to personal characteristics. This underscores how structural and cognitive aspects of social capital, along with mental health at the area level, are associated with similar personal characteristics.

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Appendix

Table 1. Main analyses: Means, standard deviations, minimum, and maximum of respondents for county-level contextual variables across waves

Contextual variables (Wave3)	Mean	Std. dev.	Minimum	Maximum
Area homogenous friendship networks	211.82	230.08	4	1457
Area civic engagement	211.82	230.08	4	1457
Area trust and cooperative norms	211.82	230.08	4	1457
Area mental health	211.82	230.08	4	1457
Contextual variables (Wave 6)				
Area homogenous friendship networks	209.59	225.50	2	1447
Area civic engagement	209.59	225.50	2	1447
Area trust and cooperative norms	209.59	225.50	2	1447
Area mental health	209.59	225.50	2	1447
Contextual variables (Wave 9)				
Area homogenous friendship networks	209.80	223.85	3	1412
Area civic engagement	209.80	223.85	3	1412
Area mental health	209.80	223.85	3	1412
Contextual variables (Wave 12)				
Area civic engagement	214.96	213.94	10	1377
Area mental health	214.96	213.94	10	1377

Table 2. Sensitivity analyses: Means, standard deviations, minimum, and maximum of respondents for county-level contextual variables across waves

Contextual variables (Wave3)	Mean	Std. dev.	Minimum	Maximum
Area homogenous friendship networks	278.75	237.19	112	1438
Area civic engagement	278.75	237.18	112	1438
Area trust and cooperative norms	278.75	237.18	112	1438
Area mental health	278.75	237.18	112	1438
Contextual variables (Wave 6)				
Area homogenous friendship networks	284.03	236.98	115	1428
Area civic engagement	284.03	236.98	115	1428
Area trust and cooperative norms	284.03	236.98	115	1428
Area mental health	284.03	236.98	115	1428
Contextual variables (Wave 9)				
Area homogenous friendship networks	284.97	236.36	115	1401
Area civic engagement	284.97	236.36	115	1401
Area mental health	284.97	236.36	115	1401
Contextual variables (Wave 12)				
Area civic engagement	287.63	228.65	115	1366
Area mental health	287.63	228.65	115	1366

Table 3. Main analysis: autoregressive cross-lagged panel analysis of the relationships between area and personal homogenous friendship networks and area and individual mental health in the Understanding Society: The UK Household Longitudinal Study (Waves 1, 3, 6, 9, 12) (N=10060)

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Mental Health W3	ON			
area mental health W3	**0.457*** **	0.111	**0.239**	**0.675**
Age W1	**0.110*** **	0.007	**0.097**	**0.124**
Non-white W1	-0.21	0.285	-0.769	0.348
Gender W1	**-0.949*** **	0.171	**-1.283**	**-0.614**
Unemployment / inactive W1 (reference: employment)	**-0.441***	0.199	**-0.832**	**-0.05**
Long-standing illness and disability W1	**-2.207*** **	0.188	**-2.576**	**-1.838**
Household income W1	0.067	0.085	-0.1	0.234
Urbanity W1 (Rural: reference)	-0.212	0.215	-0.633	0.209
Mental health W1	**0.429*** **	0.012	**0.406**	**0.452**
2010 IMD 20%-40% (reference: IMD 0%-20%)	0.378	0.258	-0.128	0.883
2010 IMD 40%-60% (reference: IMD 0%-20%)	0.025	0.26	-0.485	0.535
2010 IMD 60%-80% (reference: IMD 0%-20%)	0.091	0.272	-0.441	0.624
2010 IMD 80%-100% (reference: IMD 0%-20%)	0.14	0.308	-0.463	0.743
Divorced W1 (reference: Married)	**-0.616***	0.31	**-1.224**	**-0.008**
Widowed W1 (reference: Married)	0.348	0.45	-0.534	1.23
Never married W1 (reference: Married)	-0.123	0.265	-0.643	0.396
No qualification W1 (reference: Degree)	-0.475	0.361	-1.184	0.233
GCSE W1 (reference: Degree)	0.109	0.218	-0.318	0.537
A-Level W1 (reference: Degree)	**0.461***	0.207	**0.055**	**0.867**
Homogenous friendship networks W3	ON			
Area homogenous friendship networks W3	**0.660*** **	0.059	**0.544**	**0.776**
Age W1	**0.017*** **	0.002	**0.013**	**0.022**
Non-white W1	**-0.857*** **	0.088	**-1.03**	**-0.684**
Gender W1	**0.113***	0.052	**0.012**	**0.215**
Unemployment / inactive W1 (reference: employment)	**0.149***	0.059	**0.033**	**0.265**
Long-standing illness and disability W1	**-0.349*** **	0.055	**-0.457**	**-0.241**
Household income W1	0.02	0.026	-0.031	0.072
Urbanity W1 (Rural: reference)	-0.088	0.065	-0.216	0.04
Mental health W1	0.023***	0.003	**0.017**	**0.029**
2010 IMD 20%-40%	0.056	0.077	-0.096	0.207

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
(reference: IMD 0%-20%)				
2010 IMD 40%-60% (reference: IMD 0%-20%)	-0.056	0.078	-0.209	0.097
2010 IMD 60%-80% (reference: IMD 0%-20%)	-0.044	0.081	-0.202	0.114
2010 IMD 80%-100% (reference: IMD 0%-20%)	0.053	0.087	-0.117	0.224
Divorced W1 (reference: Married)	**-0.455*** **	0.088	**-0.628**	**-0.282**
Widowed W1 (reference: Married)	-0.086	0.146	-0.371	0.199
Never married W1 (reference: Married)	**-0.384*** **	0.077	**-0.534**	**-0.233**
No qualification W1 (reference: Degree)	**0.774*** **	0.106	**0.566**	**0.982**
GCSE W1 (reference: Degree)	**0.415*** **	0.067	**0.284**	**0.546**
A-Level W1 (reference: Degree)	**0.265*** **	0.064	**0.14**	**0.389**
Mental health W6	ON			
Mental health W3	**0.376*** **	0.012	**0.353**	**0.4**
Homogenous friendship networks W3	**0.129*** **	0.037	**0.057**	**0.202**
Area mental health W6	**0.507*** **	0.096	**0.318**	**0.696**
Area homogenous friendship networks W3	-0.254	0.206	-0.657	0.149
Age W1	**0.082*** **	0.007	**0.069**	**0.095**
Non-white W1	-0.033	0.285	-0.592	0.527
Gender W1	**-0.673*** **	0.159	**-0.984**	**-0.361**
Unemployment / inactive W1 (reference: employment)	**-0.813*** **	0.186	**-1.177**	**-0.449**
Long-standing illness and disability W1	**-0.913*** **	0.175	**-1.255**	**-0.571**
Household income W1	0.102	0.076	-0.047	0.252
Urbanity W1 (Rural: reference)	-0.069	0.197	-0.454	0.317
Mental health W1	**0.225*** **	0.012	**0.201**	**0.249**
2010 IMD 20%-40% (reference: IMD 0%-20%)	0.01	0.238	-0.457	0.477
2010 IMD 40%-60% (reference: IMD 0%-20%)	-0.257	0.248	-0.743	0.228
2010 IMD 60%-80% (reference: IMD 0%-20%)	0.183	0.252	-0.311	0.677
2010 IMD 80%-100% (reference: IMD 0%-20%)	-0.211	0.296	-0.791	0.37
Divorced W1 (reference: Married)	**-0.756***	0.307	**-1.358**	**-0.155**
Widowed W1 (reference: Married)	0.729+	0.404	-0.063	1.521
Never married W1 (reference: Married)	-0.026	0.252	-0.52	0.468
No qualification W1 (reference: Degree)	0.056	0.317	-0.565	0.677
GCSE W1 (reference: Degree)	0.272	0.209	-0.136	0.681
A-Level W1 (reference: Degree)	0.012	0.202	-0.384	0.407

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
<u>Homogenous friendship networks W6</u>	ON			
Area homogenous friendship networks W6	**0.414*** **	0.055	**0.306**	**0.522**
Homogenous friendship networks W3	**0.463*** **	0.011	**0.442**	**0.485**
Mental health W3	**0.007* **	0.003	**0.001**	**0.013**
Age W1	**0.007*** **	0.002	**0.003**	**0.011**
Non-white W1	**-0.466*** **	0.084	**-0.631**	**-0.301**
Gender W1	0.069	0.049	-0.027	0.164
Unemployment / inactive W1 (reference: employment)	0.016	0.055	-0.092	0.124
Long-standing illness and disability W1	**-0.119* **	0.053	**-0.223**	**-0.016**
Household income W1	-0.004	0.024	-0.051	0.042
Urbanity W1 (Rural: reference)	0.000	0.062	-0.121	0.121
Mental health W1	**0.010** **	0.003	**0.004**	**0.016**
2010 IMD 20%-40% (reference: IMD 0%-20%)	0.046	0.072	-0.095	0.187
2010 IMD 40%-60% (reference: IMD 0%-20%)	0.070	0.073	-0.073	0.213
2010 IMD 60%-80% (reference: IMD 0%-20%)	0.078	0.076	-0.071	0.226
2010 IMD 80%-100% (reference: IMD 0%-20%)	0.059	0.081	-0.099	0.217
Divorced W1 (reference: Married)	**-0.356*** **	0.083	**-0.519**	**-0.194**
Widowed W1 (reference: Married)	0.183	0.144	-0.1	0.466
Never married W1 (reference: Married)	**-0.277*** **	0.07	**-0.415**	**-0.139**
No qualification W1 (reference: Degree)	0.202+	0.11	-0.013	0.417
GCSE W1 (reference: Degree)	**0.297*** **	0.062	**0.176**	**0.418**
A-Level W1 (reference: Degree)	**0.243*** **	0.058	**0.129**	**0.356**
<u>Mental health W9</u>	ON			
Mental health W6	**0.350*** **	0.013	**0.323**	**0.376**
Homogenous friendship networks W6	**0.156*** **	0.040	**0.077**	**0.235**
Area mental health W9	**0.469*** **	0.103	**0.266**	**0.672**
Area homogenous friendship networks W6	**-0.470* **	0.200	**-0.863**	**-0.078**
Age W1	**0.085*** **	0.007	**0.071**	**0.099**
Non-white W1	0.15	0.293	-0.424	0.725
Gender W1	**-0.388* **	0.166	**-0.715**	**-0.062**
Unemployment / inactive W1 (reference: employment)	**-0.798*** **	0.197	**-1.185**	**-0.411**
Long-standing illness and disability W1	**-1.040*** **	0.184	**-1.400**	**-0.680**
Household income W1	0.026	0.077	-0.125	0.177
Urbanity W1 (Rural: reference)	0.114	0.213	-0.303	0.531
Mental health W1	**0.138*** **	0.012	**0.114**	**0.162**

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
2010 IMD 20%-40% (reference: IMD 0%-20%)	-0.14	0.259	-0.647	0.367
2010 IMD 40%-60% (reference: IMD 0%-20%)	0.015	0.264	-0.503	0.532
2010 IMD 60%-80% (reference: IMD 0%-20%)	-0.07	0.269	-0.598	0.457
2010 IMD 80%-100% (reference: IMD 0%-20%)	-0.239	0.307	-0.842	0.364
Divorced W1 (reference: Married)	0.074	0.298	-0.511	0.658
Widowed W1 (reference: Married)	0.556	0.424	-0.276	1.387
Never married W1 (reference: Married)	0.272	0.261	-0.239	0.783
No qualification W1 (reference: Degree)	-0.256	0.337	-0.917	0.405
GCSE W1 (reference: Degree)	**-0.907*** **	0.217	**-1.332**	**-0.483**
A-Level W1 (reference: Degree)	**-0.453***	0.208	**-0.860**	**-0.045**
Modification index-guided variables				
Mental health W3	**0.233*** **	0.013	**0.207**	**0.259**
Homogenous friendship networks W9	ON			
Area homogenous friendship networks W9	**0.264*** **	0.051	**0.163**	**0.364**
Homogenous friendship networks W6	**0.370*** **	0.013	**0.344**	**0.396**
Mental health W6	0.003	0.003	-0.003	0.009
Age W1	**0.008*** **	0.002	**0.004**	**0.012**
Non-white W1	**-0.483*** **	0.082	**-0.644**	**-0.323**
Gender W1	0.026	0.047	-0.065	0.117
Unemployment / inactive W1 (reference: employment)	0.002	0.054	-0.103	0.107
Long-standing illness and disability W1	-0.015	0.051	-0.115	0.084
Household income W1	0.016	0.022	-0.027	0.058
Urbanity W1 (Rural: reference)	**-0.127***	0.059	**-0.243**	**-0.011**
Mental health W1	**0.008** **	0.003	**0.002**	**0.014**
2010 IMD 20%-40% (reference: IMD 0%-20%)	-0.012	0.069	-0.148	0.123
2010 IMD 40%-60% (reference: IMD 0%-20%)	-0.037	0.071	-0.177	0.102
2010 IMD 60%-80% (reference: IMD 0%-20%)	0.06	0.071	-0.079	0.200
2010 IMD 80%-100% (reference: IMD 0%-20%)	-0.04	0.078	-0.194	0.114
Divorced W1 (reference: Married)	-0.131	0.082	-0.292	0.03
Widowed W1 (reference: Married)	-0.071	0.149	-0.363	0.221
Never married W1 (reference: Married)	-0.129	0.069	-0.263	0.006
No qualification W1 (reference: Degree)	**0.376*** **	0.102	**0.177**	**0.575**
GCSE W1 (reference: Degree)	**0.281*** **	0.06	**0.164**	**0.398**
A-Level W1 (reference: Degree)	**0.122***	0.055	**0.015**	**0.23**

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Modification index-guided variables				
Homogenous friendship networks W3	0.263	0.013	0.238	0.288
Mental health W12	ON			
Mental health W9	**0.335*** **	0.013	**0.310**	**0.359**
Homogenous friendship networks W9	**0.109** **	0.040	**0.032**	**0.187**
Area mental health W12	**0.465*** **	0.100	**0.268**	**0.662**
Area homogenous friendship networks W9	-0.359+	0.196	-0.743	0.024
Age W1	0.07***	0.007	0.055	0.084
Non-white W1	**0.58* **	0.295	**0.003**	**1.158**
Gender W1	**-0.72*** **	0.171	**-1.055**	**-0.385**
Unemployment / inactive W1 (reference: employment)	**-0.795*** **	0.197	**-1.181**	**-0.41**
Long-standing illness and disability W1	**-0.643** **	0.187	**-1.009**	**-0.277**
Household income W1	0.08	0.089	-0.095	0.255
Urbanity W1 (Rural: reference)	-0.244	0.215	-0.666	0.178
Mental health W1	**0.072*** **	0.012	**0.048**	**0.097**
2010 IMD 20%-40% (reference: IMD 0%-20%)	-0.032	0.253	-0.527	0.464
2010 IMD 40%-60% (reference: IMD 0%-20%)	0.361	0.257	-0.143	0.865
2010 IMD 60%-80% (reference: IMD 0%-20%)	0.217	0.271	-0.314	0.747
2010 IMD 80%-100% (reference: IMD 0%-20%)	0.243	0.301	-0.347	0.832
Divorced W1 (reference: Married)	**-0.735* **	0.316	**-1.354**	**-0.115**
Widowed W1 (reference: Married)	-0.401	0.444	-1.272	0.469
Never married W1 (reference: Married)	**-0.825** **	0.267	-1.349	-0.302
No qualification W1 (reference: Degree)	**0.827* **	0.337	**0.166**	**1.488**
GCSE W1 (reference: Degree)	**0.47* **	0.221	**0.036**	**0.904**
A-Level W1 (reference: Degree)	-0.047	0.211	-0.461	0.366
Modification index-guided variables				
Mental health W3	**0.131*** **	0.013	**0.104**	**0.157**
Mental health W6	**0.203*** **	0.014	**0.175**	**0.23**
Intercepts				
Homogenous friendship networks W3	**1.615* **	0.748	**0.148**	**3.082**
Homogenous friendship networks W6	0.062	0.696	-1.303	1.426
Homogenous friendship networks W9	0.208	0.664	-1.094	1.509
Mental health W3	1.681	5.633	-9.36	12.722
Mental health W6	-6.896	4.807	-16.318	2.526
Mental health W9	-8.908+	5.287	-19.271	1.455
Mental health W12	**-10.594* **	5.077	**-20.544**	**-0.643**

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Residual Variances				
Homogenous friendship networks W3	**5.466*** **	0.079	**5.312**	**5.62**
Homogenous friendship networks W6	**4.196*** **	0.071	**4.058**	**4.335**
Homogenous friendship networks W9	**4.044*** **	0.071	**3.905**	**4.182**
Mental health W3	**64.771*** **	1.35	**62.125**	**67.418**
Mental health W6	**58.589*** **	1.174	**56.287**	**60.89**
Mental health W9	**63.869*** **	1.207	**61.503**	**66.236**
Mental health W12	**66.325*** **	1.217	**63.938**	**68.711**

Note: The letter "W" denotes wave of longitudinal data.
+ p<0.10, *p<0.05, **p<0.01, ***p<0.001

Table 4. Autoregressive cross-lagged panel analysis of the relationships between area and personal civic engagement and area and individual mental health in the Understanding Society: The UK Household Longitudinal Study (Waves 1, 3, 6, 9, 12) (N= 10057)

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Mental Health W3	ON			

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Area mental health W3	**0.458*** **	0.111	**0.240**	**0.676**
Age W1	**0.110*** **	0.007	**0.097**	**0.124**
Non-white W1	-0.205	0.285	-0.763	0.354
Gender W1	**-0.949*** **	0.171	**-1.284**	**-0.615**
Unemployment / inactive W1 (reference: employment)	**-0.442* **	0.199	**-0.833**	**-0.051**
Long-standing illness and disability W1	**-2.207*** **	0.188	**-2.576**	**-1.838**
Household income W1	0.067	0.085	-0.100	0.234
Urbanity W1 (Rural: reference)	-0.213	0.215	-0.634	0.208
Mental health W1	**0.429*** **	0.012	**0.406**	**0.452**
2010 IMD 20%-40% (reference: IMD 0%-20%)	0.375	0.258	-0.131	0.88
2010 IMD 40%-60% (reference: IMD 0%-20%)	0.024	0.26	-0.486	0.534
2010 IMD 60%-80% (reference: IMD 0%-20%)	0.09	0.272	-0.442	0.623
2010 IMD 80%-100% (reference: IMD 0%-20%)	0.138	0.308	-0.465	0.741
Divorced W1 (reference: Married)	**-0.617* **	0.31	**-1.225**	**-0.009**
Widowed W1 (reference: Married)	0.35	0.45	-0.532	1.232
Never married W1 (reference: Married)	-0.122	0.265	-0.642	0.398
No qualification W1 (reference: Degree)	-0.47	0.361	-1.178	0.239
GCSE W1 (reference: Degree)	0.111	0.218	-0.316	0.538
A-Level W1 (reference: Degree)	**0.464* **	0.207	**0.058**	**0.870**
Civic engagement W3	ON			
Area civic engagement W3	**0.197* **	0.090	**0.020**	**0.373**
Age W1	**0.023*** **	0.003	**0.017**	**0.029**
Non-white W1	0.026	0.1	-0.17	0.222
Gender W1	0.007	0.056	-0.103	0.116
Unemployment / inactive W1 (reference: employment)	0.177+	0.101	-0.021	0.375
Long-standing illness and disability W1	-0.049	0.059	-0.165	0.066
Household income W1	0.05	0.035	-0.018	0.118
Urbanity W1 (Rural: reference)	0.109	0.077	-0.043	0.261
Mental health W1	0.002	0.003	-0.005	0.009
2010 IMD 20%-40% (reference: IMD 0%-20%)	-0.084	0.094	-0.269	0.101
2010 IMD 40%-60% (reference: IMD 0%-20%)	-0.178	0.089	-0.353	-0.004
2010 IMD 60%-80% (reference: IMD 0%-20%)	-0.066	0.092	-0.245	0.114
2010 IMD 80%-100% (reference: IMD 0%-20%)	**-0.206* **	0.096	**-0.394**	**-0.018**
Divorced W1 (reference: Married)	0.092	0.095	-0.094	0.278

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Widowed W1 (reference: Married)	-0.131	0.202	-0.527	0.266
Never married W1 (reference: Married)	0.031	0.096	-0.157	0.22
No qualification W1 (reference: Degree)	**-1.291*** **	0.152	**-1.59**	**-0.993**
GCSE W1 (reference: Degree)	**-0.906*** **	0.069	**-1.042**	**-0.77**
A-Level W1 (reference: Degree)	**-0.542*** **	0.067	**-0.674**	**-0.410**
<u>Mental Health W6</u>	ON			
Mental Health W3	**0.378*** **	0.012	**0.354**	**0.402**
Civic engagement W3	0.042	0.121	-0.195	0.279
Area mental health W6	**0.483*** **	0.092	**0.302**	**0.664**
Area civic engagement W3	-0.452	0.326	-1.09	0.187
Age W1	**0.084*** **	0.007	**0.069**	**0.098**
Non-white W1	-0.094	0.274	-0.631	0.443
Gender W1	**-0.655*** **	0.159	**-0.966**	**-0.343**
Unemployment / inactive W1 (reference: employment)	**-0.8*** **	0.187	**-1.167**	**-0.434**
Long-standing illness and disability W1	**-0.958*** **	0.174	**-1.299**	**-0.617**
Household income W1	0.107	0.076	-0.043	0.256
Urbanity W1 (Rural: reference)	-0.099	0.197	-0.484	0.287
Mental health W1	**0.227*** **	0.012	**0.203**	**0.251**
2010 IMD 20%-40% (reference: IMD 0%-20%)	0.008	0.238	-0.458	0.474
2010 IMD 40%-60% (reference: IMD 0%-20%)	-0.276	0.248	-0.762	0.209
2010 IMD 60%-80% (reference: IMD 0%-20%)	0.141	0.249	-0.347	0.629
2010 IMD 80%-100% (reference: IMD 0%-20%)	-0.272	0.296	-0.851	0.308
Divorced W1 (reference: Married)	**-0.811** **	0.307	**-1.413**	**-0.208**
Widowed W1 (reference: Married)	0.713+	0.405	-0.081	1.508
Never married W1 (reference: Married)	-0.071	0.252	-0.564	0.422
No qualification W1 (reference: Degree)	0.185	0.352	-0.505	0.875
GCSE W1 (reference: Degree)	0.348	0.235	-0.113	0.809
A-Level W1 (reference: Degree)	0.048	0.211	-0.366	0.462
<u>Civic engagement W6</u>	ON			
Area civic engagement W6	**0.541*** **	0.100	**0.345**	**0.736**
Civic engagement W3	**0.499*** **	0.024	**0.452**	**0.547**
mental health W3	0.000	0.002	-0.003	0.003
Age W1	0.003+	0.002	-0.001	0.007
Non-white W1	-0.035	0.06	-0.153	0.083
Gender W1	0.017	0.034	-0.05	0.084
Unemployment / inactive W1	-0.063	0.056	-0.172	0.046

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
(reference: employment)				
Long-standing illness and disability W1	0.068+	0.037	-0.004	0.14
Household income W1	0.009	0.021	-0.032	0.05
Urbanity W1 (Rural: reference)	0.028	0.047	-0.064	0.12
Mental health W1	0	0.002	-0.004	0.004
2010 IMD 20%-40% (reference: IMD 0%-20%)	0.043	0.056	-0.067	0.153
2010 IMD 40%-60% (reference: IMD 0%-20%)	0.049	0.054	-0.057	0.156
2010 IMD 60%-80% (reference: IMD 0%-20%)	0.041	0.056	-0.069	0.15
2010 IMD 80%-100% (reference: IMD 0%-20%)	0.07	0.059	-0.046	0.186
Divorced W1 (reference: Married)	-0.075	0.058	-0.187	0.038
Widowed W1 (reference: Married)	0.106	0.113	-0.116	0.329
Never married W1 (reference: Married)	0.005	0.057	-0.107	0.116
No qualification W1 (reference: Degree)	**-0.28****	0.091	**-0.458**	**-0.102**
GCSE W1 (reference: Degree)	**-0.184*****	0.048	**-0.278**	**-0.09**
A-Level W1 (reference: Degree)	**-0.122****	0.044	**-0.208**	**-0.035**
Mental health W9	ON			
Mental health W6	**0.352*****	0.013	**0.326**	**0.378**
Civic engagement W6	0.053	0.090	-0.124	0.229
Area mental health W9	**0.426*****	0.101	**0.228**	**0.624**
Area civic engagement W6	**-1.759****	0.609	**-2.952**	**-0.566**
Age W1	**0.087*****	0.007	**0.072**	**0.101**
Non-white W1	0.219	0.279	-0.328	0.767
Gender W1	**-0.369***	0.166	**-0.695**	**-0.043**
Unemployment / inactive W1 (reference: employment)	**-0.771*****	0.197	**-1.157**	**-0.384**
Long-standing illness and disability W1	**-1.094*****	0.183	**-1.453**	**-0.735**
Household income W1	0.034	0.077	-0.117	0.184
Urbanity W1 (Rural: reference)	0.009	0.209	-0.401	0.418
Mental health W1	**0.14*****	0.012	**0.116**	**0.164**
2010 IMD 20%-40% (reference: IMD 0%-20%)	-0.338	0.261	-0.85	0.175
2010 IMD 40%-60% (reference: IMD 0%-20%)	-0.2	0.267	-0.723	0.323
2010 IMD 60%-80% (reference: IMD 0%-20%)	-0.406	0.27	-0.935	0.124
2010 IMD 80%-100% (reference: IMD 0%-20%)	-0.531+	0.312	-1.142	0.081
Divorced W1 (reference: Married)	0.001	0.297	-0.582	0.584
Widowed W1 (reference: Married)	0.56	0.426	-0.274	1.395

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Never married W1 (reference: Married)	0.224	0.26	-0.286	0.734
No qualification W1 (reference: Degree)	-0.21	0.35	-0.895	0.476
GCSE W1 (reference: Degree)	**-0.873*** **	0.224	**-1.311**	**-0.434**
A-Level W1 (reference: Degree)	**-0.430***	0.211	**-0.843**	**-0.016**
Modification index-guided variables				
C_MCS	**0.234*** **	0.013	**0.208**	**0.261**
Civic engagement W9	ON			
Area civic engagement W9	**0.442*** **	0.078	**0.290**	**0.594**
Civic engagement W6	**0.518*** **	0.014	**0.490**	**0.546**
Mental health W6	0.003+	0.001	0.000	0.005
Age W1	**0.01*** **	0.001	**0.008**	**0.012**
Non-white W1	-0.067+	0.039	-0.143	0.01
Gender W1	0.023	0.024	-0.023	0.07
Unemployment / inactive W1 (reference: employment)	**0.055***	0.028	**0.001**	**0.109**
Long-standing illness and disability W1	-0.015	0.026	-0.065	0.035
Household income W1	**0.038***	0.013	**0.013**	**0.062**
Urbanity W1 (Rural: reference)	0.059+	0.031	-0.001	0.12
Mental health W1	0.001	0.001	-0.002	0.004
2010 IMD 20%-40% (reference: IMD 0%-20%)	0.017	0.035	-0.052	0.086
2010 IMD 40%-60% (reference: IMD 0%-20%)	0.001	0.036	-0.069	0.071
2010 IMD 60%-80% (reference: IMD 0%-20%)	0.061	0.038	-0.013	0.134
2010 IMD 80%-100% (reference: IMD 0%-20%)	0.021	0.039	-0.057	0.098
Divorced W1 (reference: Married)	**-0.097***	0.041	**-0.178**	**-0.017**
Widowed W1 (reference: Married)	-0.039	0.065	-0.167	0.089
Never married W1 (reference: Married)	0.042	0.035	-0.027	0.111
No qualification W1 (reference: Degree)	**-0.593*** **	0.047	**-0.685**	**-0.501**
GCSE W1 (reference: Degree)	**-0.488*** **	0.033	**-0.553**	**-0.424**
A-Level W1 (reference: Degree)	**-0.284*** **	0.031	**-0.345**	**-0.223**
Mental health W12	ON			
Mental health W9	**0.336*** **	0.013	**0.312**	**0.361**
Civic engagement W9	-0.011	0.078	-0.163	0.141
Area mental health W12	**0.428*** **	0.099	**0.233**	**0.623**
Area civic engagement W9	-0.139	0.564	-1.245	0.966
Age W1	**0.072*** **	0.008	**0.057**	**0.087**
Non-white W1	**0.606***	0.272	**0.072**	**1.140**

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Gender W1	**-0.705*** **	0.171	**-1.04**	**-0.37**
Unemployment / inactive W1 (reference: employment)	**-0.779*** **	0.197	**-1.165**	**-0.393**
Long-standing illness and disability W1	**-0.672*** **	0.187	**-1.037**	**-0.306**
Household income W1	0.086	0.09	-0.089	0.262
Urbanity W1 (Rural: reference)	-0.299	0.214	-0.719	0.122
Mental health W1	**0.074*** **	0.012	**0.05**	**0.098**
2010 IMD 20%-40% (reference: IMD 0%-20%)	-0.043	0.255	-0.543	0.457
2010 IMD 40%-60% (reference: IMD 0%-20%)	0.356	0.26	-0.154	0.866
2010 IMD 60%-80% (reference: IMD 0%-20%)	0.153	0.275	-0.386	0.692
2010 IMD 80%-100% (reference: IMD 0%-20%)	0.222	0.306	-0.378	0.821
Divorced W1 (reference: Married)	**-0.782***	0.316	**-1.401**	**-0.163**
Widowed W1 (reference: Married)	-0.408	0.446	-1.281	0.465
Never married W1 (reference: Married)	**-0.850****	0.266	**-1.372**	**-0.328**
No qualification W1 (reference: Degree)	**0.865***	0.347	**0.184**	**1.546**
GCSE W1 (reference: Degree)	**0.499***	0.23	**0.048**	**0.949**
A-Level W1 (reference: Degree)	-0.04	0.214	-0.46	0.379
<u>Modification index-guided variables</u>				
Mental health W6	**0.203*** **	0.014	**0.175**	**0.231**
Mental health W3	**0.132*** **	0.014	**0.105**	**0.158**
<u>Civic engagement W12</u>	ON			
Area civic engagement W12	**0.334*** **	0.065	**0.206**	**0.462**
Civic engagement W9	**0.407*** **	0.012	**0.384**	**0.431**
Mental health W9	0.000	0.001	-0.002	0.002
Age W1	0.002+	0.001	0.000	0.003
Non-white W1	**-0.092****	0.029	**-0.149**	**-0.036**
Gender W1	0.009	0.018	-0.026	0.044
Unemployment / inactive W1 (reference: employment)	-0.044+	0.023	-0.089	0.000
Long-standing illness and disability W1	-0.015	0.019	-0.053	0.023
Household income W1	**0.031****	0.01	**0.011**	**0.051**
Urbanity W1 (Rural: reference)	-0.041+	0.024	-0.088	0.006
Mental health W1	0.001	0.001	-0.001	0.003
2010 IMD 20%-40% (reference: IMD 0%-20%)	0.01	0.028	-0.045	0.065
2010 IMD 40%-60% (reference: IMD 0%-20%)	**0.063****	0.029	**0.006**	**0.12**
2010 IMD 60%-80% (reference: IMD 0%-20%)	-0.021	0.029	-0.079	0.036

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
2010 IMD 80%-100% (reference: IMD 0%-20%)	0.022	0.032	-0.041	0.084
Divorced W1 (reference: Married)	-0.026	0.03	-0.084	0.033
Widowed W1 (reference: Married)	0.003	0.052	-0.1	0.106
Never married W1 (reference: Married)	0.035	0.027	-0.018	0.087
No qualification W1 (reference: Degree)	**-0.322*** **	0.039	**-0.399**	**-0.245**
GCSE W1 (reference: Degree)	**-0.237*** **	0.028	**-0.292**	**-0.182**
A-Level W1 (reference: Degree)	**-0.207*** **	0.026	**-0.257**	**-0.156**
Modification index-guided variables				
Civic engagement W6	**0.099*** **	0.018	**0.064**	**0.135**
Civic engagement W3	**0.099*** **	0.025	**0.05**	**0.148**
Civic engagement W12	WITH			
Mental health W12	0.066	0.07	-0.071	0.203
Intercepts				
Mental health W3	1.631	5.633	-9.41	12.672
Mental health W6	-6.451	4.75	-15.761	2.859
Mental health W9	-7.471	5.256	-17.773	2.831
Mental health W12	**-11.888***	4.912	**-21.516**	**-2.26**
Civic engagement W3	0.555	0.452	-0.331	1.441
Civic engagement W6	-0.598+	0.307	-1.2	0.004
Civic engagement W9	**-0.961*** **	0.18	**-1.314**	**-0.609**
Civic engagement W12	**-0.501*** **	0.135	**-0.765**	**-0.237**
Residual Variances				
Mental health W3	**64.760*** **	1.35	**62.114**	**67.406**
Mental health W6	**58.672*** **	1.179	**56.361**	**60.982**
Mental health W9	**63.963*** **	1.21	**61.591**	**66.335**
Mental health W12	**66.409*** **	1.217	**64.024**	**68.795**
Civic engagement W3	**1.344*** **	0.068	**1.211**	**1.477**
Civic engagement W6	**0.821*** **	0.031	**0.760**	**0.883**
Civic engagement W9	**0.986*** **	0.021	**0.945**	**1.028**
Civic engagement W12	**0.638*** **	0.017	**0.605**	**0.671**
Goodness of fit				
RMSEA	0.050			
CFI	0.993			
TLI	0.972			

Note: The letter "W" denotes wave of longitudinal data.
+ p<0.10, *p<0.05, **p<0.01, ***p<0.001

Table 5. Autoregressive cross-lagged panel analysis of the relationships between area and personal trust and cooperative norms and area and individual mental health in the Understanding Society: The UK Household Longitudinal Study (Waves 1, 3 and 6) (N= 10060)

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Mental Health W3	ON			
Area mental health W3	**0.473*****	0.112	**0.254**	**0.691**
Age W1	**0.111*****	0.007	**0.097**	**0.124**
Non-white W1	-0.176	0.286	-0.737	0.384
Gender W1	**-0.975*****	0.171	**-1.31**	**-0.639**
Unemployment / inactive W1 (reference: employment)	**-0.416***	0.2	**-0.808**	**-0.024**
Long-standing illness and disability W1	**-2.19*****	0.188	**-2.56**	**-1.821**
Household income W1	0.064	0.085	-0.103	0.231
Urbanity W1 (Rural: reference)	-0.208	0.215	-0.629	0.214
Mental health W1	**0.43*****	0.012	**0.407**	**0.453**
2010 IMD 20%-40%(reference: IMD 0%-20%)	0.367	0.258	-0.14	0.873
2010 IMD 40%-60% (reference: IMD 0%-20%)	-0.007	0.261	-0.518	0.505

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
2010 IMD 60%-80% (reference: IMD 0%-20%)	0.078	0.273	-0.456	0.612
2010 IMD 80%-100% (reference: IMD 0%-20%)	0.16	0.308	-0.444	0.765
Divorced W1 (reference: Married)	**-0.628***	0.31	**-1.236**	**-0.019**
Widowed W1 (reference: Married)	0.349	0.451	-0.534	1.232
Never married W1 (reference: Married)	-0.142	0.266	-0.663	0.379
No qualification W1 (reference: Degree)	-0.443	0.363	-1.155	0.269
GCSE W1 (reference: Degree)	0.096	0.219	-0.333	0.524
A-Level W1 (reference: Degree)	0.445	0.207	0.039	0.852
<u>Trust and cooperative norms W3</u>	ON			
Area trust and cooperative norms W3	**0.649*** **	0.066	**0.521**	**0.778**
Age W1	**0.015*** **	0.002	**0.011**	**0.019**
Non-white W1	-0.044	0.08	-0.201	0.114
Gender W1	**0.109***	0.05	**0.011**	**0.208**
Unemployment / inactive W1 (reference: employment)	0.03	0.059	-0.086	0.146
Long-standing illness and disability W1	**-0.212*** **	0.054	**-0.317**	**-0.106**
Household income W1	**0.097** **	0.032	**0.035**	**0.159**
Urbanity W1 (Rural: reference)	**0.69*** **	0.064	**0.563**	**0.816**
Mental health W1	**0.021*** **	0.003	**0.015**	**0.027**
2010 IMD 20%-40% (reference: IMD 0%-20%)	0.032	0.074	-0.113	0.176
2010 IMD 40%-60% (reference: IMD 0%-20%)	-0.09	0.077	-0.242	0.061
2010 IMD 60%-80% (reference: IMD 0%-20%)	-0.113	0.08	-0.27	0.043
2010 IMD 80%-100%(reference: IMD 0%-20%)	-0.028	0.087	-0.198	0.143
Divorced W1 (reference: Married)	**-0.308** **	0.091	**-0.487**	**-0.128**
Widowed W1 (reference: Married)	-0.012	0.139	-0.285	0.261
Never married W1 (reference: Married)	**-0.447*** **	0.076	**-0.597**	**-0.297**
No qualification W1 (reference: Degree)	**-0.557*** **	0.103	**-0.758**	**-0.356**
GCSE W1 (reference: Degree)	**-0.443*** **	0.065	**-0.57**	**-0.315**
A-Level W1 (reference: Degree)	**-0.209** **	0.061	**-0.329**	**-0.089**
<u>Mental health W6</u>	ON			
Mental health W3	**0.372*** **	0.012	**0.348**	**0.396**
Trust and cooperative norms W3	**0.192*** **	0.035	**0.122**	**0.261**

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Area mental health W6	**0.582*** **	0.099	**0.388**	**0.777**
Area trust and cooperative norms W3	**-0.628** **	0.228	**-1.076**	**-0.18**
Age W1	**0.081*** **	0.007	**0.068**	**0.095**
Non-white W1	-0.17	0.279	-0.716	0.377
Gender W1	**-0.662*** **	0.159	**-0.973**	**-0.35**
Unemployment / inactive W1 (reference: employment)	**-0.82*** **	0.186	**-1.183**	**-0.456**
Long-standing illness and disability W1	**-0.893*** **	0.174	**-1.235**	**-0.552**
Household income W1	0.082	0.076	-0.066	0.231
Urbanity W1 (Rural: reference)	-0.155	0.2	-0.548	0.237
Mental health W1	**0.226*** **	0.012	**0.202**	**0.250**
2010 IMD 20%-40% (reference: IMD 0%-20%)	-0.001	0.237	-0.466	0.464
2010 IMD 40%-60% (reference: IMD 0%-20%)	-0.244	0.247	-0.727	0.24
2010 IMD 60%-80% (reference: IMD 0%-20%)	0.126	0.249	-0.362	0.614
2010 IMD 80%-100% (reference: IMD 0%-20%)	-0.265	0.296	-0.845	0.315
Divorced W1 (reference: Married)	**-0.75***	0.307	**-1.352**	**-0.148**
Widowed W1 (reference: Married)	0.73+	0.404	-0.062	1.523
Never married W1 (reference: Married)	-0.013	0.252	-0.507	0.481
No qualification W1 (reference: Degree)	0.261	0.318	-0.361	0.884
GCSE W1 (reference: Degree)	**0.42***	0.209	**0.009**	**0.83**
A-Level W1 (reference: Degree)	0.08	0.202	-0.316	0.476
Trust and cooperative norms W6	ON			
Area trust and cooperative norms W6	**0.949*** **	0.102	**0.750**	**1.148**
Trust and cooperative norms W3	**0.523*** **	0.010	**0.502**	**0.543**
Mental health W3	**0.011*** **	0.003	**0.005**	**0.016**
Age W1	0.003	0.002	-0.001	0.006
Non-white W1	0.064	0.071	-0.075	0.203
Gender W1	**0.121** **	0.042	**0.038**	**0.204**
Unemployment / inactive W1 (reference: employment)	-0.006	0.049	-0.103	0.091
Long-standing illness and disability W1	-0.015	0.045	-0.102	0.073
Household income W1	-0.002	0.021	-0.042	0.039
Urbanity W1 (Rural: reference)	**0.143** **	0.052	**0.040**	**0.246**
Mental health W1	0.005+	0.003	-0.001	0.01
2010 IMD 20%-40% (reference: IMD 0%-20%)	-0.078	0.062	-0.2	0.044

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
2010 IMD 40%-60% (reference: IMD 0%-20%)	-0.116+	0.062	-0.238	0.006
2010 IMD 60%-80% (reference: IMD 0%-20%)	**-0.179****	0.067	**-0.311**	**-0.047**
2010 IMD 80%-100% (reference: IMD 0%-20%)	-0.098	0.073	-0.242	0.046
Divorced W1 (reference: Married)	**-0.196****	0.075	**-0.344**	**-0.049**
Widowed W1 (reference: Married)	-0.174	0.115	-0.399	0.052
Never married W1 (reference: Married)	**-0.288*****	0.067	**-0.42**	**-0.155**
No qualification W1 (reference: Degree)	-0.16+	0.084	-0.324	0.004
GCSE W1 (reference: Degree)	**-0.214*****	0.055	**-0.321**	**-0.106**
A-Level W1 (reference: Degree)	**-0.181*****	0.052	**-0.283**	**-0.08**
<u>Modification index-guided variables</u>				
Area trust and cooperative norms W3	**-0.557*****	0.104	**-0.761**	**-0.353**
<u>Trust and cooperative norms W6</u>	WITH			
Mental health W6	**0.970*****	0.174	**0.629**	**1.311**
<u>Intercepts</u>				
Mental health W3	0.944	5.652	-10.133	12.022
Trust and cooperative norms W3	**2.643***	1.032	**0.621**	**4.665**
Mental health W6	-5.489	4.969	-15.228	4.25
Trust and cooperative norms W6	0.413	0.904	-1.359	2.185
<u>Residual Variances</u>				
Mental health W3	**64.698*****	1.35	**62.053**	**67.344**
Trust and cooperative norms W3	**5.886*****	0.1	**5.69**	**6.082**
Mental health W6	**58.389*****	1.178	**56.08**	**60.698**
Trust and cooperative norms W6	**3.963*****	0.075	**3.817**	**4.11**

Note: The letter “W” denotes wave of longitudinal data.
+ p<0.10, *p<0.05, **p<0.01, ***p<0.001

Table 6. Sensitivity analysis: autoregressive cross-lagged panel analysis of the relationships between area and personal homogenous friendship networks and area and individual mental health in the Understanding Society: The UK Household Longitudinal Study (Waves 1, 3, 6, 9, 12) (N=8920)

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Mental Health W3	ON			
area mental health W3	**0.429****	0.140	**0.156**	**0.703**
Age W1	**0.107*****	0.007	**0.093**	**0.122**
Non-white W1	-0.2	0.302	-0.792	0.392
Gender W1	**-0.956*****	0.182	**-1.312**	**-0.6**
Unemployment / inactive W1 (reference: employment)	-0.351+	0.213	-0.768	0.066
Long-standing illness and disability W1	**-2.331*****	0.2	**-2.722**	**-1.939**
Household income W1	0.029	0.089	-0.147	0.204
Urbanity W1 (Rural: reference)	-0.259	0.231	-0.713	0.194
Mental health W1	**0.433*****	0.012	**0.409**	**0.457**
2010 IMD 20%-40% (reference: IMD 0%-20%)	0.136	0.277	-0.406	0.678
2010 IMD 40%-60% (reference: IMD 0%-20%)	0.055	0.273	-0.481	0.59
2010 IMD 60%-80%	-0.064	0.284	-0.62	0.492

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
(reference: IMD 0%-20%)				
2010 IMD 80%-100% (reference: IMD 0%-20%)	-0.06	0.333	-0.713	0.593
Divorced W1 (reference: Married)	**-0.734***	0.324	**-1.37**	**-0.098**
Widowed W1 (reference: Married)	0.206	0.471	-0.717	1.128
Never married W1 (reference: Married)	-0.282	0.285	-0.841	0.277
No qualification W1 (reference: Degree)	-0.592	0.387	-1.35	0.166
GCSE W1 (reference: Degree)	-0.066	0.23	-0.518	0.386
A-Level W1 (reference: Degree)	0.378+	0.221	-0.054	0.811
<u>Homogenous friendship networks W3</u>	ON			
Area homogenous friendship networks W3	**0.635*****	0.067	**0.505**	**0.766**
Age W1	**0.018*****	0.002	**0.014**	**0.023**
Non-white W1	**-0.824*****	0.094	**-1.009**	**-0.64**
Gender W1	0.084	0.055	-0.024	0.193
Unemployment / inactive W1 (reference: employment)	**0.157***	0.063	**0.033**	**0.281**
Long-standing illness and disability W1	**-0.349*****	0.059	**-0.465**	**-0.234**
Household income W1	0.031	0.027	-0.021	0.083
Urbanity W1 (Rural: reference)	-0.059	0.07	-0.196	0.078
Mental health W1	**0.022*****	0.003	**0.016**	**0.028**
2010 IMD 20%-40% (reference: IMD 0%-20%)	0.062	0.082	-0.1	0.223
2010 IMD 40%-60% (reference: IMD 0%-20%)	-0.023	0.083	-0.185	0.139
2010 IMD 60%-80% (reference: IMD 0%-20%)	0.001	0.086	-0.167	0.168
2010 IMD 80%-100% (reference: IMD 0%-20%)	0.06	0.093	-0.122	0.241
Divorced W1 (reference: Married)	**-0.479*****	0.095	**-0.666**	**-0.293**
Widowed W1 (reference: Married)	-0.077	0.154	-0.379	0.224
Never married W1 (reference: Married)	**-0.426*****	0.083	**-0.588**	**-0.263**
No qualification W1 (reference: Degree)	**0.86*****	0.112	**0.64**	**1.081**
GCSE W1 (reference: Degree)	**0.447*****	0.071	**0.308**	**0.587**
A-Level W1 (reference: Degree)	**0.237*****	0.068	**0.104**	**0.370**
<u>Mental health W6</u>	ON			
Mental health W3	**0.376*****	0.013	**0.35**	**0.401**
Homogenous friendship networks W3	**0.114****	0.040	**0.037**	**0.191**
Area mental health W6	**0.570*****	0.118	**0.339**	**0.801**
Area homogenous friendship networks W3	-0.370	0.231	-0.822	0.082
Age W1	**0.084*****	0.007	**0.07**	**0.098**
Non-white W1	-0.044	0.302	-0.636	0.549

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Gender W1	**-0.809*** **	0.169	**-1.141**	**-0.478**
Unemployment / inactive W1 (reference: employment)	**-0.873*** **	0.198	**-1.261**	**-0.485**
Long-standing illness and disability W1	**-0.944*** **	0.186	**-1.308**	**-0.580**
Household income W1	0.067	0.08	-0.09	0.224
Urbanity W1 (Rural: reference)	0.018	0.211	-0.395	0.431
Mental health W1	**0.226*** **	0.013	**0.200**	**0.251**
2010 IMD 20%-40% (reference: IMD 0%-20%)	0.048	0.257	-0.455	0.552
2010 IMD 40%-60% (reference: IMD 0%-20%)	-0.122	0.262	-0.636	0.393
2010 IMD 60%-80% (reference: IMD 0%-20%)	0.267	0.273	-0.268	0.802
2010 IMD 80%-100% (reference: IMD 0%-20%)	-0.125	0.316	-0.744	0.493
Divorced W1 (reference: Married)	**-0.689***	0.327	**-1.330**	**-0.048**
Widowed W1 (reference: Married)	0.666	0.434	-0.184	1.516
Never married W1 (reference: Married)	-0.072	0.27	-0.602	0.458
No qualification W1 (reference: Degree)	0.126	0.339	-0.539	0.79
GCSE W1 (reference: Degree)	0.261	0.223	-0.176	0.698
A-Level W1 (reference: Degree)	0.083	0.216	-0.341	0.507
<u>Homogenous friendship networks W6</u>	ON			
Area homogenous friendship networks W6	**0.385*** **	0.061	**0.264**	**0.505**
Homogenous friendship networks W3	**0.473*** **	0.012	**0.45**	**0.496**
Mental health W3	**0.008** **	0.003	**0.002**	**0.015**
Age W1	**0.008** **	0.002	**0.003**	**0.012**
Non-white W1	**-0.457*** **	0.088	**-0.629**	**-0.285**
Gender W1	0.08	0.052	-0.022	0.182
Unemployment / inactive W1 (reference: employment)	-0.016	0.059	-0.132	0.100
Long-standing illness and disability W1	-0.088	0.057	-0.199	0.022
Household income W1	0.01+	0.025	-0.039	0.058
Urbanity W1 (Rural: reference)	-0.029	0.066	-0.159	0.101
Mental health W1	**0.008***	0.003	**0.001**	**0.014**
2010 IMD 20%-40% (reference: IMD 0%-20%)	0.085	0.076	-0.064	0.235
2010 IMD 40%-60% (reference: IMD 0%-20%)	0.08	0.077	-0.071	0.232
2010 IMD 60%-80% (reference: IMD 0%-20%)	0.067	0.079	-0.088	0.222
2010 IMD 80%-100% (reference: IMD 0%-20%)	0.091	0.085	-0.076	0.258
Divorced W1 (reference: Married)	**-0.327*** **	0.089	**-0.501**	**-0.154**

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Widowed W1 (reference: Married)	0.143	0.154	-0.159	0.445
Never married W1 (reference: Married)	**-0.264****	0.076	**-0.413**	**-0.115**
No qualification W1 (reference: Degree)	**0.269***	0.116	**0.042**	**0.496**
GCSE W1 (reference: Degree)	**0.292*****	0.066	**0.163**	**0.421**
A-Level W1 (reference: Degree)	**0.263*****	0.062	**0.141**	**0.385**
Mental health W9				
Mental health W6	**0.352*****	0.014	**0.324**	**0.38**
Homogenous friendship networks W6	**0.167*****	0.042	**0.084**	**0.25**
Area mental health W9	**0.313***	0.131	**0.056**	**0.57**
Area homogenous friendship networks W6	-0.286	0.222	-0.722	0.15
Age W1	**0.088*****	0.008	**0.073**	**0.104**
Non-white W1	0.276	0.309	-0.329	0.882
Gender W1	**-0.35***	0.177	**-0.697**	**-0.004**
Unemployment / inactive W1 (reference: employment)	**-0.849*****	0.21	**-1.26**	**-0.438**
Long-standing illness and disability W1	**-1.019*****	0.195	**-1.401**	**-0.637**
Household income W1	-0.021	0.079	-0.176	0.134
Urbanity W1 (Rural: reference)	0.217	0.227	-0.228	0.661
Mental health W1	**0.134*****	0.013	**0.108**	**0.159**
2010 IMD 20%-40% (reference: IMD 0%-20%)	-0.093	0.273	-0.628	0.441
2010 IMD 40%-60% (reference: IMD 0%-20%)	0.091	0.275	-0.449	0.631
2010 IMD 60%-80% (reference: IMD 0%-20%)	-0.128	0.287	-0.69	0.434
2010 IMD 80%-100% (reference: IMD 0%-20%)	-0.220	0.323	-0.853	0.414
Divorced W1 (reference: Married)	-0.012	0.317	-0.633	0.61
Widowed W1 (reference: Married)	0.188	0.452	-0.698	1.074
Never married W1 (reference: Married)	0.191	0.28	-0.357	0.739
No qualification W1 (reference: Degree)	-0.22	0.355	-0.916	0.476
GCSE W1 (reference: Degree)	**-0.97*****	0.23	**-1.420**	**-0.520**
A-Level W1 (reference: Degree)	**-0.449***	0.222	**-0.884**	**-0.014**
Modification index-guided variables				
Mental health W3	**0.240*****	0.014	**0.212**	**0.268**
Homogenous friendship networks W9	ON			
Area homogenous friendship networks W9	**0.267*****	0.055	**0.16**	**0.375**
Homogenous friendship networks W6	**0.363*****	0.014	**0.335**	**0.391**
Mental health W6	0.004	0.003	-0.002	0.01

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Age W1	**0.007****	0.002	**0.003**	**0.011**
Non-white W1	**-0.494*****	0.087	**-0.664**	**-0.324**
Gender W1	0.057	0.05	-0.041	0.154
Unemployment / inactive W1 (reference: employment)	0.016	0.057	-0.096	0.128
Long-standing illness and disability W1	0.008	0.054	-0.099	0.115
Household income W1	0.018	0.023	-0.026	0.062
Urbanity W1 (Rural: reference)	-0.124+	0.064	-0.249	0.001
Mental health W1	**0.007***	0.003	**0.001**	**0.014**
2010 IMD 20%-40% (reference: IMD 0%-20%)	0.049	0.074	-0.096	0.195
2010 IMD 40%-60% (reference: IMD 0%-20%)	-0.043	0.075	-0.191	0.105
2010 IMD 60%-80% (reference: IMD 0%-20%)	0.052	0.076	-0.096	0.201
2010 IMD 80%-100% (reference: IMD 0%-20%)	0.022	0.084	-0.143	0.187
Divorced W1 (reference: Married)	-0.126	0.088	-0.299	0.046
Widowed W1 (reference: Married)	-0.107	0.161	-0.423	0.209
Never married W1 (reference: Married)	-0.144+	0.074	-0.288	0
No qualification W1 (reference: Degree)	**0.284****	0.108	**0.073**	**0.495**
GCSE W1 (reference: Degree)	**0.267*****	0.064	**0.143**	**0.392**
A-Level W1 (reference: Degree)	0.096	0.059	-0.02	0.211
<u>Modification index-guided variables</u>				
Homogenous friendship networks W3	**0.270*****	0.014	**0.243**	**0.298**
<u>Mental health W12</u>	ON			
Mental health W9	**0.330*****	0.014	**0.304**	**0.357**
Homogenous friendship networks W9	**0.129****	0.042	**0.046**	**0.212**
Area mental health W12	**0.459*****	0.122	**0.22**	**0.697**
Area Homogenous friendship networks W9	-0.374+	0.211	-0.788	0.04
Age W1	**0.071*****	0.008	**0.055**	**0.087**
Non-white W1	**0.623***	0.313	**0.009**	**1.236**
Gender W1	**-0.692*****	0.183	**-1.051**	**-0.332**
Unemployment / inactive W1 (reference: employment)	**-0.866*****	0.211	**-1.278**	**-0.453**
Long-standing illness and disability W1	**-0.704*****	0.2	**-1.096**	**-0.311**
Household income W1	0.096	0.095	-0.09	0.282
Urbanity W1 (Rural: reference)	-0.112	0.23	-0.563	0.338
Mental health W1	**0.067*****	0.013	**0.042**	**0.092**
2010 IMD 20%-40% (reference: IMD 0%-20%)	-0.25	0.274	-0.787	0.286
2010 IMD 40%-60% (reference: IMD 0%-20%)	0.391	0.276	-0.15	0.931

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
2010 IMD 60%-80% (reference: IMD 0%-20%)	0.195	0.295	-0.383	0.772
2010 IMD 80%-100% (reference: IMD 0%-20%)	0.188	0.33	-0.459	0.836
Divorced W1 (reference: Married)	**-0.777***	0.336	**-1.436**	**-0.118**
Widowed W1 (reference: Married)	-0.198	0.474	-1.128	0.732
Never married W1 (reference: Married)	**-0.772****	0.287	**-1.334**	**-0.209**
No qualification W1 (reference: Degree)	**0.863***	0.36	**0.157**	**1.569**
GCSE W1 (reference: Degree)	0.463+	0.237	-0.001	0.926
A-Level W1 (reference: Degree)	-0.014	0.226	-0.458	0.429
<u>Modification index-guided variables</u>				
Mental health W3	**0.133*****	0.015	**0.104**	**0.161**
Mental health W6	**0.201*****	0.015	**0.172**	**0.231**
<u>Intercepts</u>				
Homogenous friendship networks W3	**1.841***	0.833	**0.207**	**3.474**
Homogenous friendship networks W6	0.14	0.77	-1.368	1.648
Homogenous friendship networks W9	0.143	0.712	-1.252	1.538
Mental health W3	3.655	7.051	-10.166	17.475
Mental health W6	-8.246	5.695	-19.409	2.917
Mental health W9	-3.528	6.491	-16.25	9.194
Mental health W12	-10.053	6.117	-22.042	1.935
<u>Residual Variances</u>				
Homogenous friendship networks W3	**5.504*****	0.084	**5.339**	**5.668**
Homogenous friendship networks W6	**4.200*****	0.075	**4.052**	**4.348**
Homogenous friendship networks W9	**4.071*****	0.076	**3.922**	**4.219**
Mental health W3	**64.843*****	1.425	**62.051**	**67.636**
Mental health W6	**59.086*****	1.253	**56.629**	**61.542**
Mental health W9	**63.950*****	1.293	**61.415**	**66.485**
Mental health W12	**67.266*****	1.323	**64.673**	**69.859**

Note: The letter “W” denotes wave of longitudinal data.
+ p<0.10, *p<0.05, **p<0.01, ***p<0.001

Table 7. Sensitivity analysis: autoregressive cross-lagged panel analysis of the relationships between area and personal civic engagement and area and individual mental health in the Understanding Society: The UK Household Longitudinal Study (Waves 1, 3, 6, 9, 12) (N=8917)

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Mental Health W3	ON			
Area mental health W3	**0.431****	0.139	**0.158**	**0.704**
Age W1	**0.107*****	0.007	**0.093**	**0.122**
Non-white W1	-0.195	0.302	-0.787	0.397
Gender W1	**-0.956*****	0.182	**-1.313**	**-0.600**
Unemployment / inactive W1 (reference: employment)	-0.353+	0.213	-0.77	0.064
Long-standing illness and disability W1	**-2.331*****	0.2	**-2.722**	**-1.939**
Household income W1	0.029	0.089	-0.146	0.204
Urbanity W1 (Rural: reference)	-0.262	0.231	-0.715	0.191
Mental health W1	**0.433*****	0.012	**0.409**	**0.457**
2010 IMD 20%-40% (reference: IMD 0%-20%)	0.135	0.277	-0.407	0.677
2010 IMD 40%-60% (reference: IMD 0%-20%)	0.053	0.273	-0.482	0.588
2010 IMD 60%-80% (reference: IMD 0%-20%)	-0.065	0.284	-0.62	0.491
2010 IMD 80%-100% (reference: IMD 0%-20%)	-0.061	0.333	-0.714	0.592
Divorced W1 (reference: Married)	**-0.735***	0.324	**-1.371**	**-0.099**
Widowed W1 (reference: Married)	0.207	0.47	-0.716	1.129
Never married W1 (reference: Married)	-0.28	0.285	-0.839	0.279
No qualification W1 (reference: Degree)	-0.588	0.387	-1.346	0.17
GCSE W1 (reference: Degree)	-0.064	0.23	-0.516	0.387
A-Level W1 (reference: Degree)	0.381+	0.221	-0.051	0.814

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Civic engagement W3	ON			
Area civic engagement W3	**0.211***	0.105	**0.005**	**0.417**
Age W1	**0.024*****	0.003	**0.017**	**0.030**
Non-white W1	0.008	0.107	-0.202	0.218
Gender W1	0.014	0.06	-0.103	0.131
Unemployment / inactive W1 (reference: employment)	0.193+	0.107	-0.016	0.402
Long-standing illness and disability W1	-0.048	0.063	-0.171	0.075
Household income W1	0.049	0.036	-0.022	0.119
Urbanity W1 (Rural: reference)	0.099	0.084	-0.065	0.263
Mental health W1	0.001	0.004	-0.006	0.008
2010 IMD 20%-40% (reference: IMD 0%-20%)	-0.13	0.102	-0.33	0.07
2010 IMD 40%-60% (reference: IMD 0%-20%)	-0.178	0.097	-0.368	0.013
2010 IMD 60%-80% (reference: IMD 0%-20%)	-0.079	0.1	-0.275	0.117
2010 IMD 80%-100% (reference: IMD 0%-20%)	**-0.222***	0.105	**-0.428**	**-0.015**
Divorced W1 (reference: Married)	0.049	0.099	-0.146	0.243
Widowed W1 (reference: Married)	-0.165	0.207	-0.57	0.24
Never married W1 (reference: Married)	0.078	0.098	-0.114	0.269
No qualification W1 (reference: Degree)	**-1.317*****	0.162	**-1.635**	**-1.000**
GCSE W1 (reference: Degree)	**-0.932*****	0.074	**-1.076**	**-0.787**
A-Level W1 (reference: Degree)	**-0.54*****	0.072	**-0.682**	**-0.399**
Mental Health W6	ON			
Mental Health W3	**0.377*****	0.013	**0.351**	**0.403**
Civic engagement W3	0.070	0.128	-0.182	0.321
Area mental health W6	**0.532*****	0.111	**0.315**	**0.749**
Area civic engagement W3	-0.648	0.364	-1.36	0.065
Age W1	**0.085*****	0.008	**0.070**	**0.100**
Non-white W1	-0.046	0.29	-0.614	0.521
Gender W1	**-0.796*****	0.169	**-1.128**	**-0.464**
Unemployment / inactive W1 (reference: employment)	**-0.869*****	0.2	**-1.261**	**-0.477**
Long-standing illness and disability W1	**-0.985*****	0.185	**-1.348**	**-0.623**
Household income W1	0.072	0.08	-0.085	0.229
Urbanity W1 (Rural: reference)	-0.025	0.211	-0.438	0.387
Mental health W1	**0.228*****	0.013	**0.202**	**0.253**
2010 IMD 20%-40% (reference: IMD 0%-20%)	0.024	0.257	-0.479	0.527

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
2010 IMD 40%-60% (reference: IMD 0%-20%)	-0.165	0.261	-0.677	0.347
2010 IMD 60%-80% (reference: IMD 0%-20%)	0.175	0.267	-0.349	0.699
2010 IMD 80%-100% (reference: IMD 0%-20%)	-0.223	0.315	-0.841	0.395
Divorced W1 (reference: Married)	-0.744	0.327	-1.384	-0.103
Widowed W1 (reference: Married)	0.653	0.434	-0.198	1.505
Never married W1 (reference: Married)	-0.118	0.27	-0.647	0.412
No qualification W1 (reference: Degree)	0.272	0.378	-0.468	1.013
GCSE W1 (reference: Degree)	0.346	0.252	-0.147	0.84
A-Level W1 (reference: Degree)	0.115	0.226	-0.328	0.558
Civic engagement W6	ON			
Area civic engagement W6	**0.478*** **	0.119	**0.245**	**0.71**
Civic engagement W3	**0.501*** **	0.025	**0.452**	**0.55**
mental health W3	0.001	0.002	-0.003	0.004
Age W1	0.002	0.002	-0.001	0.006
Non-white W1	-0.024	0.064	-0.15	0.102
Gender W1	0.037	0.037	-0.035	0.109
Unemployment / inactive W1 (reference: employment)	-0.077	0.059	-0.193	0.038
Long-standing illness and disability W1	0.056	0.039	-0.021	0.132
Household income W1	0.009	0.022	-0.034	0.052
Urbanity W1 (Rural: reference)	0.042	0.051	-0.059	0.142
Mental health W1	0.000	0.002	-0.004	0.004
2010 IMD 20%-40% (reference: IMD 0%-20%)	0.046	0.061	-0.075	0.166
2010 IMD 40%-60% (reference: IMD 0%-20%)	0.057	0.059	-0.058	0.172
2010 IMD 60%-80% (reference: IMD 0%-20%)	0.036	0.062	-0.085	0.156
2010 IMD 80%-100% (reference: IMD 0%-20%)	0.069	0.065	-0.059	0.197
Divorced W1 (reference: Married)	-0.03	0.06	-0.148	0.087
Widowed W1 (reference: Married)	0.075	0.115	-0.151	0.301
Never married W1 (reference: Married)	-0.003	0.057	-0.115	0.11
No qualification W1 (reference: Degree)	**-0.266** **	0.099	**-0.459**	**-0.072**
GCSE W1 (reference: Degree)	**-0.165** **	0.05	**-0.264**	**-0.067**
A-Level W1 (reference: Degree)	**-0.129** **	0.047	**-0.220**	**-0.038**
Mental health W9	ON			
Mental health W6	**0.354*** **	0.014	**0.327**	**0.382**

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Civic engagement W6	0.104	0.096	-0.084	0.292
Area mental health W9	**0.282***	0.127	**0.033**	**0.53**
Area civic engagement W6	**-1.738***	0.686	**-3.084**	**-0.393**
Age W1	**0.089*****	0.008	**0.074**	**0.105**
Non-white W1	0.261	0.294	-0.315	0.838
Gender W1	-0.333+	0.177	-0.68	0.013
Unemployment / inactive W1 (reference: employment)	**-0.831*****	0.21	**-1.242**	**-0.42**
Long-standing illness and disability W1	**-1.059*****	0.194	**-1.44**	**-0.678**
Household income W1	-0.013	0.078	-0.167	0.141
Urbanity W1 (Rural: reference)	0.136	0.224	-0.304	0.575
Mental health W1	**0.136*****	0.013	**0.111**	**0.161**
2010 IMD 20%-40% (reference: IMD 0%-20%)	-0.269	0.281	-0.819	0.281
2010 IMD 40%-60% (reference: IMD 0%-20%)	-0.114	0.282	-0.666	0.439
2010 IMD 60%-80% (reference: IMD 0%-20%)	-0.449	0.294	-1.026	0.127
2010 IMD 80%-100% (reference: IMD 0%-20%)	-0.488	0.333	-1.142	0.165
Divorced W1 (reference: Married)	-0.085	0.316	-0.705	0.535
Widowed W1 (reference: Married)	0.2	0.453	-0.688	1.088
Never married W1 (reference: Married)	0.116	0.279	-0.431	0.663
No qualification W1 (reference: Degree)	-0.077	0.369	-0.8	0.645
GCSE W1 (reference: Degree)	**-0.883*****	0.237	**-1.348**	**-0.417**
A-Level W1 (reference: Degree)	-0.389+	0.225	-0.831	0.052
<u>Modification index-guided variables</u>				
C_MCS	**0.241*****	0.014	**0.214**	**0.269**
<u>Civic engagement W9</u>	ON			
Area civic engagement W9	**0.438*****	0.082	**0.277**	**0.599**
Civic engagement W6	**0.516*****	0.015	**0.486**	**0.546**
Mental health W6	0.003+	0.002	0.000	0.006
Age W1	**0.01*****	0.001	**0.008**	**0.012**
Non-white W1	-0.069+	0.041	-0.15	0.012
Gender W1	0.02	0.025	-0.03	0.069
Unemployment / inactive W1 (reference: employment)	0.046	0.029	-0.011	0.103
Long-standing illness and disability W1	-0.011	0.027	-0.065	0.042
Household income W1	**0.035****	0.013	**0.009**	**0.061**
Urbanity W1 (Rural: reference)	0.061+	0.033	-0.005	0.126
Mental health W1	0.001	0.002	-0.002	0.004

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
2010 IMD 20%-40% (reference: IMD 0%-20%)	0.023	0.038	-0.051	0.097
2010 IMD 40%-60% (reference: IMD 0%-20%)	0.012	0.038	-0.063	0.086
2010 IMD 60%-80% (reference: IMD 0%-20%)	0.081	0.04	0.002	0.16
2010 IMD 80%-100% (reference: IMD 0%-20%)	0.038	0.043	-0.046	0.122
Divorced W1 (reference: Married)	-0.082+	0.043	-0.167	0.003
Widowed W1 (reference: Married)	0.004	0.069	-0.132	0.139
Never married W1 (reference: Married)	0.052	0.038	-0.023	0.126
No qualification W1 (reference: Degree)	**-0.580*******	0.050	**-0.679**	**-0.482**
GCSE W1 (reference: Degree)	**-0.493*******	0.035	**-0.561**	**-0.425**
A-Level W1 (reference: Degree)	**-0.289*******	0.033	**-0.354**	**-0.223**
<u>Mental health W12</u>	ON			
Mental health W9	**0.332*******	0.014	**0.305**	**0.359**
Civic engagement W9	-0.043	0.083	-0.205	0.119
Area mental health W12	**0.422****	0.121	**0.184**	**0.66**
Area civic engagement W9	-0.172	0.614	-1.375	1.031
Age W1	**0.074*******	0.008	**0.058**	**0.09**
Non-white W1	**0.635***	0.286	**0.074**	**1.196**
Gender W1	**-0.668*******	0.183	**-1.026**	**-0.31**
Unemployment / inactive W1 (reference: employment)	**-0.845*******	0.211	**-1.259**	**-0.432**
Long-standing illness and disability W1	**-0.731*******	0.200	**-1.124**	**-0.338**
Household income W1	0.108	0.095	-0.08	0.295
Urbanity W1 (Rural: reference)	-0.164	0.229	-0.612	0.285
Mental health W1	**0.069*******	0.013	**0.043**	**0.094**
2010 IMD 20%-40% (reference: IMD 0%-20%)	-0.252	0.280	-0.802	0.298
2010 IMD 40%-60% (reference: IMD 0%-20%)	0.372	0.280	-0.177	0.921
2010 IMD 60%-80% (reference: IMD 0%-20%)	0.125	0.300	-0.463	0.714
2010 IMD 80%-100% (reference: IMD 0%-20%)	0.175	0.337	-0.486	0.836
Divorced W1 (reference: Married)	**-0.837***	0.336	**-1.496**	**-0.178**
Widowed W1 (reference: Married)	-0.211	0.476	-1.145	0.722
Never married W1 (reference: Married)	**-0.807****	0.287	**-1.369**	**-0.246**
No qualification W1 (reference: Degree)	**0.875***	0.371	**0.149**	**1.602**
GCSE W1 (reference: Degree)	0.473+	0.245	-0.008	0.954
A-Level W1 (reference: Degree)	-0.023	0.230	-0.473	0.427

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Modification index-guided variables				
Mental health W6	**0.202*** **	0.015	**0.172**	**0.231**
Mental health W3	**0.134*** **	0.015	**0.105**	**0.163**
Civic engagement W12	ON			
Area civic engagement W12	**0.311*** **	0.071	**0.171**	**0.451**
Civic engagement W9	**0.407*** **	0.013	**0.382**	**0.432**
Mental health W9	0.001	0.001	-0.001	0.003
Age W1	0.002+	0.001	0	0.003
Non-white W1	**-0.084** **	0.031	**-0.144**	**-0.024**
Gender W1	0.004	0.019	-0.034	0.041
Unemployment / inactive W1 (reference: employment)	-0.047+	0.024	-0.095	0.00
Long-standing illness and disability W1	-0.01	0.021	-0.051	0.03
Household income W1	**0.035** **	0.011	**0.013**	**0.056**
Urbanity W1 (Rural: reference)	-0.034	0.026	-0.085	0.017
Mental health W1	0.001	0.001	-0.002	0.003
2010 IMD 20%-40% (reference: IMD 0%-20%)	0.002	0.031	-0.058	0.062
2010 IMD 40%-60% (reference: IMD 0%-20%)	**0.066***	0.031	**0.005**	**0.127**
2010 IMD 60%-80% (reference: IMD 0%-20%)	-0.034	0.031	-0.096	0.027
2010 IMD 80%-100% (reference: IMD 0%-20%)	0.018	0.035	-0.05	0.086
Divorced W1 (reference: Married)	-0.029	0.032	-0.091	0.034
Widowed W1 (reference: Married)	0.015	0.056	-0.095	0.124
Never married W1 (reference: Married)	0.048+	0.028	-0.008	0.103
No qualification W1 (reference: Degree)	**-0.315*** **	0.042	**-0.397**	**-0.232**
GCSE W1 (reference: Degree)	**-0.212*** **	0.03	**-0.272**	**-0.153**
A-Level W1 (reference: Degree)	**-0.204*** **	0.028	**-0.258**	**-0.15**
Modification index-guided variables				
Civic engagement W6	**0.102*** **	0.02	**0.064**	**0.14**
Civic engagement W3	**0.100*** **	0.027	**0.047**	**0.153**
Civic engagement W12	WITH			
Mental health W12	0.048	0.075	-0.1	0.196
Intercepts				
Mental health W3	3.558	7.049	-10.258	17.375
Mental health W6	-8.113	5.666	-19.218	2.991
Mental health W9	-0.551	6.536	-13.361	12.259

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Mental health W12	-11.331+	5.971	-23.034	0.372
Civic engagement W3	0.565	0.484	-0.383	1.514
Civic engagement W6	-0.515	0.344	-1.19	0.159
Civic engagement W9	**-0.958*** **	0.193	**-1.335**	**-0.581**
Civic engagement W12	**-0.539*** **	0.145	**-0.823**	**-0.254**
Residual Variances				
Mental health W3	**64.83*** **	1.424	**62.039**	**67.622**
Mental health W6	**59.145*** **	1.257	**56.681**	**61.609**
Mental health W9	**64.047*** **	1.296	**61.507**	**66.587**
Mental health W12	**67.375*** **	1.323	**64.782**	**69.967**
Civic engagement W3	**1.355*** **	0.074	**1.210**	**1.500**
Civic engagement W6	**0.819*** **	0.033	**0.755**	**0.883**
Civic engagement W9	**0.987*** **	0.023	**0.943**	**1.032**
Civic engagement W12	**0.648*** **	0.018	**0.612**	**0.683**
Goodness of fit				
RMSEA	0.018			
CFI	0.993			
TLI	0.975			

Note: The letter "W" denotes wave of longitudinal data.
+ p<0.10, *p<0.05, **p<0.01, ***p<0.001

Table 8. Sensitivity analysis: autoregressive cross-lagged panel analysis of the relationships between area and personal trust and cooperative norms and area and individual mental health in the Understanding Society: The UK Household Longitudinal Study (Waves 1, 3 and 6) (N=8920)

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Mental Health W3	ON			
Area mental health W3	**0.442****	0.140	**0.168**	**0.716**
Age W1	**0.107*****	0.007	**0.093**	**0.122**
Non-white W1	-0.175	0.303	-0.77	0.419
Gender W1	**-0.992*****	0.182	**-1.349**	**-0.634**
Unemployment / inactive W1 (reference: employment)	-0.329	0.213	-0.747	0.089
Long-standing illness and disability W1	**-2.319*****	0.2	**-2.711**	**-1.928**
Household income W1	0.023	0.089	-0.152	0.198
Urbanity W1 (Rural: reference)	-0.247	0.232	-0.701	0.207
Mental health W1	**0.433*****	0.012	**0.409**	**0.457**
2010 IMD 20%-40%(reference: IMD 0%-20%)	0.125	0.277	-0.418	0.668
2010 IMD 40%-60% (reference: IMD 0%-20%)	0.016	0.274	-0.52	0.553
2010 IMD 60%-80% (reference: IMD 0%-20%)	-0.08	0.284	-0.637	0.478
2010 IMD 80%-100% (reference: IMD 0%-20%)	-0.05	0.334	-0.705	0.604
Divorced W1 (reference: Married)	**-0.739***	0.324	**-1.374**	**-0.103**
Widowed W1 (reference: Married)	0.203	0.471	-0.72	1.126
Never married W1 (reference: Married)	-0.293	0.286	-0.854	0.267
No qualification W1 (reference: Degree)	-0.576	0.389	-1.337	0.186
GCSE W1 (reference: Degree)	-0.075	0.231	-0.528	0.378
A-Level W1 (reference: Degree)	0.364	0.221	-0.069	0.797
Trust and cooperative norms W3	ON			
Area trust and cooperative norms W3	**0.644*****	0.077	**0.494**	**0.794**
Age W1	**0.016*****	0.002	**0.011**	**0.020**
Non-white W1	-0.038	0.085	-0.205	0.128
Gender W1	0.100	0.054	-0.005	0.205
Unemployment / inactive W1 (reference: employment)	0.012	0.063	-0.112	0.136
Long-standing illness and disability W1	**-0.229*****	0.058	**-0.341**	**-0.116**

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Household income W1	**0.089****	0.033	**0.024**	**0.155**
Urbanity W1 (Rural: reference)	**0.773*****	0.069	**0.637**	**0.909**
Mental health W1	**0.022*****	0.003	**0.016**	**0.028**
2010 IMD 20%-40% (reference: IMD 0%-20%)	0.001	0.08	-0.156	0.158
2010 IMD 40%-60% (reference: IMD 0%-20%)	-0.135	0.083	-0.298	0.028
2010 IMD 60%-80% (reference: IMD 0%-20%)	-0.094	0.084	-0.259	0.07
2010 IMD 80%-100%(reference: IMD 0%-20%)	-0.002	0.092	-0.183	0.179
Divorced W1 (reference: Married)	**-0.286****	0.096	**-0.475**	**-0.097**
Widowed W1 (reference: Married)	-0.008	0.147	-0.296	0.28
Never married W1 (reference: Married)	**-0.465*****	0.083	**-0.627**	**-0.303**
No qualification W1 (reference: Degree)	**-0.525*****	0.107	**-0.735**	**-0.315**
GCSE W1 (reference: Degree)	**-0.525*****	0.069	**-0.661**	**-0.388**
A-Level W1 (reference: Degree)	**-0.265*****	0.065	**-0.393**	**-0.137**
<u>Mental health W6</u>	ON			
Mental health W3	**0.371*****	0.013	**0.345**	**0.396**
Trust and cooperative norms W3	**0.182*****	0.038	**0.108**	**0.256**
Area mental health W6	**0.621*****	0.115	**0.395**	**0.848**
Area trust and cooperative norms W3	**-0.795****	0.256	**-1.297**	**-0.293**
Age W1	**0.083*****	0.007	**0.069**	**0.097**
Non-white W1	-0.175	0.296	-0.755	0.405
Gender W1	**-0.796*****	0.169	**-1.128**	**-0.465**
Unemployment / inactive W1 (reference: employment)	**-0.874*****	0.198	**-1.261**	**-0.486**
Long-standing illness and disability W1	**-0.921*****	0.185	**-1.284**	**-0.557**
Household income W1	0.05	0.079	-0.105	0.205
Urbanity W1 (Rural: reference)	-0.072	0.215	-0.493	0.35
Mental health W1	**0.228*****	0.013	**0.202**	**0.253**
2010 IMD 20%-40% (reference: IMD 0%-20%)	-0.016	0.257	-0.521	0.488
2010 IMD 40%-60% (reference: IMD 0%-20%)	-0.171	0.26	-0.681	0.34
2010 IMD 60%-80% (reference: IMD 0%-20%)	0.163	0.267	-0.36	0.687
2010 IMD 80%-100% (reference: IMD 0%-20%)	-0.255	0.316	-0.874	0.363
Divorced W1 (reference: Married)	-0.712**	0.327	-1.353	-0.07
Widowed W1 (reference: Married)	0.682	0.434	-0.169	1.532

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Never married W1 (reference: Married)	-0.075	0.271	-0.606	0.455
No qualification W1 (reference: Degree)	0.319	0.34	-0.347	0.984
GCSE W1 (reference: Degree)	0.401*	0.224	-0.038	0.841
A-Level W1 (reference: Degree)	0.127	0.217	-0.297	0.552
Trust and cooperative norms W6	ON			
Area trust and cooperative norms W6	**0.964*** **	0.143	**0.682**	**1.245**
Trust and cooperative norms W3	**0.526*** **	0.011	**0.504**	**0.547**
Mental health W3	**0.01** **	0.003	**0.003**	**0.016**
Age W1	0.003	0.002	0.000	0.007
Non-white W1	0.088	0.075	-0.059	0.235
Gender W1	**0.103***	0.045	**0.015**	**0.192**
Unemployment / inactive W1 (reference: employment)	-0.012	0.053	-0.115	0.091
Long-standing illness and disability W1	-0.022	0.048	-0.115	0.071
Household income W1	0.006	0.022	-0.037	0.048
Urbanity W1 (Rural: reference)	**0.163** **	0.056	**0.053**	**0.273**
Mental health W1	0.004	0.003	-0.002	0.010
2010 IMD 20%-40% (reference: IMD 0%-20%)	-0.078	0.067	-0.210	0.054
2010 IMD 40%-60% (reference: IMD 0%-20%)	**-0.146***	0.067	**-0.276**	**-0.015**
2010 IMD 60%-80% (reference: IMD 0%-20%)	**-0.176***	0.071	**-0.316**	**-0.036**
2010 IMD 80%-100% (reference: IMD 0%-20%)	-0.108	0.078	-0.260	0.044
Divorced W1 (reference: Married)	**-0.212** **	0.081	**-0.370**	**-0.054**
Widowed W1 (reference: Married)	**-0.252***	0.121	**-0.489**	**-0.015**
Never married W1 (reference: Married)	**-0.308*** **	0.072	**-0.450**	**-0.166**
No qualification W1 (reference: Degree)	-0.13	0.089	-0.304	0.043
GCSE W1 (reference: Degree)	**-0.208*** **	0.059	**-0.323**	**-0.093**
A-Level W1 (reference: Degree)	**-0.179** **	0.056	**-0.288**	**-0.070**
Modification index-guided variables				
Area trust and cooperative norms W3	**-0.572*** **	0.145	**-0.855**	**-0.289**
Trust and cooperative norms W6				
Mental health W6	**0.935*** **	0.188	**0.566**	**1.304**
Intercepts				

			95% CI	
	Estimate	Cluster-robust standard error	Lower 2.5%	Upper 2.5%
Mental health W3	3.073	7.065	-10.774	16.921
Trust and cooperative norms W3	**2.791***	1.192	**0.455**	**5.126**
Mental health W6	-4.522	6.016	-16.314	7.27
Trust and cooperative norms W6	0.405	1.04	-1.634	2.444
Residual Variances				
Mental health W3	**64.759*****	1.424	**61.969**	**67.55**
Trust and cooperative norms W3	**5.931*****	0.106	**5.723**	**6.139**
Mental health W6	**58.901*****	1.258	**56.435**	**61.367**
Trust and cooperative norms W6	**3.993*****	0.081	**3.835**	**4.151**

Note: The letter "W" denotes wave of longitudinal data.
+ p<0.10, *p<0.05, **p<0.01, ***p<0.001

Chapter 5. Overall discussions

This thesis contributes to the literature in the fields of employment, area socioeconomic status, area and individual social capital, and health inequalities. The empirical results provide insights that can inform future research and policymaking. Below, I discuss the shared implications of these findings, directions for future research, methodological considerations, the generalisability of the results, the rational for health outcomes choices, the implications of self-reported health, as well as the limitations of the data.

Shared Implications: The role of area deprivation in health outcomes

The findings of this project underlines the importance of examining area deprivation in future research when examining health outcomes in England. Chapter 2 shows that retirement transition in deprived local authority districts (LADs) was less detrimental to physical health, compared to retirees in less deprived LADs. It might be due to differences in job qualities. Jobs in deprived areas often offer poor autonomy (Public Health England, 2015), and people are less likely to build their identities based on their jobs (Schieman, 2002). Therefore, the transition to retirement may be less stressful, which could correspond with smaller changes in physical health (Hughes *et al.*, 2017).

Additionally, analyses in chapter 2 also shows that physical improvement was associated with unemployment transition in LADs with high unemployment rates. In these areas, individuals who experienced improvements in physical health were more likely to transition into unemployment. The transition may have been relevant to their pursuit of better opportunities. Another possible explanation for this association is that, in areas with high unemployment rates, physical health may improve following a transition into unemployment.

Jobs in areas with high unemployment rates may be of low quality, and transitioning into unemployment could have benefits for physical health (Ferns, 2019).

Chapter 3 found that area deprivation was associated with poor physical health outcomes, considering compositional factors (i.e., socioeconomic status). Jobs in deprived areas are often low-skilled and physically demanding (Public Health England, 2015). Pedersen et al. (2020) demonstrate that individuals engaged in physically demanding jobs exhibit a shorter working life expectancy and encounter more health issues compared to their counterparts. Previous studies have delved into the association between socioeconomic position of individuals (e.g., employment states or transitions, cumulative occupational class and occupational status) and health (Mein *et al.*, 2003; Morefield, Ribar and Ruhm, 2012; Kjellsson, 2013; Eshak *et al.*, 2017). However, these investigations have consistently overlooked the role of area deprivation. Therefore, future research should explore the associations between socioeconomic position of individuals and health outcomes, specifically considering area deprivation as a moderator in the context of England.

Future study: Employment, social capital, and health

The associations between employment transitions or states, physical health, and individual or area-level social capital elements have not been thoroughly investigated in England. This project found that the relationship between retirement transition and physical health was reciprocal among retires in England. Specifically, retirement transition predicted declines in physical health. Additionally, Chapter 3 revealed that area civic engagement was associated with physical health, while Chapter 4 demonstrated that both homogeneous friendship networks and trust and cooperative norms were independently associated with better mental health.

Future studies could examine the role of individual and area-level social capital as potential moderators in the relationship between retirement transition and declines in physical health. Social capital, as a resource that facilitates bridging and bonding, as well as a collective feature within places, may help individuals manage daily challenges and access social support (Macintyre, Ellaway and Cummins, 2002; Berkman and Kawachi, 2015). This, in turn, could mitigate stress related to retirement transitions and improve health outcomes.

Methodological considerations: social causation and health selection

Studies from Chapters 2 and 4 independently examined the bidirectional associations between employment states and transitions, social capital, and health outcomes, while also accounting for area-level factors. Kröger, Pakpahan and Hoffmann (2015) highlighted five key methodological considerations when addressing social causation and health selection (see Chapter 1), one of which is the necessity of including both social causation and health selection within a single equation. Certain relationships, such as those between employment states and physical health, as well as between social capital and mental health, were analysed using autoregressive cross-lagged models, which allowed for the simultaneous inclusion of both social causation and health selection mechanisms. However, when examining employment transitions and physical health, fixed-effects models were employed. Consequently, it was not possible to incorporate both social causation and health selection within the same model. All findings may not affected by this issue, except the association between retirement transition and physical health. Chapter 2 shows that retirement transition and poor changes in physical health were less pronounce in the second least deprived areas (more deprived) than the least deprived areas . Additionally, poor changes in physical health predicted retirement transition. The inability to integrate both social causation and health selection in fixed-effect models imply that the results cannot be interpret as a causality.

Kröger, Pakpahan and Hoffmann (2015) also emphasise the importance of addressing missing values when examining social causation and health selection. This project employed list-wise deletion (Chapter 2) and Full Information Maximum Likelihood (FIML) (Chapter 4) to handle missing data in these analyses. In chapter 4, FIML was applied to all models except for the civic engagement models (Appendix Tables 4 and 7 in chapter 4), which failed to converge when FIML was used. Despite this, the impact of missing data on the findings is likely minimal, as the analytic sample remained largely intact. Only 3 cases were lost in both main and sensitivity analyses, suggesting that the exclusion of FIML may not affect the results. Furthermore, list-wise deletion accounted for non-response bias (Daniel *et al.*, 2012), mitigating potential concerns regarding missing data.

Generalisability of findings

Fourthly, the findings from Chapter 2 may be generalised to other parts of the UK and Western European countries. The results presented in Chapter 2 indicate that the association between retirement transition and adverse changes in physical health is less pronounced in deprived areas than in less deprived areas. Additionally, the relationship between improvements in physical health and unemployment transition appears to be stronger in deprived areas than in less deprived areas. Many parts of the UK and Western Europe have suffered from the impacts of deindustrialisation and deprivation (Walsh, Taulbut and Hanlon, 2010). For example, deprived areas in Scotland are characterised by high unemployment rates and poor job quality (e.g. insecure and low-paid employment) (Ferns, 2019). Furthermore, some workers have lost jobs that shaped their identities; for instance, former steelworkers have been forced to transition into other roles that they may perceive as less meaningful (Ferns, 2019). As a result, the retirement transition in these deprived areas may not have a profound impact on physical health outcomes compared to less deprived areas, as retirees may have already experienced stress related to identity loss prior to retirement. Moreover, unemployment transition may provide individuals in deprived areas with an opportunity to recover from the work-related stress associated with low-quality jobs, which may improve their physical health. Future research could further explore the associations between employment transitions and health outcomes in both deprived and less deprived areas across the UK and Western European countries.

By contrast, the findings from Chapter 3 may not be generalised to other parts of the UK and Western Europe. The results indicate that higher levels of deprivation, as measured by the Index of Multiple Deprivation, are associated with adverse changes in physical health and its subscales, even after adjusting for individual socioeconomic status (SES). Additionally, the study suggests that areas with high levels of civic engagement are associated with better physical health. However, existing research provides mixed evidence on this relationship. For example, Belau (2024), using data from Waves 5 to 9 of the Survey of Health, Ageing, and Retirement in Europe (SHARE), found that regional deprivation was not associated with individual risk of death from all causes or cancer after adjusting for individual deprivation. This analysis covered 14 European countries and Israel, including Austria, Belgium, the Czech Republic, Denmark, Estonia, France, Germany, Italy, Luxembourg, the Netherlands, Slovenia, Spain, Sweden, and Switzerland.

The relationship between civic engagement and health outcomes has been inconsistent in Ireland (Islam *et al.*, 2006), which may be due to variations in how civic engagement is measured. For instance, Kelleher *et al.* (2002) used voting behaviour as a measure, whereas most studies have assessed civic engagement through organisational participation (Mohan *et al.*, 2005; Snelgrove, Pikhart and Stafford, 2009). Kelleher *et al.* (2002) found no significant association between voting for the largest political parties in Ireland and mortality. However, areas with higher support for Fianna Fáil had lower levels of health dissatisfaction, whereas areas with greater support for left-wing parties were more likely to report health dissatisfaction (Kelleher et al., 2002). Future research could compare different dimensions of civic engagement and their associations with health outcomes, using data from Western Europe and the UK.

The findings from Chapter 4 may be generalised to high-income countries. The results indicate that the bidirectional association between civic engagement and mental health was not significant. However, higher levels of trust and cooperative norms and homogeneous friendship networks were associated with better mental health, while poor mental health was linked to lower levels of trust, cooperative norms, and homogeneous friendship networks. A systematic review by Ehsan and Silva (2015) similarly found that structural aspects of social capital, such as civic participation, were not significantly associated with common mental disorders. However, cognitive social capital, which includes trust and perceived social support, was positively associated with better mental health. Notably, 30 of the studies included in the systematic review focused on high-income countries, while only two examined low-income countries. UK-based studies found that better mental health was associated with both higher trust and civic engagement (Giordano and Lindström, 2011; Yu *et al.*, 2015).

Incoherence between studies: the rational for health outcome choices

This project used self-rated health as a measure of health outcomes. In Chapters 2 and 3, we measured health outcomes using physical health, whereas in Chapter 4, we focused on mental health. Chapter 2 builds on Flint *et al.* (2013), examining the association between employment states and transitions and physical health, with area deprivation as a moderating factor. To avoid redundancy with Flint et al. (2013), we used physical health as the dependent variable in this chapter. Chapter 3 contributes to existing studies that investigate the relationship between area deprivation and self-rated health, such as Verhaeghe and Tampubolon (2012). While prior research has often relied on general health measures, we employed the SF-12 Physical Component Summary (SF-12 PCS), which emphasises engagement in social activities and roles (Townsend, Phillimore and Beattie, 2023). In contrast, the general health indicator used by Verhaeghe and Tampubolon (2012) focuses on individual perceptions of health. In Chapter 4, we examined the reciprocal relationship between social capital and mental health, specifically investigating whether area-level social capital and area-level mental health are associated with personal social capital and mental health. While previous studies have explored the link between social capital and mental health (Ehsan and Silva, 2015), they have not fully considered the influence of area-level social capital and area-level mental health on personal social capital and mental health. Additionally, Chapter 4 studied social-interactive mechanisms, including social contagion and collective socialization. Social contagion is more commonly studied in relation to mental health than physical health, with obesity being a notable exception (VanderWeele, 2011; Huang *et al.*, 2016).

The implication of using self-reported health outcomes

Given the reliance on self-rated health in this project, it is important to consider its implications for measuring health outcomes. According to Sen (2002), self-reported health can mislead health policy decisions, as individuals may perceive their health differently from how it is assessed by external professionals or objective measures. For example, in India, states with low longevity and poor educational and medical facilities, such as Bihar, reported better self-rated health outcomes. In contrast, states with the highest levels of literacy and longevity, such as Kerala, exhibited the highest rates of self-reported morbidity among all Indian states. Individuals raised in deprived areas may perceive certain health difficulties as normal, leading to more positive self-rated health assessments on measures such as the SF-12 Physical Component Summary (PCS) and Mental Component Summary (MCS), even when clinical evaluation would suggest otherwise. Additionally, social desirability bias can affect survey data, as respondents may be inclined to select options they perceive as socially acceptable (Groves *et al.*, 2009). Future studies could address these limitations by incorporating objective health measures, such as allostatic load, as dependent variables.

Limitations

The findings of this study pertain to the LADs or counties in England, including the four Populations in Focus areas of NIHR ARC EoE: Great Yarmouth and Waveney, Peterborough and Fenland, Stevenage, and Thurrock. Due to the lack of a sufficient sample for these areas in UKHL, this project cannot conduct studies specifically on them. Additionally, survey weighting was not applied in the analyses. As a result, this project's findings may be biased as the sample may not be fully representative (Olena Kaminska and Peter Lynn, 2019). However, the complete cases used in Chapters 2 and 3, as well as full information maximum likelihood (FIML) in Chapter 4 (excluding civic engagement models), can account for non-response, regardless of whether survey weighting was applied (Daniel *et al.*, 2012; Craig Enders, 2022).

Conclusion and Policy Implications

This study provides insights into the relationship between physical and mental health and both individual and area deprivation among adults in England. Our findings indicate no significant reciprocal associations between transitions into unemployment and improvements in physical health. However, we observed that improvements in physical health were associated with transitions into unemployment in the second least employment-deprived areas (more deprived) compared to the least employed-deprived areas (less deprived). This suggests that individuals in the second least deprived areas may experience greater physical health benefits from transitioning into unemployment than those in the least deprived areas, possibly due to relief from work-related strain. Alternatively, it may indicate that individuals experiencing improvements in physical health are more likely to transition into unemployment in the second least deprived areas.

Additionally, our study highlights that the relationship between retirement transitions and physical health is reciprocal. Deterioration in physical health was associated with retirement transitions, and retirement transitions, in turn, were associated with smaller declines in physical health in the second least deprived areas compared to the least deprived areas. This suggests that retirees in the second least deprived areas may be less likely to construct their identities around their jobs than those in the least deprived areas. Therefore, retirement transitions do not result in pronounced physical health changes among them. Overall, we found that both unemployment and retirement were associated with both positive and negative physical health outcomes. The increase in physical health was also associated with the increase and decrease chances of being unemployed.

Our study did not establish a definitive mediating role of area social capital elements. However, we found that area deprivation was associated with physical health and its subscales. Moreover, area civic engagement was associated to physical health and its subscales, whereas area trust, cooperative norms, and homogenous friendship networks were not. While area civic engagement appeared to explain the association between area deprivation and physical health, the mediating role was not conclusive.

Furthermore, our findings support the notion that individuals living in areas with high social capital elements are more likely to exhibit high levels of social capital themselves (i.e., homogenous friendship networks, trust and cooperative norms, and civic engagement). A similar pattern was observed in the relationship between area-level and individual mental health, suggesting that the characteristics of one’s residential environment may be linked to personal attributes. However, it is also possible that individuals with high social capital and poor mental health choose to reside in particular residential areas.

We found a reciprocal relationship between homogenous friendship networks and trust and cooperative norms, and mental health independently. Specifically, individuals with better mental health were more likely to have homogenous friendship networks, and those with such networks were, in turn, more likely to experience better mental health. Additionally, individuals with good mental health were more likely to exhibit higher levels of trust and cooperative norms, and those with high trust and cooperative norms were more likely to have better mental health.

Policymakers should consider strategies that address both individual and area-level factors to improve physical and mental health. This includes extending appropriate employment support services for retirees in the least income-deprived areas, recognising that retirees in the least income-deprived areas may face more pronounced negative physical health outcomes upon retirement. These employment support services should aim to ease retirement-related challenges in less deprived areas. Additionally, strategies aimed at strengthening civic engagement in LADs may yield benefits for physical health. For example, policymaker could collaborate with organisations and societies (e.g., political party, environmental group, and others) to encourage residents in LADs to participate in these bodies. Our project also shows that enhancing social capital (i.e., civic engagement, homogenous friendship networks, and trust and cooperative norms) and mental health at the county level may also foster stronger social capital and mental health among residents. Interventions to enhance social capital in counties, such as expanding infrastructure (e.g., sport centres, parks), may help to increase personal social capital, as such infrastructure can provide opportunities for social connections (Ziersch, 2011).

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