

Health Inequality and Multimorbidity:  
exploiting administrative data to understand the  
role of social care.

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### **Abstract**

This is a report for a 1st year review of PhD Urban Studies within the College of Social Sciences at the University of Glasgow. The report is divided into 4 sections.

- Section 1 introduces the subject matter and outlines the aims and objectives of the PhD.
- Section 2 is an in-depth discussion of academic and policy literature relevant to the topic.
- In Section 3, a rapid literature review identifying pertinent methodological techniques is presented.
- Finally, proposed methodologies for two parts of the research are discussed in Section 4.

# 1. Introduction

## 1.1 Introduction

Health inequalities are differences in health outcomes between individual people and groups of people (NHS-Health-Scotland, [2015](#)). There is consensus on the fact that a social gradient exists for health: a higher socioeconomic position generally indicates better health outcomes (Graham, [2007](#); Marmot et al., [2010](#)). It is also well established that there are social determinants of health inequalities such as: access to healthcare, deprivation, quality of housing and unemployment (CSDH, [2008](#); Marmot, [2005](#); Wilkinson and Marmot, [2003](#)). Despite widespread recognition of health inequalities, gaps in health outcomes between the highest and lowest socioeconomic groups are persistent and, in some cases, widening (Graham, [2007](#); Mackenbach, [2012](#)). There is some argument that the redistribution of power and wealth would have more impact in narrowing the gap in health outcomes than public health initiatives (Barry and Yuill, [2008](#); Krieger et al., [2008](#); McCartney et al., [2013](#); Singh and Siahpush, [2006](#)). Despite calls for more investment in "upstream" interventions, many governments continue to look at public health and social care interventions to reduce health inequalities (McDaid et al., [2015](#)).

In the United Kingdom (UK), poverty remains the largest predictor of relative ill health and has associations with increased morbidity, multimorbidity, and decreased life expectancy (Baker et al., [2015](#)). People living in deprived areas are more likely to engage in unhealthy lifestyle behaviours, experience multimorbidity at a younger

age, and live in overcrowded or unsuitable housing (Baker et al., 2015; Shaw et al., 2006). The influential Marmot review into health inequalities found that those in the most deprived areas of England die, on average, 7 years earlier than their most affluent peers (Marmot et al., 2010) with the gap in life expectancy increasing between 1995 and 2008 (National-Audit-Office, 2010). Subsequent research by the King's Fund suggests the gap in life expectancy reduced between the periods 1999-2003 and 2006-2010 (Buck and Maguire, 2015). The report warns that this improvement may be due to the spending and policy decisions of the New Labour Government of the early 2000s and that recent austerity measures in the UK may undermine the progress made (Buck and Maguire, 2015). The gap in male life expectancy has not changed in Northern Ireland since 2008: those in the poorest neighbourhoods die, on average, 5 years earlier (DHSSPS, 2010). In Scotland, the Government reports statistics on healthy life expectancy which is defined as the number of years people can expect to live in good health (Scottish-Government, 2015b). The most recent figures suggest men and women in the most deprived areas can expect to become ill 25.1 and 22.1 years earlier than their most affluent peers respectively (Scottish-Government, 2015b).

Multimorbidity, the presence of 2 or more long-term health conditions, has implications for the way an individual uses health care and is therefore an important consideration in the study of health inequality (Baker et al., 2015). The number of people in the UK with three or more long-term health conditions is expected to rise to 2.9 million people by 2018 - a rise of 1 million over the preceding decade (Imison, 2012). This reflects a worldwide trend of non-communicable diseases replacing communicable diseases as the major burden of healthcare and accounting for over two-thirds of deaths globally (Imison, 2012; WHO, 2014).

In developed countries, this shift is most heavily felt in primary care systems where non-acute conditions are traditionally managed (Goodwin et al., 2010). This setting is already affected by health inequality where the inverse care law - the availability of good medical care varying inversely with the need for it in the population served (Tudor-Hart, 1971) - persists. As discussed above, the most deprived areas have lower life expectancy and higher morbidity figures and therefore greater health

needs (Baker et al., 2015). However, the poorest neighbourhoods in England have been reported to have 62.5 General Practitioners (GP) per 100,000 population whereas the most affluent neighbourhoods have 76.2 per 100,000 (CfWI, 2014) suggesting health provision does not match need. Recent planned changes in policy to distribute primary care funding based on population age are likely to exacerbate this situation (Mercer et al., 2012). Indeed, increases in workload with deteriorating proportions of budgets has lead the King's Fund to describe the situation in primary care in England and Wales as, "in crisis" (Baird et al., 2016, p.3). In Scotland, the even distribution of GP workforce among the population means GP practices in the most deprived areas need to provide more consultations, for people with greater needs, at the same funding level as practices with fewer resource demands (McLean et al., 2015; Mercer and Watt, 2007). Poorer access to primary health care is associated with greater demand for unnecessary admission to hospital (Rosano et al., 2013) which is responsible for high proportions of healthcare expenditure. As acute hospital admission rates rise, tackling health inequalities is a major policy priority. Primary care has a pivotal role to play in this action (WHO, 2008).

The World Health Organisation (2015) cites relative inequalities in improvements of health and life expectancy, within and between countries, as justification for recommended structural change to healthcare. The main recommendation is for governmental policy to shift healthcare focus from acute hospital care to outpatient and community care (WHO, 2015). The paradigm shift in the method of service delivery is suggested in response to increasing long-term, chronic conditions forming the major burden of care worldwide. Acute secondary care is expensive, thus the shift in care also reflects the need to find affordable models of healthcare in an age of diminishing budgets worldwide (WHO, 2015). Integrating health and social care services and increasing primary care spend are cited as two potential ways of facilitating this shift in focus (WHO, 2015).

Despite acknowledgement of the need to adjust the model of care delivery, there is not a large body of evidence investigating the benefits of health and social care integration. Financial integration of health and social care services has taken place, in some form or other, in Australia, Canada, England, Italy, Northern Ireland,

Scotland, Sweden, the United States, and Wales (Weatherly et al., [2010](#)). Whilst there is some evidence of improvements in self-reported satisfaction outcomes and hospital admission rates, Weatherly et al. ([2010](#)) found no evidence of beneficial health outcomes as a result of integration. This may be due to the fact the research to date has focused on the process of integration rather than outcomes for users of services (Petch, [2011](#); Petch, [2012](#)). Given many integration projects are recent, it will also take time for changes in outcomes to be measured (Petch, [2012](#)).

Regardless of evidence base, health and social care integration has been implemented across the UK with calls for acute hospital admission to be reserved for only those that cannot be cared for elsewhere (Ham et al., [2012](#)). In Scotland, acknowledging that demographic changes make the current form of healthcare delivery financially unsustainable, the Scottish Government made the integration of health and social care a statutory obligation for health boards and local authorities on the 1st of April 2016 (Audit-Scotland, [2016](#)). Joint integration boards have been set up in most areas of Scotland to administer integration of budgets and services, but will have to do so on a background of decreasing health and local authority spending (Audit-Scotland, [2016](#)). Until recently many local authorities had attempted to protect front-line services, such as social care, from austerity cuts (Hastings et al., [2015](#)). However, given continued year-on-year reductions and a further 7.2% cut to local authority spending in 2016/2017 (Audit-Scotland, [2016](#)), the ability to protect social care from reductions in spend becomes less likely. Decreased local government budgets across the United Kingdom since 2010 have affected those living in the poorest areas hardest (Hastings et al., [2015](#)). If social care budgets begin to decrease, the question of whether the most deprived areas will feel these cuts most is of grave importance.

It is now possible that the most disadvantaged in society may not only have the worst life expectancy and multimorbidity profiles whilst facing the inverse care law in primary care, but may also bear the brunt of cuts to social care. Understanding how people with multimorbidity access and use health care and social care is, therefore, vitally important to assess how inequalities can be tackled. Given the major structural changes to the delivery of health and social care, understanding the



interaction of users between these services will also give insights into the best place to direct diminishing resources for all.

Scotland has some of the best health service data in the world (ISD, 2010). However to fully understand: outcomes, service design and evaluation, and identify potential interventions in an era of health and social care integration - linked healthcare and routinely collected social care datasets are essential (Atherton et al., 2015; Pavis and Morris, 2015; Witham et al., 2015). Harnessing the potential of infrastructure designed specifically to enable such linkage (Pavis and Morris, 2015) is a unique and important opportunity to fully understand how multimorbidity, health care and social care interact across society in Scotland and identify to what extent inequalities affect use of services.

## **1.2 Aims and Objectives**

The aim of the PhD is to explore the relationships between multimorbidity and health and social care utilisation by age and socioeconomic status over time. The objectives are:-

1. To conduct scoping reviews of international literature on the definitions and measurement of multimorbidity and social care.
2. To carry out stakeholder consultation and pilot work to assess to what extent analysis of inequalities, multimorbidity and health and social care use can be operationalised using linked health and social care data.
3. To develop measures to assess the trajectory of multimorbidity over time in different age and socioeconomic groups and to assess the level of use of different health and social care services across these trajectories.
4. To explore the potential of evidencing from "natural experiment cohorts" (e.g. differences in social care services between local authorities within same health board or between different community healthcare partnerships) the longitudinal effects of health and social care services on outcomes.

Aims and objectives were set by the funders of the project. At present the first three objectives are currently being planned for with work undertaken on all three already. Given the expected difficulties in accessing data, objective four remains speculative at present. "Natural Experiment" analysis will be dependent on sufficient data and completion of the previous 3 objectives.

### **1.3 Expected contribution to scientific knowledge**

The PhD hopes to describe the interaction between health and social care and to identify the effect, if any, the amount or type of social care has on the use of health services. These interactions have rarely been studied and no definitive conclusions have been drawn. A unique facet of the proposed research is to assess the relationships between multimorbidity, health inequalities, and the interaction of health and social care. Identifying if complexity of illness has an effect on use of services and whether the inverse care law is observed in social care service delivery are of high academic and policy importance.

A further outcome of the PhD is the identification of the most prevalent clusters of health conditions that co-exist within individuals. Using a population-sized dataset and Latent Class Analysis this part of the PhD (more fully described in section 4.1) aims to identify if deprivation as a social determinant of health influences how multimorbidity presents in the general population.

## 1.4 Timeline

Date	Milestone
April 2016	Latent Class Analysis Ethical approval UBDC <sup>1</sup> pilot project application due UBDC pilot project ethics application made
May 2016	1st Year Review
June 2016	Latent Class Analysis begins UBDC pilot project outcome known Formal request to Renfrewshire Council for data access (pending ethical approval)
August 2016	UBDC Renfrewshire Council data analysis
September 2016	NHS Ethics process begins Application for data begins
October 2016	Latent Class Analysis Chapter completed
December 2016	NHS Ethics granted
January - March 2017	Data applications and transfer
April - July 2017	Data Linkage
August - December 2017	Data Analysis
January - June 2018	Thesis completion

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<sup>1</sup>Urban Big Data Centre

## 2. Literature Review

This chapter will discuss in greater detail some of the main themes of the PhD project. A broad summary of literature discussing health inequalities is presented in section 2.1. Thereafter, section 2.2 will outline scoping reviews of literature concerning multimorbidity definitions, measurement and epidemiology. Section 2.3 discusses definitions, measurement, eligibility and use of social care.

### 2.1 Health Inequality

There is no biological reason for poorer people to have worse health or to die earlier than the richest. Yet over the last five decades, despite overall trends, the most disadvantaged in society have seen slower improvements in health and life expectancy than the most affluent. This has resulted in a widening gap in health outcomes (CSDH, 2008; Scottish-Parliament, 2015; Scottish-Government, 2015b). This phenomenon has been observed between and within countries all over the world regardless of the relative prosperity of countries (CSDH, 2008). The Black Report (1982), published by the UK Government over 35 years ago, brought the subject of health inequality to international attention (Asthana and Halliday, 2006). It both described and attempted to explain health inequality. Successive UK governments commissioned subsequent reports that have described similar findings and new insights (Whitehead, 1987; Achenson et al., 1998; Marmot et al., 2010). However, there has been little progress in implementing recommendations from these reports and thus little progress in reducing disparities in health (Frank et al., 2015; Mackenbach,

2010; McCartney et al., 2012).

There are six main sociological theories as to why inequalities in health exist across social class (Asthana and Halliday, 2006; Nettleton, 2006). Four of these theories were initially described in the Black Report (1982). These are: artefact, health selection, cultural or behavioural, and materialist explanations (Asthana and Halliday, 2006; Nettleton, 2006). Subsequently two other theories, psycho-social and life-course explanations, have been added to the debate (Asthana and Halliday, 2006; Nettleton, 2006). A more recent discussion included ten theories or explanations of health inequality (Mackenbach, 2012). However, as some of these explanations can be regarded more as concepts than theories (Mackenbach, 2012) and others have been described as subordinate to other theories (McCartney et al., 2013), this discussion will concentrate on the six-theory framework as presented by Asthana and Halliday (2006) and Nettleton (2006). To a large extent, epidemiological evidence and theoretical argument has refuted the possibility that the first three theories can provide a plausible account of the existence of health inequality (Asthana and Halliday, 2006; Mackenbach, 2012; McCartney et al., 2013; Nettleton, 2006). Much of the recent sociological debate focusses on the materialist and psycho-social explanations.

The materialist, or structural, explanation for health inequality argues that the unequal distribution of wealth and power within societies is the root cause of health inequality (Asthana and Halliday, 2006; McCartney et al., 2013; Nettleton, 2006). Different experiences of poverty, quality of housing and environmental conditions, and unemployment are all believed to be the major factors that drive disparities in life expectancy and ill health (McCartney et al., 2013; Nettleton, 2006). These factors are all modifiable by governmental policy, thus the structural explanation for health inequality has deep political implications (McCartney et al., 2013). Indeed McCartney et al (2013) raise the argument that the recent shift in concentration of power to benefit the most affluent has coincided with widening health inequalities.

The psycho-social explanation for health inequality became popular during the 1990s and, for a time, was an acknowledged conventional wisdom (Asthana and

Halliday, 2006). The theory was hypothesised following the observation that life expectancy was higher in more equitable countries than simply those with higher Gross Domestic Product (GDP) (Wilkinson, 2005) and that a clear social gradient in inequality existed, even for those that not in the lowest social classes (Marmot, 2004). This led to the conclusion that in countries where income was unevenly divided, society as a whole was fractured and lacked cohesion. This resulted in greater individual isolation and, as a result of this isolation, health inequality (Asthana and Halliday, 2006; Nettleton, 2006).

Critics of the psycho-social explanation not only challenged the empirical observations that led to the theory, but argue that individualising the cause of inequality detracts from the structural causes advocated by the materialist explanation (Asthana and Halliday, 2006; Lynch et al., 2000; Nettleton, 2006). This, it is argued, put the blame for inequalities with the poor and ignored the effect that government policy could have (Lynch et al., 2000).

Whilst arguments over which theory is most plausible to explain the cause of health inequality are likely to continue, the materialist and psycho-social explanations agree on ways to remedy disparities in health (Asthana and Halliday, 2006; Nettleton, 2006). Both theories advocate the redistribution of income, wealth and political power as the most influential factors in eradicating health inequalities (Asthana and Halliday, 2006; Mackenbach, 2012; McCartney et al., 2013; Nettleton, 2006). Although health services have an important role to play, it is the "upstream" policies of redistribution that will make the biggest impacts in improving health outcomes across society (Asthana and Halliday, 2006; Scottish-Parliament, 2015). Whilst this has been known for some time, government policies in the UK and Scotland to date have not addressed these issues and have thus failed to make meaningful improvements in health inequalities (Frank et al., 2015; Mackenbach, 2010).

## 2.2 Multimorbidity

Multimorbidity is associated with higher mortality (Gijsen et al., 2001), increased use of health care (Gijsen et al., 2001; Salisbury et al., 2011), psychological distress (Fortin et al., 2006), worse quality of life (Fortin et al., 2004; Fortin et al., 2005a), and worse functional status (Kadam and Croft, 2007). It not only affects older people, but has been observed in greater absolute numbers in those under the age of 65 (Barnett et al., 2012). The number of people with multiple health conditions has been rising and is expected to rise further in coming years (Guthrie et al., 2011; Imison, 2012). This will have an effect on demands for health service use at a time when service delivery is still modelled on treatment of single diseases (Guthrie et al., 2011). Dedicated research into multimorbidity is a recent phenomenon (Fortin et al., 2005b) and has focussed on outcomes for individuals and healthcare rather than interventions (Mercer et al., 2009). This section will review academic literature in three areas of multimorbidity research: definitions, measurement and epidemiology.

### 2.2.1 Definitions

Despite the increasing importance of multimorbidity on health care systems, there is no internationally agreed definition of the term or concept (Almirall and Fortin, 2013; Lefevre et al., 2014). Van den Akker et al. (1996) first made the distinction between the terms comorbidity and multimorbidity. Comorbidity was originally described by Feinstein (1970, pp. 467) who stated, "In a patient with a particular index disease, the term co-morbidity refers to any additional co-existing ailment." Van Den Akker et al. (1996, pp.65) used the term multimorbidity to describe, "...any co-occurrence of medical conditions within a person." In this sense, multimorbidity does not rely on the presence of a primary, or index, disease but refers to the overall state of multiple illnesses.

Further development of definitions is provided by Valderas et al. (2009) who

characterise the construct of the term comorbidity found in the literature in four main groups; (a) comorbidity – additional diseases in the context of an index disease, (b) multimorbidity – more than one disease within an individual (without reference to an index disease), (c) morbidity burden – total impact of physiological dysfunction linked to patient outcomes and (d) patient complexity – the effect of non-health characteristics (e.g. deprivation, culture, environment) on morbidity burden.

Valderas et al. (2009) discuss these four constructs of comorbidity further in relation to three main research areas; clinical care, epidemiology and public health, and health service planning. It is suggested that comorbidity may be a more valid definition for use in specialist clinical care, whereas multimorbidity and morbidity burden would be more appropriate in primary care research. In epidemiological and public health research, the definitions of either comorbidity or multimorbidity would be of use depending on the origin of the diseases being studied and the particular research questions being investigated. Morbidity burden and patient complexity are, according to Valderas et al. (2009), the most appropriate definitions for research exploring healthcare use and costs.

A further definition of multimorbidity is offered by the European General Practice Research Network (EGPRN) who report findings of a systematic review in the construction of their definition. Citing over 100 different definitions for multimorbidity in academic research the EGPRN (Le Reste et al., 2013, pp.1) aimed to clarify the concept of multimorbidity and define the term as

"...any combination of chronic disease with at least one other disease (acute or chronic) biopsychosocial factor (associated or not) or somatic risk factor."

This definition goes some way to capture the complexity of the concept of multimorbidity as explained by Valderas et al. (2009) but has not ended debate on the matter.

More recently, a systematic review focussed on which diseases, risk factors and symptoms are included in varying definitions of multimorbidity (Willadsen et al., 2016). Whilst the majority of included studies in the review indicated multimor-



bidity as the presence of two or more conditions, Willadsen et al (2016) found the total number of diseases, risk factors, and symptoms used varied from 4 to 147. Of the 167 included articles in the review, 115 different ways of defining were identified (Willadsen et al., 2016).

In a draft guideline, the National Institute for Health and Care Excellence (NICE) (2016) acknowledge the complexity of defining multimorbidity. NICE agree with other commentators (Mercer et al., 2009) that basing the definition of multimorbidity on 2 or more health conditions only does not fully capture a clinically meaningful picture of the concept. The draft guideline highlights the fact that many people defined as multimorbid in this way may not be ill and have excellent quality of life requiring little or no health care input (NICE, 2016). For this reason the guideline is aimed at people with more than 1 long-term condition with any of the following:-

- Difficulty managing treatments or day-to-day activities.
- Care from multiple services and requiring care from a new service.
- Both long-term physical and mental health conditions.
- Frailty.
- Frequent use of unplanned or emergency care.
- Prescription of multiple, regular medicines. (NICE, 2016)

Although multimorbidity may seem to be an intuitive thing to understand, defining a useful concept of the term is much more difficult (Guthrie et al., 2011). Whilst the co-occurrence of 2 or more long-term conditions is the most commonly used definition of multimorbidity, there are wide variations in the number of conditions from which this definition can be based. This lack of clarity means that identifying useful ways to measure Multimorbidity is also problematic with marked variations in approaches.

### **2.2.2 Measurement**

The findings of three recent systematic reviews have highlighted the myriad ways researchers have approached the measurement of multimorbidity (De Groot et al.,

2004; Diederichs et al., 2011; Huntley et al., 2012). Each review aimed to collate evidence of measurement tools in comorbidity or multimorbidity but from different perspectives: De Groot et al. (2004) searched for comorbidity indices to inform research into Multiple Sclerosis, Diederichs et al. (2011) specifically searched for multimorbidity measurement indices, whereas Huntley et al. (2012) searched for measures of multimorbidity used only in primary care research. The systematic reviews found 13, 39 and 17 exclusive ways of measuring multimorbidity or comorbidity respectively. The number of medical conditions included in these measurements varied from 4 to 102 (Diederichs et al., 2011). Most indices are developed from secondary care populations but many have been adapted for other populations including primary care (Diederichs et al., 2011; Huntley et al., 2012)

There are two main ways of measuring multimorbidity: simple disease counts or using an index which applies weights to either prescribed medications or medical conditions and other factors in an attempt to explain severity of illness (De Groot et al., 2004; Diederichs et al., 2011; Huntley et al., 2012). In primary care research, the most frequently used measurement is simple disease counts (Huntley et al., 2012). This may be because of the ease with which it can be administered compared to more complex indices such as the Charlson index (Charlson et al., 1987) or Chronic Disease Score (Von Korff et al., 1992) and their variations. Despite the large number of multimorbidity indices available, Huntley et al. (2012) cite evidence that suggests simple counts of diseases or medications are almost as effective as the more complex indices at predicting mortality or health care use in the primary care setting. However, when aiming to predict mortality in Primary Care, Huntley et al.(2012) recommend the best measurement of multimorbidity to be provided by the Charlson index (Charlson et al., 1987) and its variations. Measurement of multimorbidity in relation to primary care healthcare use can be predicted with equivalence by either: the Adjusted Clinical Group system (Starfield et al., 1991), the Charlson index (Charlson et al., 1987), or disease counts (Huntley et al., 2012). Disease counts were also found by Huntley et al.(2012) to have good evidence to suggest they provide a robust measure of multimorbidity in relation to Quality of Life, as does the Charlson index (Charlson et al., 1987).

An emerging method of measuring multimorbidity is to identify clusters of medical conditions that co-exist in individuals at rates higher than would be expected - or non-random prevalence. Recent research and academic discussion suggests identification of disease clusters may enable clearer answers to clinically relevant research questions than currently employed measures (Le Reste et al., 2015; Islam et al., 2014; Prados-Torres et al., 2014; Sinnige et al., 2013; Holden et al., 2011; Marengoni et al., 2011; Valderas et al., 2009). Statistical techniques employed in attempts to identify such clusters include: factor analysis, cluster analysis, the observed-to-expected ratio, multiple correspondence analysis (Prados-Torres et al., 2014), principal component analysis, and latent class analysis (Islam et al., 2014). In their systematic review of clustering methods, Prados-Torres et al. (2014) found wide variations in approaches to clustering and characteristics of populations studied. As opposed to many of the studies included in the review, they recommend future attempts at clustering diseases use: population-sized datasets, statistical techniques that are suited to the dichotomous nature of diagnostic variables, and large numbers of conditions from which to form clusters (Prados-Torres et al., 2014).

### **2.2.3 Epidemiology**

Sections 2.2.1 and 2.2.2 describe the wide variations in definitions and measures of multimorbidity. It is, therefore, unsurprising that there is marked heterogeneity in reports of multimorbidity prevalence. Fortin et al (2012) illustrate this by reporting variations in the prevalence of multimorbidity from 3.5% to 98.5% across 21 studies included in their systematic review. The variation in findings is explained by the vastly different populations, settings, data collection techniques, and definitions of multimorbidity used by included studies. A more recent systematic review concentrating on primary care populations and aiming to describe prevalence, causes and patterns of multimorbidity (Violan et al., 2014) found reports of multimorbidity prevalence between 12.9% and 95.1%. Similar variations in definitions, measures and populations were found. The number of conditions used to estimate multimorbidity prevalence varied between 5 and 335 (Violan et al., 2014). Van den Akker et

al (2001) highlighted the complications that can arise when attempting to measure prevalence of multimorbidity and suggest that certain decisions made in study design will depend on the specific question being interrogated by researchers (e.g. the number of diseases to include in the measure of multimorbidity or the age-range of the sample). The systematic reviews of Violan et al. (2014) and Fortin et al. (2012) may reflect the varying decisions made by research teams in study design. Despite the difficulties in synthesising evidence on heterogeneous studies, Violan et al. (2014) found strong relationships between multimorbidity and: age, female gender, low socioeconomic status, and mental health across studies in their review.

#### **2.2.4 Summary**

Multimorbidity is most commonly defined as the presence (or co-occurrence) of 2 or more long-term conditions in an individual. Debate continues as to the type and number of long-term conditions that should be included to provide a meaningful concept for individuals, clinicians and healthcare organisations. The lack of a standard definition is mirrored in the myriad ways of measuring multimorbidity with various counts, indices, and clusters. Despite this, evidence suggests multimorbidity is increasing in prevalence and has a strong socioeconomic pattern.

### **2.3 Social Care**

#### **2.3.1 Background**

The provision of social care is of increasing policy importance across western, post-industrial societies (Anttonen, 2005; Deusdad et al., 2016; Pavolini and Ranci, 2008; Robertson et al., 2014). There are 4 ways in which social care can be provided to those in need: informally via family or community, formally via voluntary non-profit organisations, formally via the state, or formally via a for-profit organisations (Munday, 2003). In Europe, increasing demand from users has led to many welfare

systems being unable to adequately provide care (Pavolini and Ranci, 2008). Changes in demography, the labour market, democracy, and values have all contributed to the increasing pressure on care services (Anttonen, 2005). There is wide consensus that lower birth rates and higher proportions of older people mean that a gap has emerged in the number of adult children able to provide informal care to their parents (Anttonen, 2005; Deusdad et al., 2016; Pavolini and Ranci, 2008; Munday, 2003; Robertson et al., 2014). Traditionally, informal care was provided by women. As gender equality improves, more women are employed outwith domestic circumstances which also reduces the pool of informal social care available (Anttonen, 2005). Anttonen (2005) also cites changes in societal attitudes from "familism" to "individualism" as having an impact on informal care resources. These combined factors mean that formal care services are increasingly required to provide social care.

The pressures on formal social care services has seen increased discussion and comparison of models of care across Europe over the last 20 years (Anttonen and Sipilä, 1996; Fernández-Alonso and Jaime-Castillo, 2016; Munday, 2003; Sapir, 2006). In broad terms, there is agreement that 4 main European social models exist although, more recently, the lines between these models are beginning to blur (Deusdad et al., 2016). The models have been classified as the: Nordic, Mediterranean, Continental, and Anglo-Saxon models (Anttonen and Sipilä, 1996; Fernández-Alonso and Jaime-Castillo, 2016; Munday, 2003). There is some variation in the how these models are labelled - for this discussion the most recently described nomenclature is used (Fernández-Alonso and Jaime-Castillo, 2016; Sapir, 2006).

The Nordic model of social care describes high levels of universal home and institutional social care funded through taxation or nationalised insurance with little or no role for private insurance (Fernández-Alonso and Jaime-Castillo, 2016; Munday, 2003; Sapir, 2006). This model is found in Scandinavian countries such as: Sweden, Denmark, Finland, and the Netherlands and has strong local government influence on the delivery of services (Fernández-Alonso and Jaime-Castillo, 2016; Munday, 2003; Sapir, 2006).

In contrast, the Mediterranean model of social care (generally found in Greece, Italy, Portugal, and Spain) has very low intervention from local or national government with the majority of social care being informal and provided by family members (Fernández-Alonso and Jaime-Castillo, 2016; Munday, 2003; Sapir, 2006). As this role is traditionally carried out by women, the Mediterranean model has attracted criticism from a feminist perspective (Munday, 2003).

The Anglo-Saxon model of social care is used to describe the systems used in the UK and, perhaps as a misnomer, Ireland (Fernández-Alonso and Jaime-Castillo, 2016; Munday, 2003; Sapir, 2006). The system is also characterised by informal care but has provision of extensive state-funded social care for those in the most need. The model has also been referred to as "means tested", or "the Beveridge model" (Munday, 2003) and increasingly involves service provision from the private sector, particularly in terms of residential care (Munday, 2003).

Most commonly found in Austria, Belgium, France, Germany and Luxembourg, the Continental model of social care also has a strong role for informal family care (Fernández-Alonso and Jaime-Castillo, 2016; Munday, 2003; Sapir, 2006). The main difference in this model is in the delivery of formal care via non-governmental or religious organisations with funding provided by the state - also known as the subsidiarity model (Munday, 2003).

The 4 models have not only been used to describe variations in methods of social care delivery, but also to describe the wider model of welfare and social services within each group (Sapir, 2006). As part of a wider social model of care, the Nordic model has a strong redistributive effect and has the greatest effect of the four models at reducing income equality and poverty (Sapir, 2006). The Mediterranean model performs worst in this respect as does the Anglo-Saxon model when considering incidence of poverty after taxes and transfers (Sapir, 2006).

A recent examination of the effects of the 2008 financial crisis on the way social care is delivered across Europe suggests that the distinctions between the 4 social care models is beginning to blur (Deusdad et al., 2016). There is evidence of a mixture of informal, semi-informal (i.e. black market), and formal care emerging

as a more regular model for care delivery in Mediterranean countries whereas, in Nordic countries, an increase in family-based informal care is being observed (Deusdad et al., 2016). A shift from residential to home-based care, in tandem with the marketisation of the care sector, has seen a gradual move away from universalism in Scandinavian countries and a greater emphasis on informal care and non-state care being seen across the continent (Deusdad et al., 2016).

There is a remarkable similarity in the description of the change from institution to home-based social care described by Deusdad et al. (2016) and the shift in balance of health care recommended by WHO described in section 1.1. It is likely they describe the same phenomenon. WHO (2015) cite integration of health and social care as a potential process of moving care balance for treatment for non-acute, chronic conditions. Older individuals in this category are likely to have social care needs also. There have been large structural changes to delivery of social care in a number of European countries (Pavolini and Ranci, 2008). Deusdad et al (2016) argue that de-institutionalisation and the policy shift in balance of care has disguised reduction in state-funded social care support in some countries.

The remainder of this section will review literature on social care in a UK and Scottish context. Definitions, measurement, eligibility criteria and social care use will be discussed.

### **2.3.2 Definitions**

As in the case of multimorbidity, there is no internationally (or nationally) accepted definition of social care. A recent NICE guideline (2015) addressing social care needs for older people with multiple chronic conditions, used a definition provided in the UK Health and Social Care Act (2012):-

““Adult social care”— (a) includes all forms of personal care and other practical assistance provided for individuals who, by reason of age, illness, disability, pregnancy, childbirth, dependence on alcohol or drugs, or any other similar circumstances, are in need of such care

or other assistance, but (b) does not include anything provided by an establishment or agency for which Her Majesty's Chief Inspector of Education, Children's Services and Skills is the registration authority under section 5 of the Care Standards Act 2000." (The Health and Social Care Act 2012 c7, Part 3, Chapter 1, Section 65, Subsection 4)

The NICE guideline (2015) advises that social care planning for people with multimorbidity should include holistic assessment of biopsychosocial factors including sexual, spiritual, cultural, and communication needs as well as considering access to leisure and social activities incorporating issues regarding mobility and transport. Specifically, the guideline cites; self-care, taking medicines, learning, volunteering, maintaining a home, financial management, employment, socialising with friends and hobbies as activities that all patients should be able to take part in should they wish and social care assessment should assess the ability of the individual to achieve this.

A more succinct definition of social care is used in a report to the Minister for Care Services at the UK Department of Health, Platt (2007, p.4):-

"The group of services that provide personal care and support to people in social situations – such as family; the community; a communal setting; to help them achieve independence and to promote their positive contribution as citizens."

Huxley et al. (2007) are critical of this service-based definition and argue that social care is intended to improve general well-being for those that are in need. As quality of life is an important factor of wellbeing, Huxley et al. (2007) argue that wider issues regarding environment and the quality of public and private services also play an important role in social care. Indeed, Daly and Lewis (2000, p.287) argue that social care is "...an activity and set of relations lying at the intersection of state, market, family (and voluntary sector) relations."

This view is reflected in an aspirational constitution for social care published by an independent, cross-party think-tank (Bartlett and Guglielmi, 2009). The authors



argue that all citizens should have an equal ability to live and control a full and active life. Where this is not possible the state should have a duty to provide the necessary help, in whatever form that is required, to individuals who require it.

### **2.3.3 Measurement**

The definitions provided in Section 2.3.2 are broad and in some ways idealistic. Measuring types and amount of social care use may give a more realistic picture of how social care is used. This section will describe how typologies of users are defined in Scotland where social care is provided by Local Government. The scope and delivery of social care is recorded in statistics published annually.

The most recent of these, published for the Scottish Government in November 2015 by National Statistics (2015), shows Local Authority data on people who have had a social care assessment and receive any of the following services: home care (including re-ablement) meals service, housing support and, as an optional extra, other services such as shopping or laundry. Furthermore, data is collected on alarm and telecare services, self-directed support, and social worker services. Clients using social care services are categorised into one of the following groups:-

- Frail older people
- Physical disability
- Mental health
- Learning disability
- Learning and physical disability
- Dementia
- Other (including addiction, palliative care and carers)
- Not known.

The report states dementia is often under-recorded in local authority data. It is unclear how “frail older people” is classified or measured by local authorities, but the report states some authorities may use this term synonymously with “physical disability” and the groups should be considered together in sub-group analysis of

over-65s (National-Statistics, [2015](#), p.24)

The vast majority of people receiving social care classified as “frail older people” and “dementia” are over 65. Seventy-three percent classified as “physical disability” are over 65. The majority of people in the “mental health”, “learning disability”, “learning and physical disability” and “other” categories are under 65 (60%, 89%, 85%, and 56% respectively).

### **2.3.4 Eligibility**

Access to social care in Scotland is means tested via assessment carried out by a social worker. The criteria for social care delivery, therefore, has a very important part to play in how services are accessed. This section describes relevant literature on how eligibility criteria are set.

In 2010 the Scottish Government published a report identifying a strategy for the policy of self-directed support (Scottish-Government, [2010b](#)). The report was written in conjunction with the Convention of Scottish Local Authorities (COSLA) and included the recommendation that the National Eligibility Framework developed by the Sutherland review into free personal and nursing care ([2008](#)) should be applied across all social care services. The framework has four criteria for assessing risk in relation to a person’s care needs: Critical, Substantial, Moderate and Low (Scottish-Government, [2010a](#)). The Critical and Substantial levels of risk indicate social care needs should be addressed immediately or imminently, whereas a moderate level of risk may indicate either some or no services being required. There is no explicit description of severity or which care needs fall into each category and in practice each Local Authority sets the criteria and decided at which level of risk they would provide social care (Scottish-Government, [2014](#)).

Equity of access to services is directly influenced by an eligibility framework. Indeed, the Strategy for Self-Directed Support (Scottish-Government, [2010b](#), p.20) acknowledges this and states that such a framework “...can result in resources being narrowly focussed on individuals with acute needs.” However, the report

goes on to state that growing demand and finite resources requires some form of eligibility assessment but this should not have a disproportionate effect on any one group of people requiring care.

The eligibility framework allows each Local Authority to set thresholds for access to care in line with local priorities and resources. This has the effect that access to services varies across differing council areas. The potential for regional variation is again acknowledged by the Strategy for Self-Directed Support (Scottish-Government, 2010b, p.20) which states that, "... further work will be undertaken by the Scottish Government and COSLA to assess whether there is merit in establishing national thresholds for access to formal support across all client groups."

Acknowledgment of problems with eligibility criteria and the promise of "further work" to be undertaken by the Scottish Government and COSLA is repeated in practitioner guidance on Self-Directed Support published in 2014 (Scottish-Government, 2014, p.19) and that , "...it remains the case that local authorities should operate eligibility criteria to determine whether or not an individual assessed as having social care needs can access formal support and if so, which of their needs are to be met by that support."

Data is not available on levels of care provided by LAs for each of the National Eligibility Framework criteria or for the threshold that each LA provides care at. The Scottish Government collects an annual report of eligibility and waiting times for the 1st quarter of the year. The latest report (Scottish-Government, 2015a) provides information on the time individuals had to wait to receive assessment and the time individuals had to wait to receive care in the period January-March for the preceding 5 years. However, no absolute numbers of people in each category is provided.

The Scottish National Eligibility Framework has striking similarities to that formerly used in England and described in Fair Access to Care Services (FACS) produced by the Social Care Institute for Excellence (SCIE) (2013). Exactly the same nomenclature is used to describe the eligibility categories of need. Newton and Browne (2008) critiqued a previous version the FACS guidance and found similar issues to those

raised above regarding regional variations in service and concentration of services on those with the highest need. Their paper describes further issues with access to social care in the context of social theory described by Lipsky (1979) and “Street level bureaucracy” where intentional and unintentional judgment of entitlement by social care workers have an impact on whether an individual receives care or not. Newton and Browne (2008) also make the assertion that health and social care has never been accessed equitably by arguing that those with a greater ability to articulate needs and negotiate access are more likely to gain access to services. Although no citation is provided to back-up this argument it has certainly been described elsewhere (Matthews and Hastings, 2013) and sits well in the broader discussion of inequitable access to services (Hastings et al., 2014; Le Grand, 1989; Tudor-Hart, 1971).

In England, the Care Act (2014) aimed to remove regional variations in eligibility in access to social care by imposing national minimum thresholds that Local Authorities would have a statutory obligation to provide. The Care Act also aimed to ensure Local Authorities provided care, “... as early as possible to help maintain wellbeing and independence, and potentially delay a situation where longer-term care and support might be required.” (SCIE, 2015, p.2). The minimum criteria for being eligible for care involves an individual having needs that impairs their ability to meet 2 or more of a designated list of outcomes (e.g. managing and maintaining nutrition or maintaining hygiene) (SCIE, 2015) and is set by the Secretary of State for Health (Abrahams et al., 2014).

In practice, the most likely outcome is that the minimum threshold that Local Authorities will have to provide care will be similar to the “Critical” level of the National Eligibility Framework previously used in the FACS guidance (Burchardt et al., 2015; Abrahams et al., 2014) (and similar to that used in Scotland). This will legalise a shift that has already been occurring in England where fewer numbers of LAs are providing care for those with “moderate” needs and only providing care for those with “critical” needs (Burchardt et al., 2015; Abrahams et al., 2014). Burchardt et al. (2015) state that only 2% of English LAs will have to widen their care threshold whereas 12% could now, legally, tighten care provision as a result of

the Care Act.

### **2.3.5 Social Care use**

Burchardt et al. (2015) and Abrahams et al. (2014) recognise some positive changes to Social Care policy through the Social Care Act but are damning about past and present UK Government Social Care policy in England and Wales. They cite chronic underfunding and cuts for over ten years resulting in fewer numbers of people receiving care at a time when demand is sharply increasing due to demographic change. The “intensification” of services on those with the most acute needs is cited by both sets of authors as counterproductive – ignoring those with moderate care needs completely derails one of the main purposes of the Care Act, preventative services. Indeed,

“As well as lacking in moral sense, such an approach is economically unsound. Waiting for people to have high needs before providing care means that care will be more expensive, as well as pushing more older people into an already pressurised NHS.” (Abrahams et al., 2014, p.5).

A similar picture has been seen in Scotland. Absolute numbers of people receiving home care has steadily fallen over the last 10 years whilst the number of hours of care provided has increased (National-Statistics, 2015). There are wide variations in the number of hours of home care provided per population across Local Authorities (National-Statistics, 2015). This may reflect different demographic make-up of each Local Authority although reductions in ratios per population can be seen in almost all Local Authorities [edit - I can produce a table here to reflect this but is that appropriate in the Intro? Also would have to provide code in the Appendix to show how I produced the table].

In a report profiling the care at home sector in Scotland. MacLeod and Mair (2015) describe large decreases in absolute numbers of people receiving care at home over the ten years to 2013. There have also been significant reductions in the number

of people receiving non-personal care (so called “mopping and shopping”). The increase in the number of hours of home care delivered by all services reflects a focus on smaller numbers of individuals with higher care needs. This means those with moderate or low personal care needs and those requiring “mopping and shopping” services are now less likely to receive publicly funded care. Echoing the views of Burchardt et al. (2015) and Abrahams et al. (2014), Macleod and Mair (2015) highlight the potential false economy of this situation – home care services are likely to reduce the need for costly emergency admissions to hospital and delay the requirement for more intensive home care packages.

### **2.3.6 Summary**

Social care is an increasing policy priority across Europe due to demographic trends and reductions in the amount of state-based funding available to provide care. All countries, regardless of model of social care, have seen increases in market-based systems and increased use of private care. There have been marked reductions in the amounts of social care delivered in England and Scotland with warnings that such policies are likely to be counter-productive in terms of service experience and cost to governments.

## 3. Methods

### 3.1 Introduction

The aims and objectives of the PhD discussed in section [1.2](#) indicate the proposed research aims to utilise linked, administrative data to measure and understand the interactions between multimorbidity and health and social care usage. The use of this methodology was set by the Scottish Government funder of the project in order to investigate the potential of this novel form of research. There follows a rapid review of literature investigating which methodologies have been used to interrogate linked, administrative health and social care datasets.

#### 3.1.1 Rationale

Linkage of individual-level health and social care data is a relatively new phenomenon but provides the possibility of identifying new interventions and assessing the efficacy of existing health and social care services (Witham et al., [2015](#)). Whilst measurement of routine health data is relatively common, use of routine social care data is not. This PhD project aims to understand to what extent multimorbidity and socioeconomic status influence the utilisation of health and social care and to describe the interactions between these services by using existing administrative data. Understanding the different ways in which linked health and social care datasets have been analysed in the past will be useful in informing methods for this PhD project. Given the

novelty of using social care data for research, identifying how it has been measured and included in analyses will be of particular interest. A literature review was conducted to inform the choice of methods for the project.

### **3.1.2 Aims**

The aims of the literature review are:-

1. To identify the methods of measuring social care in linked health and social care datasets.
2. To identify statistical techniques used by studies to analyse the interaction of health and social care.

### **3.1.3 Research Question**

- What methods and measures have been used to analyse the interaction of health and social care with linked administrative datasets?

## **3.2 Methods**

In order to answer the stated research question a rapid review of literature was conducted. Inclusion and exclusion criteria were developed to inform the choice of studies to be included in the review. Of particular interest were studies that have used the emerging process of linking individual-level administrative data for analysis. Primary research studies that prospectively collected data were, therefore, excluded. Any study using aggregated data was also excluded as the methods used for analysis were likely to be unsuitable for use with individual-level data.



Inclusion	Exclusion
Linked administrative health and social care dataset.	Studies investigating health care only.
Individual level data linkage	Aggregated linked health and social care data.
Describes social care measurement	Studies not designed to investigate the interaction of health and social care usage.
English full-text available	Prospectively collected data

Table 3.1: Inclusion and Exclusion Criteria

Included studies described the method of measuring social care. A full list of inclusion and exclusion criteria are presented in Table 3.1.

The literature search was conducted on the 27th April 2016 via the EBSCOHost platform. A single database, The Cumulative Index of Nursing and Allied Health Literature (CINAHL) was searched using the following terms:-

1. Health care
2. Social care
3. Administrative data
4. Routine data
5. 3 OR 4
6. 1 AND 2 AND 5

Data was extracted from the included studies using a pre-defined tool and entered into a table using Microsoft Excel. For each included study, information collected included:-

- Author (s)
- Year of publication
- Country of study population

- Sources of Linked Administrative data
- Primary Outcome
- Methods of statistical analysis employed
- Main Findings

Qualitative synthesis of results is presented describing findings of social care measures and statistical techniques employed in include studies.

## 3.3 Results

### 3.3.1 Study selection

The outlined search strategy identified 315 records that had potential for inclusion in the review. Titles and abstracts were screened for relevance. After duplicates were removed, full text of 13 articles was assessed against the inclusion and exclusion criteria described in table 3.1 for eligibility. Seven articles were excluded for reasons including; use of aggregate data only, using administrative data to assess use of health care only, and use of prospectively collected survey data. No non-English articles were identified by the search.

### 3.3.2 Study characteristics

Of the six included studies, three described research carried out in England (Bardsley et al., 2010; Bardsley et al., 2012; Tian et al., 2014), one in Wales (Porter and Morrison-Rees, 2015), one in Sweden (Condelius et al., 2008), and one in Taiwan (Chi et al., 2009). All studies were published within the last eight years and half within the last four years. One included study (Porter and Morrison-Rees, 2015) is an abstract with, as yet, unpublished results but describes data that has already been linked with a clear outline of statistical methods to be implemented and was therefore deemed appropriate for inclusion. Included studies assessed the effect of

social care on: all hospital admissions (Bardsley et al., 2010; Bardsley et al., 2012; Condelius et al., 2008), unplanned secondary care use (Porter and Morrison-Rees, 2015), emergency department use (Chi et al., 2009) and costs of care before and after a fall in older people (Tian et al., 2014). All studies included administrative data from national and local health care and social care institutions.

### 3.3.3 Key findings

In all of the included studies, researchers used categories of types of social care as discrete variables within their analyses. In the case of Condelius et al. (2008) this was simply a binary variable of had/had not received social care. Others differentiated between: care delivered in institutions, care at home, day care, meals services (Bardsley et al., 2010; Bardsley et al., 2012; Porter and Morrison-Rees, 2015), equipment supplied or direct payments to service users (Bardsley et al., 2010). One study estimated individual costs of social care use by weighting observed service utilisation according to national reference costs (Bardsley et al., 2012). In an attempt to capture social care need, this newly created variable was then stratified into 4 categories of high, medium, low, and zero intensity of service use and used as an ordinal variable in analysis. One study (Tian et al., 2014) compared different groups within their dataset by absolute costs of social care only.

A variety of statistical techniques were used within the included studies. These ranged from simple descriptive statistics with counts and proportions (Bardsley et al., 2010; Tian et al., 2014), to comparison of observed/expected ratios (Bardsley et al., 2010; Bardsley et al., 2012). Chi et al. (2009) measured chi-squared statistics and multivariate logistic regression, whilst Condelius et al. (2008) used linear regression models to predict factors associated with planned and emergency hospital admission. In the abstract of their ongoing research, Porter and Morrison-Rees (2015) describe the use of interrupted time-series analysis over a six year period to assess trends in health and social care use.

## **3.4 Discussion**

### **3.4.1 Summary**

This rapid literature review aimed to identify previous research that had investigated the interactions between health and social care use by using linked administrative health and social care data. In particular, information on the methods of measuring social care for the purposes of analyses was sought. Furthermore, a description of the statistical techniques used in previous research in this area was provided with a view to informing methodology of a PhD project.

Six studies were identified that fitted the inclusion and exclusion criteria. In the majority of studies, typologies of social care (e.g. care home, home care or meals service) were used as categorical variables for the purposes of statistical analysis. Interestingly, one study (Bardsley et al., [2012](#)) attempted to describe social care need by estimating individual costs of care and then stratifying results into four levels of care intensity.

Statistical analysis within included studies varied according to data type and study aims. All included studies with reported results were cross-sectional in nature. Porter and Morrison-Rees ([2015](#)) have not yet reported results of their research but describe interrupted time-series analysis over a 6-year period to assess trends and interactions in service use over time.

### **3.4.2 Limitations**

This review has several limitations. The rapid nature of the review resulted in only one database being searched. As a result more studies fitting the inclusion and exclusion criteria may exist and have not been included in the analysis. The search terms should be replicated across platforms and other relevant databases (e.g. MEDLINE and EMBASE via OVID). The nature of the review was to simply

describe methods and techniques used in previous research involving linked, administrative health and social care data. As such outcomes have not been analysed here and assessment of bias within studies was not performed.

## 4. Methodology

Objective 3 in section 1.2 aims to develop a measure in order to assess the trajectory of multimorbidity over time in different age and socioeconomic groups. Section 2.2.2 identified the wide variety of techniques employed in previous academic literature and described more recent attempts to identify clusters of long-term conditions for this purpose. It is hoped identification of the most prevalent groups of conditions that co-exist within individuals will enable targeting of interventions and care priorities whilst improving care and reducing healthcare costs (Islam et al., 2014). Section 4.1 will describe how applying Latent Class Analysis to a population sized dataset will further knowledge in this developing area of multimorbidity research.

Section 4.2 will describe the main project of the PhD - the linkage of health and social care data and the expected techniques used to interrogate the combined datasets.

### 4.1 Latent Class Analysis

Latent class analysis (LCA) is a statistical technique that can identify unobserved subgroups with similar characteristics from a population (Hagenaars and McCutcheon, 2002). The technique clusters individual records within a dataset based on responses to categorical indicator variables and provides two main outcome measures:

1. The Latent Class Probability: the probability that a specific observation will belong to a certain latent class.

2. The Conditional Probability: the probability that any individual in a certain latent class will have a certain response to a measured indicator variable (Hagenaars and McCutcheon, 2002).

This technique differs from many other clustering techniques, such as factor analysis, in that it groups individual records as opposed to grouping variables. It is particularly suited to the clustering of health conditions given the binary categorical nature of diagnostic codes and may be better at capturing the complexity of multimorbidity than other techniques (Cornell et al., 2009). A further advantage of LCA is the ability to include covariates in analysis to assess if they have an impact on how clusters are formed (Hagenaars and McCutcheon, 2002).

Whilst every statistical technique has comparative pros and cons, LCA addresses shortcomings in previous attempts to cluster morbidities identified by Prados-Torres et al. (2014) discussed in Section 2.2.2. Specifically, LCA is able to:-

- Distinguish between chance and non-random multimorbidity (unlike expected-to-observed ratios)
- Allow a health condition to belong to more than one cluster (unlike cluster analysis)
- Assign clusters using categorical variables (unlike Exploratory Factor Analysis unless complex tetrachoric correlations are employed)

Prados-Torres et al. (2014) recommended that future clustering research should employ a wide range of mental and physical health conditions to avoid selection bias towards a small number of conditions. In order to ensure external validity, they also recommended that future research is population based and uses data from primary care where possible (Prados-Torres et al., 2014).

LCA has been used previously in context with identifying multimorbidity clusters (Barile, 2015; Islam et al., 2014; Kuwornu et al., 2014). Each of these studies used data collected from self-reported surveys with sample sizes varying from 3284 to 4574 respondents. Survey respondents self-identified diagnosis of between 10 and 27 chronic health conditions. Kuwornu et al. (2014) aimed specifically to identify

multimorbidity cluster differences between an indigenous aboriginal population and a matched group from the general population. The other 2 studies were based on the general population only although Islam et al. (2014) recruited those aged over 50 only. Three (Islam et al., 2014), four (Barile, 2015), and three or four (Kuwornu et al., 2014) latent class groups were identified with differing interpretations of clusters.

In Scotland, much multimorbidity research has been informed by the Scottish Programme for Improving Clinical Effectiveness in Primary Care (SPICE-PC) dataset (Agur et al., 2016; Barnett et al., 2012; Elder et al., 2007; McLean et al., 2015). Diagnostic data from the year 2007 is available on almost 1.8 million people in Scotland drawn from 314 general practices. The anonymised dataset has information on presence of 32 physical and 8 mental health conditions in addition to age, gender and deprivation index data for each individual. Diagnostic data is derived from codes entered into IT systems in General Practices and prescription data. Secondary analysis of the SPICE-PC dataset is an opportunity to provide externally valid results of multimorbidity clusters derived from LCA. The nationally representative nature of the data and broad number of diseases included addresses gaps in previous multimorbidity LCA research discussed above.

A further advantage of using the SPICE-PC dataset for LCA is the presence of datazone variables within the dataset. Using a measure of socioeconomic status derived for the datazone variable, most likely the Scottish Index of Multiple Deprivation (SIMD), analysis of the effect deprivation has on grouping of illnesses is possible. Previous LCA research with multimorbidity has paid little attention to this variable. Of particular interest will be which morbidities cluster across socioeconomic groups and the differences, if any, between groups. Whilst no statistical model can fully capture the complexity of multimorbidity, the proposed LCA acknowledges and includes social determinants of health within analysis. Ethical approval for secondary analysis of the SPICE-PC dataset using LCA was granted by the Research Ethics Committee of the College of Social Sciences at the University of Glasgow on 29/04/2016.



## 4.2 Health and Social Care Analysis

The PhD project aims to create a large dataset comprised of de-identified, individual level data. Linkage and security of data will be managed using the process described by Pavis and Morris (2015). Data from a number of sources across health and social care will be linked to enable creation of this dataset. A similar pilot project run by the Scottish Government linked together: demographic data from National Records of Scotland (NRS), hospital admission data (SMR01 and SMR04) and community prescription data from ISD, and social care census data held by the Scottish Government. The pilot collected data from five local authority areas in the East of Scotland and analysed one-year of care episodes. This PhD will aim to produce a similar, but larger, dataset based on local authority areas in the West of Scotland.

A desired addition to the data described above are variables measuring use of primary care and diagnostic information held in general practice. The Scottish Primary Care Information Resource (SPIRE) remains in pilot phase and it is not known what data will be available during the PhD project. Diagnoses variables may, therefore, need to be calculated from a combination of inpatient and day case statistics (SMR01) and community prescription data held by the Information Service Division (ISD) at NHS Scotland.

Social care data will be provided by individual Scottish local authorities. At present, every local authority in Scotland returns an annual census to the Scottish Government of social care use in a pre-defined census week, usually at the end of March each year. As councils are required to extract and transfer this information annually, the data may be easiest to request from a number of councils for linkage purposes - provided the information requested has suitable data for analysis.

An application had been made to the Urban Big Data Centre (UBDC) at the University of Glasgow for use of their services in a pilot project. This project aims to collect data from Renfrewshire Council to explore the nature and quality of data held on social care. As there is not a nationally accepted or standard way of collecting social

care information, each local authority has differing ways on recording social care use. The pilot project using data from Renfrewshire council will investigate the potential to derive proxy variables from the held social care data. Use of proxies has been employed in previous research using linked health and social care data and is more fully described in section 3.3.3. An example of how this may be employed in this PhD project is in the categorisation of social care into types of care received such as: care home, home care, day care and meals services. This information on its own may not capture a full picture of need. The pilot will investigate if quantifying the number of hours of care received, the number of staff assigned to an individual for care delivery or the cost of a care package can give a useful indication of care needs. As none of the studies included in the literature review described in section 3 were based in Scotland, this pilot project will give an indication of how such proxy variables may be derived from social care information particular to Scotland.

A main aim of the project is to describe the variation of health and social care use by multimorbidity profile and across the spectrum of socioeconomic status. Previous studies, as described in section 3.3.3, have employed a number of techniques for this purpose. Comparison of observed/expected ratios as well as relevant parametric and non-parametric tests for comparisons of groups will enable simple analysis. However, for more complex modelling the nature of the data will have an important bearing on which techniques to use.

Where possible, relationships between social and primary care use and secondary care use will be explored using number of emergency admissions, number of planned admissions, and number of emergency department visits as dependent variables in linear regression analysis. Type and intensity of social care use, primary care use, multimorbidity profile, gender, age, and status will be entered as independent variables to the regression models to understand interactions and predict the different types of admission to hospital. If social care data of sufficient quality and time period is available, survival analysis measuring hazard ratios will be employed.

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